APPENDIX 11 – STYGOFAUNA PILOT STUDY

NEW LENTON COAL PTY LTD
NEW LENTON COAL PROJECT

New Lenton Coal Project

Stygofauna Pilot Study

Prepared for:

Reach Environmental on behalf of Bowen Coking Coal

frc environmental

PO Box 2363, Wellington Point QLD 4160
Telephone: + 61 3286 3850

frc reference: 221101

freshwater estuarine marine

Document Control Summary

Project No.:	221101
Status:	Final Report
Project Manager:	Ben Cook
Title:	New Lenton Coal Project: Stygofauna Pilot Study
Project Team:	Ben Cook, Lucy Hurrey and Will Kempton
Client:	Reach Environmental on behalf of Bowen Coking Coal
Client Contact:	Richard Oldham
Date:	10 November 2023
Edition:	221101iii
Checked by:	Ben Cook
Issued by:	Ben Cook

Distribution Record

Reach Environmental: as .pdf and word.doc

Contents

Tables

Maps

Summary

A subsidiary of Bowen Coking Coal (BCC) acquired the New Lenton Project (the Project) from New hope Group (NHG) in mid 2022 and is undergoing Commonwealth approvals processes for the Project. Reach Environmental is supporting BCC prepare a Public Environment Report (PER), which has been requested by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) following their review of a previously submitted EPBC Act referral by NHG. An assessment of potential impacts to stygofauna is requirement of the PER.

frc environmental was commissioned by Reach Environmental, on behalf of BCC, to assess the potential impacts to stygofauna relating to the Project, to support the PER. The assessment comprised a stygofauna pilot study in accordance with the Queensland Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DoSITIA 2015).

For the purpose of this study, 'Project area' is defined as ML70337, ML 700053 and ML 700054 (together the New Lenton MLs), and the scope of the study was to:

- describe the Environmental Values (EVs) of the Project area and surrounds relating to stygofauna
- assess the potential adverse impacts of the Project on the EVs of stygofauna with reference to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and
- present mitigations for avoiding or reducing impacts to EVs of stygofauna.

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 results of this assessment therefore indicate that shallow groundwater of the Project area, especially within alluvial and regolith lithologies, in close proximity to the Isaac River provides supporting services to environmental third party users of the water resource (i.e. groundwater dependent stygobitic fauna), as defined under the EPBC Act, and contributes to the Environmental Values of groundwater, as defined under the EP Act.

The Project will cause physical disturbance to vegetation and surface and subsurface lithologies in the direct impact area, and dewatering of alluvial, regolith and coal seam geological units within and near the direct impact area. Consequently, the following sources of potential impact on stygofauna were identified for the Project:

- vegetation clearing
- localised contamination of groundwater, and
- physical disturbance of groundwater ecosystems, including dewatering.

The mitigated risk of these sources of potential impact was assessed as low, with the exception of indirect disturbance due to groundwater drawdown in alluvium and regolith, which was assessed has having a moderate risk. It is recommended that this residual risk due to groundwater drawdown in alluvium and regolith be controlled by an operational phase groundwater and stygofauna monitoring program, including the development of trigger values to determine if further action is required.

1 Introduction

A subsidiary of Bowen Coking Coal (BCC) acquired the New Lenton Project (the Project) from New hope Group (NHG) in mid 2022 and is undergoing Commonwealth approvals processes for the Project. Reach Environmental is supporting BCC prepare a Public Environment Report (PER), which has been requested by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) following their review of a previously submitted EPBC Act referral by NHG. An assessment of potential impacts to stygofauna is requirement of the PER.

frc environmental was commissioned by Reach Environmental, on behalf of BCC, to assess the potential impacts to stygofauna relating to the Project, to support the PER. The assessment comprised a stygofauna pilot study in accordance with the Queensland Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DoSITIA 2015).

For the purpose of this study, 'Project area' is defined as ML70337, ML 700053 and ML 700054 (together the New Lenton MLs), and the scope of the study was to:

- describe the Environmental Values (EVs) of the Project area and surrounds relating to stygofauna
- assess the potential adverse impacts of the Project on the EVs of stygofauna with reference to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and
- present mitigations for avoiding or reducing impacts to EVs of stygofauna.

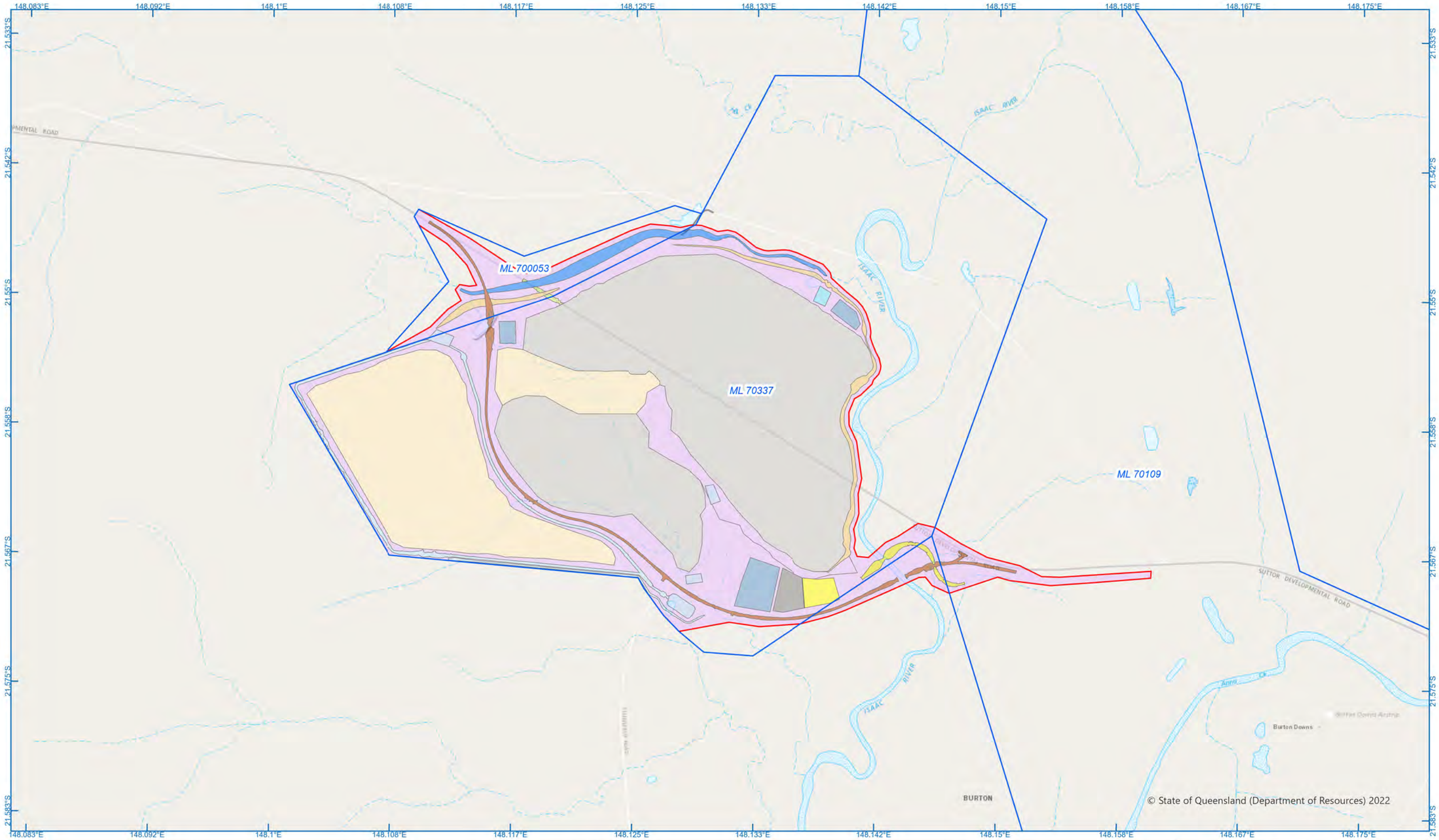
This report presents:

- the Project description
- the survey methods and results of the stygofauna survey
- an assessment of the EVs of stygofauna of the Project area and surrounds, and
- an assessment of the significance of potential impacts of the Project on the EVs of stygofauna with reference to the EPBC Act, noting mitigating measures for avoiding or reducing impacts.

2 Project Description

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). LJV holds the New Lenton MLs, where it proposes to develop the New Lenton Mine (the Project). The Project is an 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 (Map 2.1).

The Environmental Authority (EA) EPML00475513 allows for mining of up two million tonnes a year of run of mine (RoM) coal on the New Lenton MLs with an expected mine life of 18 years. An EA amendment authorising the Project, was granted in January 2021.



frc environmental
AQUATIC ECOLOGISTS
deep thinking. science.

PO Box 2363
Wellington Point
Q 4160 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

221101 New Lenton Coal Project

Map 2.1: Proposed Disturbance Boundary and Proposed Project Layout

SOURCES

© The State of Queensland (Department of Environment and Science) 2018
© Bowen Coking Coal 2023

Document Path: Y:\Utility - Documents\Mapping\Projects\2022\221101_RE_Lenton_Stygo\ArcProject\221101_Lenton\221101_Lenton.aprx

LEGEND

- Proposed disturbance boundary
- Mining lease boundary

Proposed Project Layout

- Mine Infrastructure Area
- ROM
- Dump Footprint
- Suttor Development Road Realignment
- Haul Road
- Infrastructure and Construction Working Areas
- Pit Footprint
- Temp Road Diversion
- Operational Levee
- Drain
- Ti Tree Creek Diversion
- Mine Water Dam
- Clean Water Dam
- Sediment Dam

N

SCALE

0 0.075 0.15 0.3 0.45 0.6 0.75 0.9 1.05 1.2
Kilometres

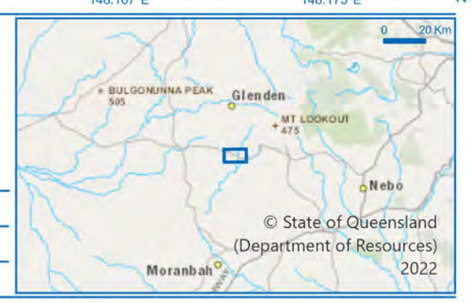
Scale: 1:25,000 @ A3

PROJECTION
Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

DATE
2023-11-07

DRAWN BY
JA

VERSION
1



3 Stygofauna Pilot Study and Assessment of Environmental Values

3.1 Methods

Stygofauna were assessed using a desktop review and field survey, as described for a stygofauna pilot study in the Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DoSITIA 2015), see also the Department of Environment and Science's (DES) Water Monitoring and Sampling Manual (DES 2018) and the Department's supplementary document 'Sampling Bores for Stygofauna AEMF046'.

3.1.1 Desktop Review

A desktop review was used to determine the suitability of groundwater ecosystems of the Project area to provide habitat for stygofauna on the basis of geological, hydrological and water quality characteristics of local groundwater ecosystems, and included:

- review of previous studies to determine the recorded presence of stygofauna in the Project area and surrounds, and more broadly in the Isaac River sub-catchment
- review of hydrogeological data for the Project area, and
- review of groundwater pH, electrical conductivity (EC) and total dissolved solids (TDS) data within and surrounding the Project area.

3.1.2 Field Survey

Fifteen bores within and surrounding the Project area were surveyed for stygofauna 14 – 16 December 2022 (Table 3.1).

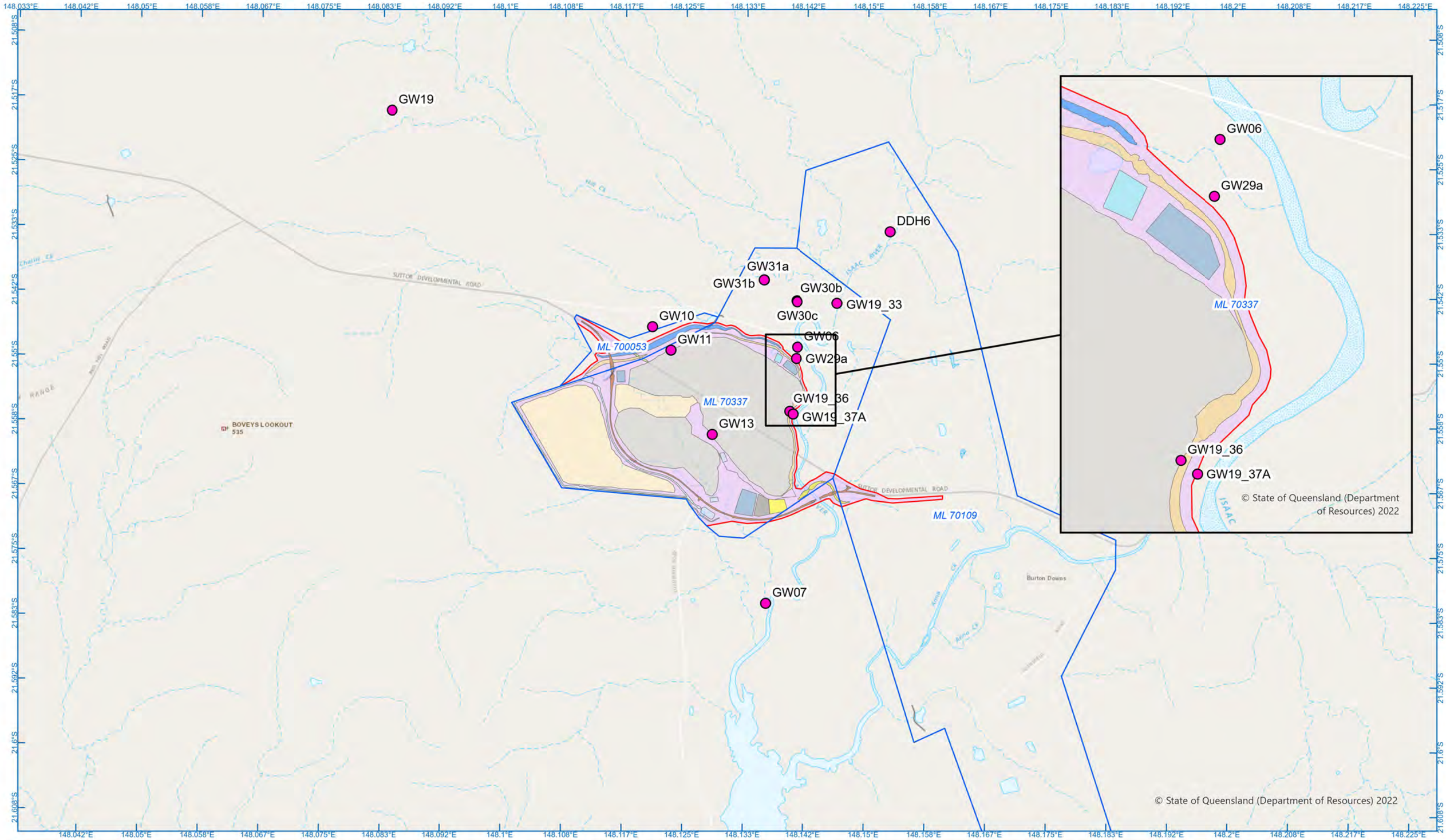
The full water column in each bore was sampled using six hauls of a weighted phreatobiological net (similar to a plankton net) that had a 50 µm mesh size. Samples were preserved in 100 per cent ethanol and transported to frc environmental's laboratory where stygofaunal specimens were identified to Order or Family using available taxonomic keys. Each specimen was then 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) were used to assign each taxon as either stygobite or stygoxene. A reference collection was established to enable taxonomic alignment across surveys should further surveys be required.

Table 3.1 Bores sampled for Stygofauna in December 2022.

Bore	Easting	Northing	Lithology	Screen Interval (mbgl)	Bore Depth (mbgl)
GW06	618097	7616723	Alluvium	3.6 – 18.6	20.6
GW07	617640	7613075	Alluvium	9 – 18	24.5
GW10	616032	7617014	Leichhardt/Vermont Seam	178 – 190	205
GW11	616294	7616680	Leichhardt/Vermont Seam	114 – 126	150
GW13	616881	7615480	Leichhardt/Vermont Seam	170 – 179	192
GW19	612323	7620097	Alluvium	22.9 – 25.9	26.5
GW29a	618081	7616561	Sandstone (Permian interburden)	62 – 80	83.6
GW30b	618088	7617382	Burton Rider Seam	70 – 73	76.2
GW30c	618094	7617368	Sandstone	23 – 29	31.1
GW31a	617624	7617680	Leichhardt/Vermont Seam	153 – 162	165.3
GW31b	617621	7617680	Weathered Sagittarius Sandstone (regolith)	17 – 20	21.2
DDH6	619304	7618185	Leichhardt/Vermont Seam	–	–
GW19_33	618664	7617348	Alluvium/Regolith	–	–
GW19_36A	617987	7615810	Regolith	–	–
GW19_37A	618034	7615771	Alluvium	–	–

Source of data: GHD (2018)

– No data available



frc environmental
AQUATIC ECOLOGISTS
deep thinking. science.

PO Box 2363
Wellington Point
Q 4160 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

221101 New Lenton Coal Project

Map 3.1: Proposed Disturbance Boundary, Proposed Project Layout and Bores Sampled for Stygofauna

SOURCES

Document Path: Y:\Mity - Documents\Mapping\Projects\2022\221101_BE_Lenton_Stygo\ArcProject\221121_Lenton\221101_Lenton.aprx

LEGEND

- Sampled bores
- Mining lease boundary
- Proposed disturbance boundary

Proposed Project Layout

- Mine Infrastructure Area
- ROM
- Dump Footprint
- Suttor Development Road Realignment
- Haul Road
- Infrastructure and Construction Working Areas
- Pit Footprint
- Temp Road Diversion
- Operational Levee
- Drain
- Ti Tree Creek Diversion
- Mine Water Dam
- Clean Water Dam
- Sediment Dam

N

SCALE

0 0.17 0.35 0.7 1.05 1.4 1.75 2.1 2.45 2.8
Kilometres

Scale: 1:50,000 @ A3

PROJECTION
Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

DATE
2023-11-07

DRAWN BY
JA

VERSION
i

3.1.3 Assessment of Environmental Value and Legislative Context

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.

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.

The EPBC Act provides the legal framework for the protection and management of matters of national environmental significance (MNES). The nine MNES to which the EPBC Act applies are:

- world heritage properties
- national heritage places
- wetlands of international importance (i.e. ‘Ramsar’ wetlands)
- nationally threatened species and ecological communities
- migratory species

- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining)
- a water resource, in relation to coal seam gas development and large coal mining development.

The Cape Range remipede (*Kumonga exleyi*), Cape Range blind gudgeon (*Milyeringa veritas*), the blind cave eel (*Ophisternon candidum*) are a stygofauna species that are listed as vulnerable under the EPBC Act; however, these Western Australian species from the Cape Range peninsula are not relevant for the current assessment.

Water resources in relation to coal seam gas and large mining developments under the EPBC Act includes surface waters and groundwaters that provide utility to third party users of the water resource, including environmental users. The presence of stygofauna, and especially stygobitic taxa, indicate groundwater ecosystems that provide supporting services to environmental third party users of the groundwater resources, as defined under the EPBC Act Significant Impact Guidelines 1.3 for water resources in relation to coal seam gas and large mining development (Department of the Environment (DoE) 2013) (i.e. stygofauna, and especially stygobitic stygofauna, are third party users of groundwater). Where an action is likely to have a significant impact on a water resource that will directly or indirectly reduce the current or future utility of a water resource for a third party user of the water resource, then the action is likely to have a significant impact on a MNES under the EPBC Act.

3.2 Results of Desktop Assessment

3.2.1 Stygofauna of the Region

The diversity and biogeography of stygofauna in Queensland is reported by Glanville et al. (2016), with their key preliminary findings being:

- A total of 24 described families and 23 described genera have been recorded from Queensland across numerous bioregional areas. The Project area is located in Northern Bowen Basin sub-bioregions, with five families from this subregion.
- Syncarid shrimps (families Parabathynellidae and Bathynellidae) are the two most widespread families in Queensland, followed by Cyclopidae (copepods) and Naididae (clitellate oligochaete worms). All of these taxa are reported from a wide

range of lithology types, including alluvium, gravel, sand, sandstone and fractured basalt.

- Of all described stygofauna families recorded from Queensland to date, 36 per cent are crustaceans, with the taxonomic richness of syncarid crustaceans higher in Queensland than the global average, but the richness of amphipods in Queensland lower than the global average.

Similarly, the diversity of stygofauna reported across Australia's coal regions were synthesised by Hose et al. (2015), with key findings synthesised from 12 studies for the Bowen Basin being:

- stygofauna, including syncarids, amphipods, and harpacticoid and cycloid copepods, were most frequently recorded from alluvial aquifers, but also from basalt aquifers and coal seams
- stygofauna were recorded where standing water level was between 1.4 and 45 m below ground level, and
- stygofauna were recorded from groundwaters with the following water quality characteristics:
  - EC: 342 – 9,975 µS/cm
  - pH: 6.39 – 10.27, and
  - dissolved oxygen: 0.93 – 6.54 mg/L.

Finally, review of frc environmental's in-house database indicates one stygobitic higher taxon (i.e. Parabathynellidae) has been previously sampled from shallow alluvial aquifers at several locations adjacent to large waterways in the region, including several locations adjacent to the Isaac River. A range of stygoxene taxa (e.g. Copepod, Ostracod, Oligochaete, Acarina, Nematoda and Dugesiidae) have also been found in the region, predominantly (but not exclusively) in alluvium at a range of depths.

3.2.2 Geology

Stygofauna have the potential to occur in aquifers composed of any geological unit with sufficient pore space to complete their life cycle (Tomlinson & Boulton 2008). Consequently, stygofauna are less likely in geological units with relatively small pore spaces, such as those dominated by mudstone, siltstone and clays. Preliminary discovery rates of stygofauna in Queensland indicate that (Glanville et al. 2016):

- no stygofauna have been recorded in mudstone or siltstone to date
- stygofauna are less common in clay, coal and basalt dominated geologies
- stygofauna are most common in alluvium, granite, gravel, sand, sandstone, silt, and volcanic geological units.

The diversity of stygofauna in Queensland is highest in alluvium, with 14 described families in alluvial geological units, five in both basalt and coal, four in both gravel and sand, two in sandstone, and one in silt (Glanville et al. 2016). Limestone reportedly has diverse stygofauna communities (Tomlinson & Boulton 2008), with preliminary data indicating the presence of diverse stygofauna in limestone geological units in Queensland (frc environmental, unpublished data). Indeed, a recent study reported 12 higher taxa of stygofauna (stygoxenes and stygobites collectively) from coastal river basins in eastern Australia from alluvial and karst geological units (Saccò et al. 2022), indicating these two units likely contain highest stygofaunal diversity in the region.

The geology of the Project area, from shallowest to deepest, comprises (SLR 2023):

- surface layers of alluvium and regolith
- the Rewan Group (composed of sandstone and mudstone)
- the Rangal Coal Measures (including the Burton Rider Seam and the Leichardt/Vermont Seams), and
- Fort Cooper Coal Measures.

The Project area therefore includes geological units that are known to provide habitat for stygofauna (Glanville et al. 2016).

3.2.3 Depth to Water Table

In eastern Australia the average number of stygofauna taxa was higher when the samples were collected where the water table was less than approximately 15 mbgl below ground (Hancock & Boulton 2008), although a more recent study indicated higher diversity of stygofauna where depth to water table is less than approximately 45 mbgl (Hose et al. 2015).

The depth to water table of bores in shallow alluvium within the Project area is generally less than 15 mbgl (i.e. shallow groundwater systems), with the maximum depth to water table being 36.3 mbgl at bore GW10 within the Leichhardt / Vermont Coal Seam (Table 3.2). Therefore, the depth to water table ranges at bores in the Project are consistent with

depth to water table where diverse stygofauna have been reported elsewhere in eastern Australia.

3.2.4 Water Quality

The mean electrical conductivity of water from which stygofauna have been sampled is less than 4,000 µS/cm; however, the range of electrical conductivity concentrations of groundwater that stygofauna have been sampled from is very large (i.e. 11.5 – 54,800 µS/cm) (Glanville et al. 2016). Electrical conductivity of groundwater within the Project area was variable, with several bores having maximum recorded electrical conductivity approximately or lower than 4,000 µS/cm (e.g. GW11, GW31a, GW31b and GW19-37A), with the overall maximum electrical conductivity of 18,132 µS/cm recorded at bore GW30b in the Burton Rider Coal Seam (Table 3.2). Therefore, electrical conductivity at bores in the Project area was consistent with electrical conductivity of groundwater elsewhere in eastern Australian where diverse stygofauna have been recorded.

Stygofauna have been recorded from groundwater with pH ranging from 3.5 to 10.3, but diversity is highest between 6.5 and 7.5 (mean of 7.0) (Hancock & Boulton 2008). The pH of groundwater within the Project area ranged 6.3 – 8.2 (Table 3.2), and overall was consistent with pH range of groundwater elsewhere in eastern Australia where diverse stygofauna have been recorded.

In Western Australia, stygofauna were almost always absent where total dissolved solids (TDS) was higher than 15 mg/L (Halse et al. 2014); however, a recent study in Queensland found stygofauna where TDS was 8,520 mg/L (frc environmental, unpublished data). The TDS of groundwater in the Project area was lower than 8,520 mg/L at all bores excluding bore GW30b that targeted the Burton Rider Coal Seam, which had a maximum recorded TDS concentration of 11,622 mg/L (Table 3.2). Therefore, TDS at bores in the Project area was generally consistent with TDS of groundwater elsewhere in eastern Australian where diverse stygofauna have been recorded.

Table 3.2 Environmental Characteristics of Bores sampled for Stygofauna in December 2022.

Bore	Lithology	Depth to Water Table (mbgl)	EC (µS/cm)	pH (unit)	TDS (mg/L)
GW06	Alluvium	10.6 – 10.9	5,230 – 16,145	6.7 – 7.4	7,715
GW07	Alluvium	3.1 – 5.3	5,360 – 7,381	6.3 – 7.8	4,771

Bore	Lithology	Depth to Water Table (mbgl)	EC (µS/cm)	pH (unit)	TDS (mg/L)
GW10	Leichhardt/Vermont Seam	35.1 – 36.3	2,238 – 6,108	6.8 – 7.6	3,880
GW11	Leichhardt/Vermont Seam	30.7 – 33.2	3,840 – 4,724	6.4 – 8.1	2,580
GW13	Leichhardt/Vermont Seam	19.6 – 22.1	12,200 – 13,305	7.2 – 8.0	8,105
GW19	Alluvium	22.1	–	–	–
GW29a	Sandstone (Permian interburden)	12.5 – 12.9	8,813	7.4	5,642
GW30b	Burton Rider Seam	15.0 – 16.3	16,800 – 18,132	6.9 – 7.8	11,622
GW30c	Sandstone	14.7 – 16.1	12,488 – 14,700	6.7 – 7.9	7,891
GW31a	Leichhardt/Vermont Seam	15.2 – 15.9	4,649	7.8	3,081
GW31b	Weathered Sagittarius Sandstone (regolith)	12.0 – 14.6	2,560 – 2,620	6.9 – 7.9	1,599
DDH6	Leichhardt/Vermont Seam	–	–	–	–
GW19_33	Alluvium/Regolith	9.2	–	–	–
GW19_36A	Regolith	dry	–	–	–
GW19_37A	Alluvium	10.6	2,500	8.2	–

Source of data: GHD (2018) and client-supplied ALS laboratory reports, noting data is historical (i.e. up to 2018).

– No data available

3.3 Results of Field Survey

Results of the stygofauna survey indicated (Table 3.3):

- 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.

Three troglofaunal taxa (i.e. subterranean terrestrial fauna) were also recorded: collembola (spring tail) at bores GW19-37A, GW29a and GW06; Myriopoda (millipede) at bore GW06; and carabidae (ground beetle) at bore GW06. All bores where troglofauna were found also recorded stygofauna, and were within alluvial and regolith lithologies in close proximity to the Isaac River. Further assessment of troglofauna was not within the scope of this study.

Table 3.3 Results of Stygofauna Survey.

Bore	Stygofaunal Taxon	Count	Class
GW06	Acarina sp. 2 (mite)	1	stygoxene
	Oligochaeta (segmented worm)	1	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)	1	stygobite
	Harpacticoid sp.1 (copepoda)	2	stygoxene
	Acarina sp. 1 (mite)	1	stygoxene
GW19_36	–	–	–
GW19_37A	Acarina sp. 1 (mite)	3	stygoxene

– no stygofauna caught

3.4 Environmental Values of Stygofauna of the Project Area

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 results of this assessment therefore indicate that shallow groundwater of the Project area, especially within alluvial and regolith lithologies, in close proximity to the Isaac River provides supporting services to environmental third party users of the water resource (i.e. groundwater dependent stygobitic fauna), as defined under the EPBC Act, and contributes to the Environmental Values of groundwater, as defined under the EP Act.

4 Impact Assessment and Mitigation

4.1 Potential Sources of Impact from the Project

The Project will cause physical disturbance to vegetation and surface and subsurface lithologies in the direct impact area, and dewatering of alluvial, sandstone and coal seam geological units within and near the direct impact area. Consequently, the following sources of potential impact on stygofauna were identified for the Project (Doody et al. 2019):

- vegetation clearing, which may cause direct impact to stygofauna habitat
- localised contamination of groundwater, which may cause lethal (i.e. mortality of stygofauna) or sub-lethal (i.e. reduced rate of reproduction, impacted physiology), and
- physical disturbance of groundwater ecosystems, including dewatering, which may cause direct impact to stygofauna habitat.

4.2 Risk Assessment Method

The assessment of potential impacts comprised a risk-based assessment.

The level of risk was defined in terms of the likelihood (Table 4.1) and consequence (Table 4.2) of the potential impact, using a conventional 5 x 3 risk matrix (

Table 4.3).

Table 4.1 Ratings used to assess the likelihood of potential impacts.

Rating	Likelihood of occurrence
Very high	Almost certain to occur frequently
High	Probably would happen sometimes to frequently
Moderate	Could happen sometimes
Low	Remote possibility of occurring or not expected to occur
Very low	Definitely would not happen at all

Table 4.2 Ratings used to assess the consequence of potential impacts.

Rating	Consequence of potential impacts
High	Catastrophic, irreversible or critical long term environmental harm or loss; significant harm or loss of sensitive components of the environment; significant harm or loss of protected components of the environment.
Moderate	Significant short-term but reversible harm of the environment; minor environmental harm to sensitive or protected components of the environment.
Low	Negligible or minimal impact with no material harm to the environment, with no harm to sensitive or protected components of the environment.

Table 4.3 Environmental risk matrix.

		Likelihood				
		Very Low	Low	Moderate	High	Very High
Consequence	Low	low	low	low	low	moderate
	Moderate	low	low	moderate	moderate	high
	High	low	moderate	moderate	high	high

4.3 Risk Assessment Results

4.3.1 Vegetation Clearing

Terrestrial vegetation overlying shallow groundwater ecosystems, where the water table intersects the root zone of the vegetation (i.e. <20 mbgl for deep-rooted vegetation), is thought to provide favourable habitat conditions for stygofauna (Eamus et al. 2006; Hancock & Boulton 2008). Clearing of vegetation may therefore reduce the habitat quality of shallow groundwater ecosystems for stygofauna. Potential impacts would be localised to the immediate area of clearing.

The depth to water table at bores where stygofauna were recorded was <20 mbgl, indicating that stygofauna in the study area occur within the root zone of deep-rooted terrestrial vegetation (see Eamus et al. 2006).

The consequence of terrestrial vegetation clearing on stygofauna is low because diverse stygofauna have been found in heavily cleared (or very sparsely vegetated) areas (GHD 2013, frc environmental unpublished data), suggesting that the presence of terrestrial vegetation is not an essential habitat element for stygofauna occurrence.

The likelihood of impact is moderate because vegetation clearing is required for the Project; however, vegetation along the Isaac River where stygofauna were concentrated will be retained, although some areas where stygofauna are likely to occur will be subject to vegetation clearing (Map 4.1).

The risk of impact to stygofauna from vegetation clearing is low.

4.3.2 Contamination of Groundwater

Contamination of groundwater includes seepage and spillage of fuels, oils and other lubricants required for the operation of vehicles and machinery. Toxicants in mine affected water (MAW) and fuel and oil are potentially toxic to aquatic flora and fauna at relatively low concentrations. Spilt chemicals, fuel and oils have potential to seep into shallow groundwater ecosystems, where they can impact the condition of the groundwater ecosystem and cause lethal or sub-lethal impacts to stygofauna. Potential impacts would depend on the magnitude of any chemical, fuel or oil spill, but a small chemical, fuel or oil spill would likely cause impact on a relatively local scale within the potential impact area.

The controlled release of MAW from site is only permissible in accordance with conditions outlined in the EA, which were developed in accordance with Queensland Government requirements for protecting downstream environmental values, including the values of underlying groundwater ecosystems. Therefore, controlled release of MAW to waterways will not cause adverse impact to stygofauna in underlying groundwaters.

Furthermore, the risk of contamination of groundwater by fuel and chemical spills is low because:

- storing and handling of all applicable materials will be in accordance with the relevant legislative requirements and Australian Standards
- control release of MAW from site in accordance with conditions outlined in the EA
- a Spill Prevention and Response Procedure will be implemented
- no refuelling facilities are part of the Project / located near the Isaac River, and will be bunded within the mine infrastructure area (MIA).

The consequence of impact to stygofauna by groundwater contamination is moderate, because MAW water will comply with EA limits and fuel and chemical use on the site is controlled such that any spill will be of limited volume and extent.

The likelihood that groundwater contamination will adversely impact stygofauna is low, because the above described mitigations effectively control likelihood of impact.

The risk of impact to stygofauna from groundwater contamination is low.

4.3.3 Physical Disturbance of Groundwater Ecosystems

Stygofauna of the Project area are concentrated in their distribution within alluvium and regolith in proximity to the Isaac River, with bores GW06 and GW19-33 representing all the stygofauna diversity that was recorded, and bore GW19-33 having a stygobitic taxon present.

Direct Physical Disturbance by Mining

The Project will cause direct physical disturbance by mining to areas within the Project area as shown in Map 4.1. However, areas of direct physical disturbance are not within 50 m of the Isaac River, except in two locations, and does not mine through the locations of either bore GW06 or GW19-33. That is, there is a buffer of alluvium and sandstone units between the mined areas and the Isaac River that will not be mined, and thus the key area of stygofauna distribution in the Project area will not be directly impacted.

The consequence of direct physical disturbance to stygofauna by mining is moderate, because stygofauna habitat would be lost. However, the recorded stygofauna likely occur in alluvial and sandstone aquifers in close proximity to the Isaac River both upstream and downstream of the Project area, because connected groundwater systems within a single sub-catchment (in this case along the main stem of a major river and adjoining floodplain areas) are likely to represent minimum distributional ranges for most stygofaunal species (Cook et al. 2012; Eberhard et al. 2009; Finston et al. 2007; Halse et al. 2014; Little et al. 2016). Thus, it is likely that only a small portion of stygofauna habitat will be lost.

The likelihood of direct physical disturbance to stygofauna by mining is low, because the locations were stygofauna were found to occur within the Project area are not within the direct disturbance area.

The risk of direct physical disturbance by mining on stygofauna is low.

Indirect Physical Disturbance by Dewatering of Aquifer

The Project will result in groundwater drawdown in the water bearing lithologies of the Project area (SLR 2023). Of relevance to this Project is the predicted drawdown in alluvium and regolith lithologies along the Isaac River, where stygobitic stygofauna were found, and the diversity and abundance of stygoxenes was concentrated.

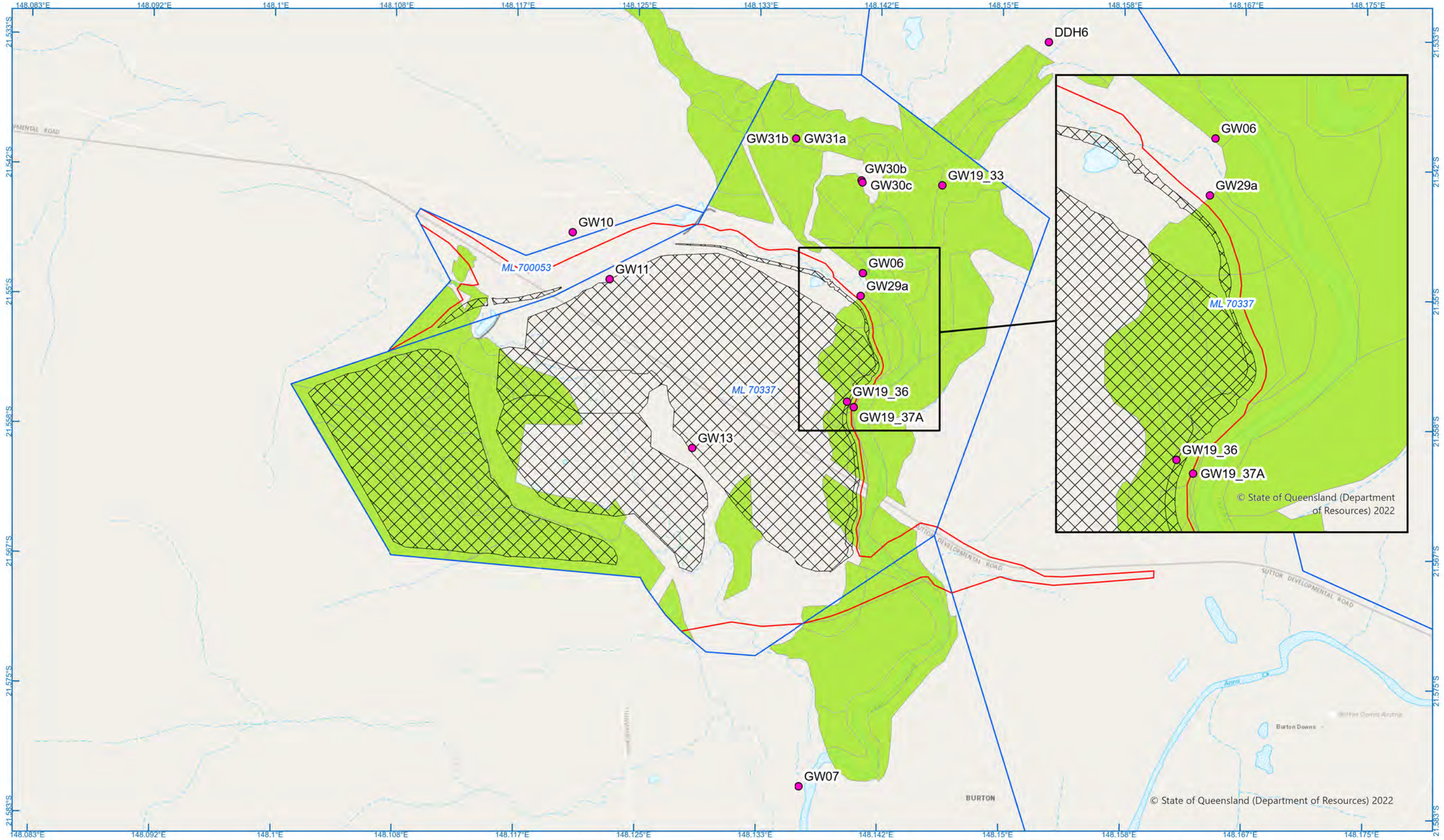
The groundwater modelling study (SLR 2023) indicated that groundwater in alluvium and regolith within the Project area along the Isaac River will be reduced in extent and saturated thickness along a section of the Isaac River adjacent to the Project area (Map 4.2 and Map 4.3).

The consequence of indirect physical disturbance to stygofauna by drawdown is moderate, because a portion of stygofauna habitat would be lost. However, stygofauna of the Project area are concentrated along the Isaac River, including at bores upstream and downstream of the Project area, and at a bore adjacent to Hill Creek. Connected groundwater systems within a single sub-catchment (in this case along the main stem of a major river and adjoining floodplain areas) are likely to represent minimum distributional ranges for most stygofaunal species (Cook et al. 2012; Eberhard et al. 2009; Finston et al. 2007; Halse et al. 2014; Little et al. 2016), with the results of this study suggesting that stygofauna likely occur more widely in shallow groundwater systems along the Isaac River, both upstream and downstream of the Project area, including along tributaries of the Isaac River. Thus, it is likely that only a small portion of stygofauna habitat will be lost.

The likelihood of indirect physical disturbance to stygofauna by drawdown is high, because model predictions indicate a high likelihood that a proportion (but not all) of stygofauna habitat within the Project area will be lost due to drawdown.

The risk of indirect physical disturbance by drawdown on stygofauna is moderate; thus, there will be likely residual risk to stygofauna within the Project area due to groundwater drawdown, especially drawdown in alluvium/regolith where the stygobitic taxon was found.

It is recommended that this residual risk be controlled by an operational phase groundwater and stygofauna monitoring program, including the development of trigger values to determine if further action is required.



frc environmental
AQUATIC ECOLOGISTS
deep thinking. science.

PO Box 2363
Wellington Point
Q 4160 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

221101 New Lenton Coal Project

Map 4.1: Proposed Areas of Surface Disturbance

SOURCES

Document Path: Y:\Bilby - Documents\Mapping\Projects\2022\221101_SE_Lenton_Stygo\ArcProject\221101_Lenton\221101_Lenton.aprx

LEGEND

- Sampled bores
- Mining lease boundary
- Proposed disturbance boundary
- Remnant vegetation communities (AARC 2023)
- Proposed pit, dump and levee disturbance; Water Diversion;

N

SCALE

0 0.075 0.15 0.3 0.45 0.6 0.75 0.9 1.05 1.2
Kilometres

Scale: 1:25,000 @ A3

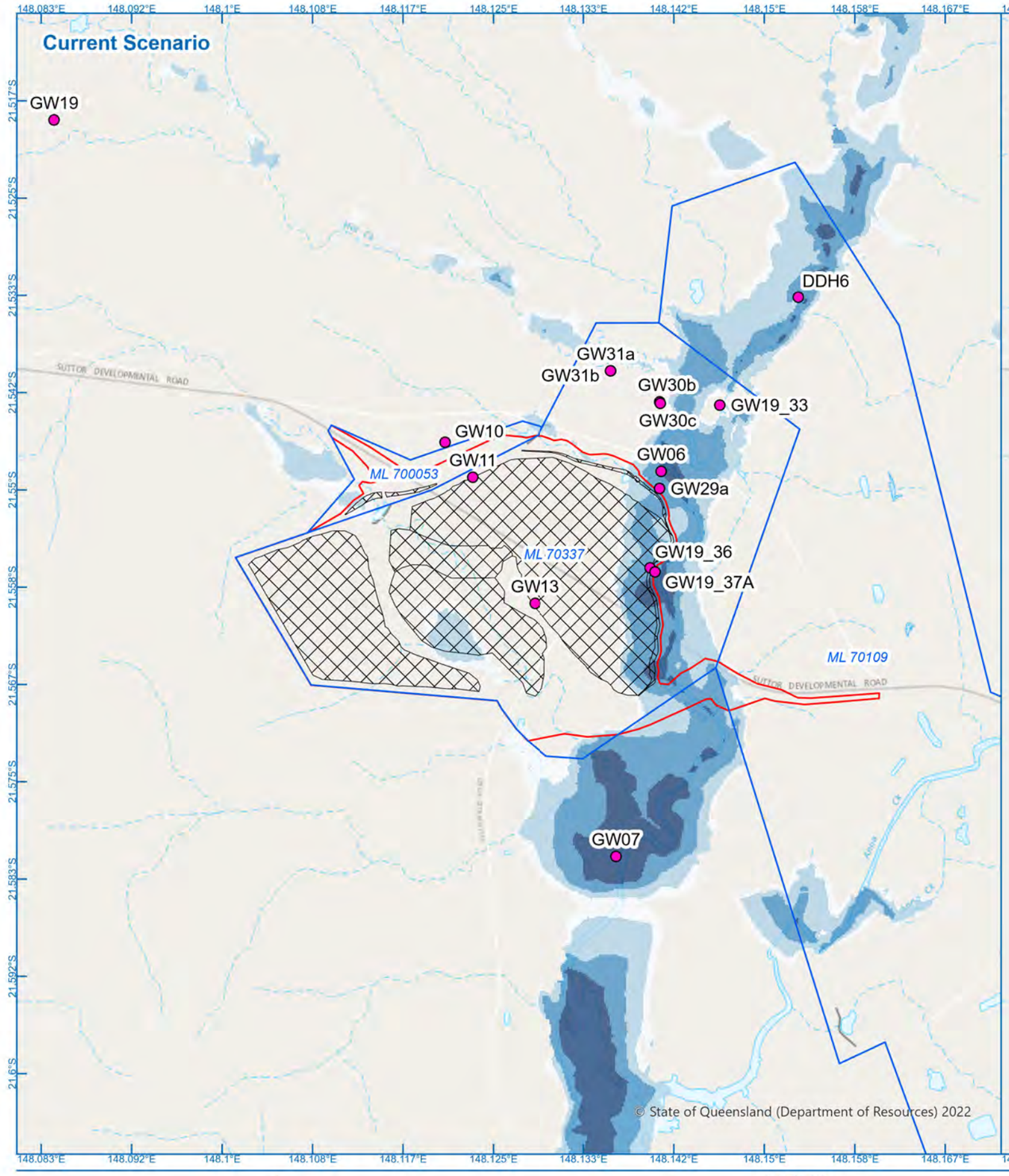
PROJECTION
Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

DATE
2023-11-09

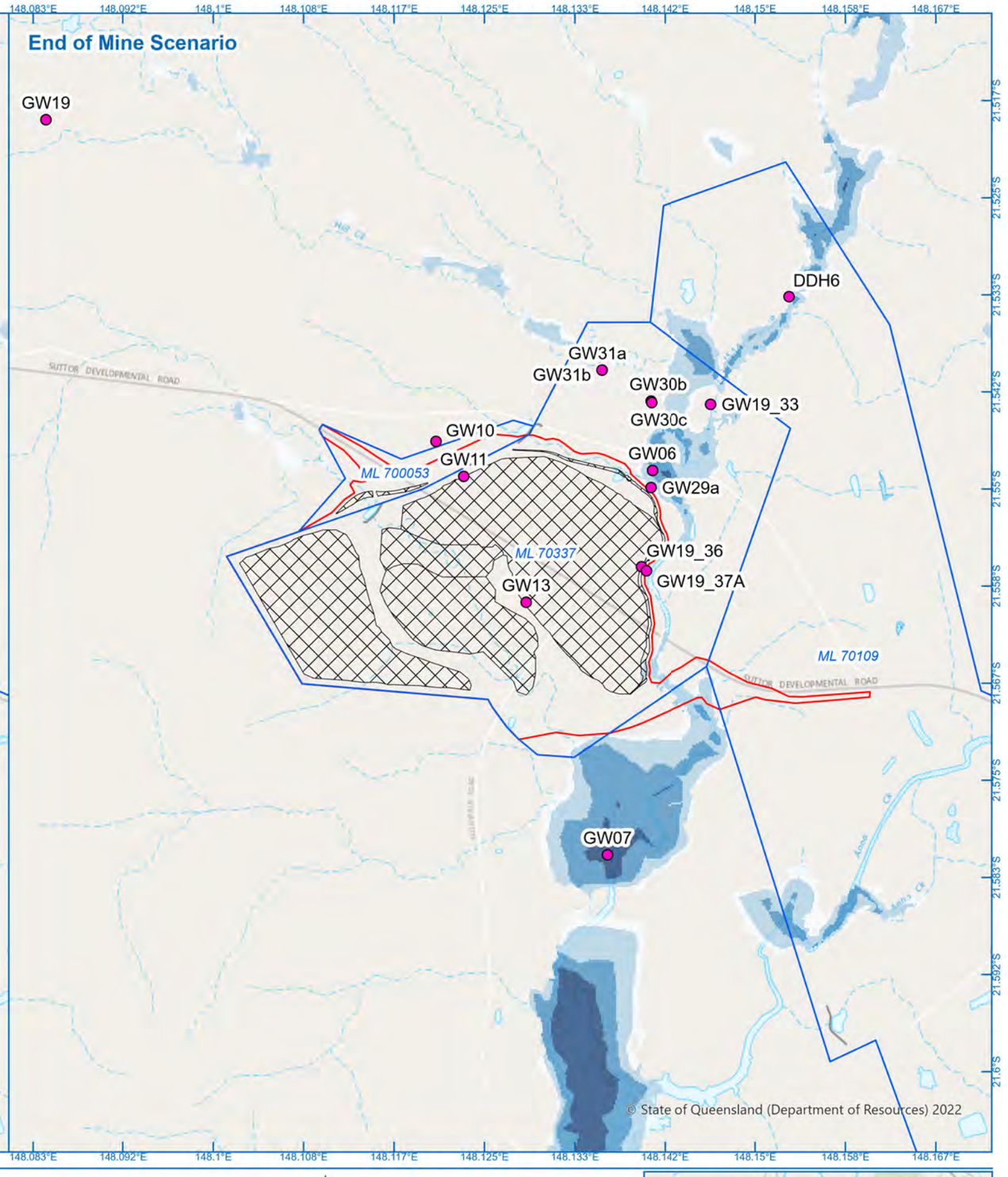
DRAWN BY
JA

VERSION
i

Current Scenario



End of Mine Scenario



frc environmental
AQUATIC ECOLOGISTS
deep thinking. science.

PO Box 2363
Wellington Point
Q 4160 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

221101 New Lenton Coal Project

Map 4.2: Predicted Groundwater Saturation Thickness in Alluvium Current and End of Mine Scenario

SOURCES

Document Path: Y:\Utility - Documents\Mapping\Projects\2022\221101_RE_Lenton_Stygo\ArcProject\221121_Lenton\221101_Lenton.aprx

LEGEND

- Sampled bores
- Mining lease boundary
- Proposed disturbance boundary
- Proposed pit, dump and levee disturbance

Groundwater saturation thickness (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20

N

SCALE

0 0.17 0.35 0.7 1.05 1.4 1.75 2.1 2.45 2.8
Kilometres

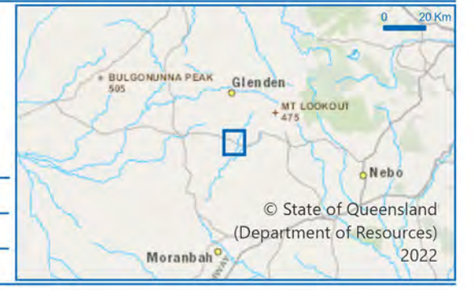
Scale: 1:50,000 @ A3

PROJECTION
Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS 1984

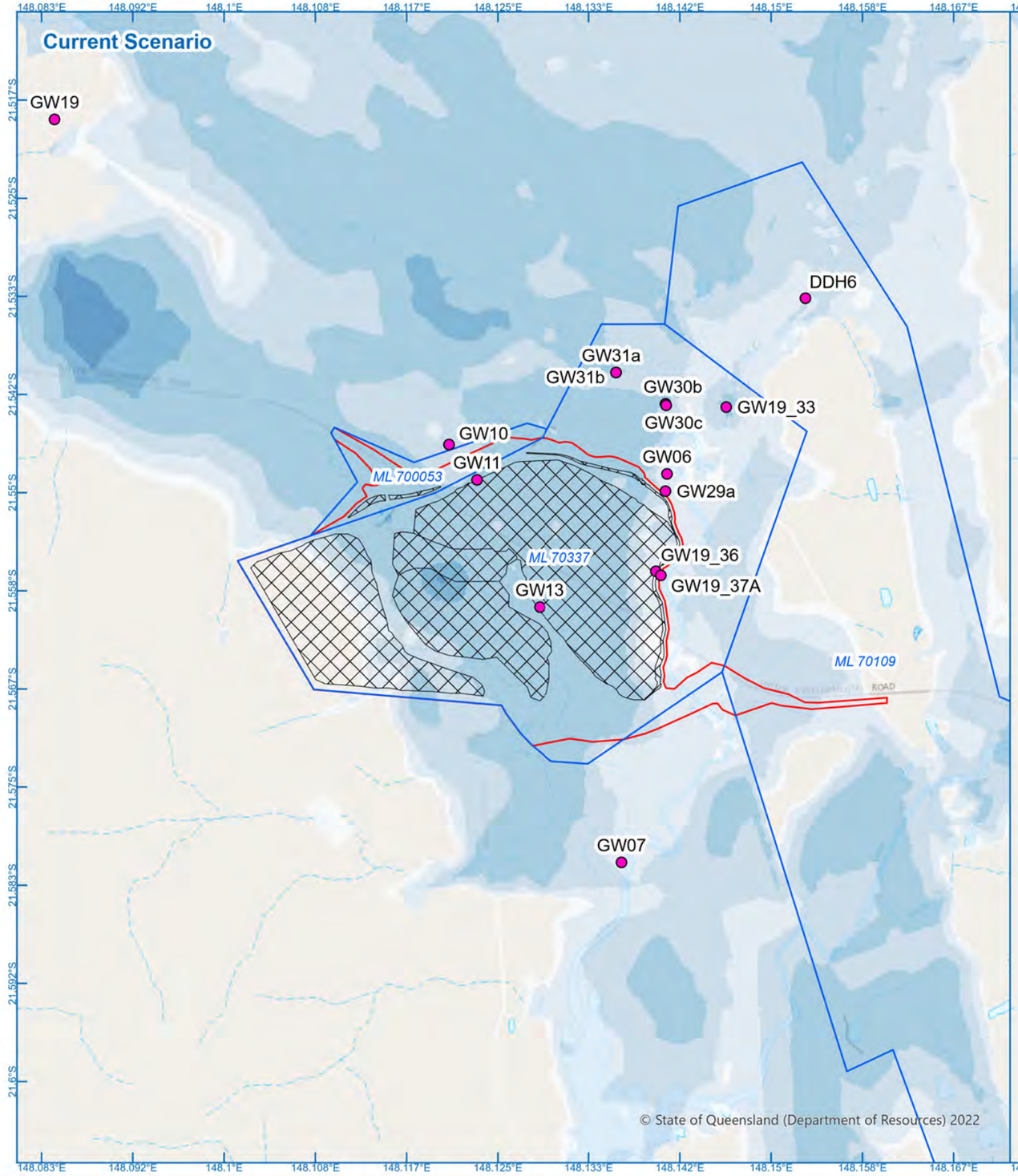
DATE
2023-11-07

DRAWN BY
JA

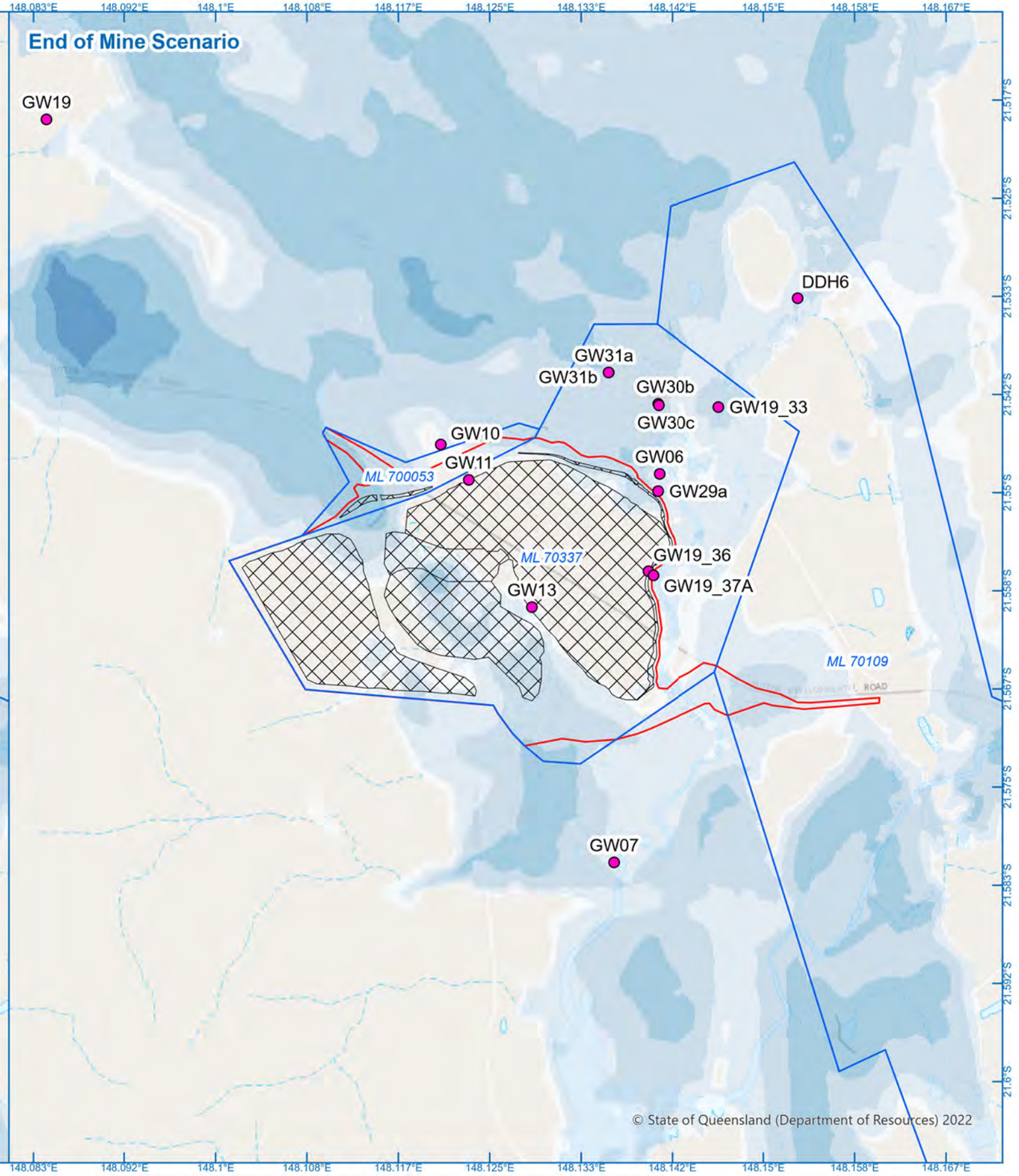
VERSION
1



Current Scenario



End of Mine Scenario



frc environmental
AQUATIC ECOLOGISTS
deep thinking. science.

PO Box 2363
Wellington Point
Q 4160 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

221101 New Lenton Coal Project

Map 4.3: Predicted Groundwater Saturation Thickness in Regolith Current and End of Mine Scenario

SOURCES

Document Path: Y:\Utility - Documents\Mapping\Projects\2022\221101_RE_Lenton_Stygo\ArcProject\221101_Lenton\221101_Lenton.aprx

LEGEND

- Sampled bores
- Mining lease boundary
- Proposed disturbance boundary
- Proposed pit, dump and levee disturbance

Groundwater saturation thickness (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60

N

SCALE

0 0.17 0.35 0.7 1.05 1.4 1.75 2.1 2.45 2.8
Kilometres

Scale: 1:50,000 @ A3

PROJECTION
Coordinate System: WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere
Datum: WGS 1984

DATE
2023-11-07

DRAWN BY
JA

VERSION
1

5 Conclusions

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.

The results of this assessment therefore indicate that shallow groundwater of the Project area within alluvial and regolith lithologies in close proximity to the Isaac River provides supporting services to environmental third party users of the water resource (i.e. groundwater dependent stygobitic fauna), as defined under the EPBC Act.

The Project will cause physical disturbance to vegetation and surface and subsurface lithologies in the direct impact area, and dewatering of alluvial, regolith and coal seam geological units within and near the direct impact area. Consequently, the following sources of potential impact on stygofauna were identified for the Project:

- vegetation clearing
- localised contamination of groundwater, and
- physical disturbance of groundwater ecosystems, including dewatering.

The mitigated risk of these sources of potential impact was assessed as low, with the exception of indirect disturbance due to groundwater drawdown in alluvium and regolith, which was assessed has having a moderate risk. It is recommended that this residual risk due to groundwater drawdown in alluvium and regolith be controlled by an operational phase groundwater and stygofauna monitoring program, including the development of trigger values to determine if further action is required.

6 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.

DES 2018, Monitoring and Sampling Manual, Environmental Protection (Water) Policy 2009, Department of Environment and Science, Brisbane.

Doody T.M., Hancock P.J. & Pritchard J.L. 2019. Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems. Report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment and Energy, Commonwealth of Australia 2019.

DoSITI 2015, Guideline for the Environmental Assessment of Subterranean Aquatic Fauna, Queensland Department of Science Information Technology and Innovation, Brisbane.

Eamus, D, Froend, R, Loomes, R, Hose, G & Murray, B 2006, 'A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation', Australian Journal of Botany, vol. 54, pp. 97-114.

Eberhard, S, Halse, S, Williams, M, Scanlon, M, Cocking, J & Barron, H 2009, 'Exploring the relationship between sampling efficiency and short-range endemism for groundwater fauna in the Pilbara region, Western Australia', Freshwater Biology, vol. 54, pp. 885-905.

Finston, T, Johnson, M, Humphreys, W, Eberhard, S & Halse, S 2007, 'Cryptic speciation in two widespread subterranean amphipod genera reflects historical drainage patterns in an ancient landscape', Molecular Ecology, vol. 16, pp. 355-365

GHD 2018. New Lenton Coal Project Groundwater and Surface Water Monitoring Report March 2017 – July 2018. Prepared for New Hope Group.

Glanville, K, Schulz, C, Tomlinson, M & Butler, D 2016, 'Biodiversity and biogeography of groundwater invertebrates in Queensland, Australia', Subterranean Biology, vol. 17, pp. 55-76.

Halse, S, Scanlon, M, Cocking, J, Barron, H, Richardson, R & Eberhard, S 2014, 'Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity', Records of the Western Australian Museum, vol. Supplement 78, pp. 443-483.

Hancock, P & Boulton, A 2008, 'Stygofauna biodiversity and endemism in four alluvial aquifers in eastern Australia', Invertebrate Systematics, vol. 22, pp. 117-126.

Hose, G, Sreekanth, J, Barron, O & Pollino, C 2015, 'Stygofauna in Australian Groundwater Systems: Extent of Knowledge', CSIRO, Australia.

Little, J, Schmidt, D, Cook, B, Page, T & Hughes, J 2016, 'Diversity and phylogeny of south-east Queensland Bathynellacea', Australian Journal of Zoology, vol. 64, pp. 36-47.

Saccò, M, Blyth, AJ, Douglas, G, Humphreys, WF, Hose, GC, Davis, J, Guzik, MT, Martínez, A, Eberhard, SM & Halse, SA 2022, 'Stygofaunal diversity and ecological sustainability of coastal groundwater ecosystems in a changing climate: The Australian paradigm', Freshwater Biology, vol. 67, pp. 2007-2023.

SLR 2023. New Lenton Coal Project, PER Groundwater Assessment. Prepared for Reach Environmental on behalf of Bowen Coking Coal, 2023.

Tomlinson, M & Boulton, A 2008, 'Subsurface Groundwater Dependant Ecosystems: a Review of their Biodiversity, Ecological Processes and Ecosystem Services', Waterlines Occasional Paper No. 8, National Water Commission.