APPENDIX A
NOISE AND VIBRATION IMPACT ASSESSMENT

South Walker Creek Mine Multi-Year Exploration Program and Gas Collection Project

Noise and Vibration Impact Assessment

Stanmore SMC Pty Ltd

12 Creek Street
Brisbane QLD 4001

Prepared by:

SLR Consulting Australia

SLR Project No.: 620.040822.00003

19 August 2024

Revision: 1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	19 August 2024	Steve Henry	Glyn Cowie	Glyn Cowie

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Stanmore SMC Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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Acronyms and Abbreviations

AQO	Acoustic Quality Objectives
CHPP	Coal Handling and Preparation Plant
CONCAWE	Conservation of Clean Air and Water Europe
CY	Calendar Years
dB	Decibel
dBA	A-weighted decibel (referenced to 20 µPa)
DESI	Department of Environment, Science and Innovation
EA	Environmental Authority
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994*
EPP(Noise)	*Environmental Protection (Noise) Policy 2019*
GIS	Geographic Information Systems
Hz	Hertz
ID	Identification
km	Kilometres
L_{Aeq}	Equivalent continuous sound level
$L_{Aeq,adj,15min}$	A-weighted equivalent sound level measured in decibels over a period of 15 minutes and adjusted for tonal or impulsive characteristics
$L_{Aeq(T)}$	The equivalent continuous sound level for a defined time period 'T'.
L_{A1}	The A-weighted sound pressure level exceeded for 1% of the measurement period
L_{A10}	The A-weighted sound pressure level exceeded for 10% of the measurement period
L_{A90}	The A-weighted sound pressure level exceeded for 90% of the measurement period
ML	Mining lease
Mtpa	Million tonnes per annum
NVIA	Noise and Vibration Impact Assessment
PNC	Planning for Noise Control Guideline
SLR	SLR Consulting Australia Pty Ltd
Stanmore	Stanmore SMC Pty Ltd
SWC Mine	South Walker Creek Mine
SWL	Sound Power Level

1.0 Introduction

The South Walker Creek Mine (SWC Mine) is an open-cut coal mining operation owned by Stanmore SMC Pty Ltd (Stanmore), a subsidiary of Stanmore Resources Ltd (Stanmore Resources). The SWC Mine is situated in the Bowen Basin geological formation, approximately 135 kilometres (km) south-west of Mackay in Queensland. The SWC Mine operates under environmental authority (EA) EPML00712313 for activities on mining lease (ML) 4750 and ML 70131.

Exploration drilling is a critical component in informing mine planning, particularly for large and complex mining operations like the SWC Mine. Stanmore is therefore seeking to carry out exploration drilling to inform mine planning for the SWC Mine. Stanmore proposes a multi-year exploration campaign to complete exploration drilling in an extended single campaign, rather than incremental and sporadic exploration activities. This allows for appropriate environmental impact assessment and consideration by regulators, environmental authorisation under the *Environmental Protection Act 1994* (the EP Act) and planned environmental management of exploration activities.

Proactively pre-draining and collecting natural gas from sections of the SWC Mine in advance of resource extraction is a useful method of managing natural gas hazards and the release of fugitive greenhouse gas emissions such as methane. The drainage of natural gas and use for electricity generation also results in an overall reduction in greenhouse gas emissions, compared to using electricity generated through the combustion of thermal coal. Stanmore intends to extract natural gas via development and operation of drainage field, which will supply the resource to a gas fired power station that will supply the mine site's electricity requirements.

SLR Consulting Australia Pty Ltd (SLR) was engaged by Stanmore to prepare a Noise and Vibration Impact Assessment (NVIA) to support an EA Amendment Application for the proposed exploration drilling and gas drainage field activities (the Project). For clarity and ease of reference, these are referred to as the Gas Drainage Project and the Multi-Year Exploration Program. Collectively, these are 'the Project'.

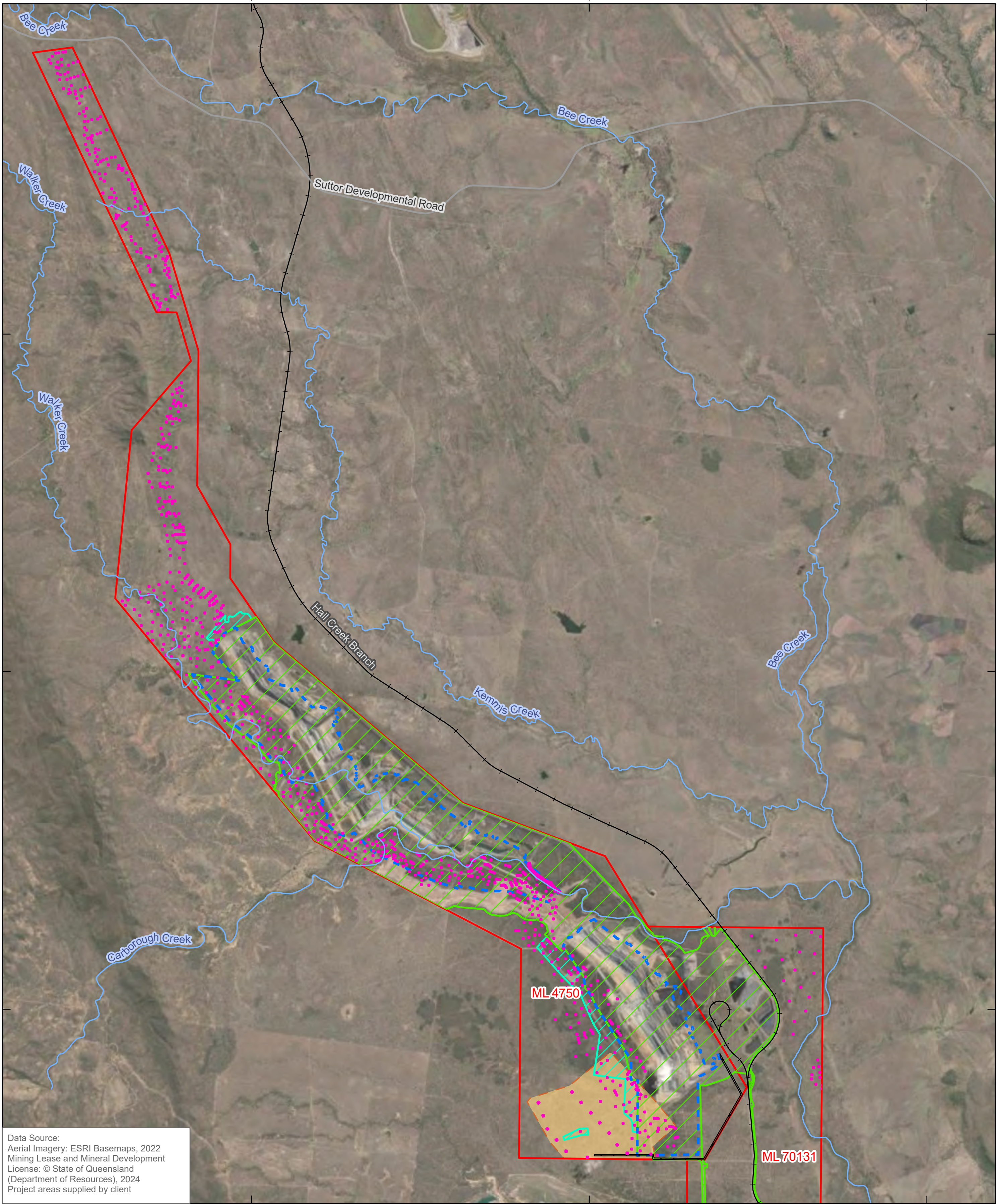
2.0 Project Overview

2.1 General

The Project comprises two main components, shown in **Figure 1**:

- The Multi-Year Exploration Program generally planned for completion over Calendar Years (CY) 2024 to 2029 (and beyond, if required) on ML4750 and ML70131 in areas beyond those authorised by the current EA, involving:
    - Exploration access tracks.
    - Exploration drill pads.
    - Seismic transects.
- The Multi-Year Exploration Program footprint is shown in **Figure 2** (northern extent of the Project area) and **Figure 3** (southern extent of the Project area). The footprint comprises access tracks, drill pads and seismic transects. These are small and isolated disturbance areas located at intervals across the exploration area.
- The Gas Drainage Project involving the development of a gas drainage field on ML4750 involving:
    - Underground gas gathering lateral lines.
    - Gas wells.
    - Gas drainage pipelines located at ground level or buried where necessary, linking each well head to a central gas drainage pipeline.
    - Water collection pipelines to allow water to be pumped from the gas wells to dams within existing operations and incorporated into the SWC Mine as part the existing mine water management system.

  The Gas Drainage Project footprint comprises a number of gas drainage wells, water pumps, pipelines, and gas drainage lines that connect to the boundary of a proposed gas fired power station located in ML4750. Approval for the proposed gas fired power station will be sought via a separate development application and is not part of the Project considered in this assessment.



Data Source:
Aerial Imagery: ESRI Basemaps, 2022
Mining Lease and Mineral Development License: © State of Queensland (Department of Resources), 2024
Project areas supplied by client

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

stanmore

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Gas Project Study Buffer
- Proposed Drill Pad
- Proposed Powerline Corridor from Power Station to Mine

SOUTH WALKER CREEK EA AMENDMENT PROJECT

EXPLORATION PROGRAM AND GAS DRAINAGE

FIGURE 1

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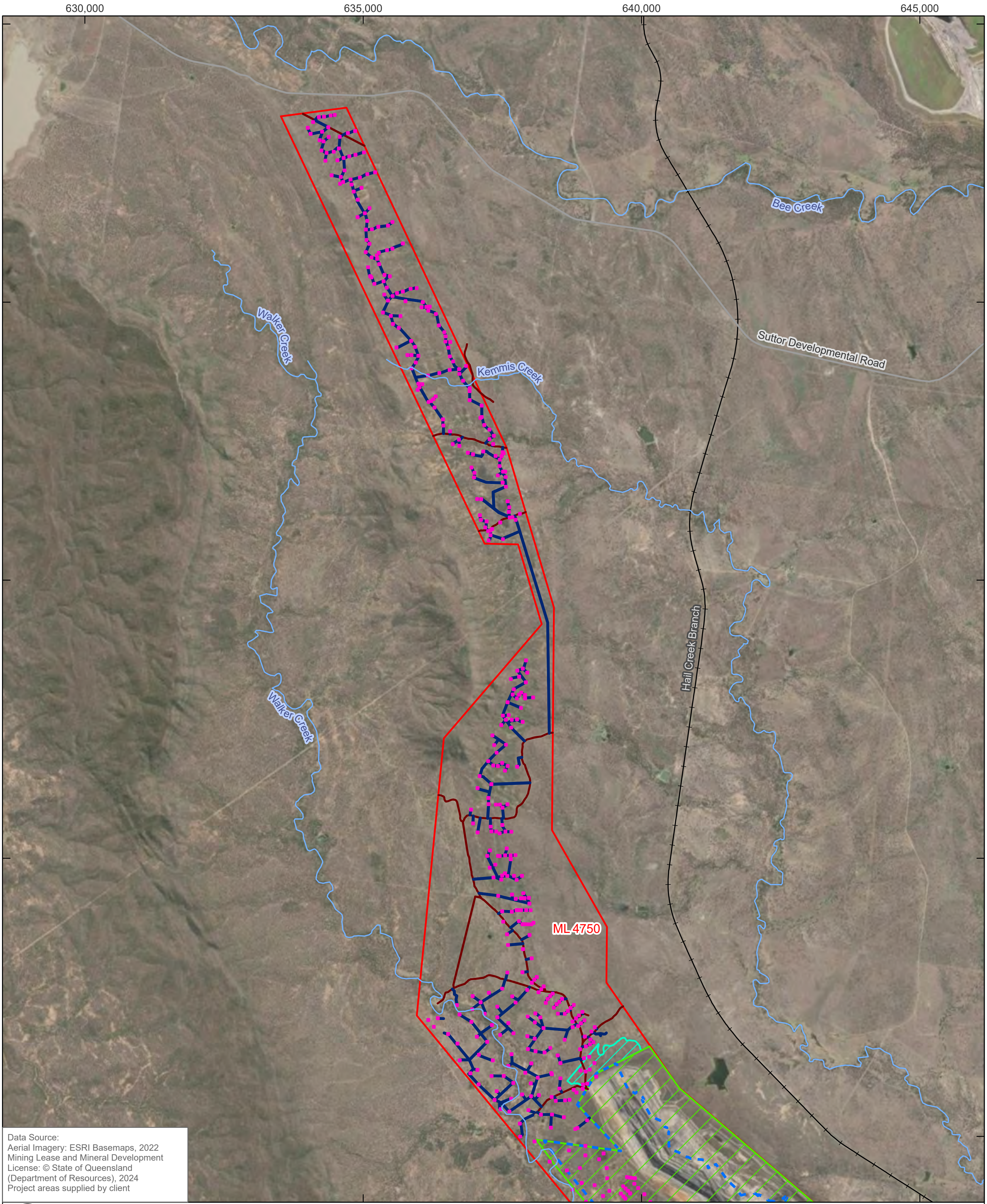

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Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Existing Track Area
- Proposed Track Area
- Proposed Drill Pad

SOUTH WALKER CREEK EA AMENDMENT PROJECT

NORTHERN EXTENT OF PROJECT AREA

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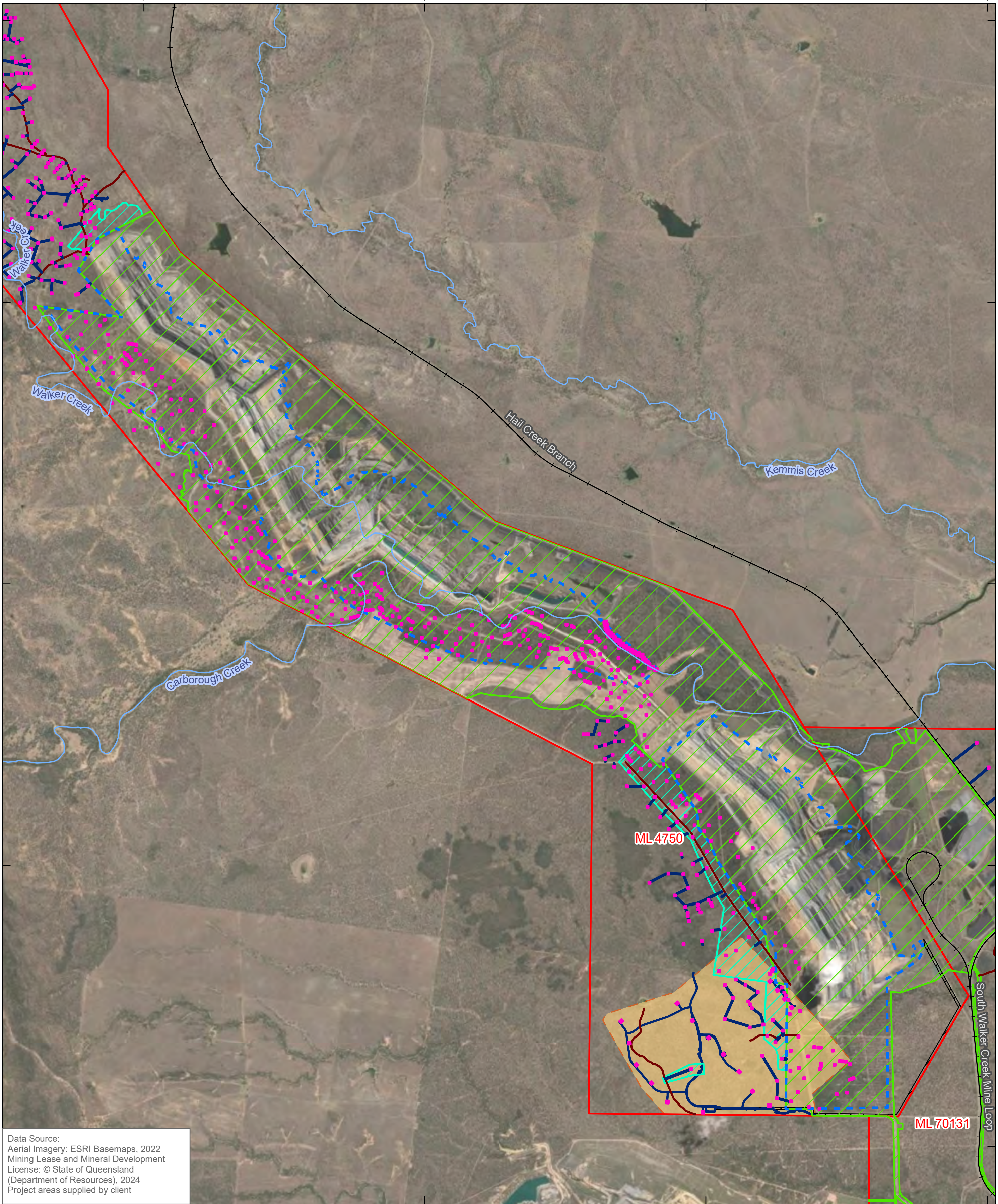
FIGURE 2

Path: \\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.040822.00001 Stanmore SWC EA Major Amendmen\07 SLR Data\01 CADGIS\GIS\ArcPro\Stanmore SWC EA Major Amendment\Stanmore SWC EA Major Amendment.aprx\620040822_PD_F03-03_Northern Extent of Project Area



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Coordinate System:	GDA2020 MGA Zone 55
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SOUTH WALKER CREEK EA AMENDMENT PROJECT

SOUTHERN EXTENT OF PROJECT AREA

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FIGURE 3

2.2 Multi-year Exploration Program

2.2.1 Exploration Drilling Activities

The exploration activities required to inform the design and development of the Gas Drainage Project and further define the coal resources at SWC Mine will include:

- Development of 4.5 m wide access tracks, with existing tracks used where possible.
- Development of drill pads of approximately 1,400 m2 area each.
- Exploration and resource definition drilling, including gas content testing.
- Drilling via core and chip methods via a truck mounted exploration drill rig with support vehicles and equipment (small truck and two to three Light Vehicles).
- Seismic exploration with approximately 3 m wide seismic exploration lines.

The exploration activities will be completed progressively and involve operation of the following equipment:

- Grader for new and existing track management and drill pad development.
- Dozer for pushing vegetation for new tracks and drill pads if needed.
- Truck mounted exploration ding rigs used to complete drilling.
- Medium Rigid trucks to support drill rigs (transportation of equipment including rods, compressors, materials).
- Small excavator or backhoe to dig sumps for management of water and drilling muds.
- Vegetation trimmers, slashers and mulchers to support vegetation trimming and removal, with the objective of minimising associated disturbance corresponding with accessing relevant exploration sites.
- Light vehicles to carry personnel and equipment used for relevant analytical processes.
- Compact seismic exploration rigs (agricultural all-terrain vehicles mounted with seismic energy sources).

The location and construction of drill pads and holes are typically dictated by site conditions (i.e., vehicle accessibility, track conditions, land-owner permission, proximity to existing access points or previous drill pads), environmental conditions (including compliance with EA conditions), mine planning priority (i.e., gaps in coal resource data) and safety considerations.

2.2.2 Seismic Investigations

Seismic exploration activities will also be required to complement resource evaluation work provided through the exploration drilling program.

As the location and extent of seismic exploration is dependent upon the outcomes of the coal exploration drilling, it is not yet possible to define the exact locations where this form of exploration will take place. However, as used at other Stanmore assets including the Wards Well Project, the proposed seismic exploration activities have been designed to minimise land and vegetation disturbance; usually resulting in negligible or minimal impacts to environmental values.

Typically, each proposed seismic area will be set up in a 50 m by 40 m spaced grid formation comprised of 3 m wide seismic lines. Hence, the preparation method for seismic survey lines will involve the slashing of grasses and non-wooded herbage along 3 m wide seismic lines.

Seismic surveying will be undertaken along the abovementioned seismic lines utilising a compact vehicle which is capable of traversing uneven terrain and narrow tracks (i.e. 3 m wide). This vehicle has been selected to limit the extent of disturbance associated with the proposed seismic survey and allows for better mobility through wooded and vegetated terrain.

2.3 Gas Drainage Project

Drainage of gas requires the implementation of a network of nominally 13 gas extraction wells, extending from the ground surface down to the target seams. These wells will be interconnected with gathering lines and supported by surface infrastructure for gas reticulation, monitoring, and control (note there is no gas processing undertaken as part of this project).

The gas drainage field will be developed in the south-western area of ML4750 (refer **Figure 1**). The gas drainage system may comprise single or dual lateral lines or a combination of both.

The preferred method for gas extraction typically involves Surface to In-Seam wells. These wells utilise directional drilling techniques to penetrate from the surface and extend laterally along the seams targeted for pre-drainage of future mining areas.

The gas drainage field is estimated to have an initial 15-year Project life. The drainage field will provide the gas to the power station which includes the capability for flaring excess gas.

Access to the gas drainage field will be via the site access centre and then via existing light vehicle access roads and tracks, including a new track the SWC power station (a separate project). A new access track will be established to provide ongoing access to the gas wells. The access tracks will be constructed via earthworks (dozing / grading and compaction) of the existing subsoil / underlying rock material. Suitable waste rock from these processes, other sources from within the mine site or imported materials may be used to provide a sub-base and all weather road surface.

The gas well pad site will be levelled and a hard stand will be constructed from compacted (non-acid forming) waste rock from the SWC mine, to approximately 150 mm above natural ground level and approximately 50 m wide by 50 m long. The construction of the gas well pads will be completed through the removal of vegetation by blade clearing using a bulldozer or pneumatic shovel / bask-hoe. Topsoil and upper subsoil layers will be removed and stored for immediate or future rehabilitation purposes at the SWC mine.

3.0 Existing Environment

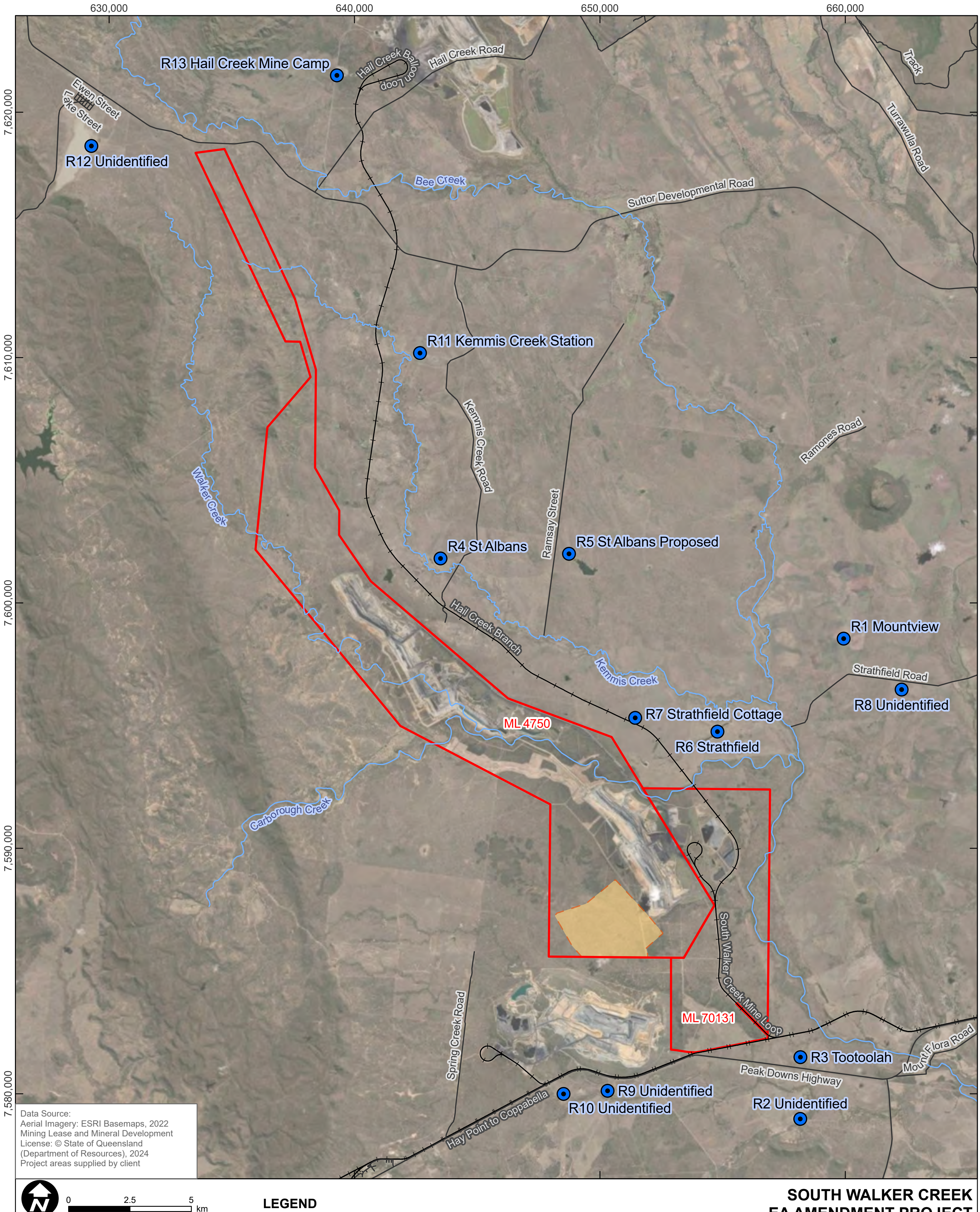
3.1 Sensitive Receptors

Potential sensitive receptors surrounding SWC Mine, detailed in **Table 1** and **Figure 4**, have been identified based on a desktop review that included a review of historical information and analysis of available aerial photographic images. As per the EA definitions, a potential sensitive receptor is not a sensitive place where the property is owned by Stanmore or a related entity, or there is an alternative arrangement in place.

Table 1 Receptors Surrounding the Project

ID	Receptor Name	Easting (m) [1]	Northing (m) [1]	Approximate Distance to Closest Drill Pad (km)	Ownership/Agreement Status
R1	Mountview	659,930	7,598,543	7.1	Privately owned
R2	Harrybrandt	658,161	7,578,973	9.1	Privately owned
R3	Tootoolah	658,168	7,581,489	6.6	Stanmore owned (not a sensitive place)
R4	St Albans (current location)	643,500	7,601,808	4.2	Stanmore owned (not a sensitive place)
R5	St Albans (proposed relocation) [2]	648,625	7,601,821	7.5	
R6	Strathfield Homestead	654,736	7,594,782	2.4	Privately owned
R7	Strathfield Cottage	651,441	7,595,314	2.7	Privately owned, alternative arrangement (commercial agreement) in place (not a sensitive place)
R8	Unidentified (7WHS139)	662,276	7,596,476	7.2	Privately owned
R9	Unidentified (5270SP144274)	650,314	7,580,119	6.0	Privately owned
R10	Unidentified (5270SP144274)	648,522	7,579,995	6.7	Privately owned
R11	Kemmis Creek Station	642,497	7,610,225	4.8	Privately owned
R12	Unidentified (18SP104452)	629,160	7,618,440	4.8	Privately owned
R13	Hail Creek Mine Camp	639,167	7,621,317	5.4	Glencore owned

Note 1: GDA 1994 MGA Zone 55 projection.
Note 2: No longer being considered for relocation



Data Source:
Aerial Imagery: ESRI Basemaps, 2022
Mining Lease and Mineral Development
License: © State of Queensland
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Project areas supplied by client

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Scale:	1:200,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

stanmore

LEGEND

- Sensitive Receptor
- Railway
- Existing Road
- Watercourse
- South Walker Creek Mine
- Gas Project Study Buffer

SOUTH WALKER CREEK EA AMENDMENT PROJECT

LOCATION OF SENSITIVE RECEPTORS

FIGURE 4

Path: \\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.040822.00001 Stanmore SWC EA Major Amendment\07 SLR Data\01 CADGIS\GIS\ArcPro\Stanmore SWC EA Major Amendment\Stanmore SWC EA Major Amendment.aprx\620040822_ANV_F06-01_Location of Sensitive Receptors

3.2 Existing Acoustic Environment

A long-term proactive noise monitoring campaign was undertaken by SWC Mine at the St Albans Homestead (Receptor ID R4) between May 2013 and December 2021 for the purpose of monitoring SWC Mine noise at the receptor. Monitoring at St Albans Homestead ceased when the property was purchased by SWC Mine.

A summary of background noise levels measured during the long-term monitoring period is summarised in **Table 2**. Samples of the St Albans Homestead noise monitoring data representing a typical winter month (i.e. July) and a summer month (i.e. December) is provided in **Appendix A**.

Table 2 Summary of Long-term Noise Monitoring Results at R4

Monitoring Location	Ambient L_{Aeq} Noise Levels, dBA			Average Background Level L_{A90}, dBA		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
R4 St Albans Homestead	46	39	38	27	30	27

From analysis of the noise monitoring data captured between 2013 and 2021, SLR note the following:

- In general, background noise levels during the night-time period occur in the range of 20-30 dBA L_{A90} and the average maximum noise levels typically range between 30-40 dBA.
- Dominant ambient noise sources at St Albans included the effects of weather (including wind, rain, thunder etc.), noise from insects (particularly during the warmer months of the year), noise from cattle (that can often be heard grazing close to the noise logger), bird song (which are especially prevalent during sunrise and sunset periods) and occasional coal train noise.
- In the absence of the above dominant ambient noise sources, noise from operations at SWC Mine was audible at St Albans particularly during certain seasonal or weather conditions such as temperature inversion conditions. SWC Mine noise, when audible at St Albans, includes haul trucks, dozers on waste dumps, occasional tonal reversing alarm noise and horn blast signals.

Of the above, the observation most relevant to this study is that background (i.e. L_{A90}) noise levels are at times below 30 dBA during the day, evening and night-time assessment periods. This is also expected to be the case at other sensitive receptor locations listed in **Table 1**.

4.0 Assessment Criteria

4.1 Noise

The SWC Mine currently operates in accordance with conditions prescribed in the EA EPML00712313 (most recent update taking effect from 16 July 2024). Condition C2 of the EA prescribes noise limits applicable at a sensitive place or commercial place (refer also to the definition of 'sensitive place' and 'alternative arrangement'). Condition C1 of the SWC Mine EA states that noise is not considered to be a nuisance if monitoring confirms that noise does not exceed the noise limits specified in Table C1 of the EA. The noise limits are reproduced in **Table 3**.

Table 3 Table C1 Noise Limits from EA EPML00712313

Sensitive Place						
Noise level dBA measured as:	Monday to Saturday			Sundays and public holidays		
	7 am to 6 pm	6 pm to 10 pm	10 pm to 7 am	9 am to 6 pm	6 pm to 10 pm	10 pm to 9 am
$L_{Aeq,adj,15 mins}$	CV = 50 AV = 5	CV = 45 AV = 5	CV = 40 AV = 0	CV = 45 AV = 5	CV = 40 AV = 5	CV = 35 AV = 0
$L_{A1,adj,15 mins}$	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5
Commercial place						
Noise level dBA measured as:	**Monday to Saturday**			**Sundays and public holidays**		
	7 am to 6 pm	**6 pm to 10 pm**	**10 pm to 7 am**	**9 am to 6 pm**	**6 pm to 10 pm**	**10 pm to 9 am**
$L_{Aeq,adj,15 mins}$	CV = 55 AV = 10	CV = 50 AV = 10	CV = 45 AV = 5	CV = 50 AV = 10	CV = 45 AV = 10	CV = 40 AV = 5

Table C1 – Noise limits notes:

1. CV = Critical Value
2. AV = Adjustment Value
3. To calculate noise limits in Table C1:
   - If bg ≤ (CV – AV): Noise limit = bg + AV
   - If (CV – AV) < bg ≤ CV: Noise limit = CV
   - If bg > CV: Noise limit = bg + 0
4. In the event that measured bg (LA90, adj, 15 mins) is less than 30 dB(A), then 30 dB(A) can be substituted for the measured background level
5. bg = background noise level (LA90, adj, 15 mins) measured over 3-5 days at the nearest sensitive receptor
6. If the project is unable to meet the noise limits as calculated above alternative limits may be calculated using the processes outlined in the "Planning for Noise Control" guideline.

As noted in **Section 3.2**, long-term noise monitoring carried out at the St Albans homestead has previously confirmed background noise levels below 30 dBA during the day (i.e. 7:00 am to 6:00 pm), evening (i.e. 6:00 pm to 10:00 pm) and night-time (i.e. 10:00 pm to 7:00 am) periods. In accordance with Note 4 (to Table C1 of the EA), a substituted background noise level ('bg') of 30 dBA applies and therefore, in accordance with Note 3 (to Table C1 of the EA), the determined noise limits applicable to noise from the SWC Mine are presented in **Table 4**.

Table 4 Summary of Project Noise Limits

Sensitive Place						
Noise level dBA measured as:	Monday to Saturday			Sundays and public holidays		
	7 am to 6 pm	6 pm to 10 pm	10 pm to 7 am	9 am to 6 pm	6 pm to 10 pm	10 pm to 9 am
$L_{Aeq,adj,15\ mins}$	35	35	30	35	35	30
$L_{A1,adj,15\ mins}$	40	40	35	40	40	35
Commercial place						
Noise level dBA measured as:	**Monday to Saturday**			**Sundays and public holidays**		
	7 am to 6 pm	**6 pm to 10 pm**	**10 pm to 7 am**	**9 am to 6 pm**	**6 pm to 10 pm**	**10 pm to 9 am**
$L_{Aeq,adj,15\ mins}$	40	40	35	40	40	35

Given the dominant noise emission from the Project (i.e. drill rig noise) is anticipated to be quasi-steady state in nature, the assessment herein will focus on the L_{Aeq} noise limits in **Table 4**.

Further to the above, Condition C3 requires consideration of tonal characteristics associated with noise emissions from the Project. Since the plant and equipment (i.e. makes and models) to be used for the exploration activities is yet to be finalised, it is recommended that the potential for tonality be assessed during the detailed design stage and, if required, tested prior to commencement of drilling in proximity to sensitive receptors. No further assessment of tonality has been carried out for this study.

4.2 Vibration

Condition C6 of the SWC Mine EA prescribes vibration limits applicable at a sensitive place or commercial place. Under Condition C6, the EA states that *vibration is not considered an environmental nuisance under condition C5 if monitoring shows that vibration does not exceed the limits specified in Table C2.* The vibration limits from the EA are reproduced in **Table 5**.

Table 5 EA Table C2 (Vibration Limits)

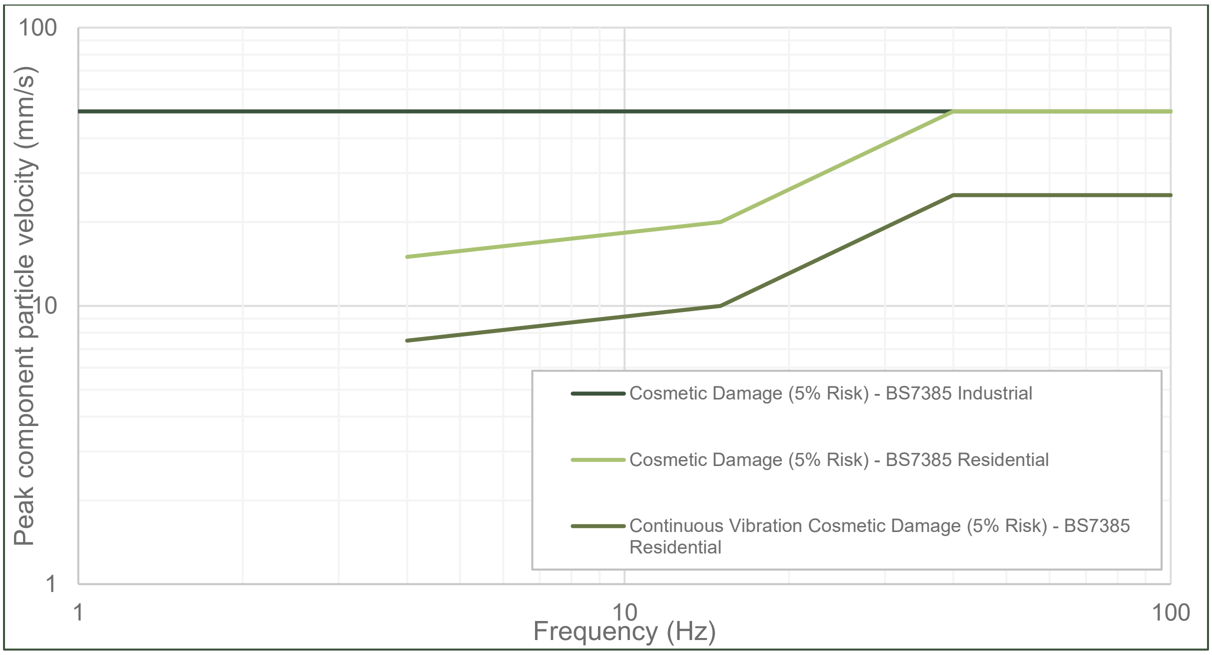
Location	Vibration Measured
Sensitive place or commercial place	5 mm/s peak particle velocity for nine (9) out of ten (10) consecutive blasts and not greater than 10 mm/s peak particle velocity at any time.

It is noted (from **Table 5**) that the SWC Mine vibration criteria specifically refers to ground vibration from blasting, however it is considered that the vibration limits relevant to the assessment of vibration from seismic investigations given the limits are comparable to the building cosmetic damage criteria recommended in British Standard 7385: Part 2-1993 Evaluation and measurement for vibration in buildings Part 2 (BS 7385). For continuous sources of vibration, BS 7385 recommends the following vibration limits:

- Peak component particle velocity limits of **7.5 mm/s** at 4 Hz increasing to **10 mm/s** at 15 Hz.
- Peak component particle velocity limits **10 mm/s** at 15 Hz increasing to **25 mm/s** at 40 Hz and above.

The BS 7385 vibration limits are also displayed graphically in **Figure 5**.

Figure 5 Graph of Transient and Continuous Vibration Guide Values for Cosmetic Damage



5.0 Assessment Modelling Methodology

5.1 Modelling Parameters and Assumptions

A SoundPLAN (Version 8.2) computer noise model was developed to predict mine noise levels at potentially affected sensitive receptors. SoundPLAN is a computer model software package enabling calculation of environmental noise by combining a digitised ground map (topography), the location and acoustic sound power levels of potentially critical noise sources on site and the location of receivers for assessment purposes.

The model can calculate noise levels taking into account such factors as the sound power levels and locations of noise sources, distance attenuation, ground absorption, air absorption and shielding attenuation, as well as meteorological conditions, including wind effects.

The Conservation of Clean Air and Water Europe (CONCAWE) (*Report no. 4/81 the propagation of noise from petroleum and petrochemical complexes to neighbouring communities)* industrial prediction algorithm has been used to model noise levels from the Project. The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 – 1982). Marsh concluded that CONCAWE was accurate to ±2 dBA in any one octave band between 63 hertz (Hz) and 4 kHz and ± 1 dBA overall.

In relation to the modelling of atmospheric conditions, the Department of Environment, Science and Innovation (DESI) *EcoAccess Planning for Noise Control* (PNC) guideline (retracted and currently undergoing review by DESI), provides guidance with respect to assessing the potential for noise enhancements due to prevailing atmospheric conditions.

In accordance with the PNC guideline, meteorological data from the SWC Mine was analysed for the following meteorological parameters:

- 30 per cent occurrence in any assessment period (day, evening or night) in any season.
- 3 m/s or less source to receiver component.
- 10 m height for wind speed.
- 30 per cent occurrence of temperature inversions for night-time (6:00 pm – 7:00 am) period during winter (June, July, August).

The wind analysis, presented as wind roses in **Appendix B**, indicated that for the 2019 calendar year there were no calculated periods of wind (of up to 3 m/s) occurring at least 30 per cent of the time in any one (1) season and assessment time period. Therefore, in accordance with the PNC guideline, wind is not considered a feature of the SWC Mine area and consequently a ‘prevailing wind’ weather condition scenario has not been considered in this assessment.

The results of the modelling of temperature gradient over the SWC Mine (presented in **Appendix B**) indicated a greater than 30 per cent occurrence of temperature inversions during the winter period. Therefore, temperature inversions are considered to be a characteristic of the SWC Mine region and must be considered as part of the NVIA.

Based on the above meteorological modelling, the default weather parameters recommended by the PNC guideline have been adopted to determine the effects of meteorology on noise emissions from the SWC Mine. The weather parameters applied to this NVIA are summarised in **Table 6**.

Table 6 Modelled Meteorological Conditions

Parameter	Neutral Weather	Adverse Weather
Temperature	10ºC	10ºC
Humidity	70%	90%
Pasqual stability class	D	F (representative of temperature inversion)
Wind speed	0 m/s	2 m/s

5.2 Noise and Vibration Modelling Scenarios

The following provides an overview of the noise and vibration modelling completed to inform the assessment of noise impacts:

- Exploration drilling:
  - Noise emission from the RC drill rig have been modelled at every proposed drill site, with the three (3) highest predicted noise levels combined to represent a worst-case predicted noise level at each receptor (i.e. from the concurrent operation of the three (3) RC drill rigs). The modelled sound power level (SWL) data is summarised in **Table 7**.
  - The pre-drilling stage involving the development of the access tracks and drill pads has not been modelled on the assumption that noise emission from these activities will be noticeably lower than the noise from the RC drill rig, and that dozer and grader noise is a current feature of existing approved operations at the SWC mine.
  - Vibration modelling and assessment has not been carried out for the exploration drilling activities as it is expected that vibration from these activities will be negligible at sensitive receptors which are located at least 4.8 km from the closest drill pad.
- Seismic investigations:
  - As noted in **Section 2.2.2**, the exact location and extent of the seismic investigations is yet to be confirmed. In considering this, noise offset buffer distances have been modelled to determine the minimum separation distance required between source and receptor to comply with the most stringent EA noise limit of 30 dBA $L_{Aeq,adj,15min}$. The noise offset buffer distances can be used by Stanmore to inform future seismic investigations to avoid noise impacting on sensitive receptors. The buffer distances have been conservatively calculated for the seismic survey vehicle based on a UniVib truck, noting that a smaller machine (i.e. a vibration hammer mounted to an all-terrain vehicle) is likely to be used for these works.
- Gas drainage:
  - Given the gas drainage field is proposed to be developed in the south-western area of ML4750, which is approximately 5.5 km from the closest sensitive receptor, modelling of this activity has not been completed as part of the NVIA. Further to this, based on SLR's extensive gas experience, noise emission associated with the drilling of the vertical and lateral wells are expected to be lower than the noise emission modelled from the RC drilling. Therefore, demonstrating compliance through the modelling of RC drilling

implies that noise emission resulting from the gas drainage activities would also comply with the EA noise limits.

Table 7 Modelled RC Drill Rig and Seismic Vehicle SWL Data – A-weighted

Plant Item	Octave Band Centre Frequency (Hz)									Total SWL	Source Height
	31.5	63	125	250	500	1k	2k	4k	8k		
RC drill rig Epiroc Explorac 235	82	105	109	111	117	122	119	111	102	125	3.0 m
UniVib	57	75	90	100	101	102	100	94	86	107	0.5 m

6.0 Assessment of Impacts

6.1 Noise

6.1.1 Exploration Drilling

SoundPLAN predicted exploration drilling noise emission levels under neutral weather conditions, are summarised in **Table 8**. As noted in **Section 5.2**, the predicted noise levels represent the combined effect of the three (3) loudest wells relative to each receptor being drilled concurrently (i.e. worst-case scenario).

Exploration drilling activities are assumed to occur during daytime hours only (i.e. typically 7:00 am to 5:30 pm). As such, the EA noise limits for the daytime period have been included for reference in **Table 8**.

Table 8 Predicted Worst-case Exploration Drilling Noise Levels

Receptor	EA Noise Limit $L_{Aeq,adj,15min}$ (dBA)[1]	Predicted Exploration Drilling Noise Level $L_{Aeq,adj,15min}$ (dBA)
		Neutral Weather
R1 Mountview	35	16
R2 Harrybrandt	35	12
R3 Tootoolah	N/A	17
R4 St Albans (current)	N/A	27
R5 St Albans (proposed)	N/A	15
R6 Strathfield Homestead	35	**36**
R7 Strathfield Cottage	N/A	35
R8 Unidentified	35	17
R9 Unidentified	35	19
R10 Unidentified	35	17
R11 Kemmis Creek Station	35	24
R12 Unidentified (18SP104452)	35	15
R13 Hail Creek Mine Camp	35	22
Note: Greyed cells represent receptors that are not sensitive to the Project (i.e. either owned by Stanmore or an agreement exists).		

From the noise prediction modelling results presented in **Table 8**, the following is noted:

- The highest predicted exploration drilling noise level at a sensitive receptor was 36 dBA L_{Aeq} at R6 (Strathfield Homestead). The predicted exceedance results from the proximity of the drill sites in the north-east corner of ML 70131. In view of this predicted marginal 1 dB exceedance, noise mitigation measures (as detailed in **Section 7.0**) will be required.
- Excluding sensitive receptor R6, worst-case exploration drilling noise levels under neutral weather conditions are predicted to comply at all other sensitive receptors surrounding the SWC Mine.

With consideration to previous SWC Mine noise modelling completed by SLR (‘*620.31322-R02-v1.0-20230321*’, dated 21 March 2023), there is potential for a 1 dBA cumulative (i.e. exploration drilling and approved SWC Mine) noise increase at sensitive receptor R6. In relation to this 1 dBA difference in noise, it is well documented (i.e. through numerous regulatory bodies) that a difference of 1 or 2 dB is insignificant or negligible.

In relation to exploration drilling activities proposed to occur within the gas drainage field (shown in **Figure 1**), the highest predicted worst-case noise of 19 dBA $L_{Aeq,adj,15min}$ (i.e. predicted at sensitive receptor R9) complies with the 30 dBA $L_{Aeq,adj,15min}$ EA noise limit. This indicates that the drilling of the vertical and lateral wells and associated activities within the gas drainage field are also expected to comply with the EA at all sensitive receptors.

6.1.2 Seismic Investigations

Noise offset buffer distances, which represent the minimum separation distance required between source and receptor to comply with the most stringent EA noise limit of 30 dBA $L_{Aeq,adj,15min}$, are summarised in **Table 9**.

Table 9 Seismic Investigations Noise Offset Buffer Distances

Seismic Vehicle	Required Off-set Distance to Achieve the 30 dBA $L_{Aeq,adj,15min}$ EA Night-time Noise Criterion	
	Neutral Weather	Adverse Weather
UniVib	750 m	1,150 m

In considering the offset buffer distances in **Table 9**, noise levels resulting from the seismic investigations are not expected to result in impacts to sensitive receptors particularly in the context of the separation distances (refer to **Table 1**) between the exploration work areas and sensitive receptors and the likely conservative nature of the predicted offset buffer distances.

6.2 Vibration

Based on vibration measurements completed by SLR, vibration offset buffer distances for the seismic vehicle have been calculated to inform the assessment. These are summarised as follows:

- Approximately 20 m to comply with the 5 mm/s EA vibration limit.
- Approximately 200 m to be below the threshold of human perception (i.e. <0.15 mm/s[1]).

Based on the above, the risk of vibration-related impacts is negligible for any receptor during the seismic investigations.

[1] British Standard BS 5228-2:2009, *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*, states “*Human beings are known to be very sensitive to vibration, the threshold of perception being typically in the PPV range of 0.14 mm/s to 0.3 mm/s*”.

7.0 Recommendations

As a result of the predicted gas exploration drilling noise limit exceedances at sensitive receptor R6, the following mitigation measures are recommended:

- It is recommended that, at any time, only one (1) RC drill rig operate in proximity to sensitive receptor R6 to ensure compliance is predicted with the 35 dBA $L_{Aeq,adj,15min}$ noise limit.

Outside of the potential for noise impacts and consequently mitigation requirements for sensitive receptor R6, no specific noise mitigation measures are required as a result of the predicted compliance of the two (2) projects with the assessment criteria.

It should be noted that the actual requirement/ extent of noise mitigation would be confirmed during the detailed modelling/design stage of the Project.

8.0 Conclusion

SLR was engaged by Stanmore to prepare a NVIA to support an EA Amendment Application for the Project. The NVIA has investigated the potential for impacts associated with:

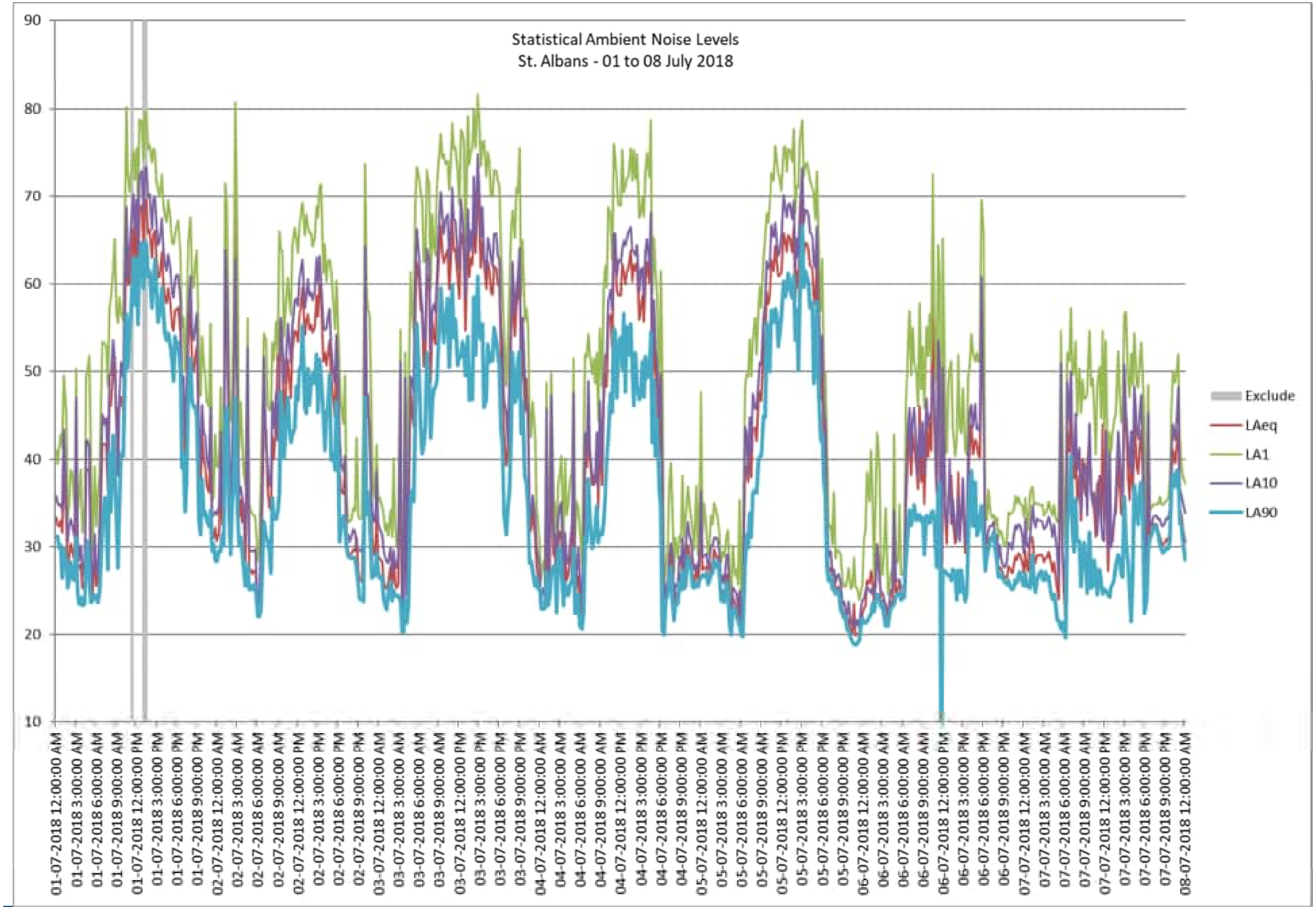
- The Multi-Year Exploration Program involving development of access tracks, exploration drill pads, drilling and seismic transects.
- The Gas Drainage Project involving the development of a gas drainage field on ML4750 involving development of underground gas gathering lateral lines, gas wells and gas drainage pipelines.

SoundPLAN modelled exploration project noise levels were predicted under neutral and adverse weather conditions and assessed against the most stringent night-time period noise limit prescribed in the current the SWC Mine EA.

The findings of the NVIA have indicated the following:

- The highest predicted exploration drilling noise level at a sensitive receptor was 36 dBA L_{Aeq} at R6 (Strathfield Homestead) occurring under neutral weather conditions. The predicted exceedances result from the proximity of the drill sites in the north-east corner of ML 70131. Noise mitigation in the form of limiting drilling to one (1) rig in the north of ML 70131 is recommended unless detailed design indicates that compliance can always be achieved at R6.
- Excluding sensitive receptor R6, worst-case exploration drilling noise levels under neutral weather conditions are predicted to comply at all other sensitive receptors surrounding the SWC Mine.
- With guidance from the exploration drilling predicted noise levels, drilling of the vertical and lateral wells and associated activities within the gas drainage field are also expected to comply with the EA noise limits at all sensitive receptors.
- Noise levels resulting from the seismic investigations are not expected to result in impacts to sensitive receptors particularly in the context of the separation distances between the exploration work areas and sensitive receptors.
- The vibration offset buffer distance calculated for a typical seismic vehicle indicated compliance with the EA vibration limit of 5 mm/s PPV. Further to this, it is likely that seismic investigation vibration levels will be below the threshold of human perception at all sensitive receptor locations.

Appendix A SWC Mine Noise Monitoring Results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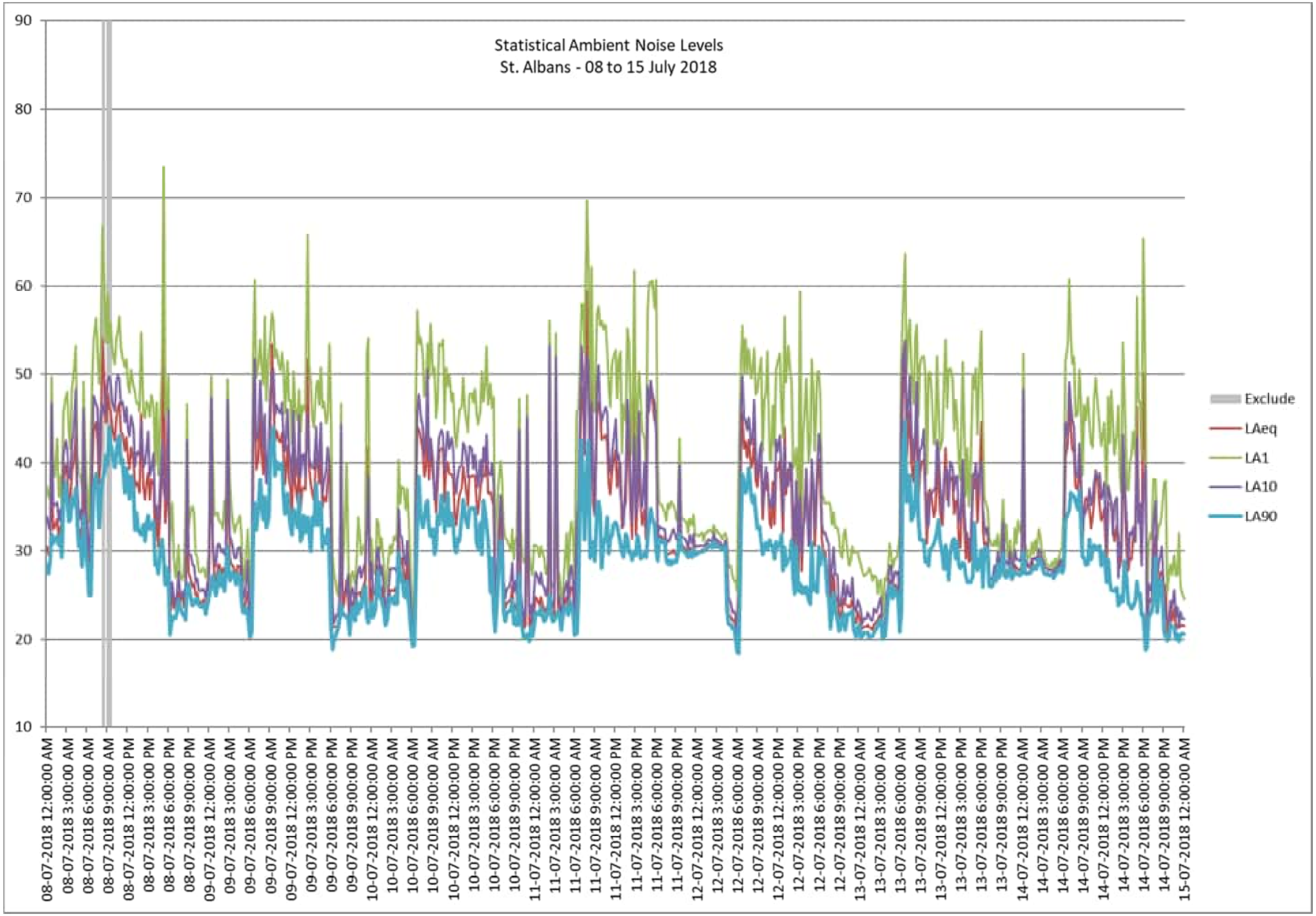
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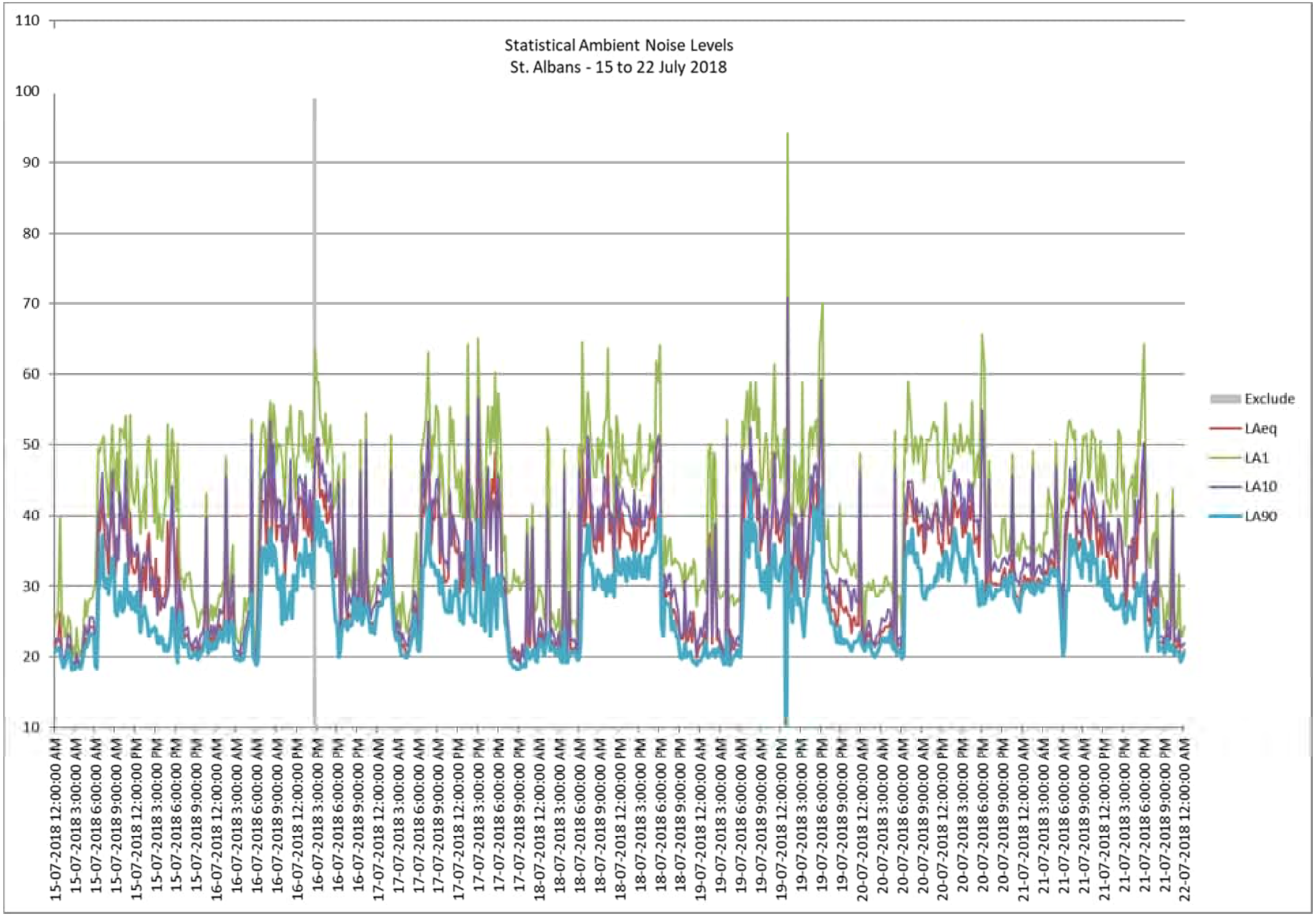
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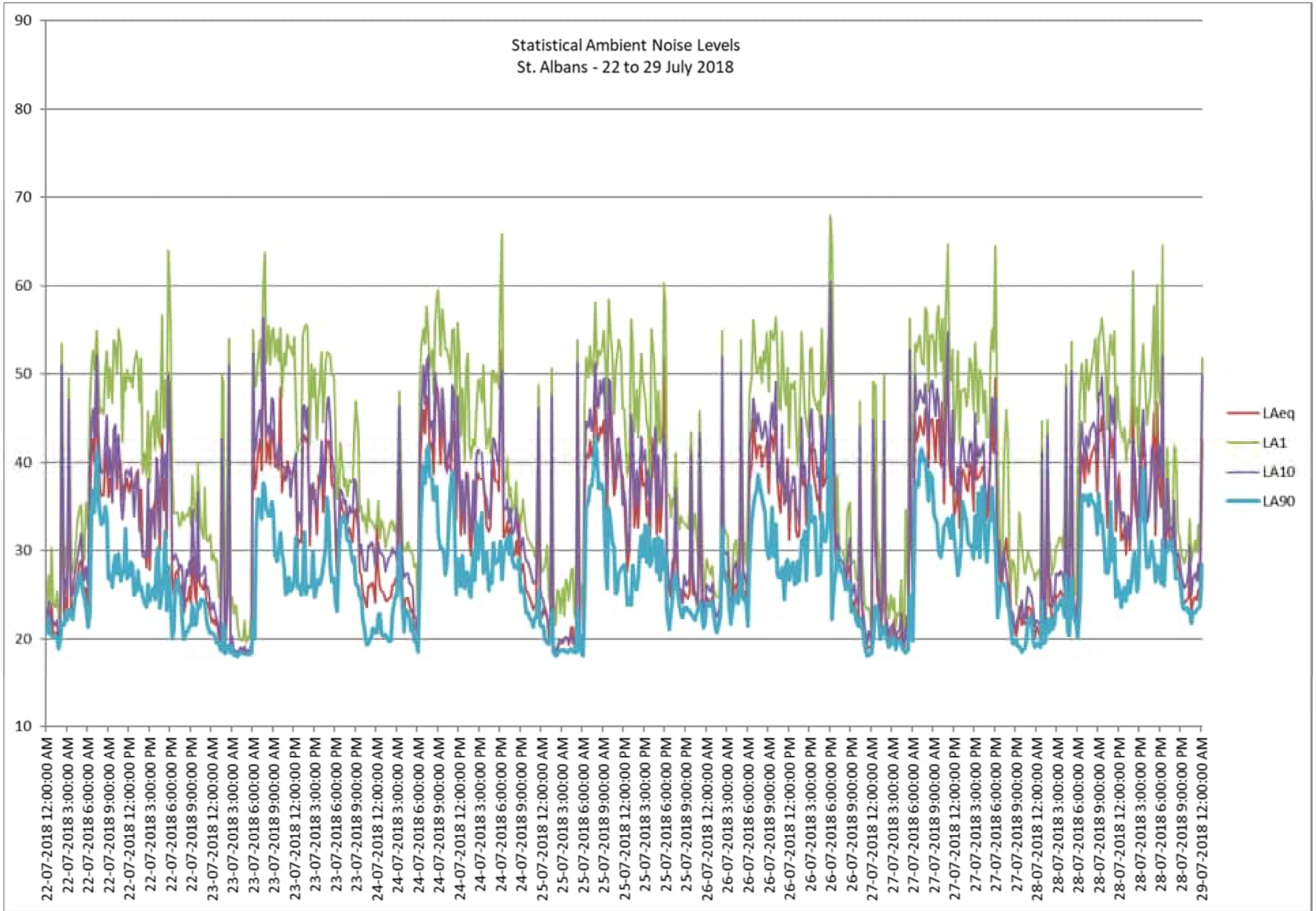
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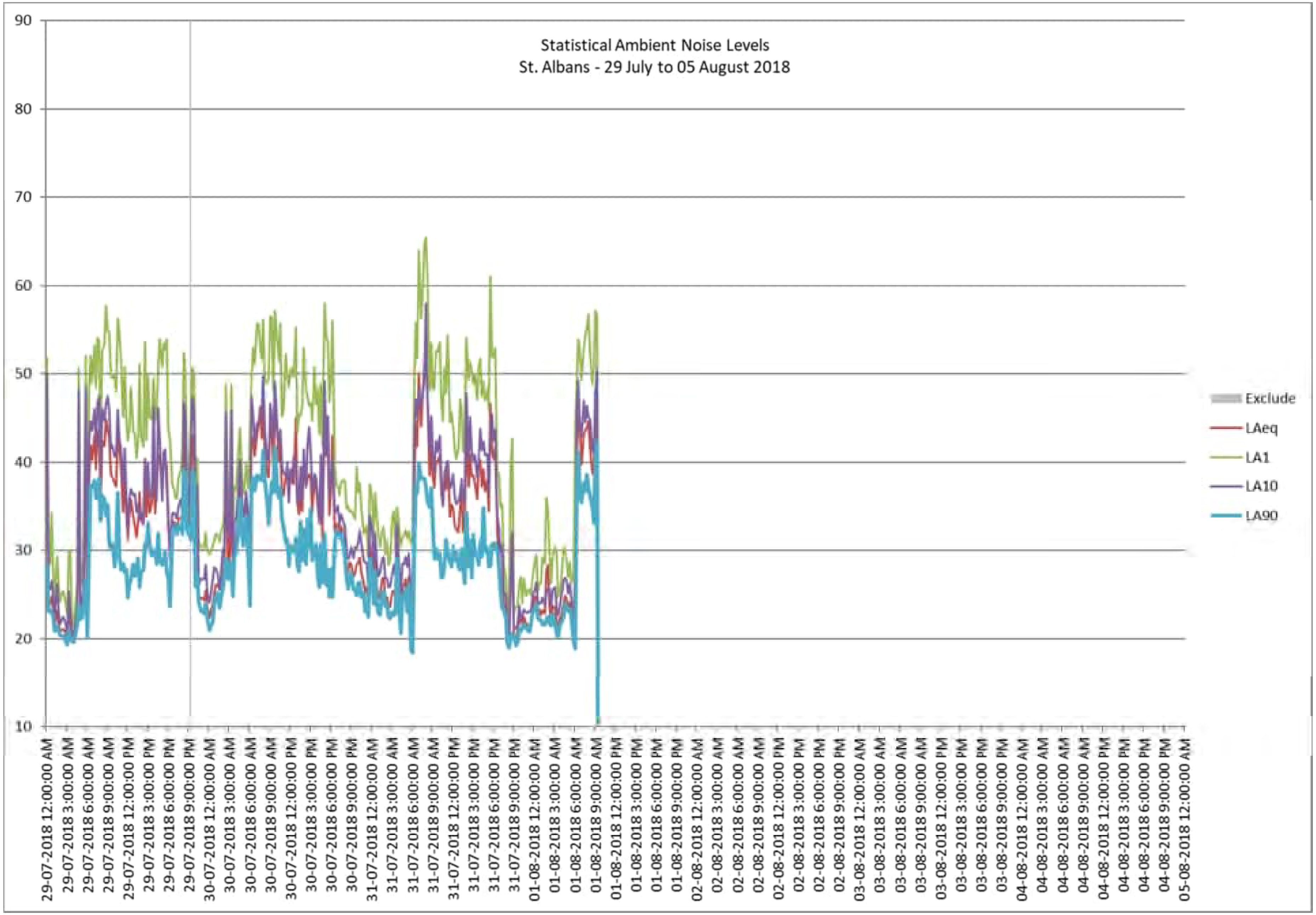
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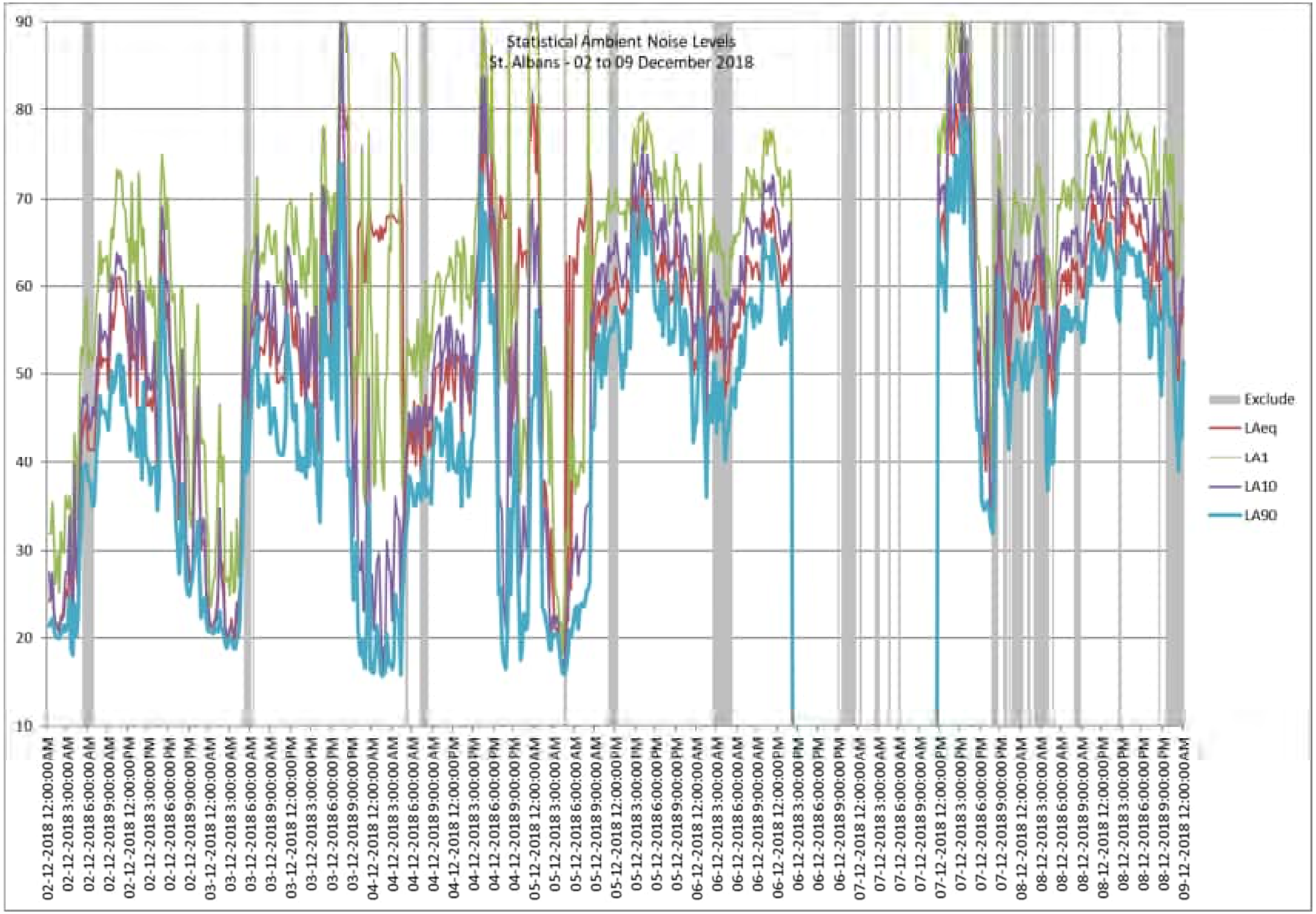
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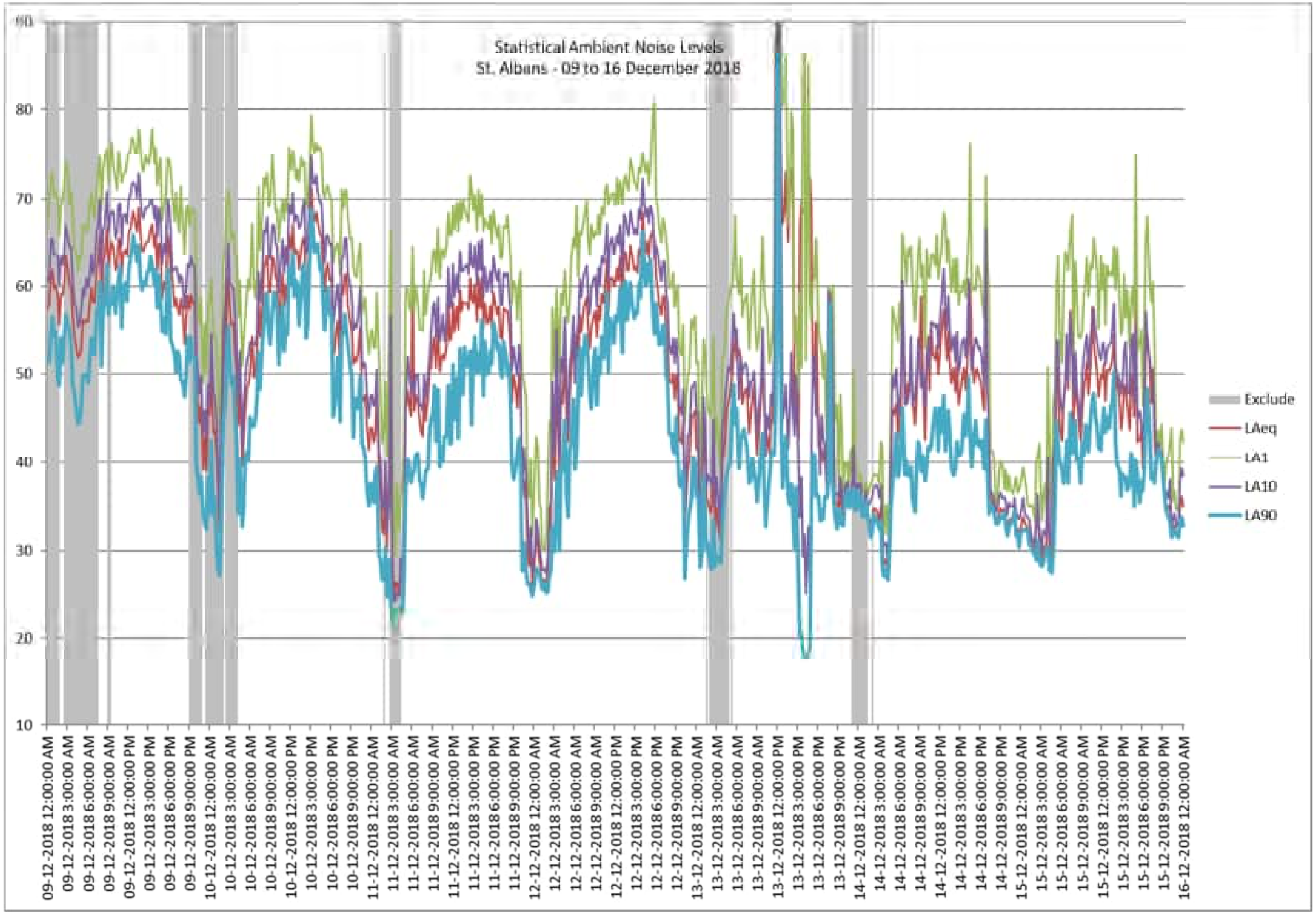
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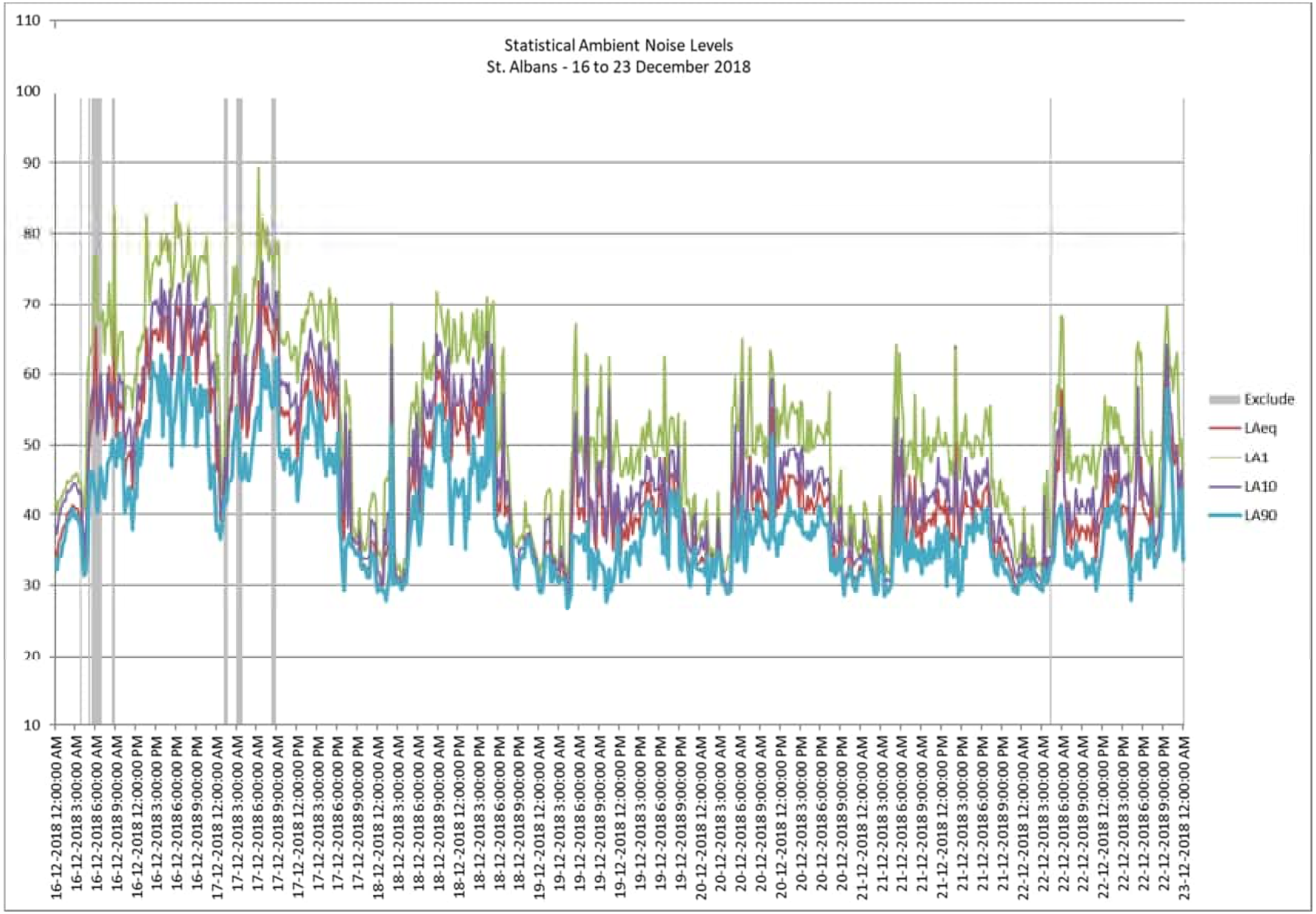
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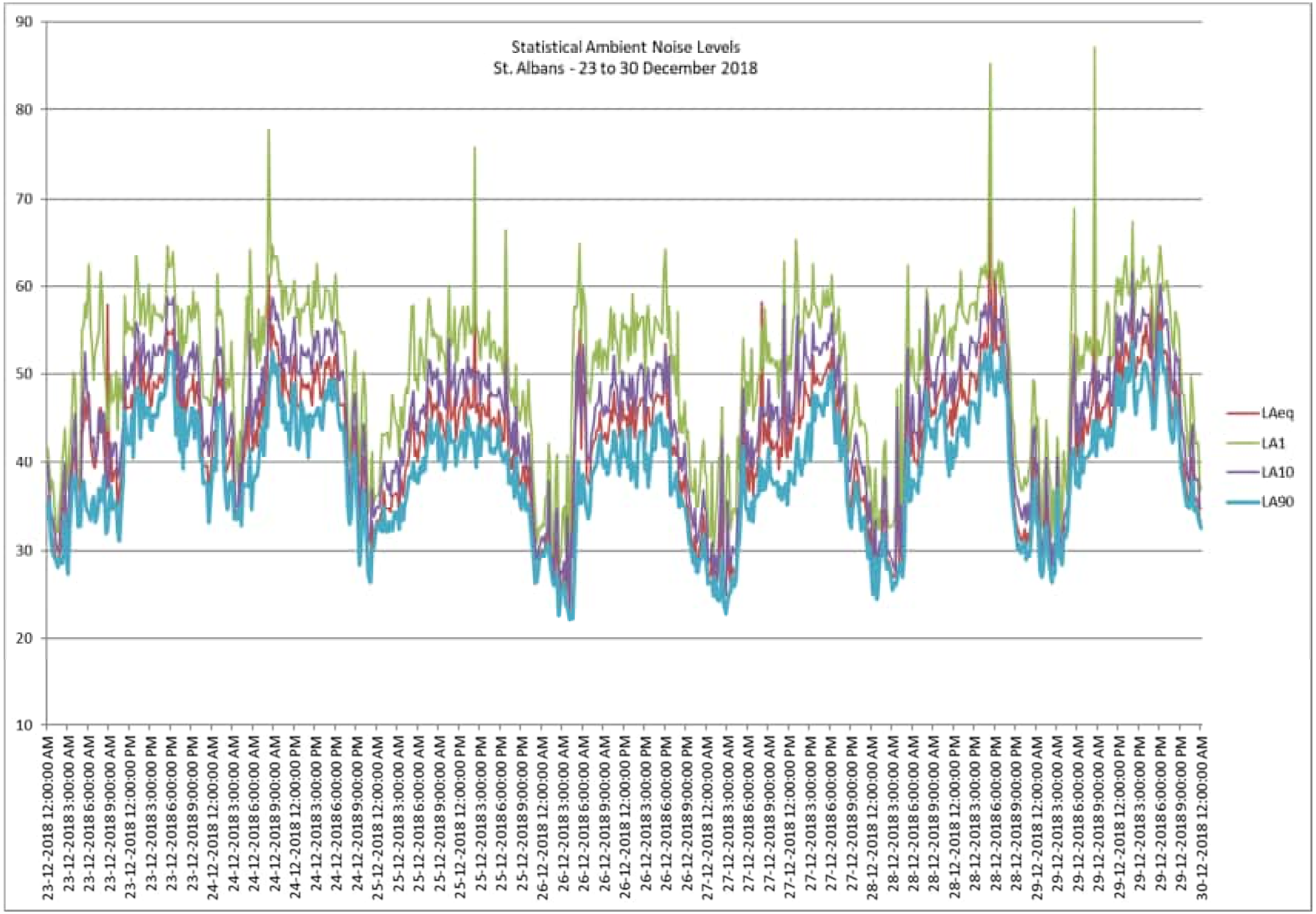
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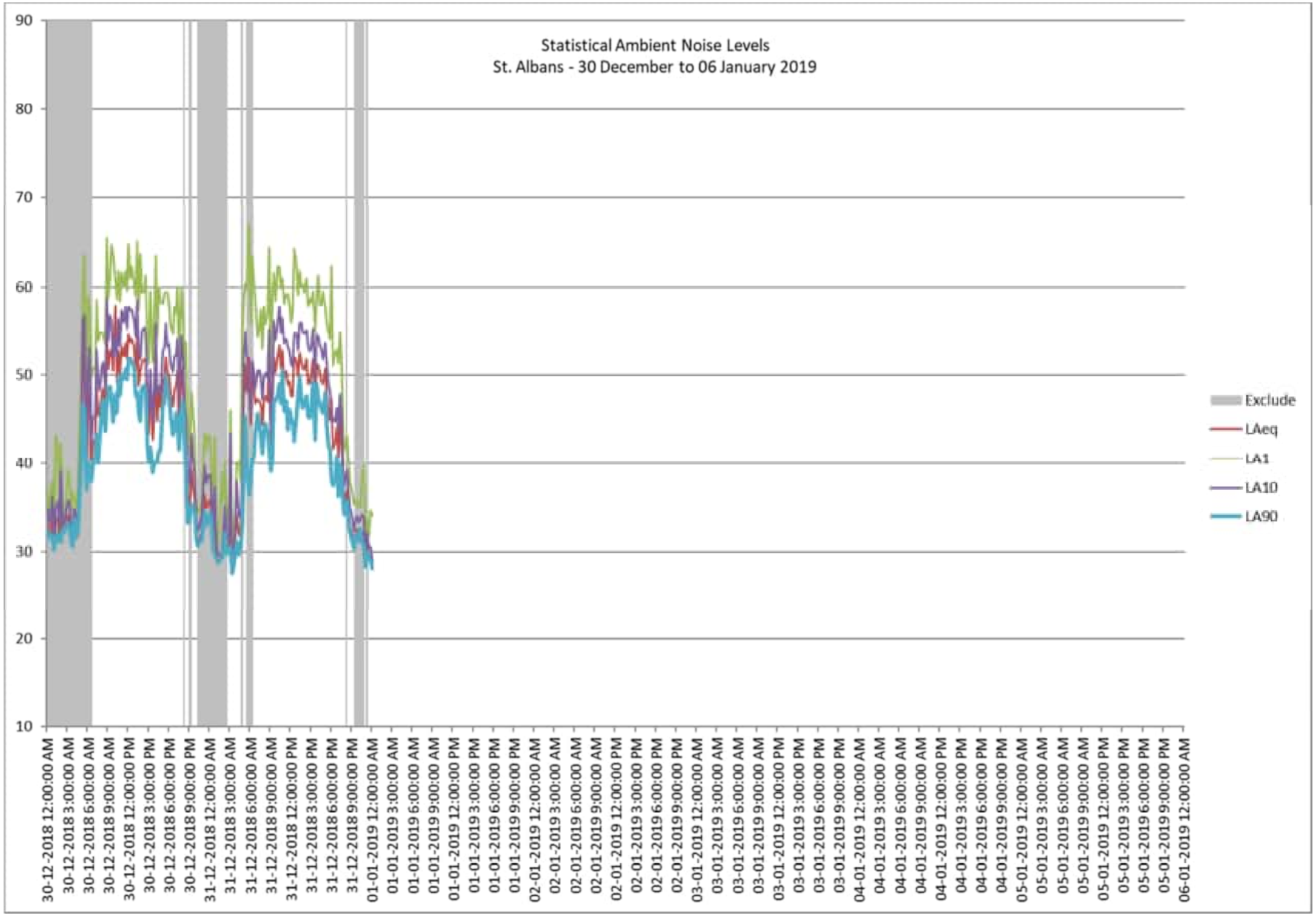
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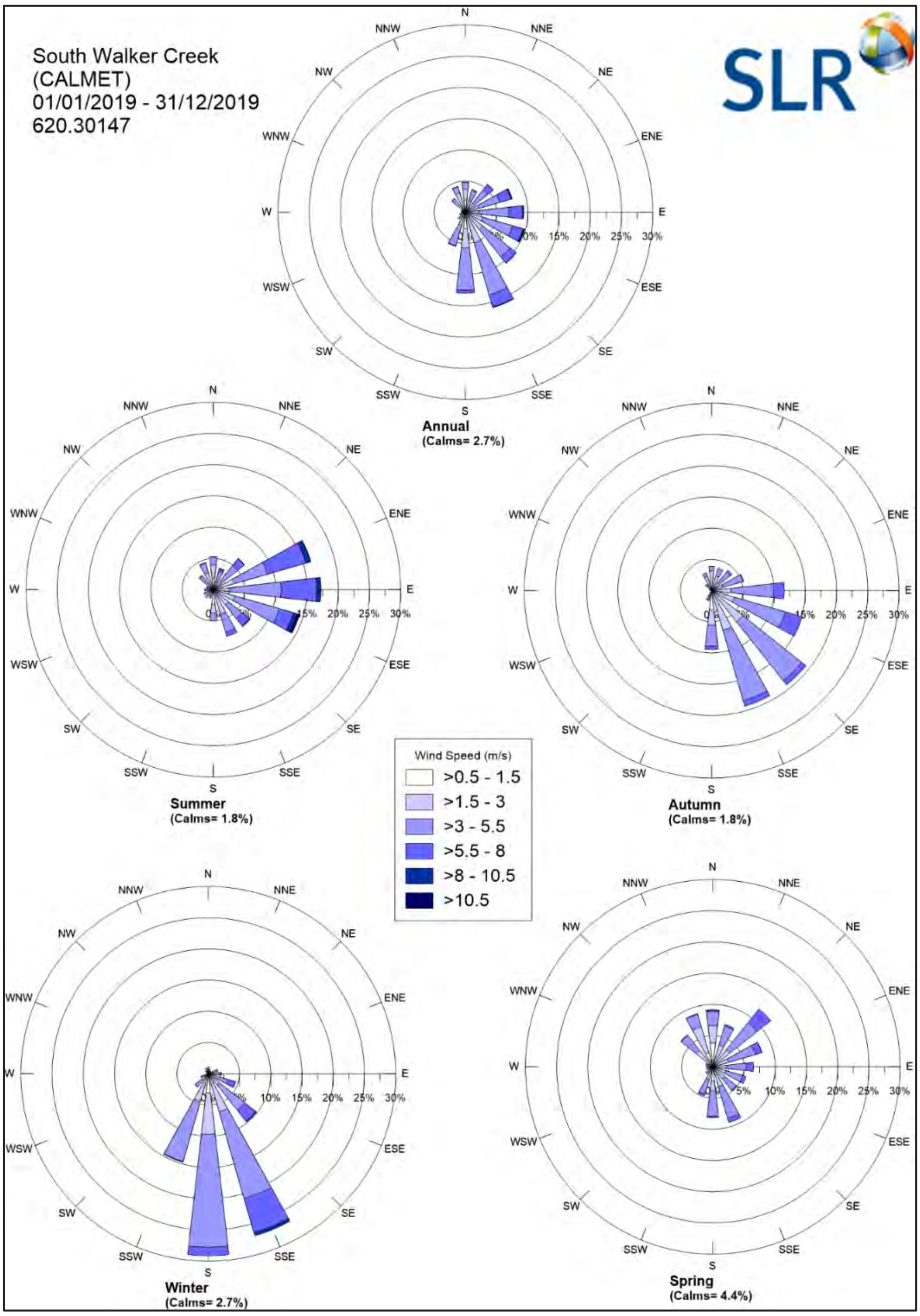
Appendix B Meteorological Modelling

Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for SWC Mine is presented in **Figure B1.**

Figure B1 Wind Roses for SWC, as Predicted by CALMET (2019)



Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner (PGT) assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability as follows:

A = Extremely unstable conditions

B = Moderately unstable conditions

C = Slightly unstable conditions

D = Neutral conditions

E = Slightly stable conditions

F = Moderately stable conditions

The meteorological conditions defining each PGT stability class are shown in **Table B1**.

Table B1 Meteorological Conditions Defining PGT Stability Classes

Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Notes:

Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter.

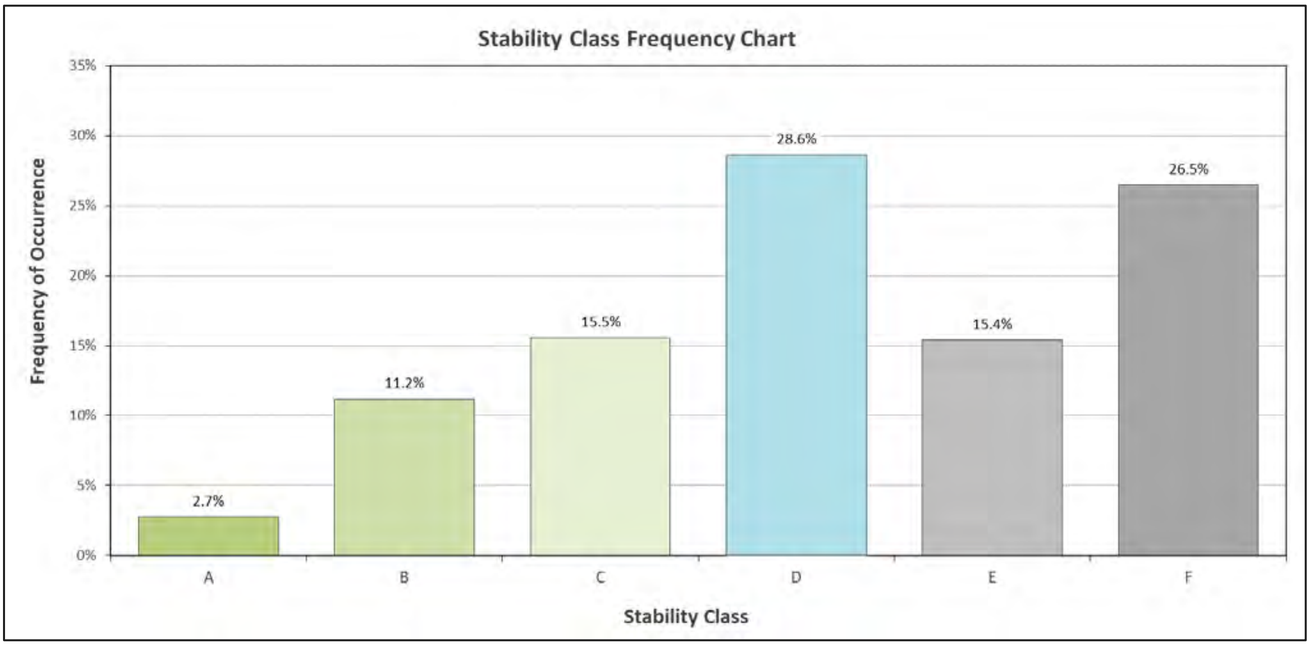
Night refers to the period from 1 hour before sunset to 1 hour after sunrise.

The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

Source: NOAA, 2018.

Figure B1 shows the frequency distribution of the atmospheric stability classes predicted for SWC Mine. The results indicate that neutral conditions (Stability Class D) occur most frequently at the site and the surrounding area, with a significant number of stable conditions (Stability Class F) also predicted. These conditions are associated with a low level of pollutant dispersion due to limited mechanical mixing in the atmosphere.

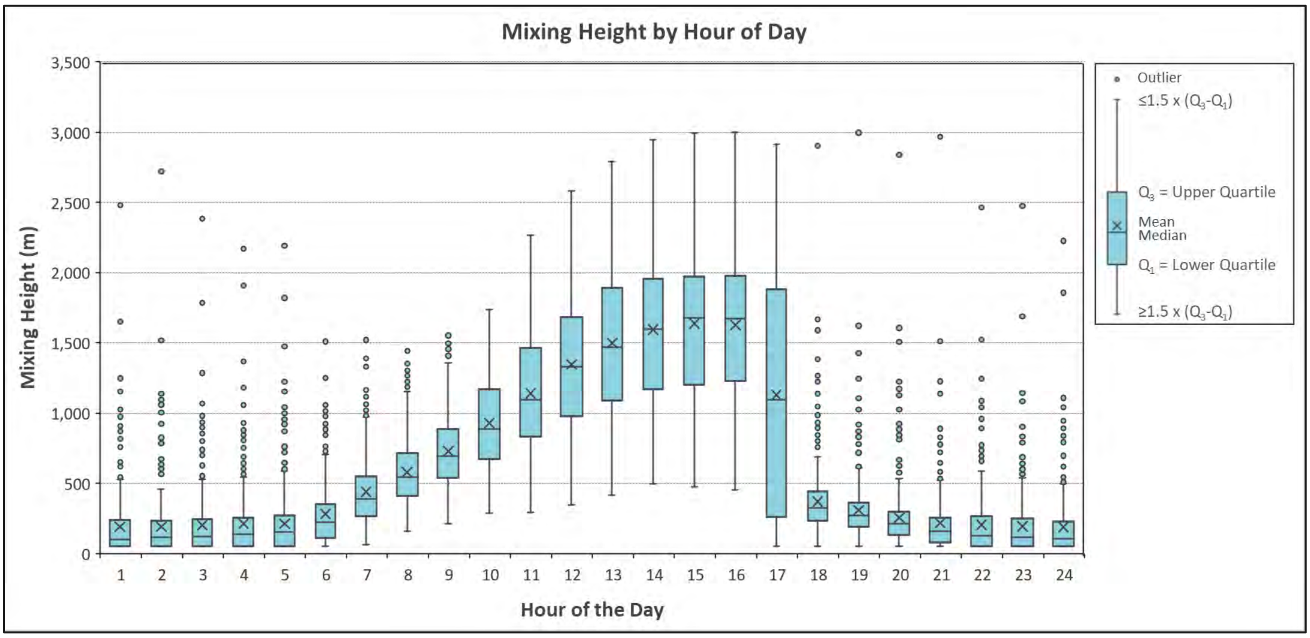
Figure B1 Stability Class Distribution Predicted by CALMET for SWC (2019)



Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at SWC Mine are illustrated in **Figure B2**. As would be expected, an increase in the mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure B2 Mixing Heights Predicted by CALMET for SWC Mine (2019)



Making Sustainability Happen

APPENDIX B
GROUNDWATER ASSESSMENT

Stanmore SMC Pty Ltd

Groundwater Impact Technical Report

South Walker Mine Gas Drainage Project

August 2024

Confidential

Question today
Imagine tomorrow
Create for the future

Groundwater Impact Technical Report
South Walker Mine Gas Drainage Project

Stanmore SMC Pty Ltd

WSP
Level 12, 900 Ann Street
Fortitude Valley QLD 4006
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Rev	Date	Details
A	12 August 2024	Unsigned DRAFT issued for client comment
0	22 August 2024	Final

	Name	Date	Signature
Prepared by:	Fabiana Cesar	22 August 2024	[signature]
Reviewed by:	Craig Wicenciak	22 August 2024	[signature]
Approved by:	Jason van den Akker	22 August 2024	[signature]

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

Our ref: PS209709-WSP-BNE-MNG-REP-00001 Rev0

Your ref: PS209709-WSP-BNE-MNG-REP-00001 Rev0

By email
ryan.pane@stanmore.net.au

22 August 2024

Confidential

Mr Ryan Pane
Principal Environmental Approvals
Stanmore SMC Pty Ltd
Level 32 / 12 Creek Street
GPO Box 2602 | Brisbane QLD 4000

Dear Sir

Groundwater Impact Technical Report
South Walker Mine Gas Drainage Project

Please find within the Groundwater Impact Assessment Technical Report for the South Walker Creek Mine gas drainage project.

Yours faithfully

Fabiana Cesar	Craig Wicenciak	Jason van den Akker
Senior Hydrogeologist	Principal Hydrogeologist	Technical Executive, Hydrogeology

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www.wsp.com

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Executive summary

Introduction

Stanmore SMC Pty Ltd (SMC) is seeking to develop a gas drainage field – referred to as the Project, at the South Walker Creek (SWC) mine within mine lease (ML) 4750, in Queensland's northern Bowen Basin.

The proposed gas well field will be located to the southwest of the Carborough, Walker, and Toolah pits, and will be designed to extract gas ahead of open cut mining and fuel a power station to supply electricity to the mine. It will involve the staged drilling of horizontal gas production wells, initially comprising 26 dual lateral wells to be installed in the first 13 years of the Project to maintain the expected 4 terajoules per day (TJ/d) gas delivery. Additional wells may though be installed as required. Gas will be extracted from the Rangal Coal Measures using directional drilling techniques, and the gas wells will be interconnected with gathering lines and supported by surface infrastructure for gas processing, monitoring, and control.

Gas drainage water production is required as part of the gas extraction for the Project. Groundwater is removed via gas production wells to depressurise the coal seams, with this depressurisation generating gas flow and maintaining operational gas pressures. Average water production rates over the 13-year period are estimated to be approximately 41 m^3/day. All water extracted will be managed in the existing mine-affected water system, with annual production from the gas field between 0.5 1.0 % of the annual water usage for the mine. No treatment of water is proposed to be undertaken, and no water will be stored at the gas fields.

In support of the necessary approvals and following requirements in the *Environmental Protection Act 1994* (EP Act), a comprehensive groundwater impact assessment (GIA) has been conducted. This includes the development of a numerical groundwater model to evaluate potential short-term and long-term impacts on groundwater resulting from coal seam water extraction, planned exploration drillholes to inform the design and development of the gas collection Project, and changes in groundwater quality.

GIA methodology

The GIA involved developing both conceptual and numerical hydrogeological models of the Project area and its surroundings. These models were utilised to assess the potential impacts of the Project on groundwater elevations, flow directions, environmental values, and sensitive receptors, including groundwater-dependent ecosystems (GDEs).

The numerical groundwater flow model was previously developed by Golder (2022) in MODFLOW-USG and updated by WSP as part of the current scope of work to change the grid refinement in the Project area to allow more 'refined' predictions. Calibration was verified to ensure it was fit for purpose for this GIA. The boundary of the model has been defined based on the location of topographical ridges and expected regional flow of shallow groundwater and Coal Seam aquifers. It has been set far enough away from the SWC pit and Project area to minimise boundary-induced effects while ensuring that it follows sensible hydrogeological units.

The model domain is 45 km long (NNW–SSE), 40 km wide (SSW–NNE) and covers an active area of approximately 1,290 km^2. Cell size varies across the model domain from a refined quadtree grid of 100 m around the Project area, to 200 m within the mining area and around the main creeks, to 400 m outside of these areas and to the model boundaries. Temporally, the stress periods are based on wet/dry seasons, with the life of mine scenarios considering the period from July 2021 to September 2043, when mining is scheduled to cease. The post-closure simulation considered the period from October 2043 to December 2534, encompassing 491 years of groundwater level recovery. It followed a variable stress period setup (starting with yearly to 10-yearly towards the end of the simulation period).

Modelling included simulations to predict the impacts of the Project, considering the current SWC mine's approved mining plan and third-party operations. Potential impacts from exploration drilling across the SWC mine were also assessed. Predictions considered potential impacts on springs and groundwater extraction bores in relation to trigger thresholds within the Water Act 2000. Additionally, impacts on other potential receptors, such as potential GDEs, were evaluated based on their location, underlying stratigraphy, and predicted aquifer drawdown results.

Assessment outcomes

All **registered bores** predicted to be impacted by Project-induced changes in groundwater elevations and pressures are either:

— owned by SMC, or

— located at the nearby Coppabella Mine to the south of the Project area.

All are registered and used for groundwater monitoring purposes and are not suitable for groundwater extraction purposes.

Ecology surveys and expert advice provided indicates that aside from subterranean **GDEs** (stygofauna), there are no other GDEs either within the study area or within the wider assessment area used for the assessment of GDEs. It is noted that riparian vegetation along Sandy Creek and Humbug Gully may though intermittently use groundwater during and following rainfall events. This process of intermittent recharge along the line of these creeks is not expected to change due to the construction and/or operation of the Project, and unlikely to impact existing riparian vegetation.

Stygofauna has been identified in several groundwater monitoring bores in the central and northern portions of the SWC mine, all of which are screened in the alluvial or regolith HSUs. Although stygofauna were not observed during field assessments in the Project area, it is reasonable to consider that stygofauna may also be present in the alluvial and regolith HSUs at and surrounding the Project area, including along the alignment of Sandy Creek and Humbug Creek. Considering the predicted Project-induced changes in groundwater elevations in the alluvial and regolith HSUs at and surrounding the Project area are negligible, the significance of any potential impact of the Project on any stygofauna is considered low to negligible.

The closest known **spring** is located about 16 km northwest of the Project area. It is located on the western ('opposite') side of the unnamed major SSE-NNW oriented fault which is thought to act as a regionally significant hydraulic 'barrier', hence the construction and/or operation of the Project is not expected to impact groundwater elevations, yields, geochemistry or uses of that water emanating from this spring.

The only **wetland** at the SWC mine is **Pink Lily Lagoon**, located about 3.5 km to the northeast of the nearest planned gas extraction well of the Project. It is underlain by regolith derived from the weathering of the underburden HSU and owing to the structural orientation of the Permo-Triassic bedrock units, is not expected to be impacted by the Project. This understanding is supported by numerical groundwater model predictions of Project-induced changes of groundwater elevations which are not expected to extend to Pink Lily Lagoon.

The drilling of **exploration boreholes** is expected to:

(i) lower groundwater elevations in the top of the regolith, and

(ii) allow the passive underdrainage (downward leakage) of some groundwater from the alluvial sediments to the (now lower) water table in the regolith.

In stating this however, it is expected this change will have a negligible influence on any GDEs along the alignment of these waterways given:

— the often-dry nature of these streambeds

— the general absence of groundwater in the shallow alluvial sediments (with groundwater, if present, typically occurring towards the base of these alluvial sediments), and

— the demonstrated disconnection of creekbeds from groundwater in the alluvium.

This drawdown is also expected to reduce the saturated thickness of the regolith HSU, which could impact yields of any future groundwater abstraction bores installed in this HSU in the cumulative (i.e., area of multiple open gas boreholes) area of influence.

As gas and groundwater is extracted during Project operation, inflow of groundwater is likely to occur from those HSUs either above or below the coal seams, and/or laterally from adjacent areas of the coal seam. As such it is likely to be of similar **geochemistry and quality** to that removed during the operation of the Project. Similarly, following the cessation of gas extraction, groundwater levels in the coal seams and adjoining HSUs will recover, with this water is expected to largely be of similar or equivalent geochemistry and quality of that groundwater inflow to the coal seams during Project operation. As such the overall significance of the Project impacting groundwater geochemistry and quality is assessed as low.

Predicted outcomes from the **cumulative impact scenario** suggest that groundwater-take activities at the **Coppabella mine** may result in:

- between about 1.5 and 2.0 m of additional groundwater drawdown in the coal seams in the southern portion of the Project area, and
- negligible to no predicted additional drawdown in the alluvium or regolith HSUs in this area.

Given (i) groundwater in the coal seams in this area is not used, and (ii) the predicted change in groundwater elevations is less than the groundwater drawdown trigger thresholds of the Water Act, the Project is not considered likely to contribute to any adverse cumulative impacts to groundwater within the region.

Potential impacts of the Project are considered to present low or negligible risks to groundwater elevations, geochemistry, quality or use.

Impacts not associated with Project-induced depressurisation of the coal seams include those related to well drilling and construction. No produced water will be stored or treated within the gas field, but rather that water generated by gas extraction will be managed as mine-affected water subject to the site Water Management Plan. After adoption of these measures, these impacts are likely to be of low significance.

Abbreviation	Definition
ADWG	Australian Drinking Water Guidelines (2011)
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment and Conservation Council (2018)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian standard
AWQG	Australian Water Quality Guidelines
bgl	Below ground level
BMC	BHP Mitsui Coal
BoM	Bureau of Meteorology
CDMMR	Cumulative deviation from mean monthly rainfall
CVFD	Control volume finite difference
CWT	Carborough, Walker and Toolah (combined) pit at the SWC mine
DEM	Digital elevation model
DES	Department of Environment and Science
DNRME	Queensland Department of Natural Resources, Mines and Energy
DoEE	Commonwealth Department of Environment and Energy
DPIE	New South Wales Department of Industry and Environment
EA	Environment Authority
EC	Electrical conductivity
EoM	End of mining
EP Act	Environmental Protection Act 1994
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPP Water	The Environmental Protection (Water) Policy 2009 (Qld)
EPP WWB	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
ERA	Environmentally relevant activity
EV	Environmental value
EVT	Evapotranspiration
FCCM	Fort Cooper Coal Measures
GDE	Groundwater dependent ecosystem
GIA	Groundwater impact assessment
HCM	Hydrogeological conceptual model
HSU	Hydrostratigraphic unit

Abbreviation	Definition
IESC	Independent Expert Scientific Committee
K	Hydraulic conductivity
Kh	Horizontal hydraulic conductivity
Kv	Vertical hydraulic conductivity
LOM	Life of mine
L/s	Litres per second
m	Metres
MB	Monitoring bore
mE	Metres east
mN	Metres north
MCM	Moranbah Coal Measures
ML	Megalitres
MNES	Matter of National Environmental Significance
MSES	Matters of State Environmental Significance
Mtpa	Megatonnes per annum
NATA	National Association of Testing Authorities
NC Act	Nature Conservation Act 1992 (Qld)
NCWR	Nature Conservation (Wildlife) Regulation 2006 (Qld)
NNW	North-north-west
NWQMS	National Water Quality Management Strategy
OGIA	Office of Groundwater Impact Assessment
pH	Potential of hydrogen (measure of acidity or alkalinity)
QLD	Queensland
QWC	Queensland Water Commission
RCM	Rangal Coal Measures
SILO	Scientific Information for Land Owners (Queensland Government daily climate database)
SMC	Stanmore SMC Pty Ltd
Ss	Specific storage
SSE	South-south-east
SWC	South Walker Creek mine
Sy	Specific yield
TPH	Total petroleum hydrocarbons

Abbreviation	Definition
TSF	Tailings storage facility
µS/cm	Microsiemens per centimetre
WQO	Water quality objectives
WRR Act	Waste Reduction and Recycling Act 2011 (Qld)
WSP	WSP Australia Pty Ltd

1 Introduction

Stanmore SMC Pty Ltd (SMC) aims to develop a gas drainage field – referred to as the Project, at the South Walker Creek (SWC) mine within mine lease (ML) 4750. Accordingly, SMC must amend its current Environmental Authority EPML00712313 (the EA) by submitting an application and completing a groundwater impact assessment (GIA), following requirements in the *Environmental Protection Act 1994* (EP Act).

WSP Pty Limited (WSP) has been engaged by SMC to undertake the groundwater impact assessment (GIA) for the Project to support the EA application. WSP developed a groundwater numerical model to inform the GIA, with this technical report providing an overview of the groundwater numerical modelling work carried out and subsequent outcomes of the impact assessment component of the GIA.

1.1 Background and purpose

SWC Mine is an open-cut coal mine located in Queensland's northern Bowen Basin, 25 kilometres (km) south-west of Nebo and approximately 115 km south-west of Mackay. It operates under environmental authority (EA) EPML00712313 for activities on mining lease (ML) 4750 and ML 70131 and has been in operation for more than 20 years.

SWC comprises a series of open-cut pits which target the metallurgical coal seams of the Rangal Coal Measures. Seven pit groupings are mined along a 16-km strike extent (north-west to south-east) at SWC: from south to north these being the Toolah, Walker, Carborough, F Pit, Mulgrave, Kemmis 1 and Kemmis 2 pits.

Other operations near SWC, which have been included in the GIA described in this report, include:

- the Coppabella Coal Mine: an open-cut coal mine operated by Peabody through the Coppabella (approximately 5 km south-west of SWC) and Moorvale Coal Mines Joint Venture (less than 20 km south of SWC), and
- Arrow Energy Bowen Gas Project: coal seam gas (CSG) extraction from Arrow Energy's gas fields in the Bowen Basin, occurring between Moranbah and north of Glenden.

SMC propose to develop a gas drainage field at the SWC mine to the southwest of the Carborough, Walker, and Toolah pits. The well field will be designed to extract gas ahead of open cut mining in this area and fuel a power station to supply electricity to the mine. The footprint of the proposed works is shown in Figure 1.1.

The purpose of this GIA is twofold, namely to:

(i) describe the potential effects of the proposed Project on groundwater resources, and

(ii) identify suitable mitigation and management measures to reduce the risk of these impacts to an acceptable level.

This report addresses the requirements for groundwater assessment set out in the Department of Environment and Science (DES) Guideline: *Application Requirements for activities with impacts to water SR/2015/1837 Version 4.01* (water impact guideline) (DES, 2017a).

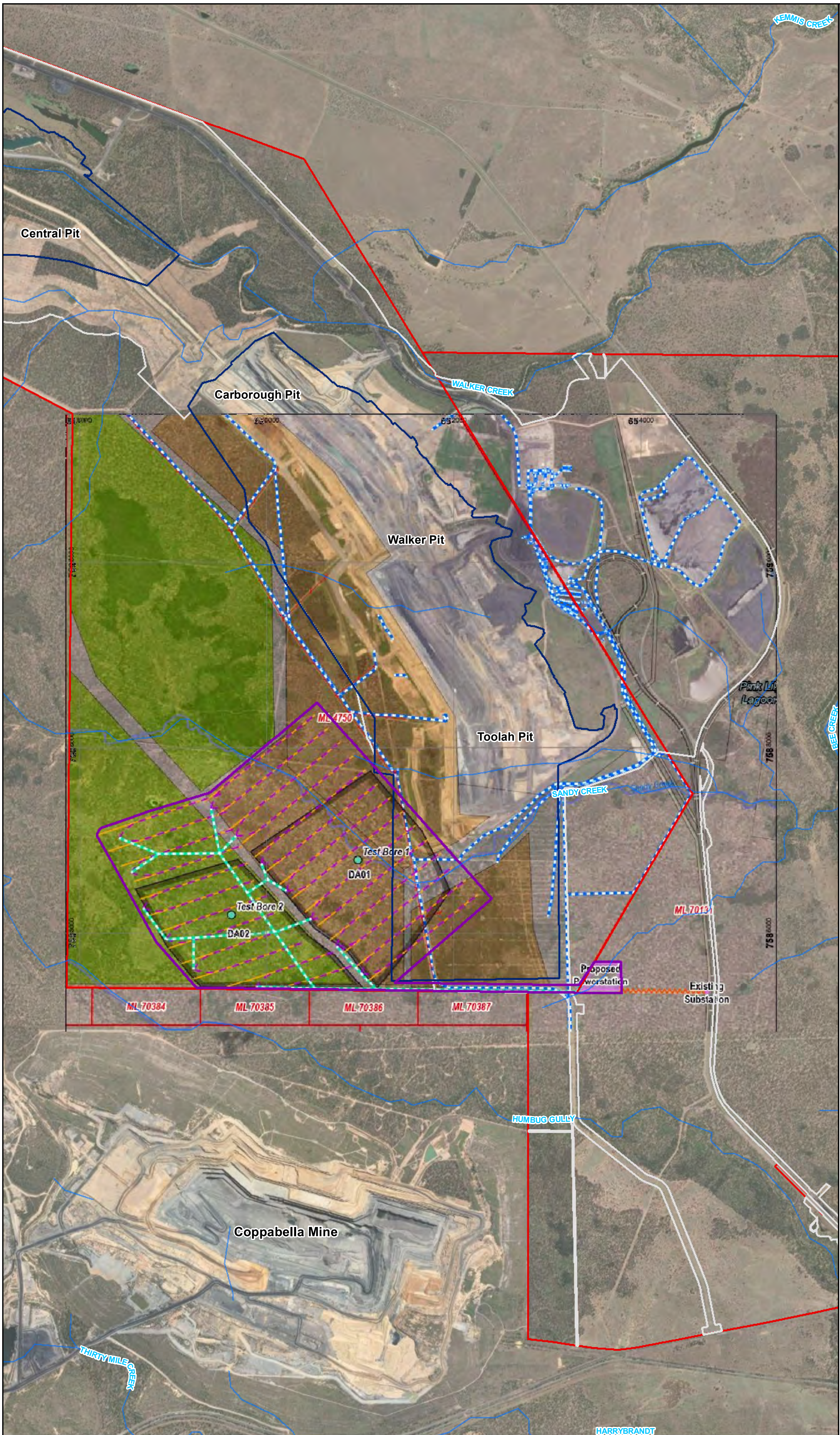
This report summarises:

- the baseline hydrogeological setting at and in the vicinity of the site, with a focus on groundwater quantity and quality
- those groundwater environmental values in the Project area
- the development of a numerical groundwater flow model of the Project area, SWC mine and surrounds, and the use of this model to assess the likely impacts of the Project on groundwater elevations, flow directions, environmental values and any sensitive receptors, including groundwater-dependent ecosystems, and

- the assessment of the impacts of gas drainage production water use in accordance with applicable Queensland CSG water management regulations and guidelines.

The critical groundwater considerations from the Project during normal operations and those that have been assessed for the Project area and surroundings include:

- Short and long-term aquifer depressurisation and drawdown due to the extraction of coal seam water.
- Potential impacts of planned exploration drillholes on groundwater.
- Changes in groundwater quality due to contamination during drilling works or extraction of groundwater.



WSP

PS209709
SWC Mine Gas Drainage Project

Figure 1.1
South Walker Creek Mine gas drainage project footprint

Legend

- Watercourses
- Proposed Gas Project Area
- Mining Leases
- Approved Subsurface Disturbance
- Approved Surface Disturbance
- Initial Drilling Areas
- Proposed Test Bore Sites
- Single Lateral Layout 200m
- Dual Lateral Layout 200m
- Gas Gathering Pipelines
- Proposed Gas Powerstation Location
- Proposed Powerline
- Existing Mine Water Pipelines
- Future Open Cut
- Future Underground

Source of the tif: provided by SMC

0 1,000 2,000
Meters

Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
1:40,000 Date: 10/07/2024

Data sources: DELWP, Geoscience Australia

1.2 Project description overview

The purpose of the Project is to allow SMC to collect and utilise that gas in the Rangal Coal Measures in the southern portion of ML 4750 to internally generate and supply the mine's electrical demand on an uninterrupted basis. It will involve the staged drilling of horizontal gas production wells in that area to the southwest of the Carborough, Walker, and Toolah pits, and the construction and operation of supporting infrastructure, including a power station which will be connected to the electrical supply lines which currently feeds SWC; this will allow SWC to retain its grid connection which will offer greater security of supply than being solely dependent on electricity produced solely from the Project.

The intention is for the power station to supply SWC's total demand year-round, this being approximately 20 megawatts (MW). This power station will require approximately four terajoules (TJ) of gas supply per day (4 TJ/d), with this sourced from an initial gas well field comprising 26 dual lateral wells, all of which to be installed in the first 13 years of the Project. Additional wells may though be installed as required to maintain the expected 4 TJ/d gas delivery.

1.2.1 Gas drainage field

The gas drainage field will include the development, operation and maintenance of the following infrastructure:

— Underground gas gathering lateral lines.

— Gas horizontal wells.

— Gas collection pipelines, which will be located at ground level or buried where necessary and link each well head to a central gas collection pipeline.

— Water collection pipelines, which will allow water to be pumped from the gas wells to dams within existing operations and incorporated into the SWC mine as part of the existing mine water management system.

Collection of gas requires the implementation of a network of 14 gas extraction wells, extending from the ground surface down to the target coal seams. These wells will be interconnected with gathering lines and supported by surface infrastructure for gas processing, monitoring, and control.

The gas drainage field will be developed in the south-western area of ML4750 and may comprise single or dual lateral collection lines or a combination of both.

The preferred method for gas extraction typically involves Surface to In-Seam wells. These wells utilise directional drilling techniques to penetrate from the surface and extend laterally along the seams targeted for gas pre-drainage.

Vertical wells are also drilled from the surface. The lateral wells are drilled to intersect the vertical wells. The vertical wells are used for collecting and conveying the gas and associated water to the surface for further processing.

Water arising from the collection system will be integrated into the SWC Mine Affected Water System.

The gas drainage field is estimated to have an initial 13-year life. The details of volumes, gas processing, compression and storage facilities is being developed by Stanmore. The collection field will include the capability for flaring excess gas at the proposed power station (separate project) or a nearby location.

1.2.2 Gas drainage water production

Gas drainage water production is an essential part of the gas extraction process for the Project. Groundwater is removed via gas production wells to depressurise the coal seams. This depressurisation generates gas flow and maintains operational gas pressures.

In coal seams, natural gas and water are stored in the cleats (fractures) that naturally occur in coal. However, most gas is adsorbed in the coal matrix and held in place by confining pressure from the overlying rock and groundwater (hydrostatic pressure).

When recovering natural gas from coal seams, the coals remain in place. Gas is produced by drilling a well into the coal seam and removing groundwater from the coal seam, thereby reducing the confining hydrostatic pressure. This allows gas to separate from the coal (desorb) and flow through fractures within the coal to the well and on to the surface. In general, producing natural gas from coal seams does not require all groundwater to be removed from the coal seam, but rather hydrostatic pressures are typically reduced only to the extent required to achieve consistent gas flow.

The rate of groundwater extracted from coal seams occurs incrementally at first until it peaks, then reduces significantly. The development cycle for a prospective area includes exploration, appraisal, production well and infrastructure construction, production operations and then decommissioning and rehabilitation. New information gained from ongoing exploration, appraisal and production activities is used to inform future field development planning.

Overall water production characteristics from a gas drainage field can be forecast using established techniques and field data. The forecast (often termed the water production profile) provides the rate and total volume of coal seam water extracted over a gas field area.

Figure 1.2 presents the estimated rate of water production during gas drainage operations at SWC for individual lateral gas wells, with DA01 and DA02 representing single lateral wells of 1,500 m and 1,200 m lengths respectively (Transition Energy Corporation, 2024[1]). These estimates show that water production rates from a single gas well is expected to be highest in the first two years, reaching approximately 24 m^3/day for 1,500 m length wells and 15 m^3/day for 1,200 m length wells within the first year, although water production rates decrease significantly thereafter, being almost zero after about four years of production.

Gas wells will be designed and installed progressively, with initial estimates indicating the final well field will comprise 26 dual lateral well pairings. All wells are expected to be installed in the first 13 years of gas extraction, with this sum comprising 14 wells of 1,500 m length and 12 wells of 1,200 m length. Average water production rates between 2026 and 2039 are expected to be about 41 m^3/day.

Figure 1.3 and Figure 1.4 present the drilling schedule and the total flow rate over time.

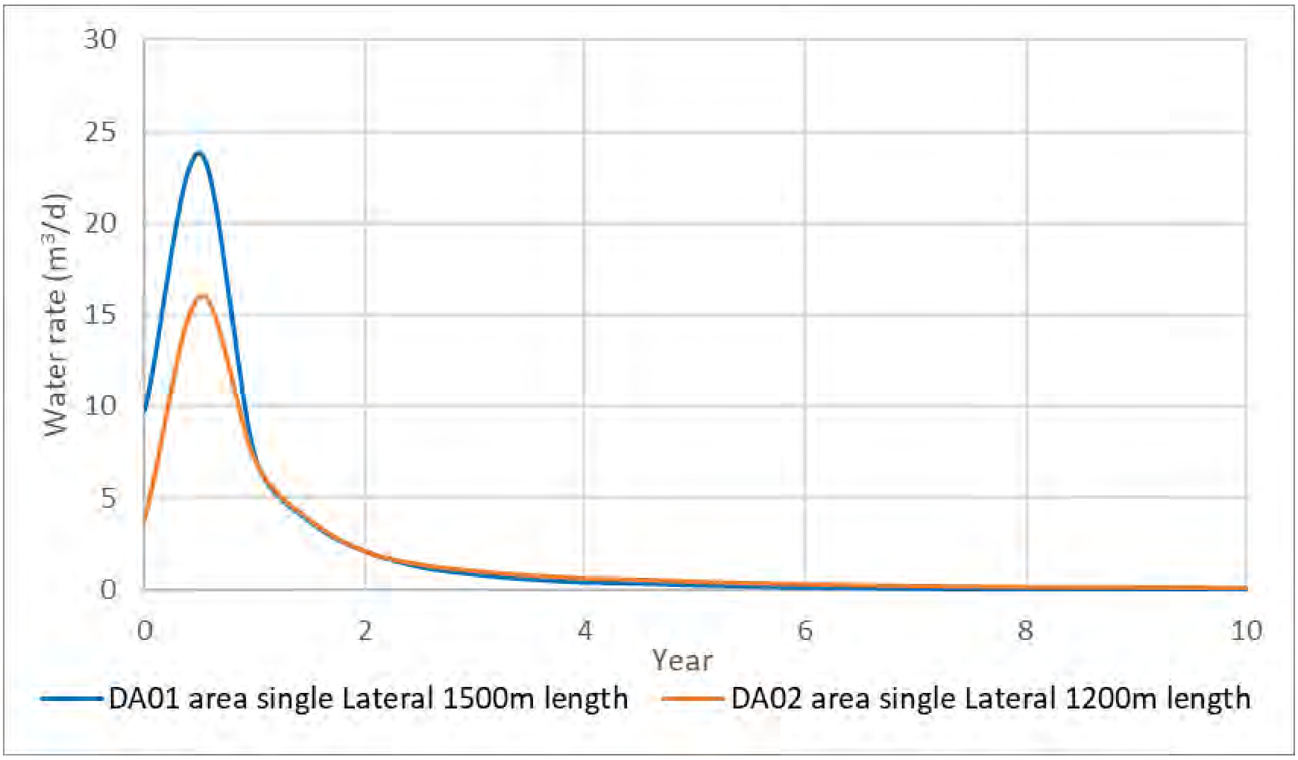


Figure 1.2 Water production profile for a single lateral well

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1 Section 4 of report from Transition Corporation to Stanmore Green, provided by SMC (2024)

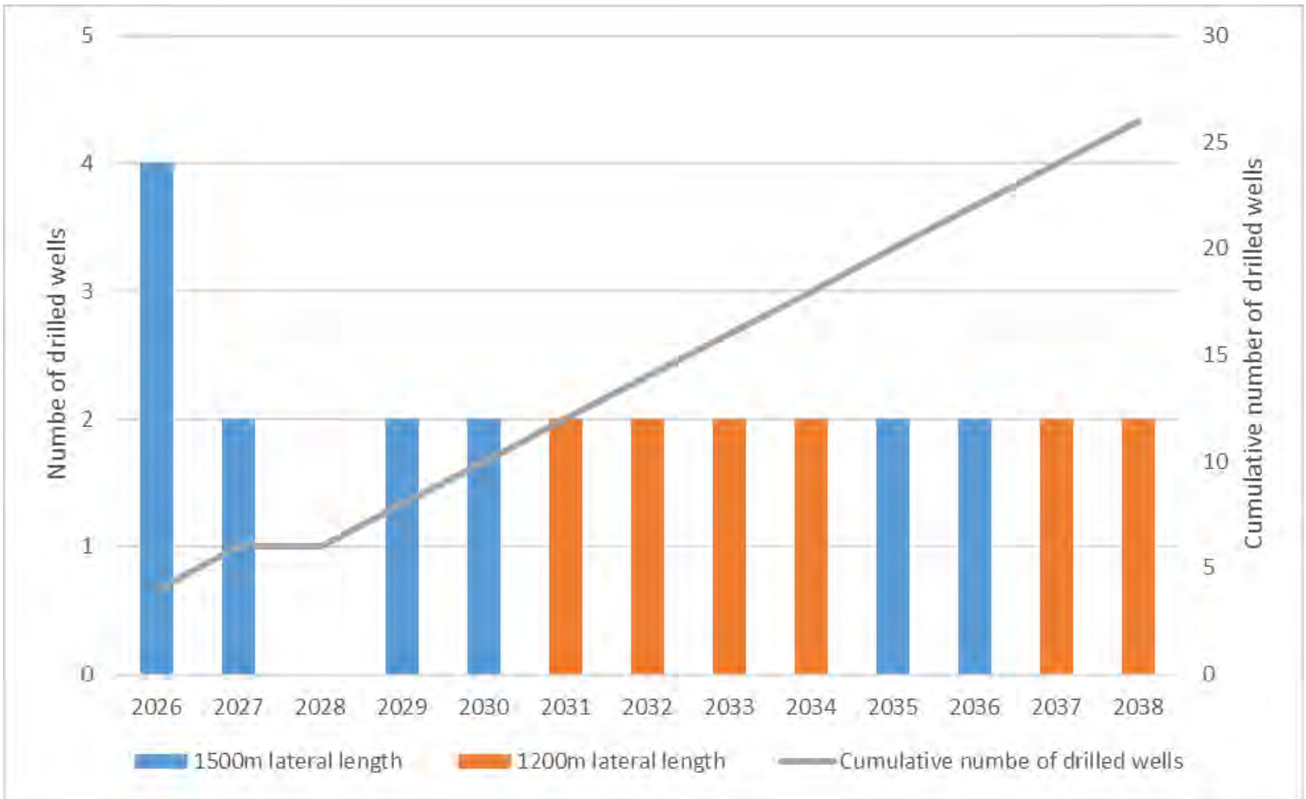


Figure 1.3 Drilling schedule

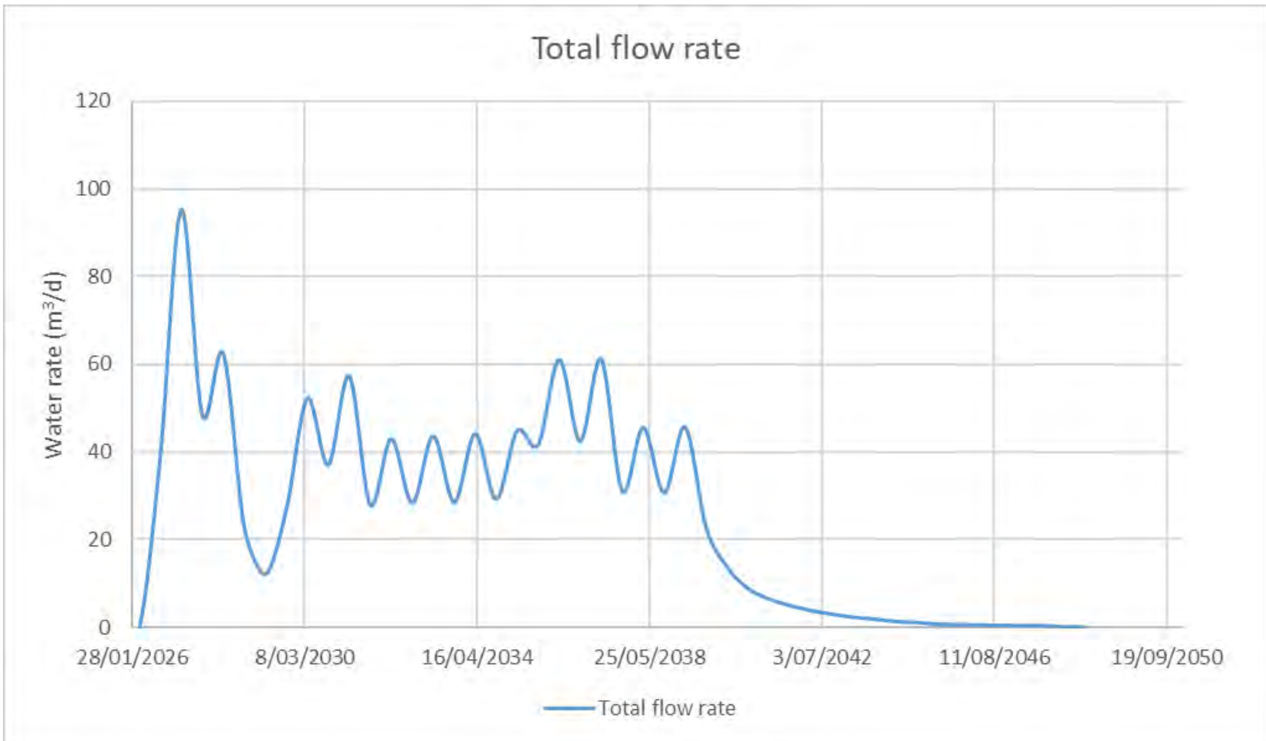


Figure 1.4 Total production profile

1.3 Description of study area

1.3.1 Spatial boundaries

Areas have been defined for this GIA to identify potential effects arising from the Project on valued components. Additionally, a broader regional area encompassing the entire SWC Mine area and its surroundings is considered important for this study. These two areas are described below, along with their relevance to the current study:

— **Project Area:** the local study area for assessing immediate impacts, including the vicinity of the proposed CGS extraction wells and a buffer of approximately 5 km from proposed well locations. The area is designed to be large enough to effectively analyse and mitigate potential effects from the Project on the receiving environment, but not so large as to dilute or confound Project-related effects with other human-induced and natural influences. This local study area is defined as the "Project area" or "site" for the groundwater study.

— **Regional Study Area:** this encompasses the entire SWC Mine area and its surroundings, serving as the basis for the numerical model domain. It is designed to include a large enough region to analyse broad regional effects of the Project on existing groundwater users and to account for induced effects and cumulative impacts from nearby mining operations.

1.3.2 Temporal boundaries

Temporal boundaries for Project-related effects are defined in terms of the Project phases:

— Baseline – covers ecological, physical and human-related characteristics of the environment such as groundwater flow direction, groundwater pressure, connectivity between aquifers, existing users, flow direction etc., as characterised prior to the initiation of the construction phase.

— Construction – includes all activities associated with Project construction and before commencement of gas extraction, including development of drill pads and construction of the gas drainage field in the south-western area of ML475.

— Operations – includes ongoing gas extraction and processing with associated extraction and separation of groundwater, including transport of gas and water through the collection system.

— Decommissioning – all activities to decommission gas drainage field and remove equipment and materials from the site, including the proper abandonment of bores, restoration of drainage patterns to stable long-term conditions and implement the final rehabilitation procedures to prevent erosion and restore vegetation cover.

— Closure – refers to conditions following the decommissioning of the project and completion of closure works.

2 Legislative framework

2.1 Federal legislation

2.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

Under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), actions that have, or are likely to have, a significant impact on a matter of national environmental significance (MNES) require approval from the Commonwealth Department of Environment and Energy (DoEE) and the relevant Minister. If it is determined that a proposed action will impact upon a MNES, then the action is declared a 'controlled' action and must go through an assessment and approval process. The nature, significance/intensity, and complexity of those impacts will determine the applicable level of assessment required by the Commonwealth.

MNES include, among other things:

— World heritage

— National heritage

— Wetlands of international importance

— Listed threatened species and communities, and

— Water resources, in relation to gas drainage and large coal mining developments.

Amendments to the EPBC Act enacted on 22 June 2013 made water resources an MNES in relation to coal seam gas and large coal mining developments (commonly known as the 'water trigger'). This means those gas drainage developments that have potential for significant impact on water resources must be referred to DoEE for assessment under the EPBC Act.

The determination of the significance of the proposed action can be undertaken through a self-assessment against the DoEE impact significance criteria presented in The Matters of National Environmental Significance: Significant Impact Guidelines Version 1.1 (the MNES guidelines) (DoEE, 2013). The self-assessment can then be used by the proponent to determine if the action should be a controlled action or not. If the proposed action is not likely to be significant, the action can proceed, subject to any additional state or local government requirements.

While an official decision on whether the Project will be a controlled action is yet to be determined, it is likely to activate the water trigger for gas drainage activities and have controlling provision placed as per section 24D and 24E of the EPBC Act.

Additionally, an Independent Expert Scientific Committee (IESC) on gas drainage and large coal mining development is a statutory committee established in 2012 under the EPBC Act. The IESC provides scientific advice to DoEE regarding potential impacts gas drainage and large coal mining developments may have on water resources. State regulators can also seek the IESC's advice in accordance with the terms of the National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development.

2.2 State legislation

2.2.1 *Water Act 2000*

The Water Act is administered by the Queensland Department of Natural Resources, Mines and Energy (DNRME) and its purpose is to provide a framework for the sustainable management of Queensland's surface and groundwater resources, regulating the taking, supplying or interfering with water.

The purpose of the Water Act is to provide for the sustainable management and efficient use of water and other resources, a regulatory framework for providing water services and the establishment and operation of water authorities.

The Water Act regulates groundwater impacts caused by resource tenure holders by setting out monitoring and reporting requirements, groundwater drawdown trigger thresholds levels, and make good obligations if the extraction of coal seam water adversely affects groundwater supply to a third-party water bore or a natural spring.

Monitoring requirements include resource tenure holders undertaking baseline assessments of private water bores in areas where gas production or testing has commenced. Baseline assessments are required to assist with the development of any future make good agreements and involve the collection of information about, and data from, groundwater bores, including:

- the depth of the bore
- bore construction details including the type and depth of screened intervals (i.e., water intake zones)
- the type of infrastructure used to pump water from the bore
- the depth to groundwater in a bore, including changes to this elevation during seasonal events, and
- the quality and geochemistry of groundwater, and
- the use(s) of groundwater abstracted from the bore.

The groundwater drawdown trigger thresholds in the Water Act include:

- bore trigger thresholds, where there is a decline in the water level in the aquifer that is:
  - prescribed by regulation
  - for a consolidated aquifer: 5 m
  - for an unconsolidated aquifer: 2 m
- Spring trigger thresholds, where there is a decline in the water level of the aquifer that is:
  - prescribed by regulation
  - 0.2 m or greater.

An immediately affected area (IAA) is defined under the Water Act as the area of an aquifer where the water level is predicted to decline, due to water extraction by resource tenure holders, by more than the bore trigger threshold within three years of the Underground Water Impact Report (UWIR). An immediately impacted bore is defined as a bore located within the IAA.

A long-term affected area (LAA) is defined under the Water Act as the area of an aquifer where the water level is predicted to decline due to water extraction by more than the bore trigger threshold at some time in the future.

A potentially affected spring is defined under the Water Act as a spring where the water level of the underlying aquifer (or aquifers) is predicted to decline by more than the spring trigger threshold at the location of the spring at some time in the future. The potentially affected aquifer though does not necessarily have to be the source aquifer for the spring. The UWIR includes springs within 10 km of the spring trigger threshold as potentially affected, to allow for the limitation of modelling small changes in water level/pressure (Queensland Water Commission [QWC], 2012a).

Where impacts to a bore occur and make good obligations apply, a resource tenure holder is required to:

- undertake a bore assessment
- enter into a make good agreement with the owner of the bore
- comply with the make good agreement, and
- if asked to vary the make good agreement, negotiate a variation of the make good agreement.

The Water Act also defines the roles and responsibilities of the Office of Groundwater Impact Assessment (OGIA) for assessment and management of cumulative impacts on groundwater resources such as third-party bores and springs resulting from multiple resource projects in the Surat Basin. With the Surat and southern Bowen basins undergoing a major expansion in natural gas production in 2011, this led to declaration of the Surat Cumulative Management Area (Surat CMA). The Queensland Water Commission (QWC) has prepared an UWIR for the Surat CMA, which include the Project area

Underground Water Impact Report for the Surat Cumulative Management Area

The UWIR for the Surat CMA was first released in 2012 and is a statutory instrument under the Water Act. The report assesses the cumulative impacts on groundwater in the Surat CMA (which encompasses the Surat and southern Bowen Basins), because of water extraction by conventional and unconventional gas production. The UWIR also establishes integrated management arrangements. An updated UWIR for the Surat CMA was published by the OGIA in September 2016.

In preparing the Surat CMA UWIR, the QWC undertook groundwater flow modelling to predict impacts on water levels and found that 85 registered bores within the Surat CMA would experience water level declines by more than the trigger threshold within three years (2015), and a total of 528 bores would be affected at some time in the future. Under the Water Act, resource tenure holders are required to 'make good' the impairment of private bore supplies that may result from gas activities. The Surat CMA UWIR identifies which resource tenure holder is responsible as more than one tenure holder could be contributing to the impact.

The Surat CMA UWIR includes a Water Monitoring Strategy, an integrated water monitoring network to collect data on groundwater levels and basic groundwater quality in the Surat CMA. The network includes 498 water level monitoring points at 142 locations and 120 water quality monitoring points. There are already networks of monitoring bores in place, and the remaining monitoring points are being constructed by resource tenure holders.

There are five spring complexes in the Surat CMA where the predicted decline in groundwater level in the source aquifer is more than 0.2 m at the location of the spring (QWC, 2012a). The Spring Impact Management Strategy in the Surat CMA UWIR requires resource tenure holders to evaluate and submit a report to OGIA on potential mitigation options at these locations. Petroleum tenure holders are also required to monitor conditions in springs and submit the results to OGIA. In stating the above, these springs are not located in either the Project area or regional study area, and therefore not expected to be impacted by the Project.

Water Plan (Fitzroy Basin) 2011

The Water Plan (Fitzroy Basin) 2011 applies to all surface and groundwater in the Fitzroy region, with the exception of aquifers within the Great Artesian Basin. Under the plan supplemented water is provided through a resource operations licence and a Water Supply Scheme fed by a dam. Un-supplemented water is in relation to river and creek flows during storm events. SWC is within the Isaac Connors sub-catchment and groundwater management area. This area of the plan has no water supply schemes for supplemented water.

Bee Creek runs just to the east of the mine site, whereas Walker Creek, which runs through the mine site diversions, falls into the Isaac Connors Alluvium Groundwater sub-catchment. There are no specific flow or drawdown duration objectives for the Project area under this plan.

2.2.2 Environmental Protection Act 1994

The Environmental Protection Act 1994 (Qld) (EP Act) has the objective to protect Queensland's environment while allowing for the development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).

The EP Act requires that, to carry out an environmentally relevant activity (ERA), an environmental authority (EA) is required. A resource activity which includes coal seam gas extractions is defined as an ERA.

SMC proposed to seek an amendment of the existing EA to allow coal seam gas production activities within the Project Area. To achieve this, the EA amendment must include the following items as detailed in Section 125 of the EP Act:

- include an assessment of the likely impacts of each relevant activity on the environmental values, including:
  - a description of the environmental values likely to be affected by each relevant activity
  - details of any emissions or releases likely to be generated by each relevant activity
  - a description of the risk and likely magnitude of impacts on environmental values
  - details of the management practices proposed to be implemented to prevent or minimise adverse impacts, and
  - details of how the land the subject of the application will be rehabilitated after each relevant activity ceases.

Section 126A of the EP Act outlines the application requirements related to the exercise of underground water rights. These requirements are outlined in Table 1 which also includes references to sections of this report where these items are addressed.

Table 2.1 Key Environmental Protection Act 1994 Statutory Requirements Related to Groundwater

EP Act Section	Requirement	Reference
126A(2)(a)	The application must also state the following: Any proposed exercise of underground water rights during the period in which resources activities will be carried out under the relevant tenure.	Section 1.2
126A(2)(b)	The areas in which underground water rights are proposed to be exercised.	Section 1.2
126A(2)(c)	For each aquifer affected, or likely to be affected, by the exercise of underground water rights: (i) a description of the aquifer.	Section 4.4
	(ii) An analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with the other aquifers and surface waters.	Section 4.4 Section 5.3
	(iii) A description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights.	Section 6.2
	(iv) The predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out.	Section 1.2.2 and 6.1.5.1
126A(2)(d)	The environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values.	Section 7.4
126A(2)(e)	Any impacts on the quality of groundwater that will, or may, have happened because of the exercise of underground water rights during or after the period in which resource activities are carried out.	Section 7.4.5
126A(2)(f)	Strategies for avoiding, mitigating or managing the predicted impacts on the environmental values stated for paragraph (d) or the impacts on the quality of groundwater mentioned in paragraph (e).	Section 8

Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (Qld) (EPP Water) was established to protect Queensland waters while allowing for ecologically sustainable development. It sets the broad environmental protection measures for Queensland waters and provides a framework for:

— identifying environmental values for aquatic ecosystems and for human uses, and

— determining water quality guidelines and objectives to enhance or protect the environmental values.

The EPP Water states the relevant environmental values and water quality objectives for water, and the relevant water quality guidelines and indicators for protecting these values. Environmental values of specific waters to be protected or enhanced, such as those within the vicinity of the Project, are defined in Schedule 1 of the EPP Water.

2.2.3 Waste Reduction and Recycling Act 2011

The Waste Reduction and Recycling Act 2011 (Qld) (WRR Act) aims to reduce the consumption of natural resources and minimise the disposal of waste by encouraging waste avoidance and the recovery, reuse and recycling of waste. The WRR Act authorises particular and general beneficial uses of coal seam water. The grant of a beneficial use approval can change the status of coal seam water from a waste under the EP Act to a resource that is to be used for a beneficial purpose.

2.2.4 Nature Conservation Act 1992

Native flora and fauna species are protected in Queensland under the Nature Conservation Act 1992 (Qld) (NC Act). The subordinate Nature Conservation (Wildlife) Regulation 2006 (Qld) (NCWR) contains categories such as extinct in the wild, endangered, vulnerable, near threatened and least concern, each reflecting both the abundance and levels of protection for a species.

Protected areas on state lands such as National Parks and Conservation Parks are listed in the Nature Conservation (Protected Areas) Regulation 1994. The NC Act protects individual species and ecological communities associated with groundwater-dependent springs that may be found in proximity to the Project Area.

3 Methodology

WSP conducted hydrogeological studies in the Project area as part of the GIA at the SWC to support the approval process for developing gas extraction. This work focused on the Project area and included an assessment of the broader SWC mine area (the regional study area) to account for cumulative impacts, these arising from depressurisation for gas production, mine inflows, and third-party operations, ensuring adequate environmental coverage. The GIA development consisted of three stages:

i) The development of a conceptual hydrogeological model of the Project area and surrounds using past assessments carried out by Golder (2022), site datasets provided by SMC (groundwater levels and groundwater quality data) as well as publicly available datasets (QLD Globe and SILO).

ii) The development of a numerical groundwater flow model of the Project area, SWC mine and surrounds, and the use of this model to assess the likely impacts of the Project on groundwater elevations, flow directions, environmental values and any sensitive receptors, including groundwater-dependent ecosystems.

iii) The assessment of the impacts of gas drainage production water use in accordance with the applicable water management regulations and guidelines.

Further details regarding each of the above key steps are summarised below and in the following sections.

3.1 Existing environment and environmental values

A desktop assessment was carried out for the regional study area to establish the baseline groundwater conditions, potential connectivity between aquifers, environmental values, and potential receptors. The desktop assessment utilised data and information provided by SMC, past assessments carried out by Golder Associates Pty Ltd, and publicly available reports and data. Primary data and information utilised in this assessment included the following.

Datasets

- Geological maps including:
  - Detailed surface geology (QLD DNRME, 2020)
  - Solid bedrock geology and structures (QLD DNRME, 2020)
- 'Surfaces' from digital elevation models (DEMs) for target coal seams, and details of spatial variation in net coal thickness within the target coal measures
- Registered bore data, including aquifer attribution, bore purpose, static water level measurements, and water use estimates
- Potential GDE mapping published by the Department of Environment and Science (year), and
- Site monitoring bore groundwater levels and groundwater quality data.

Reports

- Post-Closure Hydrogeological Assessment, South Walker Creek Mine (WSP, 2024).
- South Walker Creek Kemmis 2 Pit Extension, Groundwater Model (WSP, 2023).
- Water Licence Annual Groundwater Monitoring Report – 1 July 2022 to 30 June 2023 (WSP, 2023).
- TSFs Groundwater Monitoring Plan Design – Gap Analysis, South Walker Creek Mine (WSP Golder, 2022).
- BMC South Walker Creek Mine Kemmis Pit Extension Project, Groundwater Impact Assessment (Golder, 2022).
- Groundwater Modelling in Support of BHP South Walker Creek EA Amendment, Hydrogeological Conceptual Model (Golder, 2021).

— BHP Billiton Mitsui Coal, Groundwater Impact Assessment for the South Walker Creek Mine MRA2C Project (Golder, 2018).

3.2 Numerical modelling

Numerical groundwater flow modelling has been undertaken to assess potential impacts of the Project to environmental values. Modelling is based on the Project setting summarised in Section 4 and the hydrogeological conceptualisation summarised in Section 5.3. Numerical model construction is detailed in Section 6.1.1 and results of the modelling including calibration details, scenario outcomes, and sensitivity analysis results are presented in Section 6.2.

3.3 Impact assessment

Modelling included simulations to provide impact predictions from the Project only. Outcomes of these predictive scenarios were processed and considered as part of this assessment, with:

- modelled scenario outcomes presented in Section 6.2
- outcomes of the modelled scenarios specific to environmental values and receptors presented and discussed in Section 7.4, and
- assessment of impacts of the exploration boreholes on groundwater presented in Section 7.5.

The assessment criteria used to consider the groundwater drawdown impacts associated with the Project refers to the Water Act trigger thresholds, as outlined in Section 2.2.1:

- Bore trigger threshold, represents the maximum allowable groundwater level decline in a groundwater bore, due to resource tenure holders' activities, prior to triggering an investigation into the water level decline.
  - For a consolidated aquifer: 5 m.
  - For an unconsolidated aquifer: 2 m.
- Spring trigger threshold represents the maximum allowable decline in the water level of an aquifer or aquifers underlying a spring, at the spring location, prior to triggering an investigation into the water level decline. The maximum allowable decline in water level is 0.2 m.

Other potential impacts associated with the Project are presented in Section 7.4, with the relevant mitigation, management and monitoring measures to address these potential impacts provided in Section 8.

4 Project setting

4.1 Topography and drainage

4.1.1 Topography

The Project area is situated within ML 4750, west of the Toolah pit. Figure 4.1 shows the pre mining surface topography of the regional study area, with surface generally grading to the southeast towards Bee Creek to the east of the active mining areas at the SWC mine. Kemmis Creek, Walker Creek, Carborough Creek and Sandy Creek all flow into Bee Creek, which is a regionally significant creek flowing from north to south-east to the east of the active mining areas at the SWC mine.

Topographic information available within QLD Globe (Geoscience Australia, 2020) shows the SWC site is relatively flat with elevations ranging from approximately 260 m Australian Height Datum (AHD) near the Kemmis pit to approximately 205 m AHD near the Toolah pit. Areas with the highest elevation occur along the Carborough Range to the west of SWC, with elevations of up to approximately 530 m AHD associated to the north-northwest to south-southeast ranges in this area.

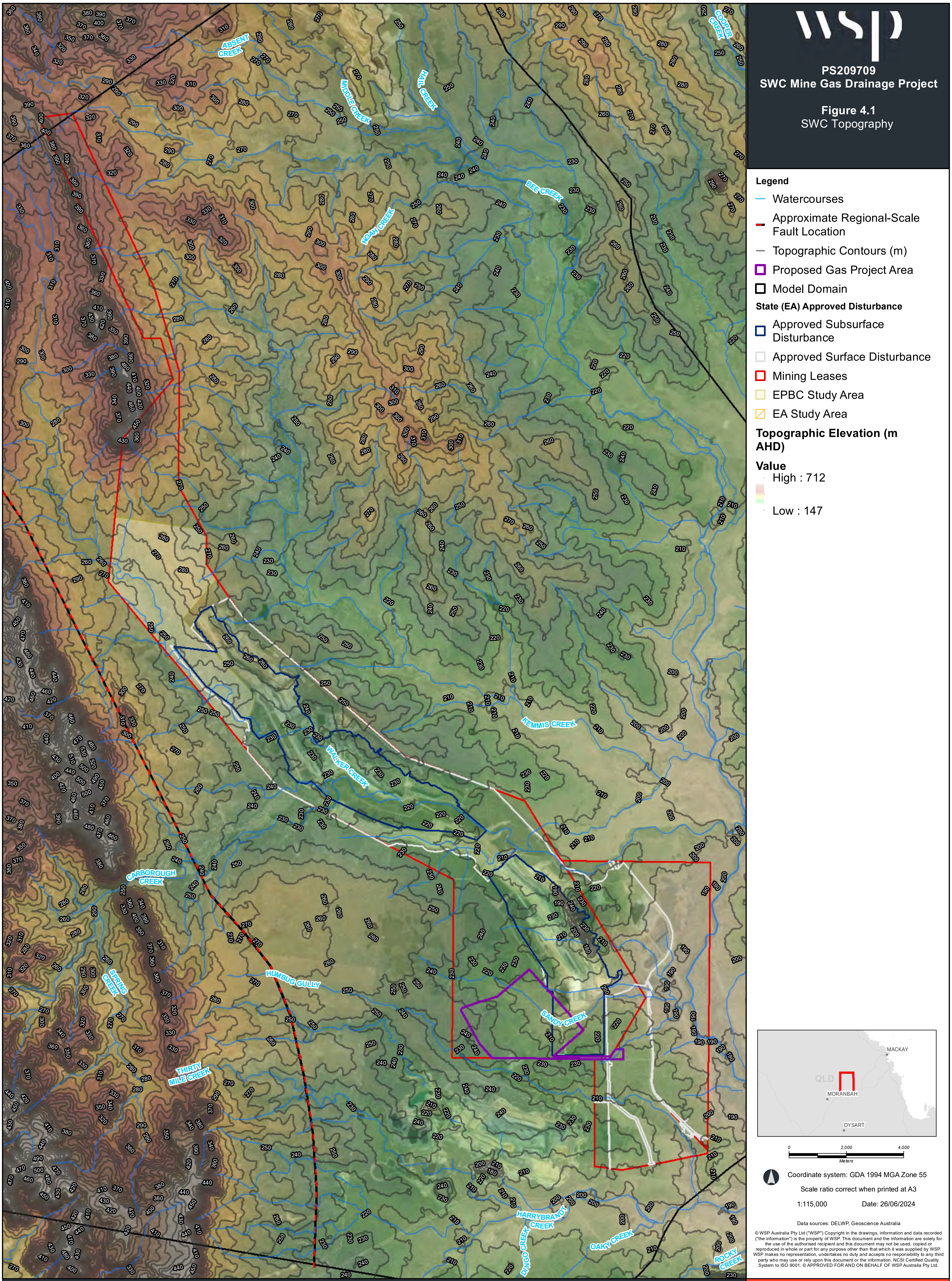
Sandy Creek traverses above the planned gas well field in the northern portion of the Project area, whilst Humbug Gully, a local network of shallow ephemeral waterways, is located to the south of the Project area (Figure 4.2). The Project area largely comprises undulating terrain between about 240 m AHD in the west and 205 m AHD in the east, the latter along Sandy Creek's course which largely forms a 'valley' within the Project area.

4.1.2 Drainage

The Project area is in the Central Tributaries sub catchment of the Connors River catchment (Figure 4.3). It is located north of Humbug Gully and comprising part of Sandy Creek, the latter of which flows into Bee Creek to the east. Humbug Gully flows into Harrybrandt Creek, which in turn flows into Bee Creek.

In the regional study area, the ephemeral Carborough and Walker Creeks flow into Bee Creek, which then continue south-east and south, joining with the Connors River just upstream of its juncture with the Isaac River.

The Isaac and Connor Rivers are major tributaries to the Fitzroy River. The Fitzroy River Basin encompasses six major river systems and has an area of more than 140,000 km^2, with all collected waters in this basin eventually draining to Keppel Bay near Rockhampton.


PS209709
SWC Mine Gas Drainage Project
Figure 4.1
SWC Topography
Legend
Watercourses
Approximate Regional-Scale Fault Location
Topographic Contours (m)
Proposed Gas Project Area
Model Domain
State (EA) Approved Disturbance
Approved Subsurface Disturbance
Approved Surface Disturbance
Mining Leases
EPBC Study Area
EA Study Area
Topographic Elevation (m AHD)
Value
High : 712
Low : 147
ABSENT CREEK
MIDDLE CREEK
TAIL CREEK
COOPER CREEK
BEE CREEK
NOAH CREEK
KEMMIS CREEK
WALKER CREEK
CARBOROUGH CREEK
HUMBUG GULLY
SPRING CREEK
SANDY CREEK
THIRTY MILE CREEK
HARRYBRANDT CREEK
DINGO CREEK
OAKY CREEK
ROCKY CREEK
MACKAY
QLD
MORANBAH
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Data sources: DELWP, Geoscience Australia

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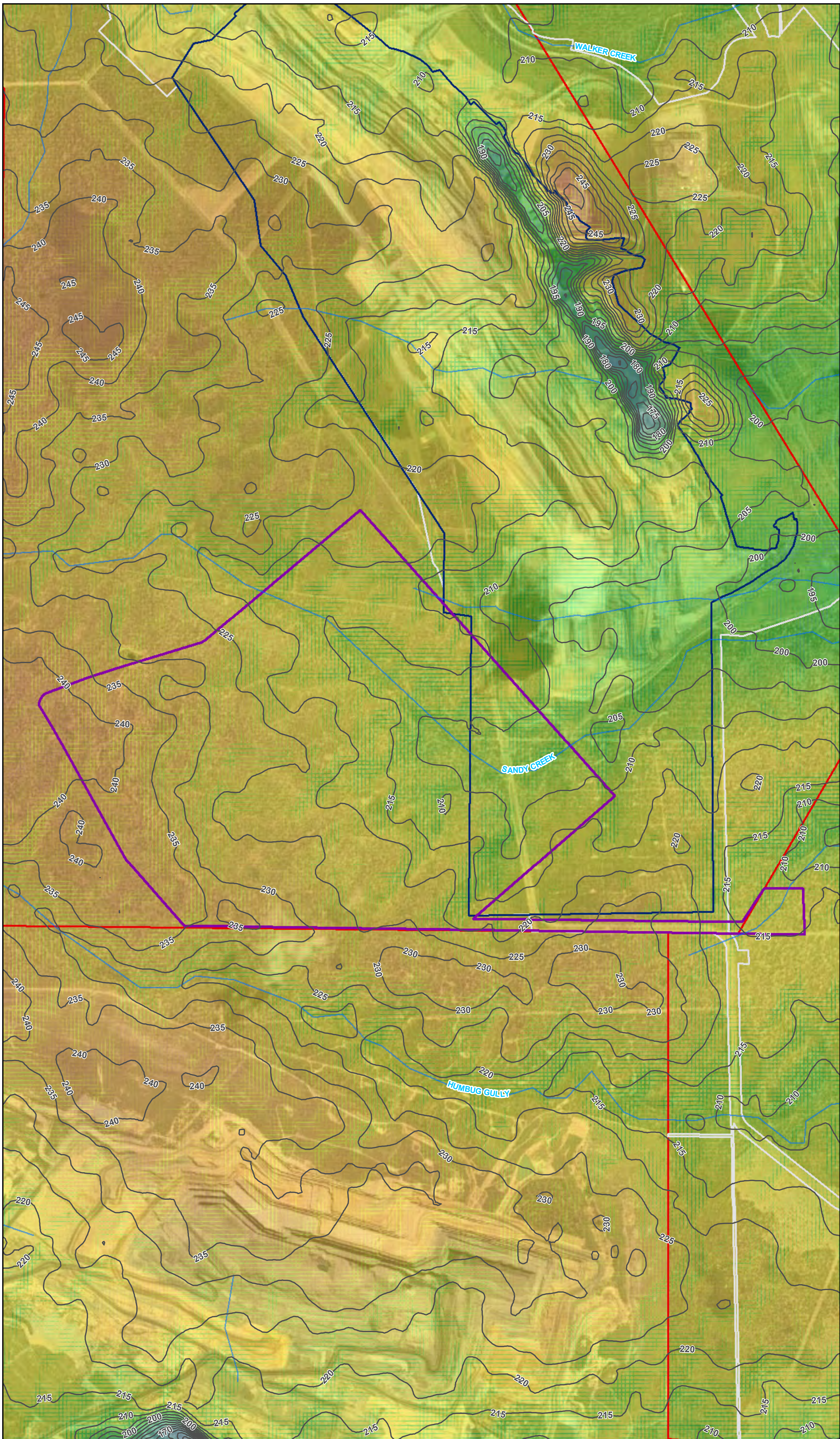
SWC Mine Gas Drainage Project

Figure 4.2
Gas ProjectTopography



Legend

- Topographic Contours (m)
- Proposed Gas Project Area
- Mining Leases
- Model Domain

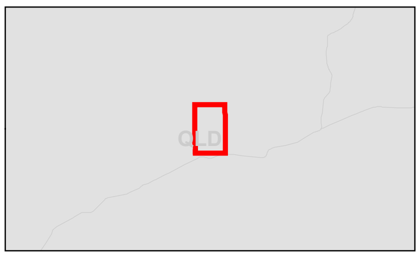
State (EA) Approved Disturbance Area

- Approved Subsurface Disturbance
- Approved Surface Disturbance

Topographic Elevation (m AHD)

High : 476.264

Low : 146.547



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Data sources: DELWP, Geoscience Australia

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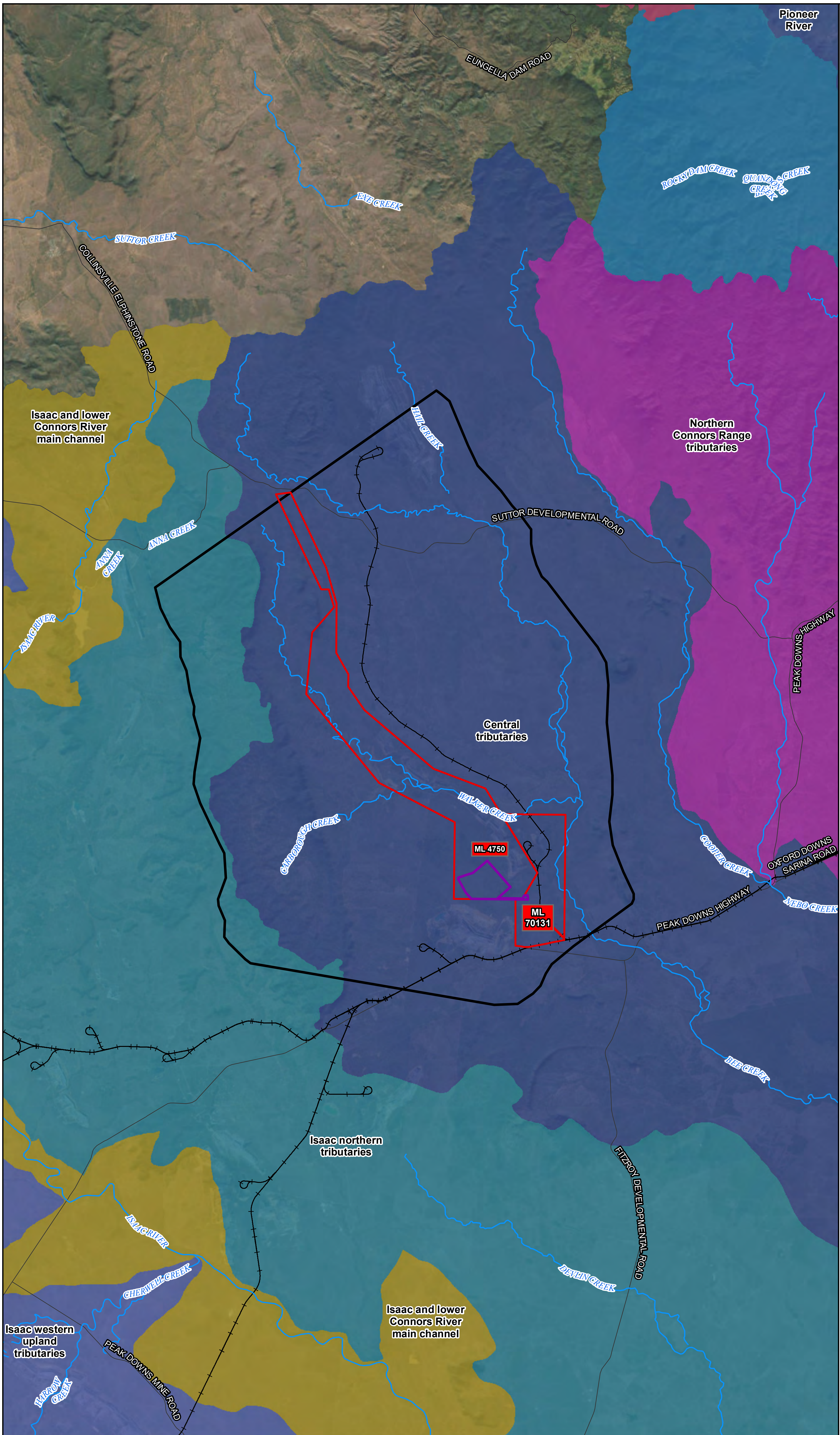
SWC Mine Gas Drainage Project

Figure 4.3
Surface water catchments

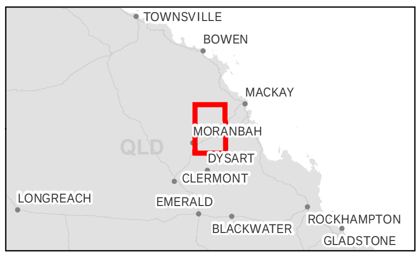


Legend

- Watercourse
- State Controlled Road
- Railway
- Mining Lease
- Proposed Gas Project Area
- Model Domain

Surface Water Subcatchment

- Blacks Creek
- Central tributaries
- Isaac and lower Connors River main channel
- Isaac northern tributaries
- Isaac western upland tributaries
- Northern Connors Range tributaries
- Pioneer River
- Upper Cattle Creek



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Data sources: DELWP, Geoscience Australia

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4.2 Climate

Figure 4.4 and Figure 4.5 present key statistics for the regional study area obtained from the Department of Science, Information Technology, Innovation and the Arts (DSITIA) Scientific Information for Land Owners (SILO) climate database. The SILO data comprises a gridded dataset derived from Bureau of Meteorology (BoM) records, wherein gaps in data are filled and a spatially complete dataset is generated through processing. The nearest SILO grid point data in proximity to the Project area was considered (latitude – 21.80 148.45 decimal degrees, longitude 21 48'S 148 27'E standard).

The long-term monthly rainfall based on daily data generated from 1892 to 2024 is shown by blue boxplots with whiskers at 10th and 90th percentiles on Figure 4.4. An envelope of evaporation estimates is also shown on Figure 4.4 by the solid orange lines and equivalent shading highlighting the minimum and maximum monthly evaporation, whilst mean monthly evaporation is shown by the orange dotted line with the evaporation envelop.

Figure 4.5 shows annual rainfall aggregates between 1970 and 2023 plotted in blue bars, with the long-term annual rainfall average shown by the red dotted line. The cumulative deviation from mean monthly rainfall (CDMMR), calculated from 1892 onwards, is also shown on this figure by the solid green line.

Based on that information presented on Figure 4.4 and Figure 4.5, it can be seen that:

- Rainfall is summer dominant, with an extended dry season typically occurring between April and November of each year.
- The annual average rainfall (approximately 618 mm) is significantly lower than the potential (Class A pan) evaporation rate (1,996.4 mm/year); this is expected to limit rainfall recharge potential to local aquifers and water-bearing units.
- Above-average rainfall generally occurred from 1970 through to 1991, following which a decline in rainfall occurred, following which periods of below-average rainfall occurred between 1991 – 1996 and 2001 – 2006. This was then followed by a period of typically below-average rainfall, albeit with the highest annual rainfall aggregate in the reported period occurring in 2010.

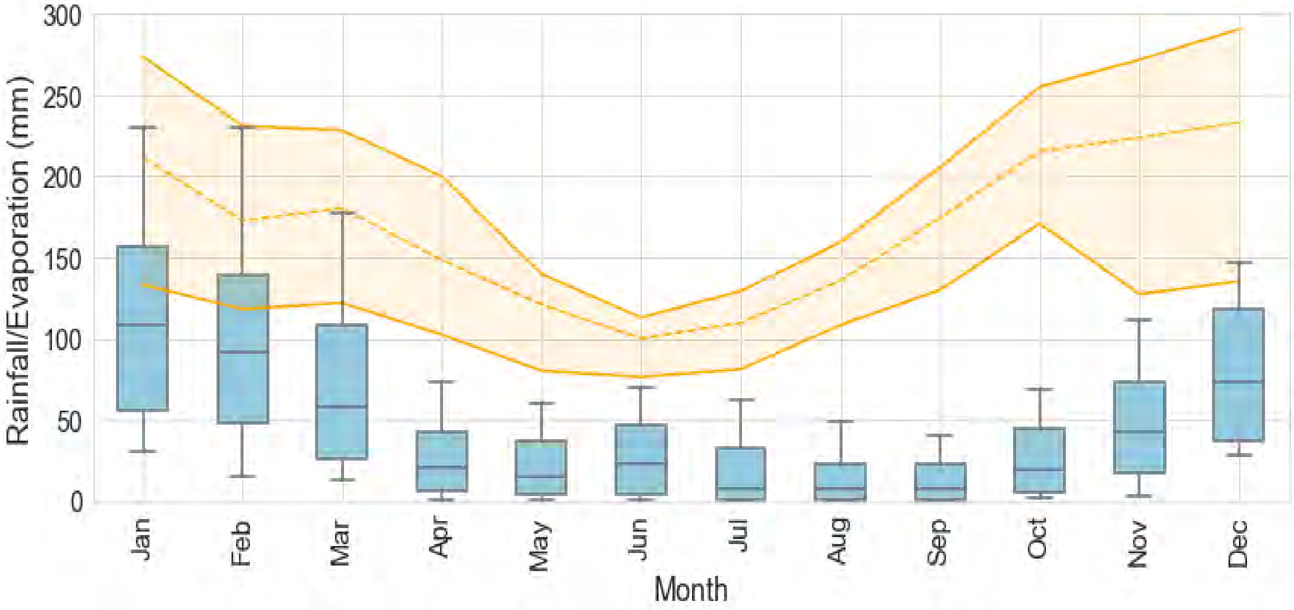


Figure 4.4 Long-term rainfall (blue box plot) and envelope of evapotranspiration statistics (solid orange lines: minimum and maximum, dashed orange line: median) for the Project

Figure 4.5 Total annual rainfall (blue bars), long-term annual rainfall mean (red dotted line) and CDMMR (green line) for the Project area

4.3 Geological setting

The geological context of the SWC Mine has been detailed in prior studies by CDM Smith (2016) and Golder (2022). This assessment provides a summary of the previous works with focus on the Project area located to the west of the Carborough, Walker and Toolah pits.

4.3.1 Regional geology

The Bowen Basin covers an area over 60,000 km^2 from Collinsville to Theodore in Central Queensland and contains one of the largest reserves of coal in the world. It contains up to 10 km of Permo-Triassic, terrestrial and shallow marine, largely clastic, sediments, with the thickest succession occurring in the Taroom and Denison Troughs in the southern portion of the basin (CDM Smith, 2016).

Deposition in the basin started in the Early Permian with a phase of limited back arc extension, producing a series of grabens and half grabens that were filled mostly with continental alluvium sediments. This was followed by regional thermal subsidence (sag), into which a widespread marine transgression developed over the entire basin from the Early to Late Permian, giving rise to coal forming alluvial and delta plain conditions that are preserved as Permian coal measures. Sediment accumulation in the Basin terminated during the Middle Triassic.

SWC is located on the eastern margin of the northern Bowen Basin within the Nebo Synclinorium. The geology in this region reflects the post deposition compressional tectonic phase which occurred during the Triassic, during which the sediments were lithified into rocks, and these then deformed into a series of northwest to southeast trending and variably faulted anticlinal and synclinal structures.

4.3.2 Local geology and stratigraphy

Figure 4.6 presents the surface geology of the regional study area whilst solid geology showing the bedrock subcrop/outcrop is shown on Figure 4.7. These figures also show the location of the conceptual cross section presented and discussed in Section 5.3.

Table 4.1 summarises the stratigraphy at SWC and surroundings, from youngest to oldest.

Table 4.1 Stratigraphy at SWC and surroundings

Period	Group	Sub-group/formation	Dominant lithology
Quaternary / Tertiary	-	Surficial	Unconsolidated sand, gravel, and clay
Triassic	Mimosa Group	Rewan Formation	Mudstone, siltstone, and sandstone
Permian	Blackwater Group	Rangal Coal Measures (RCM)	Coal with sandstone, siltstone, and mudstone
		Fort Cooper Coal Measures (FCCM)	Coal with sandstone, siltstone, mudstone, and tuff
		Moranbah Coal Measures (MCM)	Coal with sandstone, siltstone, mudstone, and tuff

Source: (CDM Smith, 2016)

As shown in Figure 4.6, Quaternary and Tertiary-age alluvial deposits are typically localised near watercourses or paleochannels. As such, these sediments are limited laterally in their extent, in this case occurring mostly near the alignment of these watercourses, and exhibit varying degrees of compartmentalisation as a result of their geological evolution.

Immediately underlying the alluvium deposits is a broad expanse of shallow regolith comprising weathered and fractured profiles of the Rewan Formation, RCM and FCCM. Regolith derived from the weathering of the RCM and Rewan Formation is located further to the east and west of the Project area and SWC mine respectively, while regolith derived from the weathering of the FCCM is located further to the east.

The Rewan Formation is a Triassic-aged formation outcropping in the western portion of the mining lease and is underlain by the Permian-aged RCM. The RCM comprises sandstone, siltstone, mudstone, coal, tuff, and conglomerate. This formation outcrops as an elongate, approximately 1,000 m wide strip along the eastern flank of the major basin-wide syncline (Figure 4.7), the axis of which aligns with the Carborough Range (CDM Smith, 2016). The coal seams and interburden of the RCM outcrop/subcrop along the eastern flank of this syncline and are underlain by the Permian-age FCCM which outcrops across the SWC mine footprint and to the east.

The FCCM is comprised of coal, sandstone, conglomerate, mudstone, carbonaceous shale, and cherty tuff. The FCCM is not currently mined in this area, however, with SWC rather targeting two main coal seams within the RCM. Both the RCM and FCCM dip broadly to the west.

4.3.3 Geological structure

4.3.3.1 Regional-scale Faults

The description of major fault structures within the regional study area and surroundings is based on a review of existing geological and hydrogeological literature, and interpretations of nearby seismic reflection surveys carried out by Golder (2022).

Arrow Energy (2013a) describes the regional structures in the northern Bowen Basin as '*predominantly of south to north or south-southeast to north-northwest trending gentle folds and faults*'. The geological model summarised by Arrow Energy (2014b) includes a review of published, and mapped faulting, within the basin which considers (i) interpretation of 2D seismic sections for faults (Silva, 2011), and (ii) a study of the hydraulic properties of the faults. It is noted that the basin stress regime allows for a contemporary compressive stress regime which produces reverse and thrust faulting which may reduce, or close fracture apertures associated with such stresses (Arrow Energy, 2014b).

Information viewed as part of the literature review suggest the presence of a major SSE-NNW-oriented reverse fault on the eastern limb of the northern basin syncline. The axis of this syncline is located along the Carborough Range about 6 km west of SWC. This unnamed major SSE-NNW fault intersects the RCM geology downgradient of the pits (Figure

4.7), and appears to cut across the Permian and Triassic strata, compartmentalising these geological blocks, albeit without repetition of individual geological formations (Arrow Energy, 2013a).

Based on cross-sections from Arrow Energy (2013a), the unnamed SSE-NNW fault displaces several HSUs with offsets near the regional study area of up to 440 m. This is expected to limit lateral flow within hydrostratigraphic units since the vertical displacement of the HSUs across the fault has resulted in aquifers being juxtaposed against other geological formations, the most notable being the Rewan Formation which is a regionally significant aquitard. Seismic interpretations carried out by Golder (2022) suggest offsets vary between 200 and 580 m, and often juxtapose the upper Permian coal seams to the east (i.e. on the hanging wall) against the Rewan Formation to the west (the footwall). Golder's interpretation of this fault from seismic surveys obtained from the Geological Survey of Queensland Open Data Portal (2021) is shown in Figure 4.7. The location of the sections and details of that analysis is presented in Golder (2022).

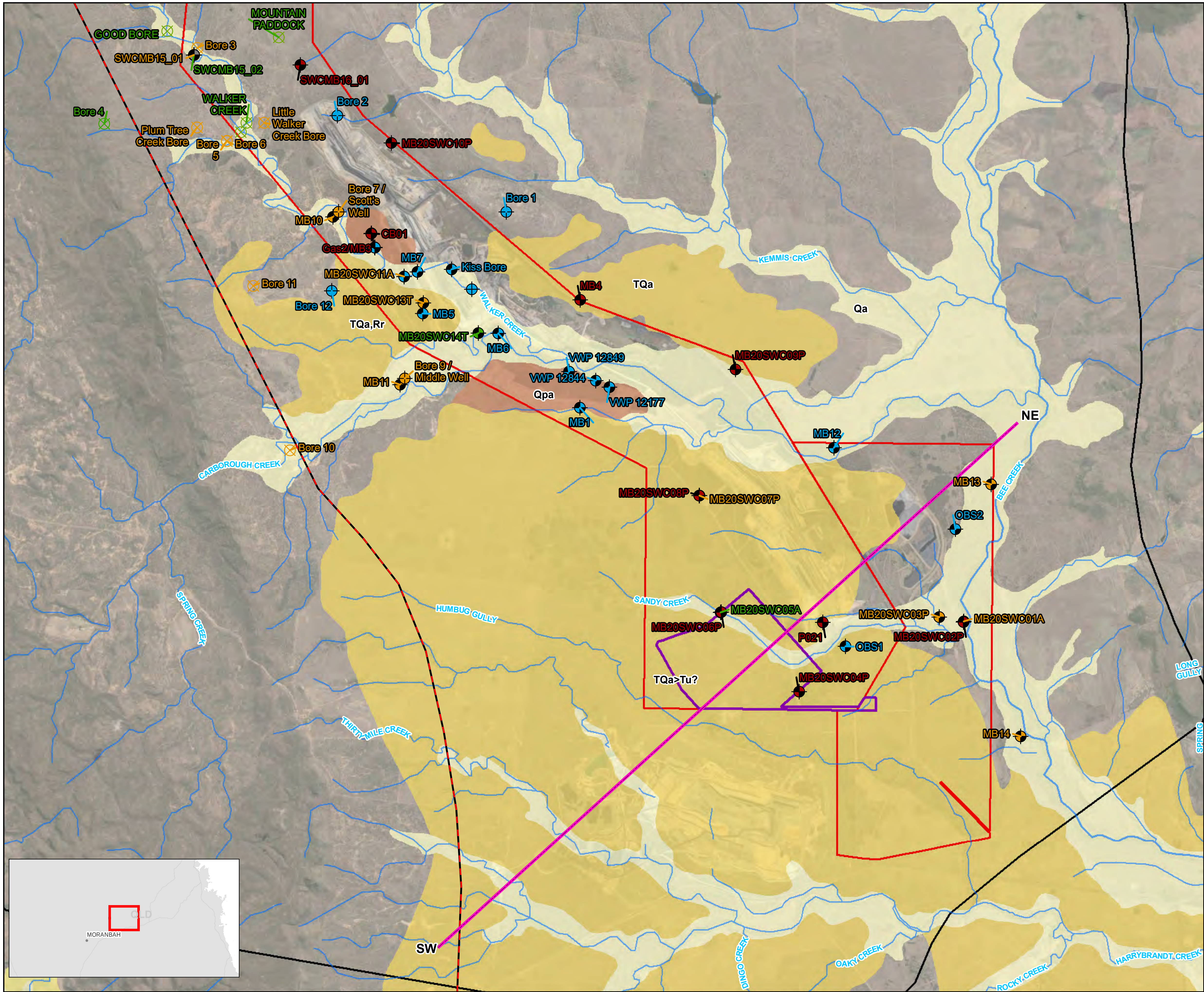
4.3.3.2 Local-scale Faults

Figure 4.7 shows the bedrock extents and the locations of local-scale faults and geological boundaries based on the 1:100,000 scale "Solid Geology" geological map. This geological map suggests these faults often have lengths of up to 5 km and are spatially isolated from regional fault structures.

It is possible that northeast-southwest oriented faults may have formed during regionally significant tensional tectonic events, resulting in the development of normal faults and accompanying dilational ('open') bedrock structures. These faults and structures may enhance local bedrock groundwater flow, thereby allowing these zones to act as locally significant water-bearing zones.

Northwest-southeast oriented faults are thought to be the result of past compressional tectonic stresses (based on these being perpendicular to west-east basin compressional stresses). This is thought to have resulted in the onset of reverse and thrust faulting, both of which are likely to have lower permeabilities, both locally and regionally, compared to similar scale normal faults in the area.

The above is conceptual only and has not been confirmed.



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PS209709
SWC Mine Gas Drainage Project

Figure 4.6
Surface geology

Legend

- Watercourses
- Approximate Regional-Scale Fault Location
- Conceptual cross section
- Mining Lease
- Model Domain
- Proposed Gas Project Area

Monitoring Bore, Screen Geology

Status, HSU

- Operational, Alluvium
- Operational, Regolith
- Operational, Overburden
- Operational, Coal Seam
- Operational, Interburden
- Previous monitoring, Alluvium
- Previous monitoring, Regolith
- No monitoring, Alluvium
- No monitoring, Regolith
- No monitoring, Overburden

Geology

- Qa-QLD (Quaternary Alluvium) - Qa
- Qa\f-QLD (Quaternary Alluvium) - Qa
- Qpa-QLD (Pleistocene Alluvium) - Qpa
- TQa-QLD (Tertiary Alluvium) - TQa
- TQa-QLD,Rewan Group - TQa
- TQa-QLD>Suttor Formation? -TQa

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Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

1:95,000 Date: 3/07/2024

Data sources: DELWP, Geoscience Australia

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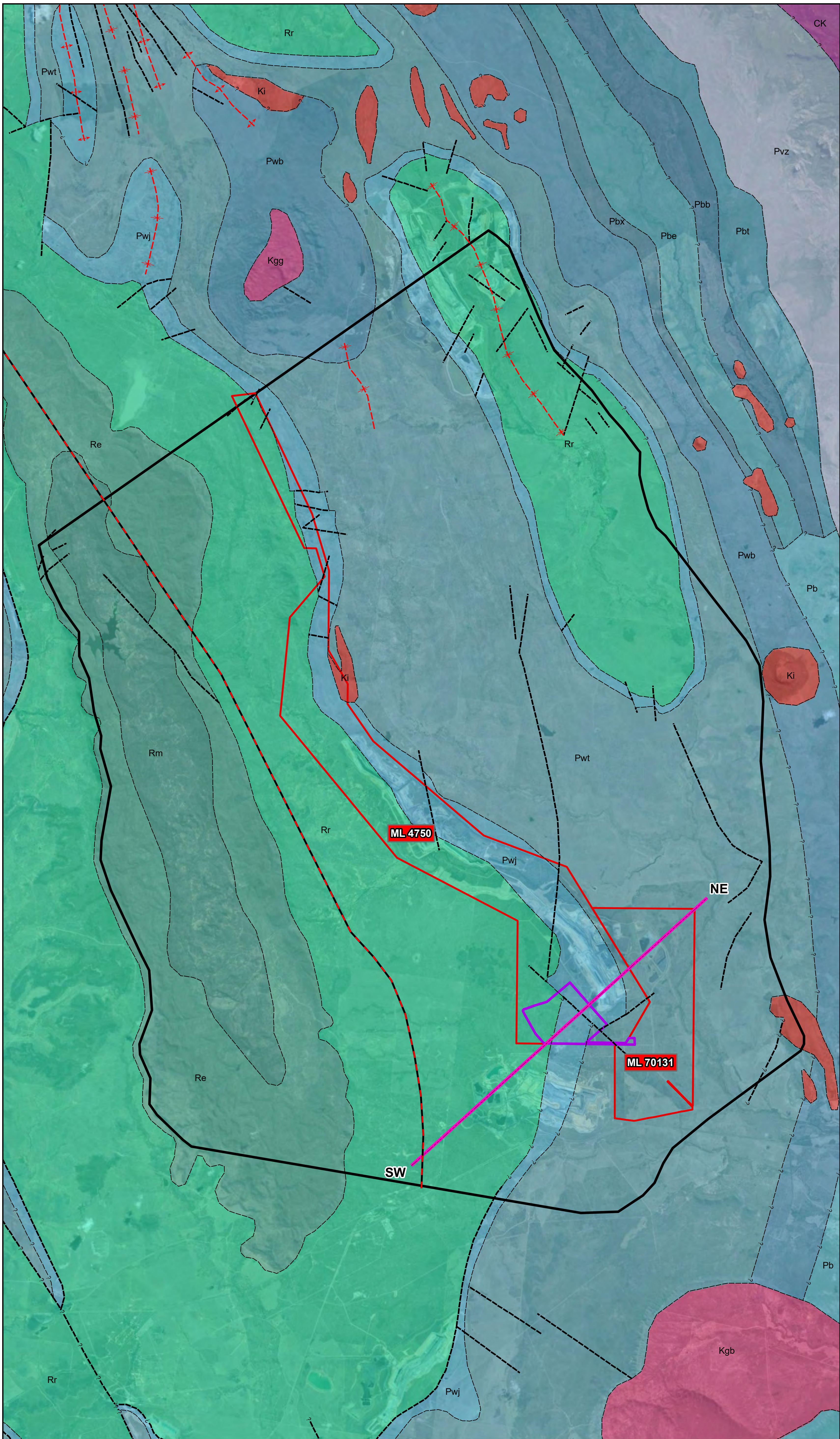
SWC Mine Gas Drainage Project

Figure 4.7
Solid geology map



Legend

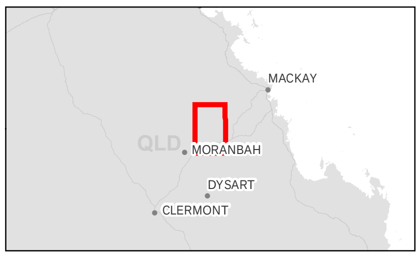
- Approximate Regional-Scale Fault Location
- Conceptual cross section
- Model Domain
- Mining Lease
- Proposed Gas Project Area

Bowen Basin - Regional structure 1985

- Anticline Approximate
- Anticline Approximate Showing Plunge
- Fault Approximate
- Fault Inferred
- Geological Boundary Approximate
- Geological Boundary Inferred
- Syncline Approximate
- Syncline Approximate Showing Double Plunge Towards Culmination

Bowen Basin - Regional solid geology 1985

- Back Creek Group (Pb)
- Blenheim Subgroup (Pbe)
- Bundarra Granodiorite (Kgb)
- Clematis Group (Re)
- Exmoor Formation (Pbx)
- Fair Hill Formation,Fort Cooper Coal Measures (Pwt)
- Gebbie Subgroup (Pbb)
- Gotthardt Granodiorite (Kgg)
- Ki-CQ (Ki)
- Lizzie Creek Volcanic Group (Pvz)
- Moolayember Formation (Rm)
- Moranbah Coal Measures (Pwb)
- Rangal Coal Measures,Bandanna Formation,Baralaba Coal Measures (Pwj)
- Rewan Group (Rr)
- Tiverton Formation (Pbt)
- Urannah Igneous Complex (CK)



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Data sources: DELWP, Geoscience Australia

4.4 Hydrostratigraphic units

Hydrostratigraphic units (HSUs) group lithological units together where they have similar hydraulic properties and are likely to function consistently as flow units within a broader groundwater system. HSU interpretation takes account of geological interpretation (based on the geological setting, formations, and lithology), hydrochemistry, hydraulic properties, and water table/potentiometric trends. As such, each HSU represents zones which are expected to exhibit similar hydrogeological characteristics and behaviour.

The HSUs at SWC have been defined and summarised in previous studies (CDM Smith, 2016; Golder, 2018a; Golder, 2022) and provide the basis for various groundwater impact assessments. A key input to previous interpretations of HSUs was a three-dimensional (3D) geological model developed in *Leapfrog Hydro™* by CDM Smith (2016) and updated by Golder (2022) as part of groundwater assessments at SWC. That 3D geological model was again the basis for the local scale HCM presented in this report.

The main interpreted HSUs are the following and can be visualised in the conceptual cross-section presented in Section 5.3:

— **Alluvium**, comprising both Quaternary and Tertiary-age sediments.

— **Regolith**, corresponding to weathered/fractured zones of outcropping bedrock units including the Rewan Formation, RCM and FCCM.

— **Overburden**, corresponding to the generally fresh and 'unfractured' (other than those typical bedrock fabric discontinuities such as joints and cleavage arrays) bedrock including those non-coal units of the Rewan Formation and the units overlying the coal seams within the Permian coal measures.

— **Coal Seams** of the Permian coal measures (RCM and FCCM).

— **Interburden and underburden**, corresponding to the unweathered, non-coal interbeds and underbeds of the Permian coal measures.

4.4.1 Overview of hydrostratigraphic units

In summary, two main coal seams occur within the RCM in the regional study area, each with a thickness greater than 1 m. These are separated by less permeable overburden, interburden, and underburden – which typically comprises siltstone, mudstone, and occasional sandstone. The RCM is regionally overlain by the Rewan Formation aquitard and is also overlain locally by Quaternary and Tertiary age alluvium. Shallow regolith, comprising of weathered and fractured bedrock, acts as a laterally extensive unconfined aquifer.

As described in Section 4.3.2, the coal seams and interburden units of the RCM outcrop/subcrop along the eastern flank of a major basin wide syncline (Figure 4.7), and their hydraulic conductivity is expected to decrease with depth. In the shallow eastern extents of the RCM outcrop/subcrop, the coal seams are expected to act as confined water bearing zones/local aquifers. At depth within the coal measures and towards the axis of the syncline, groundwater flow is mostly associated with fractures and cleats, with the adjoining sandstone and siltstone interbeds forming confining units.

As discussed in Section 4.3.3.1, seismic interpretation of the unnamed major SSE-NNW fault suggests offsets of between 200 and 580 m, compartmentalising geological units either side of this fault. Given the throw of the fault, compressive stress regime and expected high shale gauge ratios, this fault is likely to act as a barrier to horizontal groundwater flow, thereby restricting the westward flow of groundwater within the coal seams of the RCM.

In stating the above, little is known regarding the hydraulic properties of the damage zone of this fault and whether it acts as a barrier or conduit to vertical flow. Outcrops of the Clematis Sandstone and Moolayember Formation to the west of the fault (along the Carborough Range) are likely hydraulically isolated from the RCM due to the presence of hundreds of metres of Rewan Formation aquitard separating the coal seams from the Clematis Sandstone. This premise was assessed by Golder using the numerical groundwater flow model prepared for the Kemmis pit extension project and the results summarised in its report (Golder, 2022).

Interpreted HSUs in the regional study area are summarised below:

4.4.1.1 Alluvium

The alluvium comprises both Quaternary and Tertiary-age sediments. Quaternary sediments comprise unconsolidated clay, silt, sand and gravel, while Tertiary sediments, which are more widely distributed than the Quaternary sediments (QLD DNRME, 2020), typically comprise poorly consolidated sand, silt, clay, and minor gravel.

Quaternary deposits fill the channels of the modern drainage systems, which are incised into the underlying Tertiary sediments and regolith. They occur predominantly along Bee Creek, Walker Creek, Kemmis Creek and Sandy Creek, with their lateral extents based on their surface expressions shown on the 1:100,000 geological map sheet (Figure 4.6). Their vertical extents are interpreted from lithological logs and the geological model (which contains over 3,000 borehole logs in the mine area).

The Quaternary and Tertiary alluvium at SWC form highly localised water bearing zones or occasionally local aquifers (in those instances where there is a higher degree of more permeable, interconnected, coarse grained material that remains saturated year-round). In the Project area, Tertiary alluvium extends across the site, reaching approximately 2 km to the east and 8 km to the west. To the north, Quaternary alluvium is associated with Sandy Creek, running eastwards towards Bee Creek (Figure 4.6).

Saturated thicknesses of the alluvium across SWC are generally between 5 and 10 m (CDM Smith, 2016). At the mine scale, it has been observed that water supplies targeting the alluvium have generally proven unreliable owing to their fragmented distribution (Douglas Partners, 2014b), variability in permeability and temporal variability in recharge from ephemeral creeks.

4.4.1.2 Regolith

The upper weathered/fractured zone of bedrock is collectively referred to as “regolith”, irrespective of the source of formation. Several geological units outcrop/subcrop in and around the regional study area including the Rewan Formation immediately west of the mine footprint, the RCM across the mine footprint, and the FCCM to the east of the mine. Where exposed in the near surface environment, these formations tend to be more fractured and weathered than the fresh bedrock and can form a shallow zone of enhanced permeability compared to the same geological units at greater depths. This shallow fracturing is commonly observed in lithologic logs of exploration boreholes and results of hydraulic testing (see Section Figure 4.5).

The logic for the grouping of fractured profiles of the Rewan Formation, RCM and FCCM is that secondary weathering and secondary porosity features have been developed post deposition resulting in higher permeabilities than the lower primary porosity bedrock itself. Regardless however, it is not conceptualised as an aquifer, and typically can either remain largely unsaturated or form localised zones of groundwater including localised perched water tables.

Drilling and hydraulic testing has shown that the regolith is often unsaturated, with groundwater likely to be present in discontinuous, isolated and localised zones including perched water tables. Hydraulic testing and groundwater elevation monitoring also suggests the water table and a zone of enhanced hydraulic conductivity generally occur within the top 40 m of exposed bedrock (CDM Smith, 2016). This zone was represented in the numerical model as an average thickness of 30 meters, which was considered representative for the site.

4.4.1.3 Overburden

The term overburden reflects the unweathered, non-coal beds of the entire Rewan Formation and the units overlying the coal seams within the Permian coal measures. This comprises the sandstones, siltstones, and mudstones of the RCM and FCCM and terrestrial floodplain deposits (siltstones, mudstones and sandstones) of the Rewan Formation.

For this study, the RCM and FCCM overburden have been conservatively grouped as a leaky aquitard; whilst some sandstone beds are present within these coal measures, the vertical resistance to groundwater fluxes owing to presence of siltstone and mudstone beds in these sedimentary stacks is expected to be significant. The Rewan Formation is expected to act as a tight aquitard, and collectively these units are expected to act as a competent confining unit to the (underlying) coal seams.

4.4.1.4 Coal seams

The coal seams of the Permian coal measures (RCM and FCCM) form the most prominent confined water bearing zones/aquifers at and in the vicinity of SWC and are collectively referred to as the "coal seams" in this assessment. The RCM coal seams are referred to as the "Main Seams". The Main Seams have been characterised regionally as having restricted vertical hydraulic interaction with the interbedded leaky aquitards (Arrow Energy, 2014a). In accordance with the geological model, these coal seams dip to the west and are continuous between the SWC mine and the major SSE NNW oriented reverse fault at the foot of the Carborough Range to the west of the Project area.

At shallow depths, the coal seams are relatively permeable and groundwater flow is mostly associated with fractures and cleats. As observed throughout the Surat and Bowen Basins (OGIA, 2019), the permeability of the coal seams in the RCM and FCCM decreases with depth as fractures and cleats are compressed by lithostatic pressure. The adjoining sandstone and siltstone interbeds throughout SWC typically represent leaky aquitards and confine groundwater within the coal seams away from outcrop areas.

4.4.1.5 Interburden and underburden

The terms 'interburden' and 'underburden' represent the unweathered, non-coal interbeds and underbeds of the Permian coal measures. At SWC, the Main Seam locally splits into the Main Top Seam and Main Bottom Seam, both of which are separated by several metres of low hydraulic conductivity interburden that is likely to act as a leaky aquitard. This 'interburden' may locally limit the hydraulic connection between the Main Top and Main Bottom coal seams (CDM Smith, 2016) and is recognised as a separate hydrostratigraphic unit in this assessment. The remainder of the underlying RCM coupled with the FCCM are considered to form a regionally significant aquitard at the base of the Main Seam which collectively form the lowermost hydrostratigraphic unit at and in the vicinity of SWC and are referred to as the 'underburden' in this assessment.

This HSU is expected to vary locally between a leaky aquitard (where sandstone is present and permeable) and a tight aquitard (where siltstone and mudstone dominate, or the unit becomes deeper to the west).

4.5 Hydraulic characteristics

Hydraulic characteristics were based on information compiled from previous studies (Golder, 2018a; Golder, 2022), from information provided by BMC for monitoring bores constructed in 2020 and 2021, and from data obtained from the QLD Globe (2024) online database.

4.5.1 Bore yields

Bore yields reported in the regional study area are an indication of the general transmissive nature of the various HSUs. As described by CDM Smith (2016), airlift yields recorded during drilling of exploration holes generally range from less than 0.1 L/s to approximately 2.5 L/s. The highest airlift yield recorded was 10 L/s from a borehole located within the footprint of the MRA2C mining area (undifferentiated geology; CDM Smith, 2016).

At depths greater than 120 m, yields are less than 0.5 L/s, and at shallowest depths they are in general less than 1.5 L/s although may be up to about 2.5 L/s.

Bore yields reported in SWC Bores OBS1 and OBS2 by Douglas Partners (2014b), which are screened in the regolith, were about 0.02 and 0.1 L/s respectively, indicating a relatively low yield for the regolith at these locations.

4.5.2 Hydraulic testing

The hydraulic conductivity (K) for the main HSUs at SWC have been evaluated over the last decade of hydrogeological investigations. Estimates of K have derived from several hydraulic test methods including:

- falling and rising head 'slug' tests
- constant-rate pumping tests, and
- injection falloff tests.

These tests were mostly carried out in previous studies, as described by CDM Smith (2016) and Golder (2022), which includes estimates of K from slug tests carried out in the monitoring bores constructed in 2020 and 2021. That testing carried out is summarised in the following bullet points whilst statistics regarding the K of the various HSUs at the SWC mine are presented in Table 4.2.

- AGE (2014a) hydraulically tested five monitoring bores screened in the regolith by rapidly injecting 8 to 200 L of water into these bores and monitoring the recovery (fall) of the groundwater level towards the static (pre-test) level.
- Douglas Partners (2014a) estimated the hydraulic conductivity of the confined coal seam from the analysis of injection falloff tests carried out in four exploration holes drilled into the main bottom seam of the RCM.
- In June 2015, Airwell Group carried out both step-rate and constant-rate pumping tests on seven unregistered landholder bores screened both in the alluvium and regolith. The transmissivity (T) and K of the test intervals in these wells were then estimated by Airwell Group using the Cooper Jacob and Theis analytical solutions.
- In May 2016, BMC conducted falling and rising head slug tests on three monitoring bores screened in the alluvium.
- In October and November 2020, BMC conducted falling and rising head slug tests on 15 monitoring bores. The monitoring bores were constructed in 2020 and target the alluvium, regolith, overburden, interburden and coal seams.

Table 4.2 Summary of hydraulic conductivity estimates from testing across the SWC mine

HSU	Slug tests			Pumping tests			Injection falloff tests	
	No. tests	Minimum K (m/day)	Maximum K (m/day)	No. tests	Minimum K (m/day)	Maximum K (m/day)	No. tests	Mean K (m/day)
Alluvium	7	0.002	63	2	3.8 (2)	10 (2)	No tests carried out	
Regolith	6	0.05 (1)	0.5	5	0.01 (2)	1.9 (2)	No tests carried out	
Overburden	3	0.20	5	No tests carried out			No tests carried out	
Coal seams	7	0.0005	0.5	No tests carried out			4	0.02

Notes: HSU – hydrostratigraphic unit
K refers to hydraulic conductivity
1) Analysis undertaken by AGE (AGE, 2014a; AGE, 2014b).
2) K is calculated from transmissivity assuming saturated thickness is equal to standing water column height.

The following interpretations are based on both site wide and local hydraulic testing of each HSU.

- **Alluvium:** Nine alluvial monitoring bores at the SWC mine were hydraulically tested (with seven derived from slug tests and two from pumping tests). K estimates from these tests vary between 0.002 and 62.3 m/day. This wide range of values demonstrates the lithological variability in the unconsolidated deposits (as described in Section 4.4.1).

  Of relevance for the proposed as Project area, four hydraulic tests have been carried out in groundwater monitoring bores installed in the southern portion of the SWC mine and screened across this HSU. All four of these bores have been installed along the alignment of Bee Creek to the east and south-east of the Walker and Toolah pits with estimates of K varying between 0.02 and 17 m/day in MB13 and MB20SWC01A respectively.

  Lower estimates of K are reflective of the finer grained silts and clays, while higher estimates of K are attributable to coarser grained sands and gravels.

Figure 4.8A presents a histogram showing the distribution of K in the alluvium. This figure demonstrates the bimodal nature of the alluvium; specifically, the varying beds in this HSU typically comprise either very low permeability fine grained sediments, or moderate to high permeability coarser grained sediments.

— **Regolith:** Eleven bores have been hydraulically tested in the regolith from which six estimates of K were derived from slug tests, and five from pumping tests. K estimates vary from 0.01 to 1.9 m/day reflecting moderate permeability in this HSU.

  No measurements of K are known within 6 km of the Project area.

— **Overburden:** Three bores have been tested in the overburden (all slug tests), with hydraulic conductivities varying from 0.2 to 4.9 m/day. Of relevance to the Project, hydraulic testing in monitoring bore MB20SWC05A, located southeast of Toolah pit, indicated the K of overburden screened in this bore was about 3 m/day. High K values are expected to reflect the more permeable part of the sequence tested (sandstones) and are therefore considered to be upper estimates only. Much of the sequence comprises siltstone and mudstone which are expected to have considerably lower K values.

  Whilst untested, the vertical K of the overburden is considered low owing to the dominance of low-K rocks such as siltstones and mudstones within this HSU, all of which increase the vertical hydraulic resistance to groundwater flow in this HSU. As a result, this unit forms a regionally significant aquitard, albeit with some lateral groundwater flow occurring primarily in the sandstones in the sedimentary stack. In stating this, it is expected these sandstones may not be regionally extensive as suggested by the general lack of water supply bores targeting this formation in this part of the Bowen Basin.

— **Coal seams:** Eleven bores screened across the coal seams at depths less than 100 m have been hydraulically tested, with estimates of K derived from seven slug tests and four injection falloff tests. K estimates vary from 0.0005 to 0.5 m/day, the latter reflecting the permeability of coal in outcrop/subcrop areas.

  Hydraulic testing carried out in five groundwater monitoring bores (MB20SWC02P, MB20SWC04P, MB20SWC06P, MB20SWC08P and MB20SWC09P) installed in the southern portion of the SWC mine and screened across the upper coal seam indicated the hydraulic conductivity of this seam near the Project area varied between 0.01 and 0.13 m/day. The mean K of the upper coal seam from these tests was 0.05 m/day.

  At the Project area, coal seams are at depths of between 90 and 250 m. Their K values are expected to be lower than those K values listed above, and potentially one or two orders of magnitude lower toward the west. Figure 4.8B presents a histogram showing the distribution of K in the coal seams, showing the range spanning four orders of magnitude. Uncertainty associated with the range of K values of these coal seams was addressed through sensitivity and uncertainty analysis by Golder (2022).

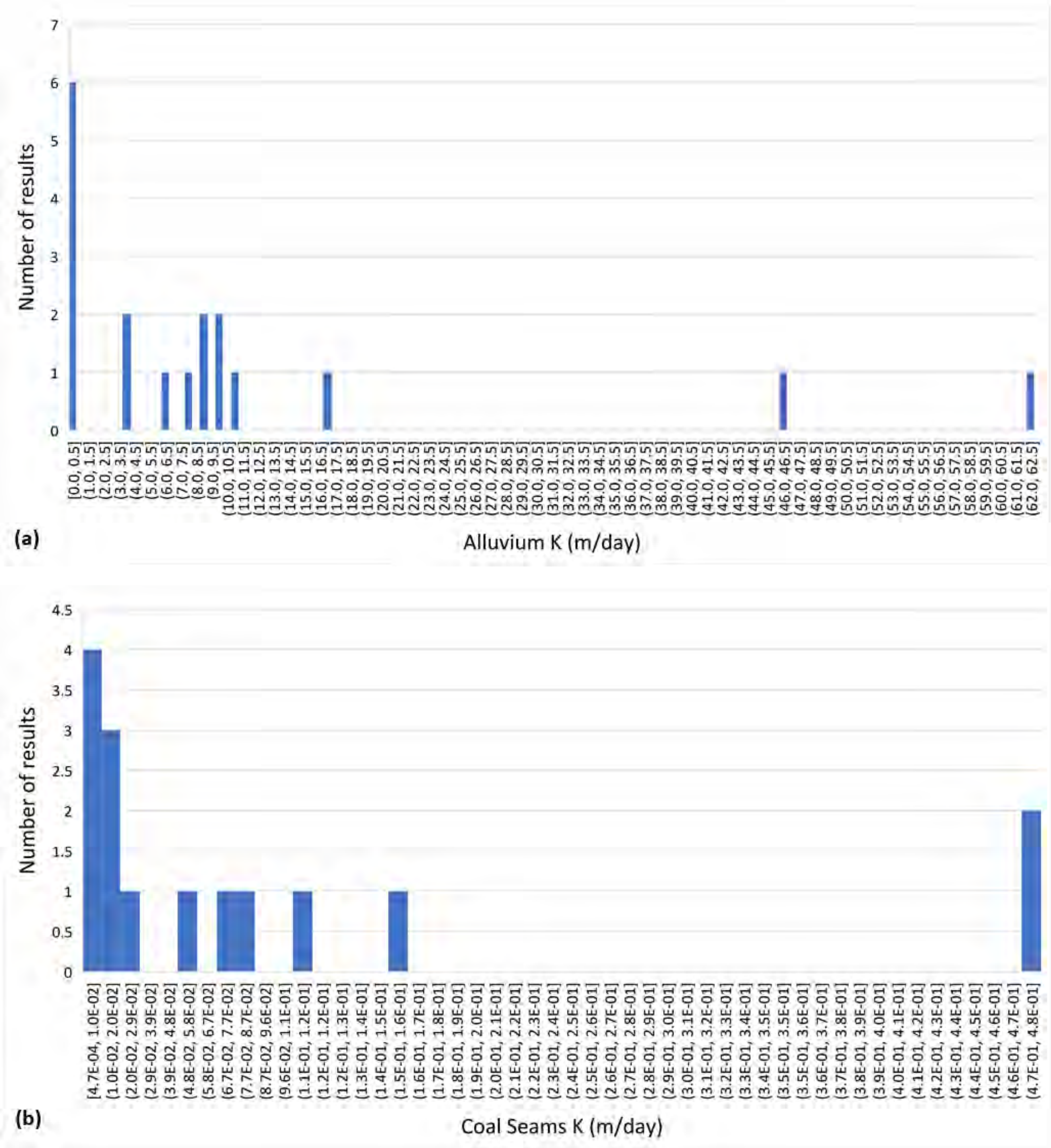


Figure 4.8 Histogram showing distribution of hydraulic conductivity in the alluvium (a) and in the coal seams (b)

4.5.3 Literature values

4.5.3.1 Hydraulic conductivity

Estimates of K in the regolith (the weathered, upper part of the Rewan Formation and Permian coal measures) derived from hydraulic testing of shallow monitoring bores range from 0.03 to 0.08 m/day at the nearby Broadlea Coal Mine (37 km southwest), and from 0.05 to 1.5 m/day at the Hillalong Mine (42 km north). These estimates are similar to those derived across SWC (AGE, 2008; CDM Smith, 2016).

Coal seams within the Permian coal measures of the Bowen Basin and elsewhere typically have K values one to three orders of magnitude higher than those of the adjacent siltstone and sandstone interburden. As such, groundwater preferentially flows via the coal seams, with this expected to be the situation at the SWC mine, including within the Project area (AGE, 2008; Heritage Computing, 2012; AGE, 2014b; CDM Smith, 2016). The results of hydraulic testing at Hail Creek Mine are consistent with this interpretation, supported by a geometric mean K of 0.02 m/day for the coal seams compared to 0.00002 m/day for the adjoining interburden (Douglas Partners, 2015; CDM Smith, 2016).

Hydraulic testing of the Permian coal measures in other parts of the Bowen Basin also shows hydraulic conductivity of these units decreases with depth. For example, Lugeon water-injection testing of the Pollux Seam within the RCM at the Togara North Project indicated a decrease in hydraulic conductivity from 0.2 m/day near the surface to around 0.03 m/day at 250 m depth (AGE, 2014b; CDM Smith, 2016). A trend derived from a study combining coal seam hydraulic conductivity data from the Warrior Basin in the USA with data from the Moura (now Dawson) Mine in the Bowen Basin indicates a decrease from around 0.1 m/d at 50 m depth to 0.004 m/d at depths of 300 to 400 m (AGE, 2006; CDM Smith, 2016).

4.5.3.2 Storage

As discussed by Golder (2018a; 2022), there is a lack of field-derived estimates of the specific yield (Sy) of alluvium and regolith in the Bowen Basin. Typical values of Sy applied to the water table aquifer in studies in the Bowen Basin range from 0.001 to 0.05 (i.e., 0.1 to 5.0 per cent) for regolith materials, and up to 25 per cent (%) for alluvium.

Estimates of specific storage (Ss) for the coal seam interburden and confining units are the least well defined in terms of available data. For the Arrow Bowen Basin EIS groundwater model (Arrow Energy, 2014b), calibrated values of Ss for the confined formations ranged from 5×10^{-5} to 5×10^{-6} m^{-1} (Ausenco Norwest, 2012). These estimates are slightly higher than the typical range of storage values adopted for coal measures in the Office of Groundwater Impact Assessment (OGIA) Surat Cumulative Management Area (CMA) groundwater model (OGIA, 2019), which tend to have a maximum Ss of $\sim 1.0 \times 10^{-5} m^{-1}$.

4.6 Conceptual boundaries

Conceptual boundaries within the regional study area were defined by Golder (2022) for the Kemmis pit extension Project. These considered topography, configuration of streams, hydrological processes (including rainfall, evapotranspiration, runoff, and others), expected regional groundwater flows, HSUs and relevant geological structures associated. These were assessed by WSP for the Project area, considering the anticipated types and extents of impact, and were deemed suitable for this GIA. The conceptual boundaries are as follows.

— **No flow barrier:** No lateral flow is expected to occur regionally across the unnamed major SSE-NNW fault at the foot of the Carborough Range west of the Project area. There may also be limited to negligible upward groundwater flow potential along this structure given the compressive stress regime and closing of fractures within the fault damage zone.

  Although the unnamed major SSE-NNW fault will likely act as a lateral no flow barrier for the coal seams, the structure was represented in the numerical groundwater flow model as a separate HSU and the connectivity between those HSUs on the eastern (hanging wall) and western (footwall) sides of this fault was assessed as part of the sensitivity and uncertainty analyses carried out by Golder (2022). The results of the sensitivity and uncertainty analyses indicated that variations in the fault Kv do not significantly affect the model outcomes or the quality of the calibration. This suggests that even with high Kv applied to the fault and damage zone, the fault still acts as a barrier, preventing drawdown from propagating further to the west which supports the conceptual understanding.

— **No flow barrier:** A no flow boundary condition was considered to represent the contact between the Clematis Sandstone and the Rewan Group to west of the regional study area. Regional groundwater flow is parallel to this boundary.

- **No flow barrier:** geological mapping (Figure 4.7) shows a complex network of east-west oriented faults intersecting the RCM to the north of the SWC Mine, approximately 15 km north of Bore 3. Given the thin nature of the coals in this area, these faults are expected to act as a potential barrier for northern propagation of mine impact drawdowns within the RCM formation.
- Ephemeral streams and tailings storage facility (TSF) act locally as losing streams thereby supplying recharge to the water table during wet season flows.
- Recharge at and in the vicinity of the SWC mine occurs via two mechanisms: direct infiltration of rainfall, and infiltration of surface water from ephemeral streams during dry periods (refer to Section 4.7.1 for more details).
- Evapotranspiration is expected to be low at and in the vicinity of the SWC mine due to the greater depth to groundwater in relation to the extinction depth (refer to Section 4.7.2 for more details).

4.7 Groundwater recharge and discharge

4.7.1 Groundwater recharge

Recharge to the shallow water bearing units (i.e., alluvium and regolith) at and in the vicinity of SWC occurs via two mechanisms: (i) direct infiltration of rainfall, and (ii) infiltration of surface water from ephemeral streams during wet periods with high rainfall. These two processes are linked, with streamflow present only during periods of high rainfall and runoff.

A qualitative review of rainfall and surface water discharge in Bee Creek during the dry season (Golder, 2018a) suggests groundwater recharge may only occur during and after storm events that generate greater than about 90 mm rainfall in a short time period, typically less than three days. Groundwater recharge though may be more frequent during wet months when the ground is already saturated and sustained rainfall events occur.

Studies by Crosbie et. al. (2010) suggest recharge rates at other sites in Australia with similar soils and climates may be between about 5 and 15 mm per year (i.e., between 0.8 and 2.4 per cent of annual rainfall, respectively). Douglas Partners (2014b) conducted a study which suggested rainfall recharge rates are likely an order of magnitude lower, with rates varying between 0.05 and 0.1 per cent of rainfall; Douglas Partners did note that the lower estimate (i.e., 0.05 per cent) was for more diffuse recharge across the region.

Golder (2018a) estimated recharge rates by disregarding the first 90 mm of rainfall in each month (as recharge only occurs after events of a sufficient magnitude), and then calculating the monthly recharge rate as 1 per cent of monthly rainfall available to recharge. This gives an average of 3 mm/year which is equivalent to 0.5 per cent of annual rainfall. This is consistent with estimates at other sites in the Bowen Basin (Arris, 2017).

4.7.2 Groundwater discharge

Discharge occurs mainly via three mechanisms, namely as:

i) natural groundwater throughflow through the basin towards lower hydraulic heads (to the southeast)

ii) discharge to the open pits, and

iii) evapotranspiration where the water table is present at shallow depths and can be accessed by vegetation roots.

Discharge from the Project will constitute an additional discharge mechanism at SWC. Within the first 13 years, discharge rates are expected to range between 20 and 60 m^3/day, with higher rates (approximately 95 m^3/day) anticipated during the initial years of operation (refer to Figure 1.4). Additional wells will be drilled as needed to maintain gas delivery and supply energy to the mine. These estimates cover the first 13 years of operation to supply the power station.

Site monitoring data shows that groundwater discharge to watercourses is negligible, with baseflow generally occurring only for short durations after rainfall events. This is supported by groundwater elevations in all near-surface hydrostratigraphic units typically being 10 m lower than ground surface elevations, indicating a common and frequent disconnection between creek beds and the water table (as discussed in Section 4.8.4)

Evaporative losses by evapotranspiration are expected to be low given the depth of groundwater, which is often beyond the vegetation roots as previously conceptualised by Golder (2018b; 2022).

Currently, observed discharges to the various open cut pits on site is limited. AQ2 Water Resources Management (AQ2, 2020) estimated a pit water extraction rate of approximately 0.5 ML/day for Mulgrave and Kemmis Pit II between 2016 and 2020. The methodology to determine the groundwater take volume was based on the water balance method specified in the DNRME guidelines for quantifying the volume of associated water taken under a mining lease or mineral development licence under the Mineral Resources Act 1989. It is expected groundwater discharge rates to the pits is less than the high evaporation rates.

4.8 Groundwater occurrence

4.8.1 Groundwater levels

A total of 59 monitoring bores were identified in the regional study area (Figure 4.9), of which 44 bores contained at least one groundwater level measurement. Of the monitoring bores with data, 12 are screened in alluvium, 17 in regolith, four in overburden, and 11 bores in the coal seams.

Of relevance to the Project area, 13 surrounding monitoring bores have water level data. Of these, four are screened in the alluvium (MB13, MB14, MB20SWC01A and MB20SWC03P), three in the regolith (MB12, OBS1 and OBS2), one in the overburden (MB20SWC05A) and five in the coal seams (MB20SWC02P, MB20SWC04P, MB20SWC06P, MB20SWC08P and MB20SWC09P). Figure 4.10 to Figure 4.13 present time series of available groundwater levels at those monitoring bores near the Project area, whilst the cumulative deviation from mean monthly rainfall (CDMMR) is also shown on these figures. The monitoring bores are grouped by hydrogeological unit. Note groundwater elevations for those groundwater monitoring bores with only one data point were not plotted in these figures.

General observations for the monitored groundwater levels in the regional study area include the following:

- Baseline data is not available before the beginning of the mining operation in 1996 (at which point in time the mine was managed by BM Alliance Coal Operations Pty Ltd).
- Groundwater levels in the alluvium have been steadily declining since 2014, coinciding with long-term below average rainfall. For instance, MB14 presents a drawdown of approximately 3.9 m since the latter months of 2014 and early months of 2015. There were slight increases in groundwater level during the 2016 and 2017 wet season and after 2022 following the above average rainfall trend, although these increases were minor (<2 m).
- Only two monitoring bores (OBS1 and OSB2 – both screened in the regolith) present long-term water level datasets. Monitoring in these bores started in 2003, with both bores located to the south of the SWC mine, near the Project area.

  Monitoring in these and other bores at the SWC mine increased in and following 2014. The monitoring network was further expanded with the inclusion of additional bores installed around the SWC mine area, including 18 monitoring bores installed in 2020 and 2021.
- Slight declines in groundwater elevations occurred in most groundwater monitoring bores installed in the coal seams between 2021 and 2023 (<1 m); this is expected to be in response to mining. Exceptions to this though are groundwater elevations in MB20SWC02P near the Project area (located to the east and behind the low wall of the Toolah Pit close to Bee Creek) and MB20SWC10P (located immediately east of the Kemmis pit), where water levels increased between early 2022 to May 2023, with this likely attributable to above average rainfall during this period.

General observations relevant for the Project area are:

- Monitoring in regolith bores OBS1 and OBS2 started in 2003 and has been continuing since. Groundwater levels in both bores declined approximately 0.15 m/year until 2007, consistent with the lower-than-average rainfall, following which groundwater levels in OBS2 increased (~2.5 m) while water levels in OBS1 continued to decline (~1.5 m).

  The decline of groundwater elevations in OBS1 from 2009 onwards is attributed to the effects of mine dewatering.

  The increase of groundwater elevations in OBS2 from 2007 onwards may be in response to both:

  (i) seepage infiltration from the nearby TSF, and

  (ii) generally above average rainfall between late 2007 to 2010 and 2011 to 2013.

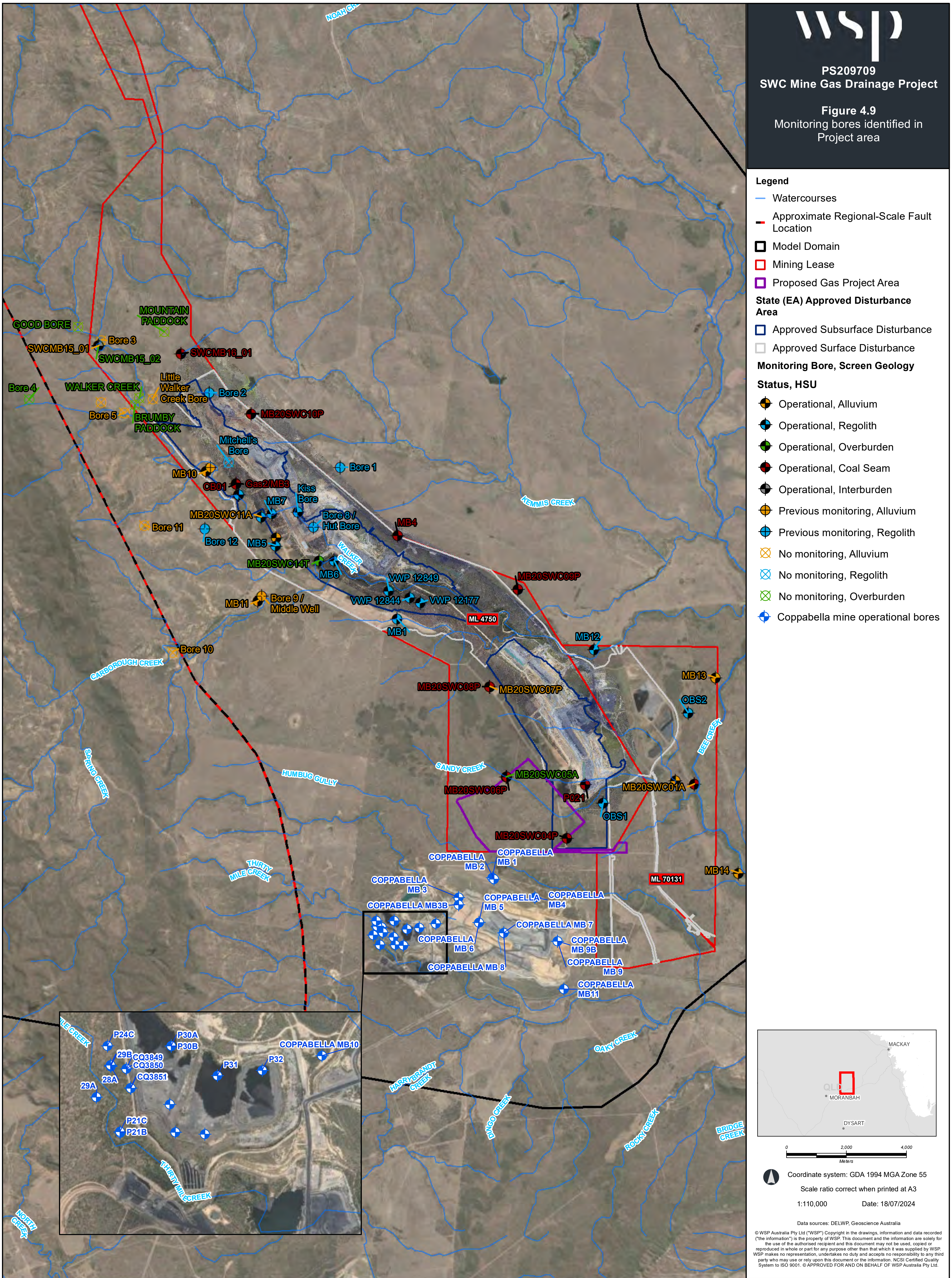
  MB12 showed relatively constant groundwater levels and it is considered likely that no drawdown has occurred at this location in response to mine operations; this is considered reasonable given:

  (i) the distance of this bore from active mine pits (approximately 1 km away from Carborough pit), and

  (ii) the expected relationship between groundwater elevation fluctuations and month-to-month and seasonal rainfall occurrence (as shown by the common trends between groundwater levels and the CDMMR).

- Groundwater levels in the single groundwater bore installed in the overburden (MB20SWC05A) have remained relatively stable throughout the monitoring period from 2021 to 2023, only with minor variations (all less than 0.1 m) following rainfall trends.

- Those locations at which paired monitoring have been installed, namely MB20SWC06P and MB20SWC05A (coal seams and overburden) and MB20SWC02P and MB20SWC01A (coal seams and alluvium), indicate upward hydraulic gradients occur from the coal seams to the overlying overburden and alluvial sediments. Data from March 2021 to May 2023 confirm the pressurized nature of the coal seams, with approximately 1 m pressure difference between coal seams and alluvium and a 5 m difference between coal seams and overburden. These observations suggest, at these locations, groundwater pressures in and the fluxes between these hydrostratigraphic units may be affected by dewatering and depressurisation associated with mining, however the direction of groundwater movement in the sedimentary pile remains the same.



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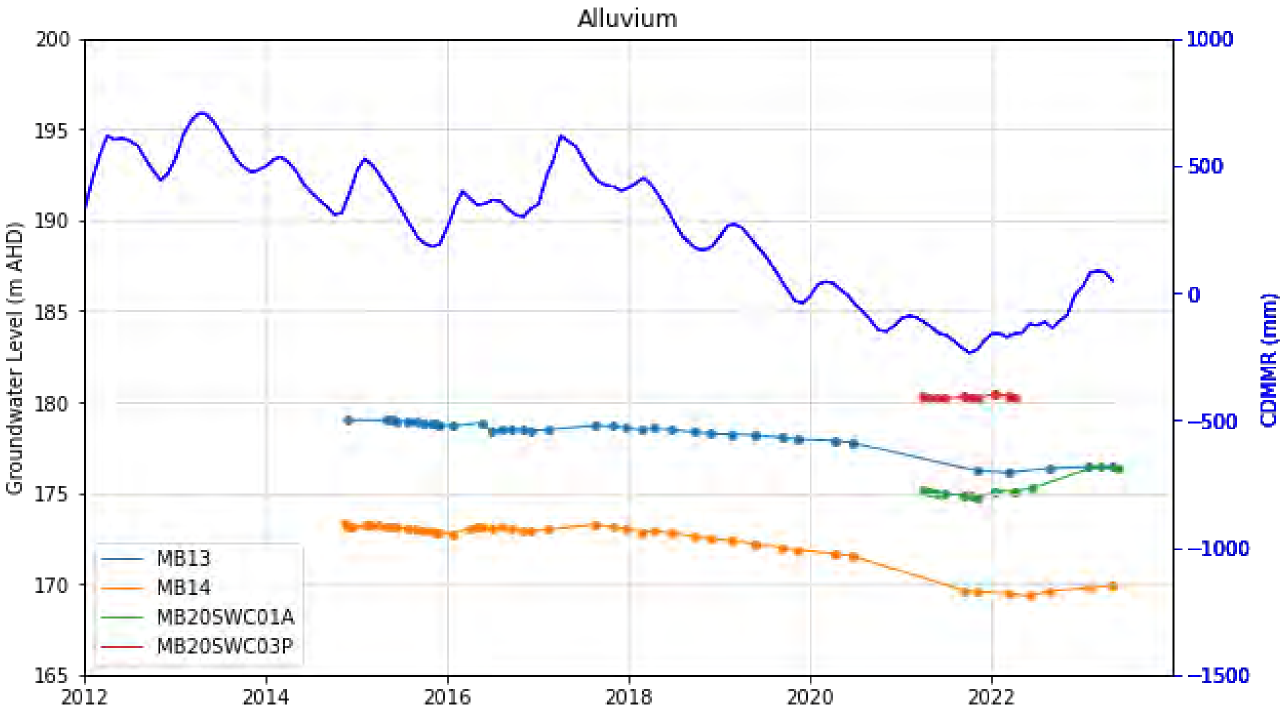


Figure 4.10 Groundwater elevations – alluvium

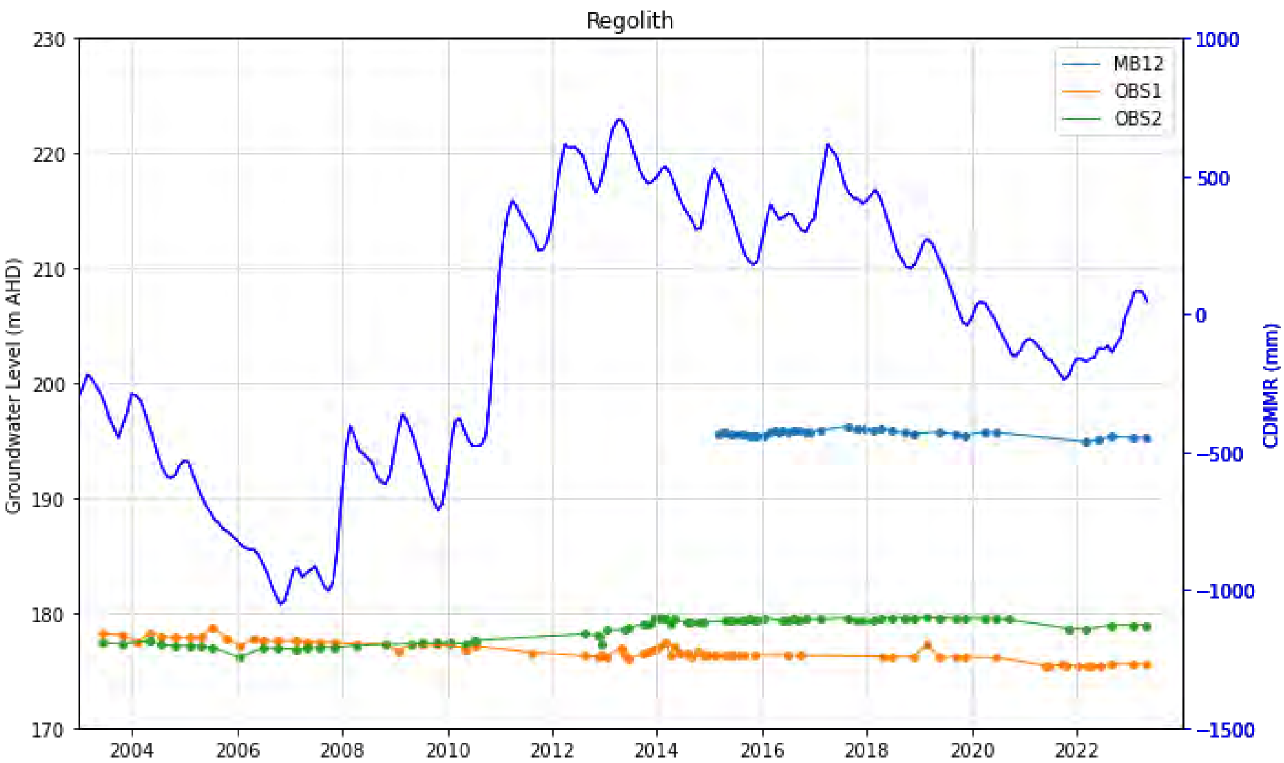


Figure 4.11 Groundwater elevations - regolith

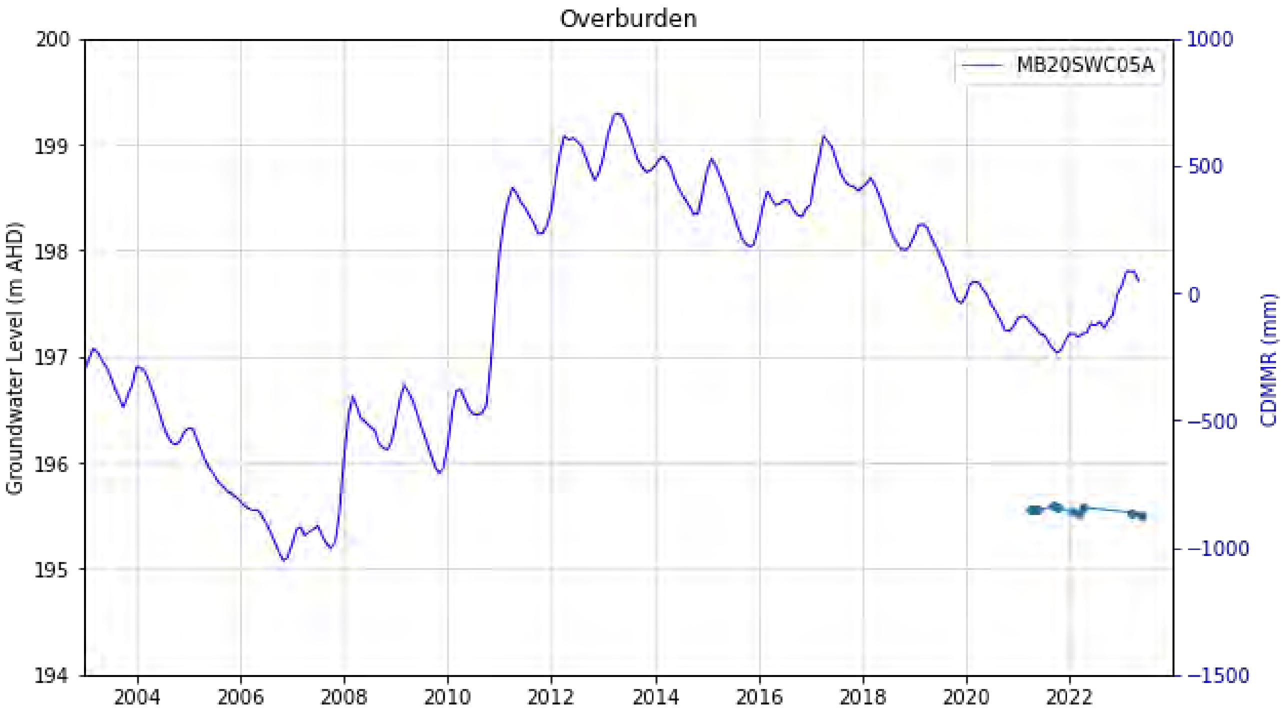


Figure 4.12 Groundwater elevations - overburden

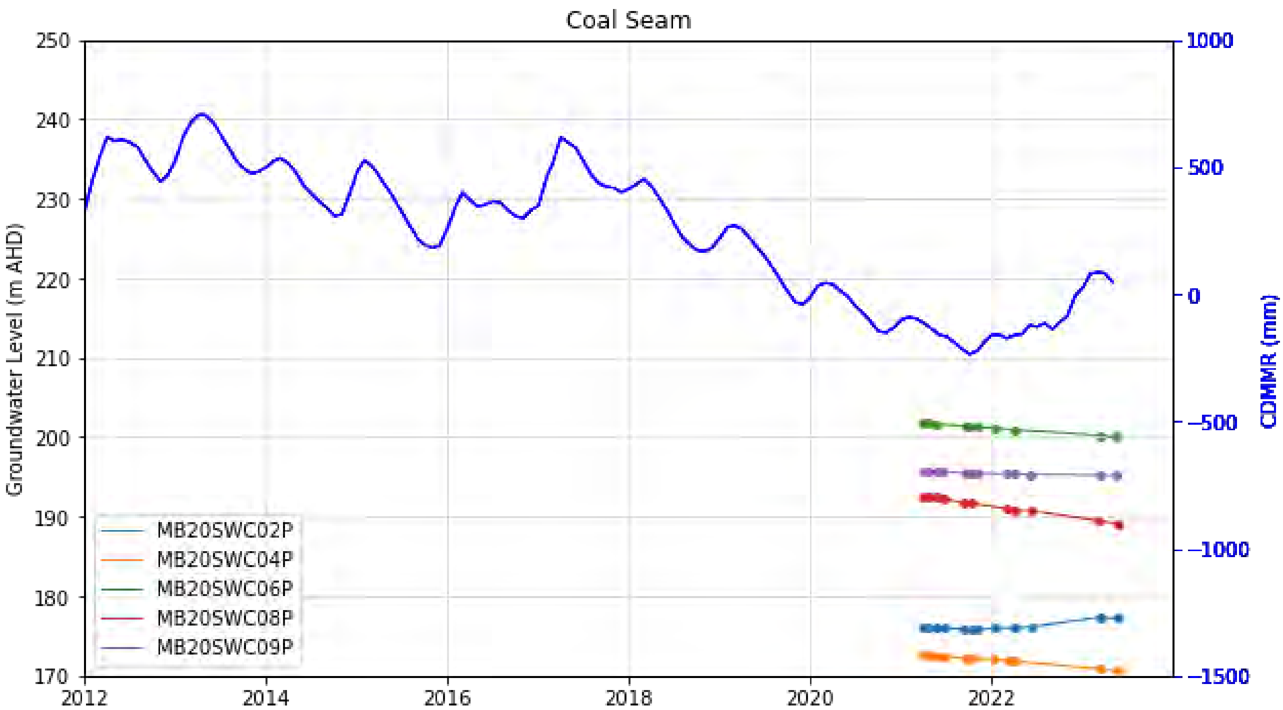


Figure 4.13 Groundwater elevations – coal seams

4.8.2 Flow directions

A groundwater level contour map has been prepared for the main aquifers in the regional study area. As groundwater level measurements prior to the start of mining (i.e., baseline data sets) are not available, it was decided to consider the measurements of a period which had both (i) an abundance of data, and (ii) represented the end of a dry period when groundwater levels were expected to be at their lowest (and therefore effects of differential recharge rates do not affect the interpretation). The dates considered aim to minimise the interference of seasonality, although the mine is in operation and drawdown effect is being captured by the monitoring bores. For coal seams bores, the first monitoring data has been considered to minimise interference from pit dewatering.

Figure 4.14, Figure 4.15 and Figure 4.16 represent the interpreted hydraulic head in the alluvium (Tertiary and Quaternary alluvium combined), regolith, and coal seam (Permian), respectively, whilst Table 4.3 lists the bores that were considered in these figures. Each figure includes water level measurements between late 2015 and early 2016, which corresponds to the end of a dry period. This dataset has though also been supplemented by groundwater level measurements from:

- those monitoring bores installed in 2020 and 2021
- landholder bores (taken in 2015), and
- relevant available groundwater levels from public bores registered in Queensland government database (represented in red in the maps).

The groundwater elevation contours in the areas where information is not available were "inferred" by using the topography as reference.

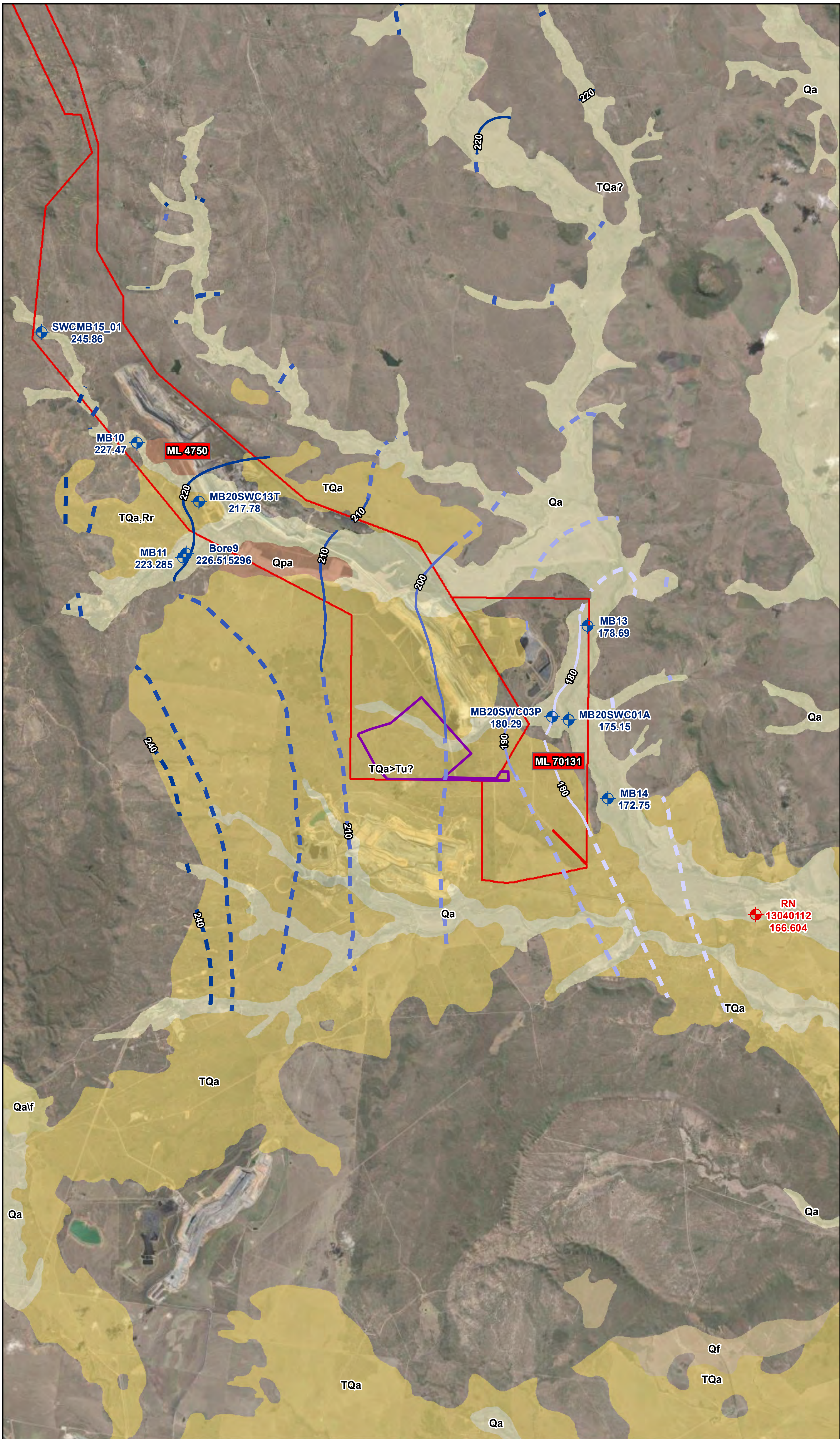
Figure 4.14 and Figure 4.15 show that the water table both in the alluvium and regolith form a subdued reflection of topography, with groundwater flowing from areas of higher elevation – including the Carborough Range north-west of the regional study area – to the southeast towards Bee Creek. Localised zones of dewatering/depressurisation associated with the mine are not well shown in these figures owing to the sparsity of monitoring points in the regolith and alluvium. It should be noted that any dewatering of these HSUs because of mining and dewatering carried out at the Coppabella mine is not represented in these maps as publicly available information references only refer to depth to water rather than groundwater elevations. The tighter hydraulic gradient in the west is inferred from the steep topography in the Carborough Range.

Regionally, hydraulic gradients in the shallow aquifers are low, typically in the order of 0.002 to 0.003. They are thought likely to be higher closer to the SWC pits (albeit not shown on these figures due to the sparsity of information). Figure 4.16 indicates that flow directions in the coal seams are similar to those in the alluvium and regolith.

In the area surrounding the Project, groundwater elevations in the alluvium and the coal seams also generally decrease towards the southeast. Monitoring bores to the north of the Project area such as MB20SWC08P, MB20SWC05A, MB20SWC06P and MB12 have groundwater levels in excess of 190 m AHD. In comparison, those monitoring bores to the southeast of the Project area such as MB20SWC03P, MB20SWC01A and MB14 show groundwater elevations less than 180 m AHD. These local groundwater levels trends are consistent with the dominant south-eastern direction of regional groundwater flow in the alluvium and coal seams.

PS209709
SWC Mine Gas Drainage Project

Figure 4.14
Hydraulic head contours – Alluvium



Legend

- Registered Public Bores
- Alluvium Groundwater Monitoring Bores
- Proposed Gas Project Area
- Mining Lease

Groundwater Contour Elevation (m AHD)

Interpreted contours

- 180
- 190
- 200
- 210
- 220

Inferred contours

- 180
- 190
- 200
- 210
- 220
- 230
- 240

Geology

- Qa-QLD (Quaternary Alluvium) - Qa
- Qa\f-QLD (Quaternary Alluvium) - Qa
- Qf-QLD
- Qpa-QLD (Pleistocene Alluvium) - Qpa
- TQa-QLD (Tertiary Alluvium) - TQa
- TQa-QLD,Rewan Group - TQa
- TQa-QLD>Suttor Formation? -TQa

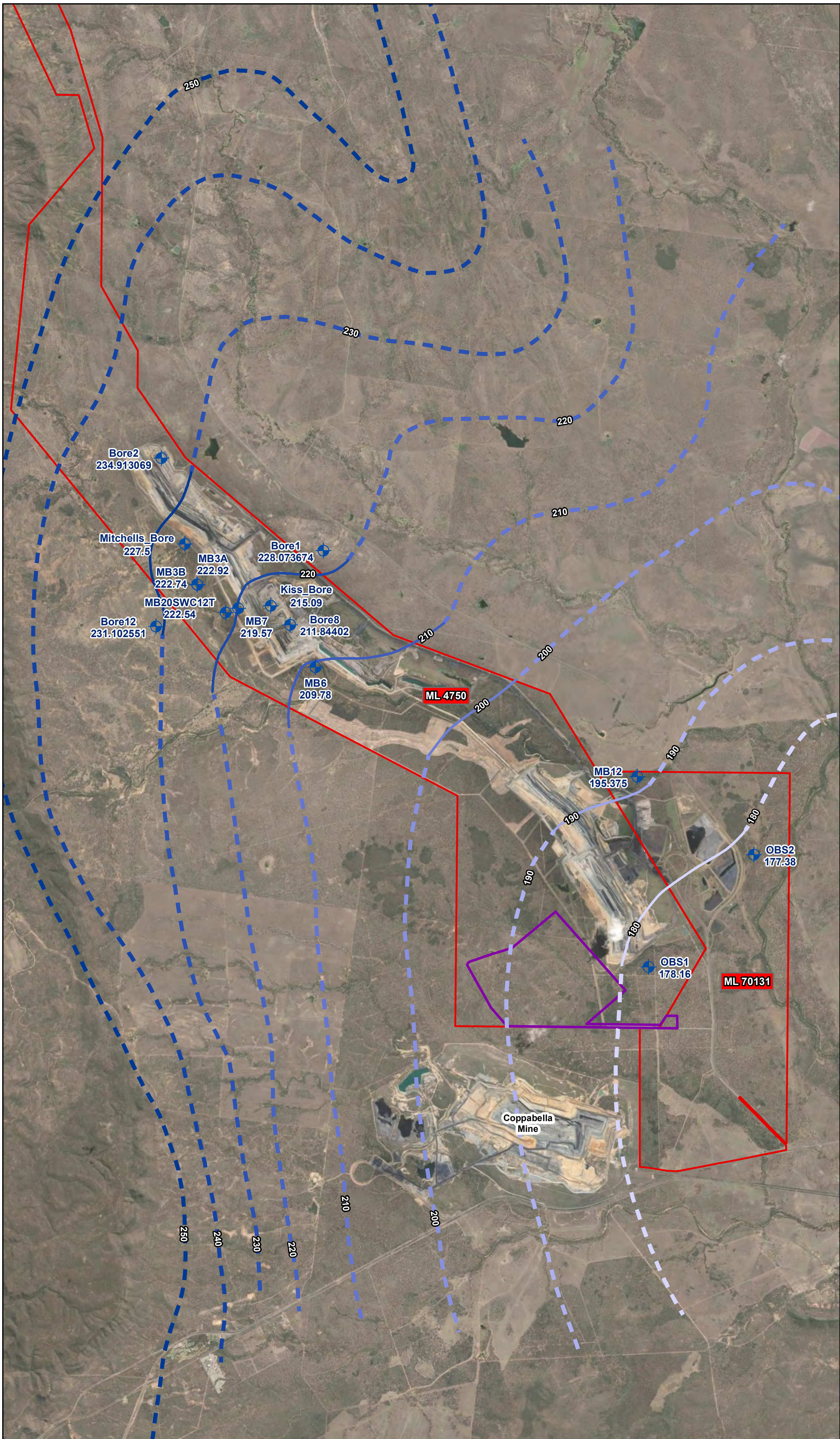
0 2,000 4,000
Meters

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

1:140,000 Date: 3/07/2024

Data sources: DELWP, Geoscience Australia



PS209709
SWC Mine Gas Drainage Project

Figure 4.15
Hydraulic head contours for regolith

Legend

Regolith Groundwater Monitoring Bores

Proposed Gas Project Area

Mining Lease

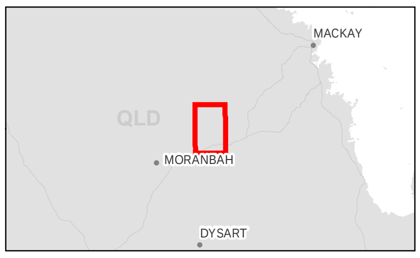
Groundwater Contour Elevation (m AHD)

Interpreted contours

180
190
200
210
220
230

Inferred contours

180
190
200
210
220
230
240
250



0 2,000 4,000
Meters

Coordinate system: GDA 1994 MGA Zone 55

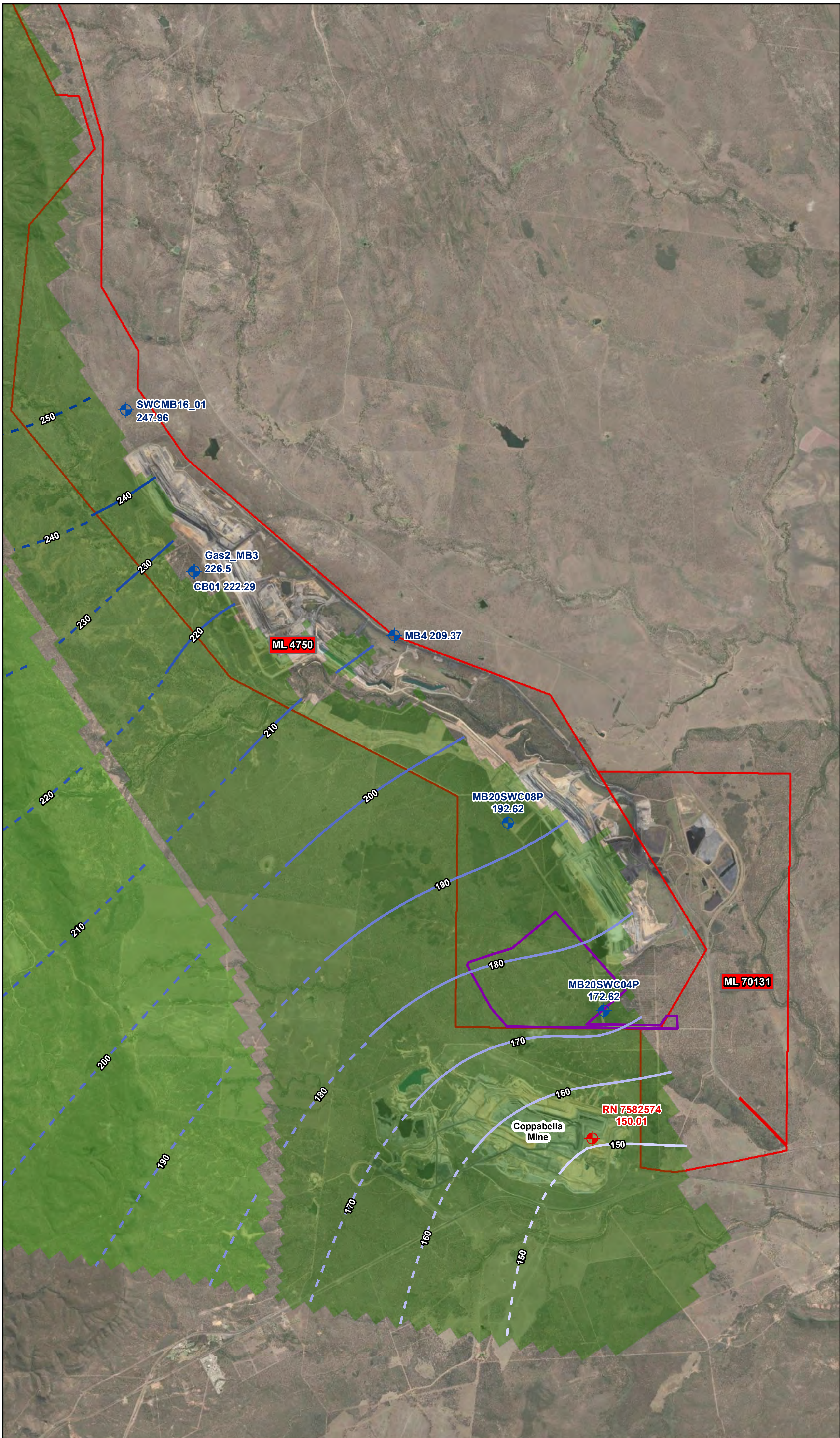
Scale ratio correct when printed at A3

1:100,000 Date: 3/07/2024

Data sources: DELWP, Geoscience Australia

PS209709
SWC Mine Gas Drainage Project

Figure 4.16
Hydraulic head contours for coal seam (Permian)



Legend

- Coal Seam Groundwater Monitoring Bores
- Registered Public Bores
- Coal Seams
- Proposed Gas Project Area
- Mining Lease

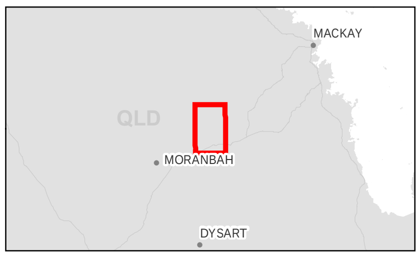
Groundwater Contour Elevation (m AHD)

Inferred contours

150
160
170
180
190
200
210
220
230
240
250

Interpreted contours

150
160
170
180
190
200
210
220
230
240



0 2,000 4,000
Meters

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

1:100,000 Date: 10/07/2024

Data sources: DELWP, Geoscience Australia

Table 4.3 Monitoring bores considered in the potentiometric maps

Bore No	Easting (mE)	Northing (mN)	Screen elevation (m AHD)		Water level (m AHD)	Measurement Date	HSU
			From	To			
Bore7	639,925	7,598,198	Unknown	Unknown	232.5	Jun-15	Alluvium
Bore9	641,636	7,593,910	Unknown	Unknown	226.5	Jun-15	
MB10	639,782	7,598,073	230.6	220.6	227.5	Jan-16	
MB11	641,513	7,593,749	216.8	213.8	221.5	Jan-16	
MB13	656,766	7,591,177	176.7	167.7	178.7	Jan-16	
MB14	657,528	7,584,673	170.8	162.2	172.8	Jan-16	
MB20SWC01A	656,060	7,587,638	177.7	171.7	175.2	Mar-21	
MB20SWC03P	655,430	7,587,752	174.9	168.9	180.3	Mar-21	
MB20SWC13T	642,118	7,595,856	219.1	213.1	217.8	Mar-21	
SWCMB15_01	636,195	7,602,246	247.6	244.6	245.9	Mar-21	
Bore1	644,260	7,598,204	Unknown	Unknown	228.1	Jun-15	Regolith
Bore12	639,752	7,596,163	Unknown	Unknown	231.1	Jun-15	
Bore2	639,895	7,600,690	Unknown	Unknown	234.9	Jun-15	
Bore8	643,363	7,596,208	Unknown	Unknown	211.8	Jun-15	
Kiss_Bore	642,842	7,596,717	Unknown	Unknown	215.1	Jun-15	
MB12	652,709	7,592,123	197.2	191.2	195.4	Dec-15	
MB20SWC12T	641,624	7,596,535	217.9	214.9	222.5	Mar-21	
MB3A	640,860	7,597,291	213.2	210.2	222.9	Dec-15	
MB3B	640,866	7,597,282	219.6	216.6	222.7	Dec-15	
MB6	644,044	7,595,070	213.3	207.3	209.8	Dec-15	
MB7	641,965	7,596,654	216.2	198.2	219.6	Dec-15	
Mitchells Bore	640,530	7,598,384	Unknown	Unknown	227.5	Jun-15	
OBS1	653,011	7,587,001	177.9	173.9	178.2	Jun-03	
OBS2	655,845	7,590,019	168.4	159.4	177.4	Jun-03	
CB01	640,774	7,597,645	106.8	100.8	222.3	Apr-14	Coal seams
Gas2_MB3	640,781	7,597,648	Unknown	Unknown	226.5	Dec-12	
MB20SWC04P	651,811	7,585,831	138.7	134.7	172.6	Mar-21	
MB20SWC06P	649,801	7,587,879	106.6	100.6	201.8	Mar-21	
MB20SWC08P	649,229	7,590,886	85.9	80.9	192.6	Mar-21	
MB4	646,166	7,595,932	176.1	164.1	209.4	Nov-12	
SWCMB16_01	638,943	7,601,990	231.9	228.9	248.0	Mar-21	

Notes mE – metres east
mN – metres north
m AHD - metres Australia Height Datum
HSU - hydrostratigraphic unit.

4.8.3 Density-dependent flow

Density-dependent flow is not a likely factor for groundwater flow conditions at the regional study area. This is based on the limited variation in the median electrical conductivity among the HSUs (1,460 in the alluvium to 6,470 µS/cm in the Coal Seams) and temperature measurements (typically between 26.4°C and 28.8°C) of groundwater across site. There are localised occurrences of elevated electrical conductivity, however, these are not expected to be significant enough to impact density-dependent flow throughout the site.

4.8.4 Groundwater and surface water interaction

The main creeks in the regional study area and surroundings are classified as ephemeral streams, including the creeks near the Project area (Sandy Creek to the immediate north, Humbug Gully to the south and Bee Creek to the east). These creeks flow for a short time following episodic rainfall events, especially in the wet season (frc environmental, 2022a; BMT WBM, 2011).

Depth to groundwater measurements indicate that creek beds are:

— elevated with respect to the groundwater table

— disconnected from groundwater, and

— when flowing, act as losing streams locally supplying recharge to the water table (CDM Smith, 2016).

Groundwater has not been documented to discharge to surface at SWC, nor are springs noted in the regional study area.

To corroborate this with the conceptual understanding of connectivity between surface and groundwater in the regional study area, Golder (2022) reviewed two key datasets to assess potential for groundwater discharge to mean creek through the alluvial aquifer. These were:

— seasonal groundwater depths within monitoring bores that are screened across alluvial sediments, and

— streamflow gauging data.

This data provides an opportunity to assess potential baseflow conditions at key locations across the regional study area. A lack of baseflow would suggest a hydraulic disconnection between alluvial groundwater and surface ecosystems.
The review of these datasets indicated that:

— Historically the watertable is usually deeper than 10 m bgl and likely not in connection with any of the creeks or surface water bodies.

— Across the broader region, seasonal depths to groundwater in the alluvium vary between 2.5 to >25.0 m bgl across the regional study area and are generally greater than 10 m bgl. Shallowest depths to groundwater in the alluvium are observed in MB10 and MB11 (2.5 m bgl), located over 14 km north of the Project area. However, at the proposed Project area, depths to groundwater in the alluvium vary between approximately 6.9 m bgl (in MB20SWC03P close to the confluence of Sandy Creek and Bee Creek to the east of the Toolah Pit) and 17.4 m bgl (in MB14 along Bee Creek top the southeast of the Project area). It is noted MB20SWC03P is located approximately 750 m south of Pink Lily lagoon (an area of cultural heritage significance), thereby providing an indication of the water table depth near this body of water.

— Across the broader region, historical depths to groundwater in the regolith vary between 2.5 and 28.5 m bgl. Shallowest depths occur at MB3A and MB3B (with minimum monitored values of 2.5 and 1.8 m bgl, respectively). However, close to the proposed Project area, depths to groundwater vary between approximately 10 m bgl (in monitoring bore MB12 to the east of the Kemmis Pit) and 28.5 m bgl (in monitoring bore OBS1 immediately south of the Toolah Pit). The latter of which is expected to represent the passive depressurisation and dewatering of this unit in response to mining.

— At surface water flow monitoring points installed along the alignment of Bee Creek and Walker Creek, monitoring shows that these reaches are typically dry or experience negligible flows at most. Baseflow from alluvium aquifer may temporarily occur after rainfall events, however flow rates diminish quickly and return to typical conditions in short duration.

4.9 Groundwater quality

Groundwater samples have been collected in the regional study area since 2003 and hydrochemistry trends for SWC assessed in previous studies by CDM Smith (2016) and Golder (2018a; 2022; 2023).

Key statistics on groundwater chemistry data are presented in this section to provide an overview of groundwater quality in the context of the Project and of relevance for the current study.

4.9.1 pH

Groundwater at the SWC mine is typically slightly alkaline to alkaline (Figure 4.17 to Figure 4.20). In the alluvium, the pH of groundwater ranges from 6.5 to 8.5, with measurements of pH from those monitoring bores in the Project area ranging between about 6.9 and 8.3.

In the regolith, pH of groundwater generally ranges from 6.5 to 8.7, with measurements of pH from those monitoring bores in the Project area ranging between about 6.5 and 8.6. pH levels usually do not exceed the trigger levels, which are set between 6.5 and 8.5 for both the alluvium and regolith.

In the overburden, groundwater is generally more alkaline than in the alluvium and regolith, with pH values ranging between 7.4 and 8.7. In the Project area, the pH of groundwater in MB20SWC05A is at the end of measurements at the SWC mine, with pH values ranging between about 7.4 and 8.2.

In the coal seams, groundwater pH typically ranges from 7.1 to 10.1, with one anomalous measurement of 11.9 at CB01; this may be attributable to the construction of the monitoring bore (cement contamination) and is not considered further in this GIA. Within the Project area, groundwater pH values range between about 7.2 and 8.2 which are within the trigger levels for the Project area. These values do not exceed the trigger levels in the Project area, which are set between 6.5 and 8.5 for both the overburden and coal seams.

4.9.2 Electrical conductivity

Groundwater salinity across the SWC mine area ranges from fresh (with electrical conductivity measurements typically lower than 1,500 microsiemens per centimetre, µS/cm) to saline (greater than 20,000 µS/cm) and is generally considered to be unsuitable for drinking. Figure 4.21 to Figure 4.24 present electrical conductivity (EC) measurements for each monitored HSU throughout monitoring.

Groundwater salinity in the alluvium bores across the SWC mine is generally fresh to saline with EC measurements varying between 576 and 29,000 µS/cm. In the Project area, EC measurements in this unit vary from fresh (800 to 1,650 µS/cm) in bores MB13 and MB14, to brackish in MB20SWC01A (with EC concentrations ranging between 1,890 and 2,430 µS/cm), and ultimately saline (25,100 to 29,900 µS/cm) in MB20SWC03P.

It is noted EC measurements in MB20SWC03P exceeds the EC trigger threshold (8,910 µS/cm) in all instances, although it is within the historical maximum (9,520 µS/cm; June 2022).

Electrical conductivity measurements of groundwater in those monitoring bores across the SWC mine screened in the regolith indicates this water is generally fresh to saline, with EC measurements varying between 640 and 33,300 µS/cm. In the Project area, EC measurements in monitoring bores OBS1 and OBS2 vary between 12,500 and 33,300 µS/cm, with groundwater in MB12 being brackish with EC measurements between 3,970 and 8,670 µS/cm.

Groundwater geochemistry and quality in the overburden is monitored in three bores. Measurements from these bores indicates EC varies between 1,570 and 15,700 µS/cm with this groundwater typically being brackish to saline. The highest EC concentrations are observed in monitoring bore MB20SWC05A in the Project area, with measurements varying between 14,200 and 15,700 µS/cm, all of which are above the EC trigger threshold of 8,910 µS/cm.

Groundwater in those monitoring bores screened in the coal seams is generally brackish across the SWC mine, with measurements of EC varying between 70 and 17,200 µS/cm. In the Project area, EC measurements vary between 4,150 and 17,200 µS/cm.

Measurements of EC in MB20SWC04P, MB20SWC06P and MB20SWC08P all exceeded the EC trigger threshold (8,910 µS/cm). MB20SWC04P (17,200 µS/cm; March 2023) was above the previous maximum whereas MB20SWC06P and MB20SWC08P were both below the historical maximum (12,600 µS/cm in January 2022; and 15,700 µS/cm in June 2021 respectively).

4.9.3 Major ion chemistry

Major ion ratios at SWC are illustrated in Piper plots from July 2022 to June 2023. The symbology indicates each bore and aquifer (Figure 4.25) and reflects each HSU (Figure 4.26). Data from previous monitoring periods have been analysed in Golder (2022; 2023) and are summarized here.

Overall, the groundwater chemistry results in the regional study area are consistent with monitoring results from previous reporting years. Groundwater in the alluvium HSU remains dominated by magnesium and bicarbonate, however, there has been an increase in sodium and a decrease in calcium.

Groundwater in regolith is mostly sodium and chloride dominant, which is similar to groundwater ion chemistry in the overburden.

Major groundwater ions in the coal seams vary, however it generally tends to have higher sodium and magnesium concentrations compared to other major ions.

In the Project area, sulphate concentrations:

— in the alluvium generally range from 6 to 30 mg/L, with exception of MB20SWC03P, with concentration ranging from 451 to 496 mg/L, above the trigger threshold of 318 mg/L

— in the regolith generally range from 0.5 to 75 mg/L, with exception of OBS2, with concentration ranging from 344 to 1,300 mg/L, above the trigger threshold of 318 mg/L

— in the regolith range from 280 to 377 mg/L, generally above the trigger threshold of 318 mg/L, and

— in the coal seams generally range from 0.5 to 82 mg/L, with exception of MB20SWC02P, with concentration ranging from 242 to 265 mg/L, below the trigger threshold of 318 mg/L.

4.9.4 Dissolved metals

Table 4.4 presents a summary of the dissolved metal concentrations for the monitoring bores located in the Project area and surrounding from 2004 to present. For those metals detected below laboratory detection limits, concentrations are assumed to be half of the respective detection limit. Concentrations of aluminium, antimony, arsenic, cadmium, manganese, nickel, selenium and iron were detected above the ADWG guideline values, and apart from antimony, manganese, mercury and iron, all metals were also detected at concentrations above the relevant ANZECC guideline values for aquatic ecosystems with 95% protection level.

Table 4.4 Summary of dissolved metal concentration

Dissolved metal / metalloid	Lowermost guideline value (mg/L) in ADWG† (2011)	95% Protection level and trigger levels ANZECC‡ (2018) (mg/L)			Measured concentration (mg/L)		
		Irrigation	Stock Water	Aquatic Ecosystems	Minimum	Mean	Maximum
Aluminium	0.2	5	5	0.0055 (pH>6.5) 0.0008 (pH<6.5)	0.001	**0.009**	**0.25**
Antimony	0.003	-	0.009	0.009	0.0005	0.0007	0.009
Arsenic	0.01	0.1	0.5	0.0024	0.0005	**0.004**	**0.073**
Boron	4.0	0.5	5.0	0.94	0.05	0.34	**0.98**
Cadmium	0.002	0.01	0.01	0.0002	0.00005	0.0001	**0.0025**
Chromium	0.05	0.1	1.0	0.0043	0.0001	0.0008	**0.008**
Cobalt	-	0.05	1.0	0.0014	0.0005	**0.003**	**0.03**
Copper	2.0	0.2	5.0	0.0014	0.0005	**0.0017**	**0.025**
Lead	0.01	0.2	0.1	0.0034	0.0005	0.0008	**0.005**
Manganese	0.1	2.0	0.1	1.9	0.003	0.5	1.78
Molybdenum	0.05	0.2	0.15	0.034	0.0005	0.0027	**0.035**
Mercury	0.001	0.002	0.002	0.00006	0.00005	0.00005	0.00005
Nickel	0.02	0.01	0.15	0.011	0.0005	0.005	**0.122**
Selenium	0.01	0.2	1.0	0.011	0.0002	0.007	**0.05**
Silver	0.1	0.02	0.02	0.00005	0.0005	**0.0008**	**0.005**
Vanadium	-	-	0.00005	0.00005	0.005	**0.008**	**0.05**
Zinc	3.0	0.1	-	0.008	0.0025	**0.09**	**1.55**
Iron	0.3	2.0	20	-	0.005	0.46	3.31

Notes † Australian Drinking Water Guidelines, lower guideline value for health and aesthetic purposes.
‡ Australian and New Zealand Environment Conservation Council.
Water quality guideline and trigger values is light-blue shading
Concentrations in **bold** text exceed the referenced protection and trigger levels presented in ANZECC (2018).
Concentrations in light red shading exceed the minimum guideline value presented in ADWG (2011).

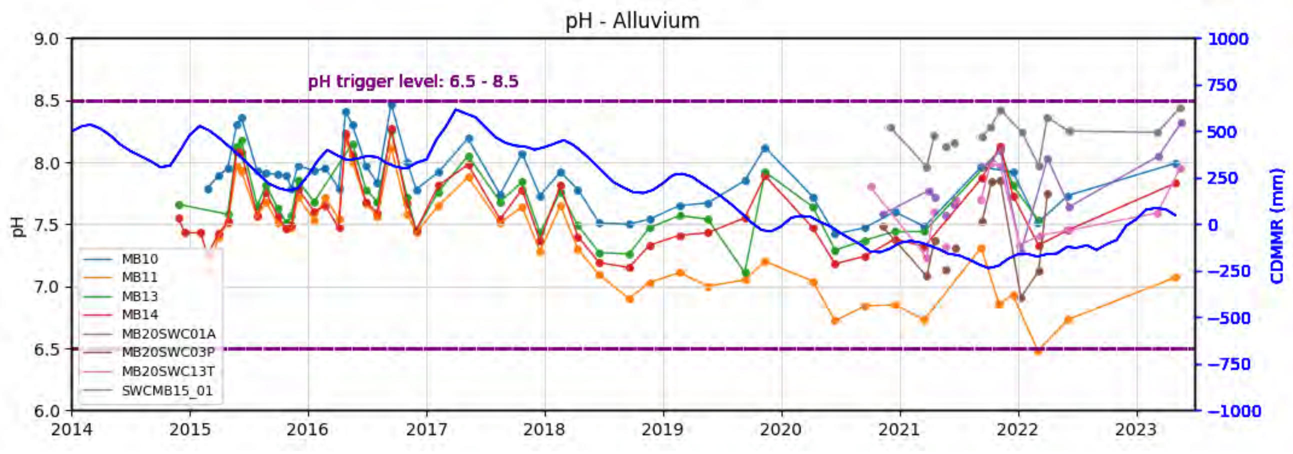


Figure 4.17 Groundwater pH – alluvium

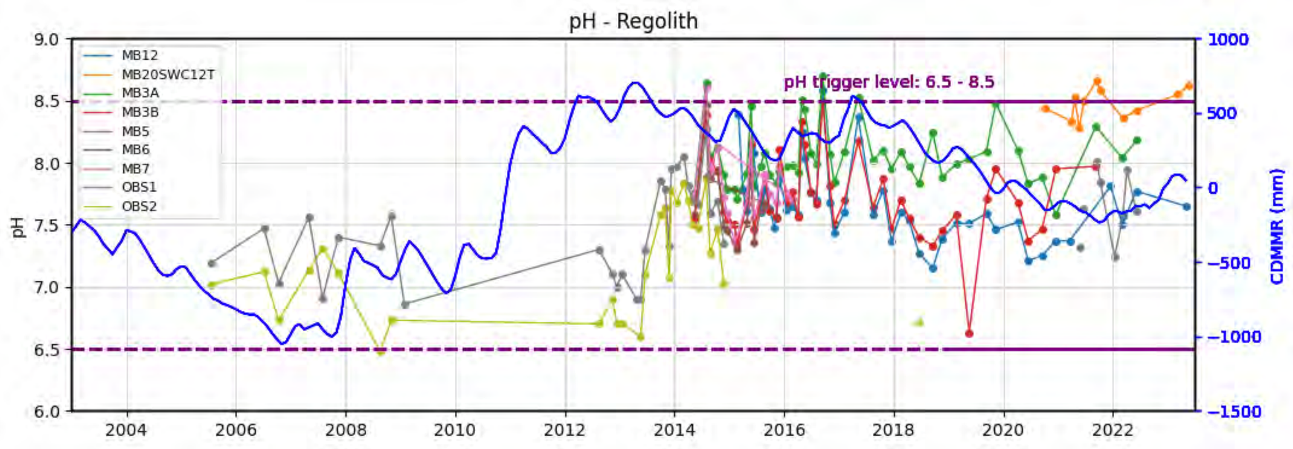


Figure 4.18 Groundwater pH – regolith

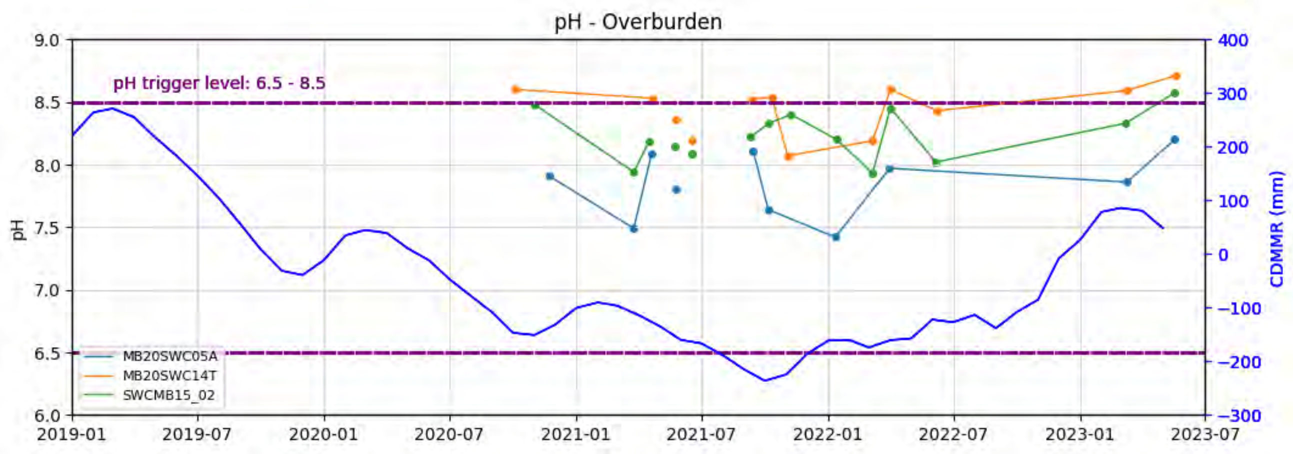


Figure 4.19 Groundwater pH – overburden

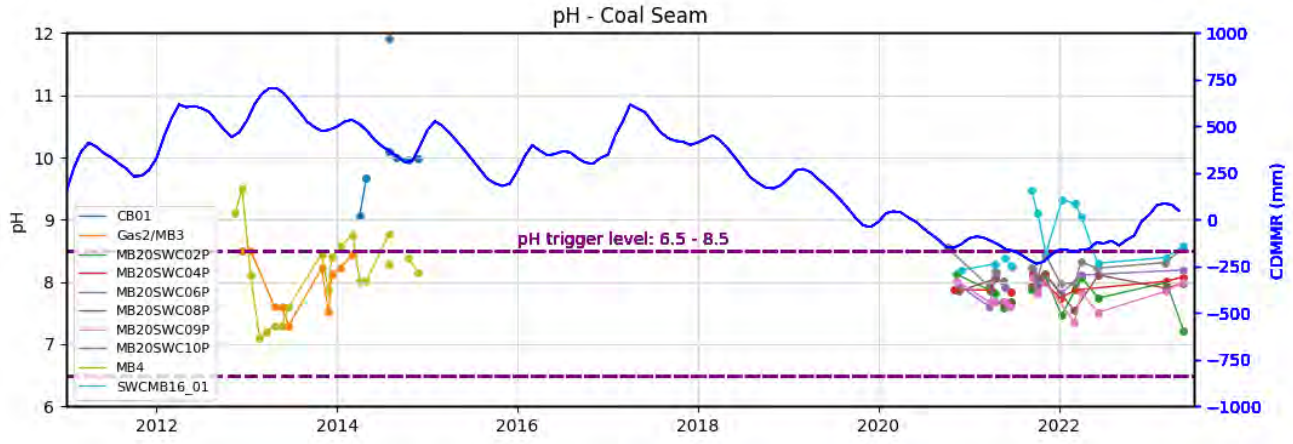


Figure 4.20 Groundwater pH – coal seams

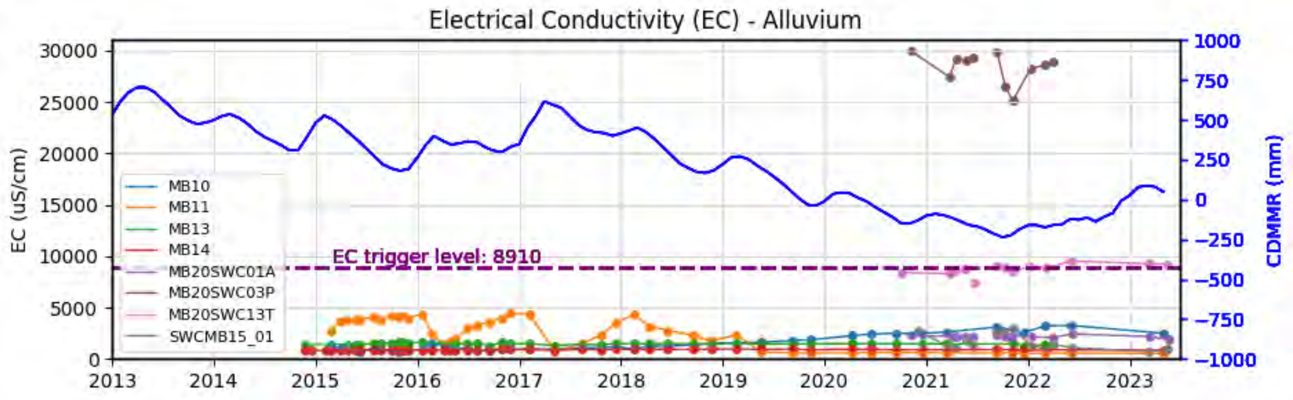


Figure 4.21 Groundwater electrical conductivity – alluvium

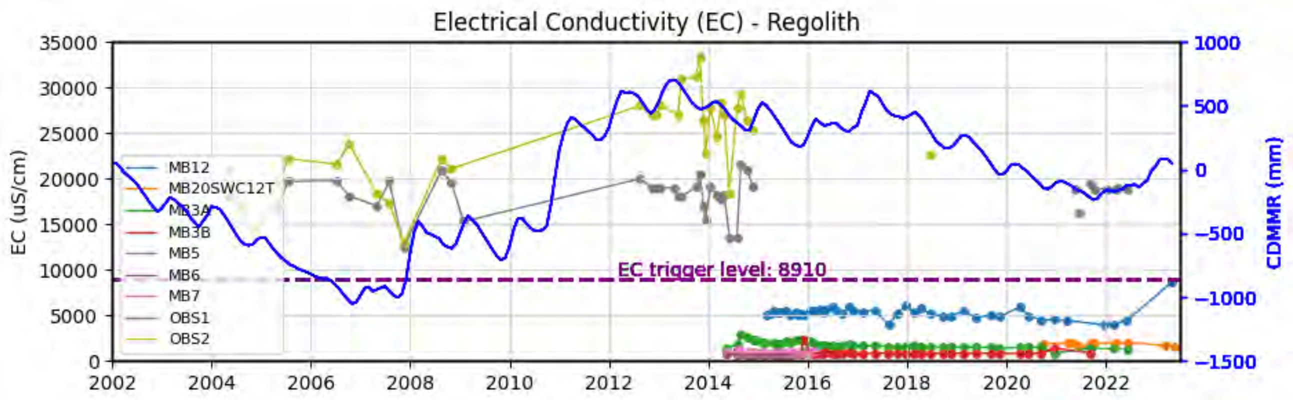


Figure 4.22 Groundwater electrical conductivity – regolith

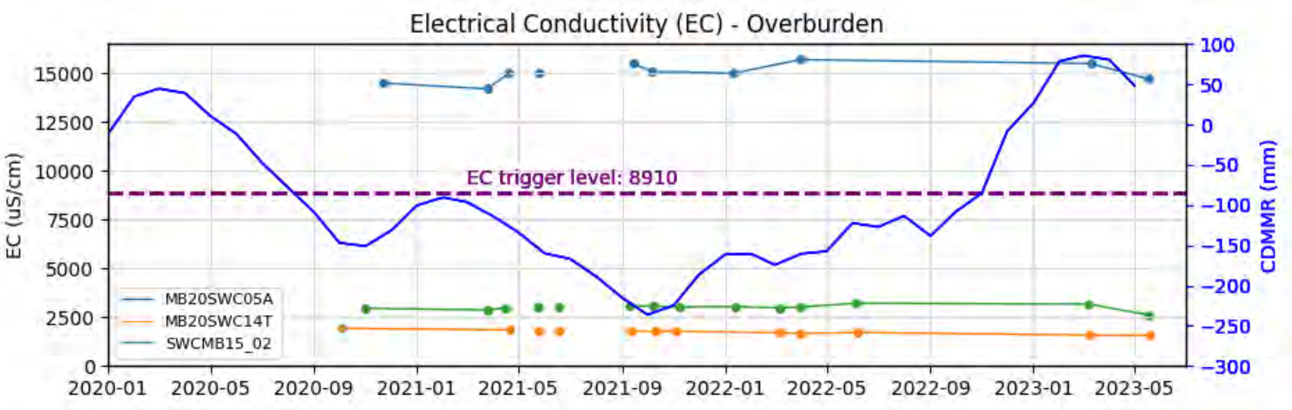


Figure 4.23 Groundwater electrical conductivity – overburden

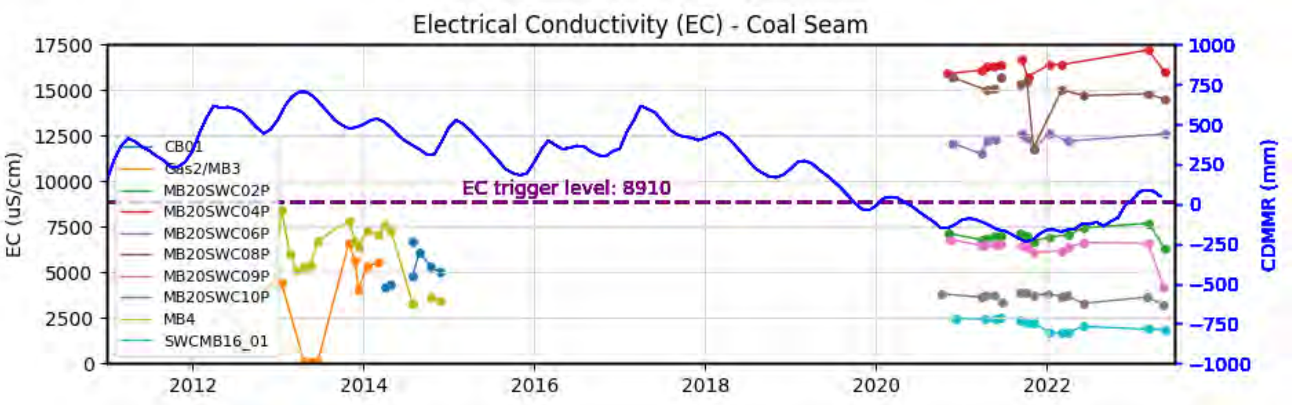


Figure 4.24 Groundwater electrical conductivity – coal seams

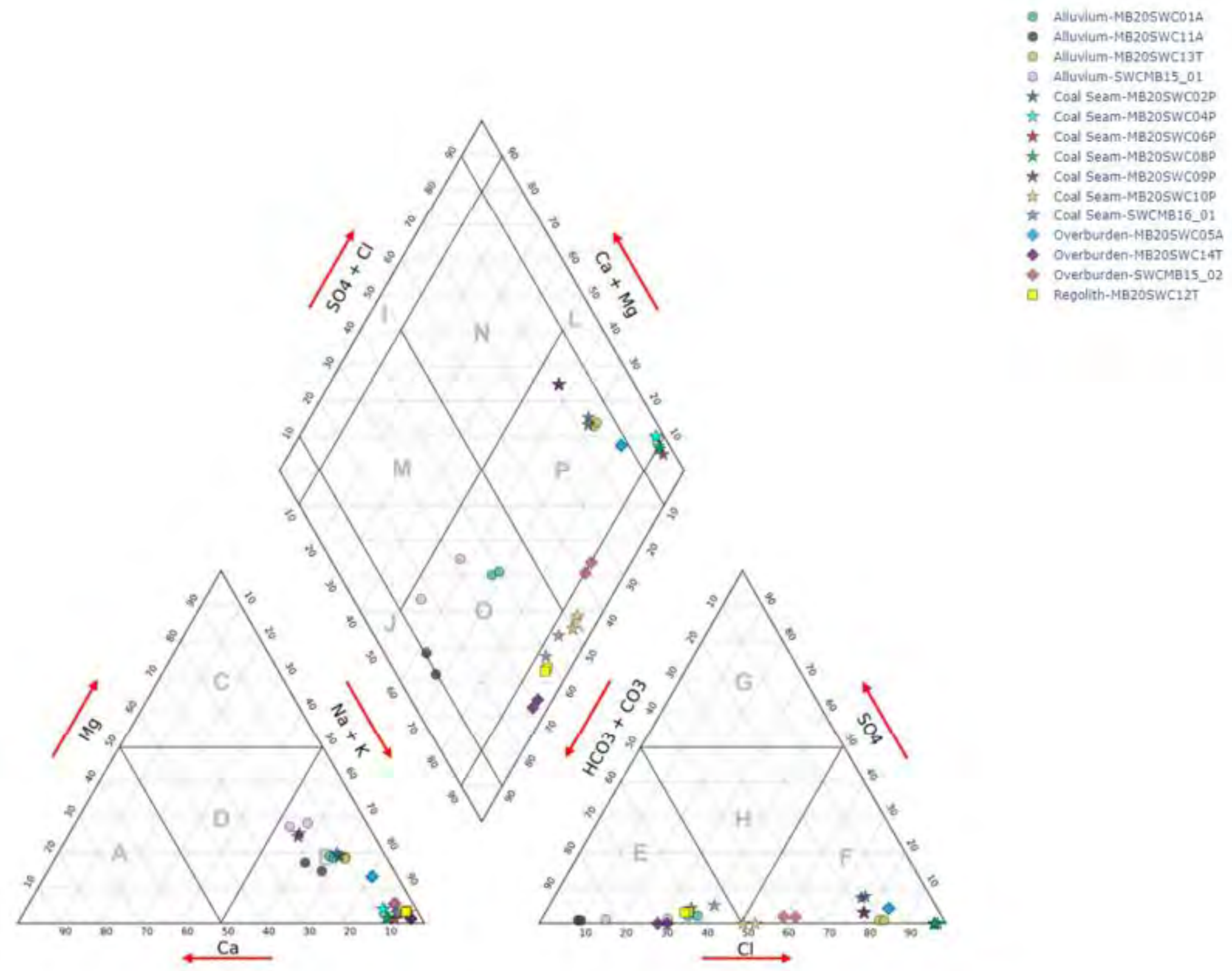


Figure 4.25 Piper plot of major ion chemistry at SWC between July 2022 and June 2023, with symbology depicting each bore and shape indicating relevant HSU

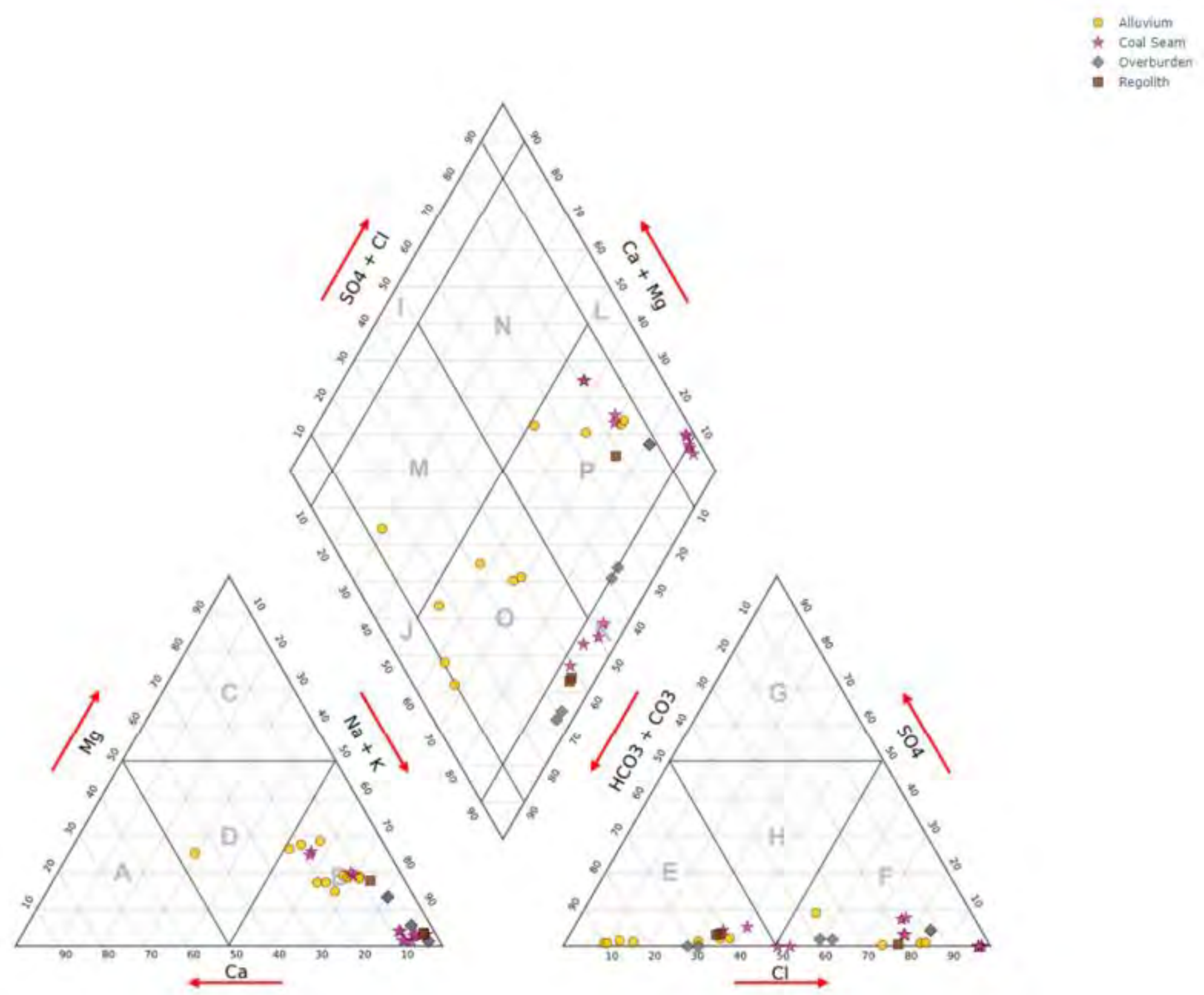


Figure 4.26 Piper plot of major ion chemistry at SWC between July 2022 and June 2023, with symbology depicting relevant HSU

5 Environmental values and receptors

5.1 Environmental values and water quality objectives

The EPP WWB states the relevant EVs and WQOs for water, and the relevant water quality guidelines and indicators for protecting these values. EVs of specific waters to be protected or enhanced, such as those within the vicinity of the Project, are defined in Schedule 1 of the EPP WWB.

These values encompass direct uses including water supply for (where relevant) drinking water, irrigation and stock watering, as well as recreational, aesthetic uses and the inherent cultural and spiritual values of waterways. The EPP WWB defines EVs and WQOs for the surface and groundwater environment in Queensland as a measure for maintaining and/or improving the long-term provision of these services.

It should be noted that due to the significantly high electrical conductivity values measured at the Project area, it is unlikely that the environmental values for drinking water will be met and is not considered further.

This Project is located within the Fitzroy Basin and the EVs for this area are set out under the plan Isaac River Sub Basin Environmental Values and Water Quality Objectives – Basin No. 130 (part), including all waters of the Isaac River Sub basin (including Connors River) September 2011. The Project falls within the Connors Groundwaters zone. Under this document, the EVs and WQOs attributed to this zone are summarised in Table 5.1.

Table 5.1 Environmental values and water quality objectives

Environmental values		**Water quality objectives**
Water supply	Irrigation	Uphold Australian and New Zealand Environment Conservation Council (ANZECC) objectives for pathogens and metals.
	Farm use	Refer to Australian Water Quality Guidelines (AWQG) for objectives.
	Stock water	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 mL.
	Industrial use	No WQOs are provided.
Aquatic ecosystems		Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters. Otherwise WQO's are set for the chemistry zone (Zone 34 applies to the Project location).
Cultural, spiritual and ceremonial values		Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.

5.2 Sensitive receptors

5.2.1 Groundwater users

Fifteen registered landholder bores are present at SWC, none of which are closer than 9 km from the proposed Project area. The closest registered bores to the Project area are located at the nearby Coppabella Mine to the south and are used for groundwater monitoring purposes.

As described in Section 4.9, groundwater in the regolith, overburden and coal seams is typically brackish to saline. As such, groundwater in these HSUs is unlikely to be suitable for future livestock watering or other uses.

Conversely, groundwater in the Quaternary alluvium typically has much lower salinities and may be suitable for future stock and domestic purposes.

5.2.2 Groundwater dependent ecosystems

GDEs are natural environments which are dependent on the access to groundwater on a constant or intermittent basis to sustain aquatic and/or terrestrial ecosystems such as vegetation, springs, wetlands and rivers (WetlandInfo, 2021). The ephemeral nature of the waterways in the proposed Project area, typically disconnected from the underlying aquifer, makes it unlikely that they support or are associated with GDEs.

However, a search of potential GDEs within the Australian GDE Atlas for the Project area and surroundings indicates potential surface and terrestrial GDEs based on a national assessment. These potential GDEs are listed below and presented in Figure 5.1.

High to moderate potential aquatic GDEs from national assessment:

- Associated with Bee Creek and its tributaries (classified as “river” type).

  In the proposed Project area and surroundings, GDEs associated with watercourses are mostly classified as high potential.
- Associated with different types of wetlands, including artificial and natural water bodies throughout the site and around the main streams. In the Project area, the GDEs associated with wetlands are mostly classified as high potential.

High to low potential terrestrial GDEs from national assessment:

- Riparian vegetation associated with the main creeks, including Bee Creek (classified as high potential GDEs).
- Riparian vegetation associated with minor creeks and spread throughout the proposed Project area and surroundings, including parts of Sandy Creek and parts of Humbug Gully.

The following sections evaluates the potential for GDEs at the project site, based on current groundwater conditions and ecological surveys.

5.2.2.1 Aquatic GDEs

Aquatic GDEs are surface expression groundwater, such as wetlands, lakes, seeps, springs, and river baseflow systems, rely on groundwater discharge to support aquatic biodiversity. The Australian GDE Atlas identifies potential surface expression GDEs in the Project area and its surroundings, including Bee Creek, Walker Creek, Humbug Gully, a wetland associated with Sandy Creek, and a culturally significant lagoon named Pink Lily Lagoon located southwest of Bidgerley TSF. However, site investigations and field assessments by project aquatic ecologists (frc environmental, 2022a) confirmed the absence of actual surface expression GDEs within the regional study area and mining lease. This conclusion is based on a review of aerial imagery and the observation that these waterways are mostly ephemeral with no sustained groundwater flows. Additionally, some of the mapped wetlands within the mining lease are associated with mine water storages or farm dams, and not associated with or dependent on groundwater (frc environmental, 2022a; 2022b). Groundwater depths and flow data further support these findings, indicating a typical disconnection between surface water and groundwater in the Project area.

It should be noted that Matters of State Environmental Significance (MSES) Wetlands do not occur within the Project area. The closest MSES wetland is located approximately 9 km to the northwest (and hydraulically up-gradient) of the Project area.

5.2.2.2 Riparian GDEs

Within the Project area, riparian vegetation associated with Eucalyptus Woodlands on alluvial plains and drainage lines (Regional Ecosystems 11.3.4 and 11.3.25) is mapped as a potential terrestrial GDE. However, Project terrestrial ecologists have confirmed the absence of water or the dominance of halophytic or swamp flora species on the creek bed, which are characteristics associated with terrestrial GDEs (Eco Logical Australia, 2021).

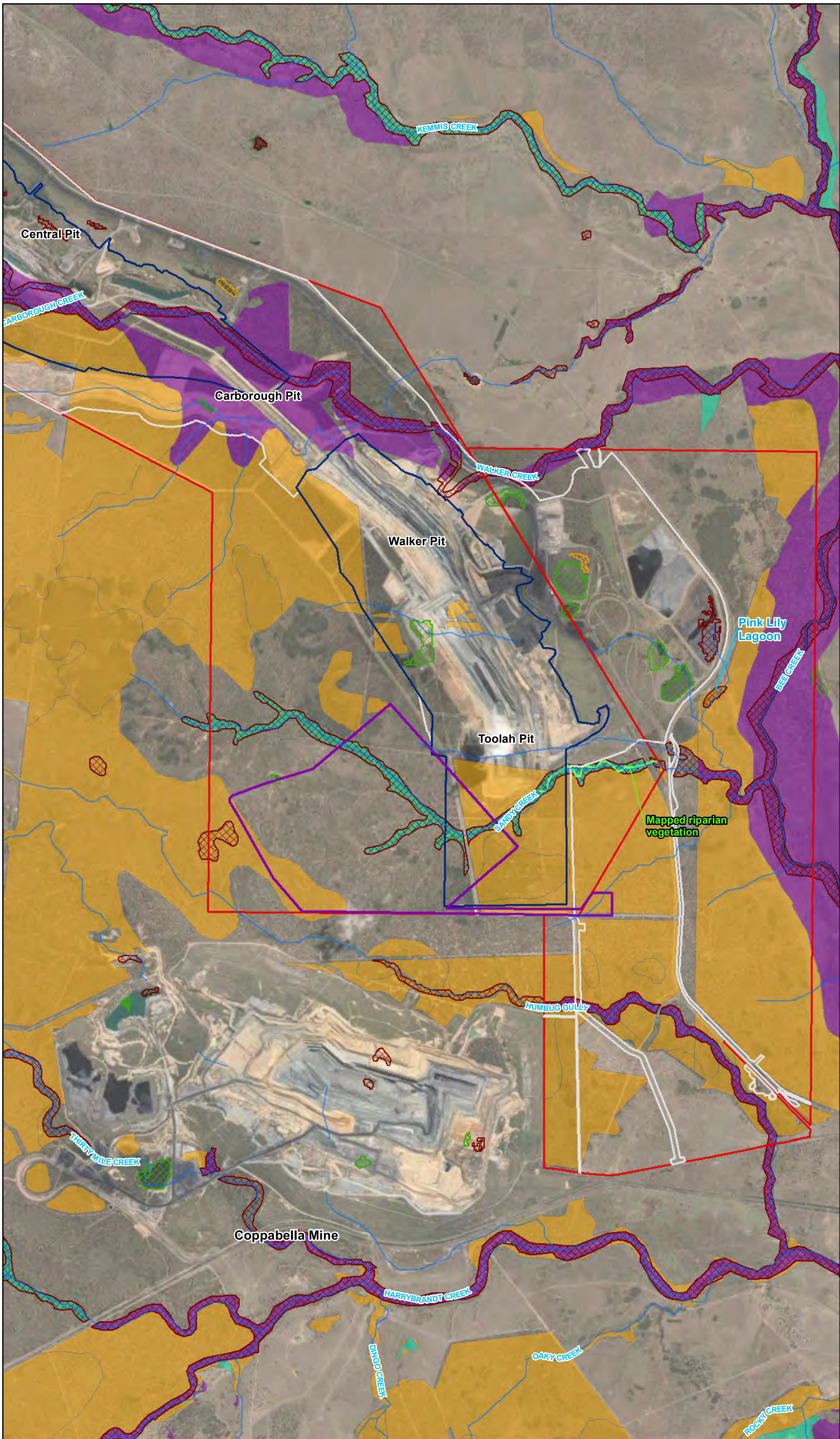
Additionally, the minimum historical depth to groundwater in the Project area was 7.0 m bgl (MB20SWC03P), with current (pre gas extraction) groundwater levels at 7.1 m bgl, which is below the root zone of most species. As such it is considered unlikely that terrestrial GDEs are present within the Project area.

5.2.2.3 Subterranean GDEs

frc environmental have undertaken desktop reviews and onsite surveys for stygofauna across SWC for several years. Stygofauna is widespread throughout SWC, with the highest diversity and environmental value recorded within the alluvium of the regional study area at MB10 (frc environmental, 2022c; 2022d), located over 10 km to the northwest of the Project area. Despite the local variability in stygofauna occurrence, the presence of stygofauna within both the alluvium and regolith units indicates that there is potential for a subterranean GDE within the Project area. The Project risk to these has been considered by this impact assessment.

PS209709
SWC Mine Gas Drainage Project

Figure 5.1
Potential groundwater dependent ecosystems



Legend

- Watercourses
- Proposed Gas Project Area
- Mining Leases
- Mapped Riparian vegetation

State (EA) Approved Disturbance Area

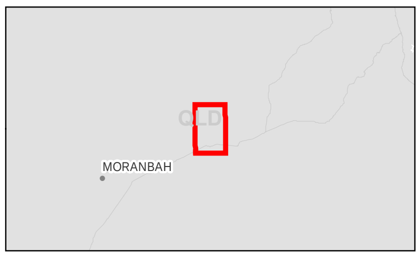
- Approved Subsurface Disturbance
- Approved Surface Disturbance

Potential GDE - Aquatic

- Low potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- High potential GDE - from national assessment

Potential GDE - Terrestrial

- Low potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- High potential GDE - from national assessment



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Meters

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Scale ratio correct when printed at A3

1:55,000 Date: 18/07/2024

Data sources: DELWP, Geoscience Australia

5.3 Hydrogeological conceptualisation

Figure 5.2 depicts the conceptualisation of the hydrogeological system in the proposed Project area and surroundings along a representative section oriented SW-NE. The approximate location of this cross-section is shown in Figure 4.6 and Figure 4.7 and shows the depths and extents of the main interpreted HSUs that are present in the Project area as well as the general occurrence of the water table.

- The primary aquifers at the SWC mine and Project area comprise:
  - where saturated, the Quaternary sediments along the alignment of Bee Creek, Sandy Creek and Humbug Gully, all of which are expected to form localised (and spatially disconnected) unconfined aquifers
  - the Tertiary sediments and weathered regolith, which together are expected to form a regionally significant and largely unconfined watertable aquifer, and
  - the coal seams of the RCM, which are expected to form separate confined aquifers separated by the interburden of the RCM.
- Where unweathered, the Rewan Formation, interburden of the RCM and FCCM form regionally significant aquitards. Apart from the interburden of the RCM, which is expected to form a leaky aquitard, these HSUs are expected to form confining units inhibiting any notable vertical or horizontal groundwater flow, including in part across the unnamed regionally significant fault at the foot of the Carborough Range to the west of the Project area and SWC mine.
- Generally, shallow groundwater flow mimics surface topography, with groundwater flow generally being directed towards a south-eastern direction (as described in Section 4.8.2), consistent with the topographic slope. Groundwater flow in the deeper units follow the dominant south-eastern direction of regional groundwater flow as in the alluvium.
- Groundwater elevations indicate groundwater in all HSUs generally flows from northwest to southeast in line with topography and the flow direction of Bee Creek. Locally however groundwater flow directions are influenced by mining at the SWC and Copabella mines, with groundwater elevations in all HSUs at and in the vicinity of the Project showing the influence of these activities.
- Groundwater elevation measurements indicate creek beds are:

  (i) elevated with respect to the groundwater table

  (ii) disconnected from groundwater, and

  (iii) when flowing, act as losing streams locally supplying recharge to the water table.
- Recharge occurs mainly via two mechanisms:

  (i) direct infiltration of rainfall, and

  (ii) leakage from ephemeral streams, ponds, storage facilities, wetlands and/or other structures.

  Recharge in response to rainfall events are estimated to be between 0.05 and 2% of annual rainfall. In stating this, such recharge is only likely to occur following rainfall events of sufficient magnitude to overcome interception (essentially the build-up of the 'wetting front' and saturation status) by dry soils and subsequent evapotranspiration from soil layers.
- Discharge occurs mainly via three mechanisms:

  (i) as natural groundwater throughflow draining to the southeast towards lower hydraulic heads

  (ii) as discharge to the open pits, and

  (iii) as evapotranspiration.

  Discharge from the Project (i.e., that groundwater take necessary to promote the desorption of gas from the coal) will constitute an additional discharge mechanism at SWC, with such rates in the first 13 years of operation expected to range between 20 and 60 m³/day.

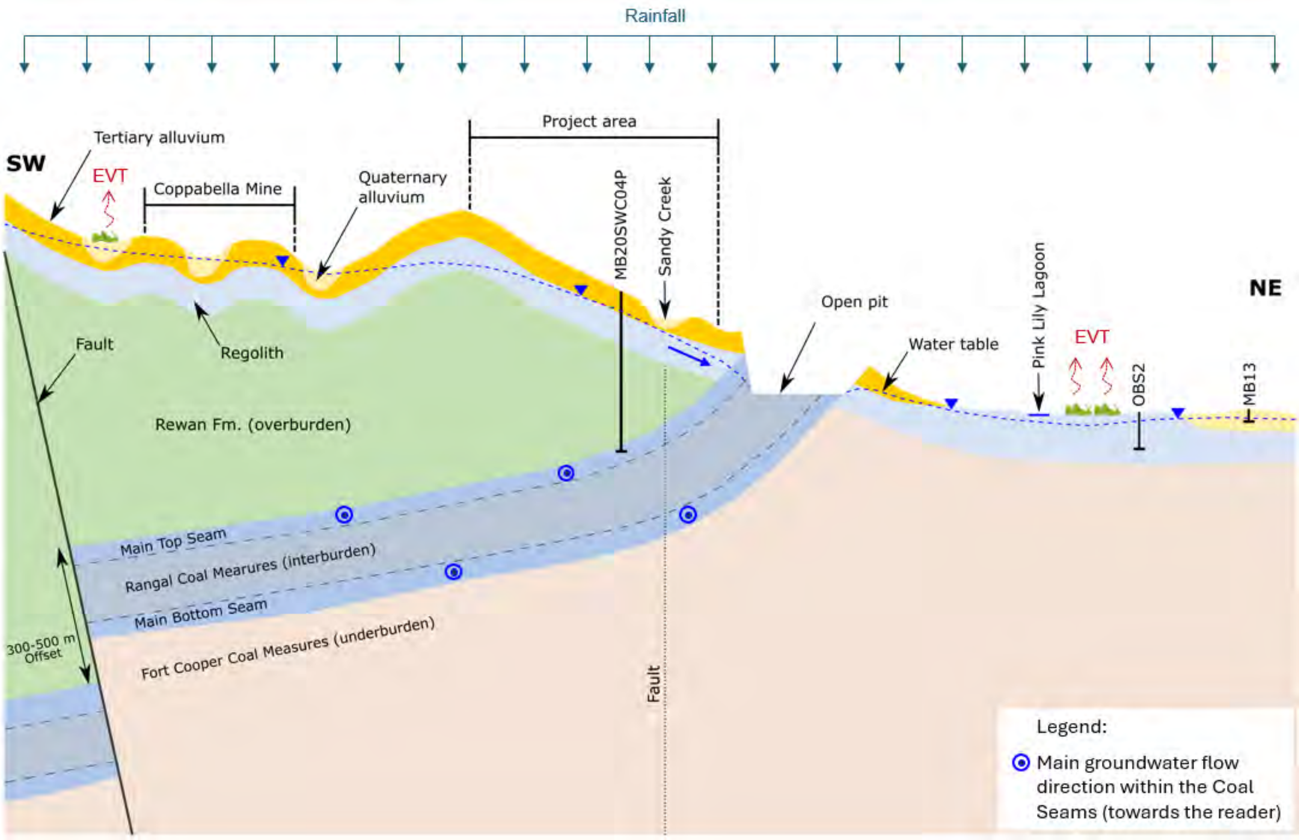


Figure 5.2 Conceptual SW-NE hydrogeological cross-section across the Project area

6 Numerical modelling

As part of the hydrogeological studies for the GIA, three-dimensional numerical groundwater flow modelling was undertaken. The objectives of the modelling were to:

— assess the potential impacts of the coal seam gas extraction on the groundwater regime including private supply bores and GDEs during operation and post-closure periods, and

— inform the cumulative impact assessment considering the nearby SMC open cut mine and third-party operations, including Coppabella and Arrow Energy operations.

The numerical groundwater flow model previously developed by Golder (2022) was used for this assessment. This model was considered appropriate for the purpose of this assessment given:

— its extents and boundary conditions are specific to the SWC mine and its operations

— the model extent is suitable to allow the inclusion of third-party operations for cumulative impact assessments

— the grid and discretisation are appropriate for the scale of this assessment, albeit with some refinement carried out in the Project area (as further discussed below)

— it has been calibrated in both steady-state and transient, including approximately 20 years of groundwater level data, and

— it has undergone an independent third-party review.

Changes to the grid refinement in the Project area in the model were carried out by WSP to allow more ‘refined’ predictions for each modelled scenario for this GIA.

Following the refinement of the model grid, WSP verified the calibration of the model to ensure it was fit for purpose for this GIA.

In considering the adequacy of the model for this GIA, WSP noted the groundwater model prepared by Golder (2022) had been developed in a manner consistent with the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). The Australian Groundwater Modelling Guidelines outlines the concept of “model confidence level”, which is defined based on modelling criteria, with both the numerical model prepared by Golder and the revised model used by WSP for this GIA considered to have a predominantly Class 2 confidence level classification, with some elements of a class 3 model. A summary of model confidence class characteristics presented in (Barnett at al., 2012) is provided in Appendix A.

A summary of the design and development of the numerical model is provided in this section.

6.1.1 Numerical model construction

The numerical groundwater flow model was initially developed by Golder (2022) and refined by WSP to focus on the proposed Project area. The model was amended to assess potential impacts to GDEs and existing groundwater users (registered bores) as a result of the Project and estimate the duration of any impacts.

Calibration to historical (pre-production) hydrogeological conditions was undertaken in steady state by Golder (2022) and validated by WSP for this GIA. Calibrated heads were used as initial heads for the transient calibration and predictive scenarios, with the calibration period approximately 20 years and predictive runs including 22 years of production. This was followed by approximately 500 years of post-Project groundwater recovery.

Key simplifications to the general model setup include the following.

— Heterogeneities such as localised faults and fractures are not included in the model.

  This is justified by the scale of the Project, the corresponding need for a regional scale model, and paucity of specific data regarding those faults and the objectives of the study. An exception to the above though was made for the regionally significant NNW-SSE fault to the west of the CWT pit and greater SWC mine, which was represented as a separate HSU to align with the conceptual understanding.

This simplification is thought to be a conservative approach as some faults, including those NW-SE oriented structures, are conceptualised to be barriers to regional groundwater flow, therefore likely resulting in less impact to nearby environmental values than those estimated by the model.

— Exclusion of processes specific to coal seam gas production such as dual domain flow (i.e. fracture flow and porous medium flow), gas desorption, dual phase flow, and geomechanical deformation.

  The modelling of the impacts of water extraction for gas production using a single phase (i.e., water) flow model rather than a dual phase flow model tends to over-predict drawdown in the coal seam.

6.1.2 Simulation code

The control volume finite difference (CVFD) modelling code MODFLOW-USG was selected to simulate the saturated groundwater environment. MODFLOW-USG was developed by the development team (Panday, S. et al , 2017) and is maintained by the United States Geological Survey (USGS). For this project Groundwater Vistas 8 was used as the Graphical User Interface (GUI) for the model build, calibration and simulations.

MODFLOW is one of the most widely used groundwater modelling codes. It is considered an international standard for groundwater modelling. MODFLOW-USG allows flexibility in grid design (unstructured grids), allowing a better resolution along discrete features and infrastructure. It enabled the discretisation of the grid around the proposed Project area without compromising the quality of the grid and results for the current assessment.

6.1.3 Extents and discretisation

The boundary of the model has been defined based on the location of topographical ridges and expected regional flow of shallow groundwater and Coal Seam aquifers. It has been set far enough away from the SWC pit and proposed Project area to minimise boundary-induced effects while ensuring that it follows sensible hydrogeological units.

In the west, the boundary of the model partially aligns with the unnamed major NNW-SSE fault, representing the contact between the Clematis Sandstone and the Rewan Group to the west of the fault.

In the north the boundary of the model aligns along faults intersecting the Rangal Coal Measures. In the east, it runs parallel to Bee Creek and across the aquitards where the flow is assumed to be primarily vertical, whilst in the south it partially aligns with the expected regional equipotential lines (i.e. flow lines are perpendicular to the boundary).

The model grid is rotated approximately 35 degrees from north to align model cells with the general NNW-SSE orientation of the interpreted regional groundwater flow directions in the main aquifers in the modelled area. Figure 6.1 and Figure 6.2 show the groundwater model configuration in plan view.

The model domain is 45 km long (NNW–SSE), 40 km wide (SSW–NNE) and covers an active area of approximately 1,290 km^2.

The model grid comprises 114 rows, 101 columns and 13 layers for a total of 193,089 active cells. Cell size varies across the model domain from a refined quadtree grid of 100 m around the proposed Project area, to 200 m outside the proposed Project area and within the mining area and around the main creeks, to 400 m outside of these areas and to the model boundaries.

All model layers are laterally continuous across the model domain, and of variable thickness. Layer thickness was defined based on the geometry of the aquifers and on the surface topography, with Table 6.1 below presenting a summary of the model layering, layer thicknesses and associated model layer (conceptual) lithology.

Both SSW–NNE and NNW–SSE cross-sections of the model grid are presented in Figure 6.2; these show the various HSUs as represented within Groundwater Vistas.

Table 6.1 Model layering

Conceptual HSU	Model layer	Degree of confinement (LAYCON setting)	Thickness
Quaternary alluvium	1	Unconfined	0.1 to 10.5 m
Tertiary alluvium	1 and 2	Unconfined	0.1 to 40.5 m
Regolith	1, 2 and 3	Unconfined	31 m
Rewan Formation	4 - 9	Confined	Variable
RCM overburden	5	Confined	Up to 50 m
RCM main seam 1	6 and 10	Confined	0.1 to 46.8 m
RCM interburden	7 and 11	Confined	0.1 to 129.2 m
RCM main seam 2	8 and 12	Confined	0.1 to 46.8 m
FCCM underburden	4 - 13	Confined	166 to 300 m
Unnamed major SSE-NNW fault	4 - 13	Confined	-
Damage zone	4 - 13	Confined	-

6.1.4 Hydraulic parameters

To provide a geological basis for the structure of the groundwater model development, Golder (2022) extended the 3D hydrostratigraphic model developed by CDM Smith (2016) using Leapfrog Hydro™ to the north and west. The updated geological model considered:

— the surface geology (QLD DNRME, 2020)

— the interpretation of eight regional west-east seismic reflection profiles (to characterise the offset of the unnamed major SSE-NNW fault), and

— geological logs from 18 additional monitoring bores drilled at the site in 2020 and 2021.

Hydraulic parameter ranges considered for the steady-state and transient groundwater flow model are summarised in Table 6.2. Ranges were defined based on hydraulic tests carried out within the regional study area and on literature values from analogous geological units (refer to Section 4.5 for details).

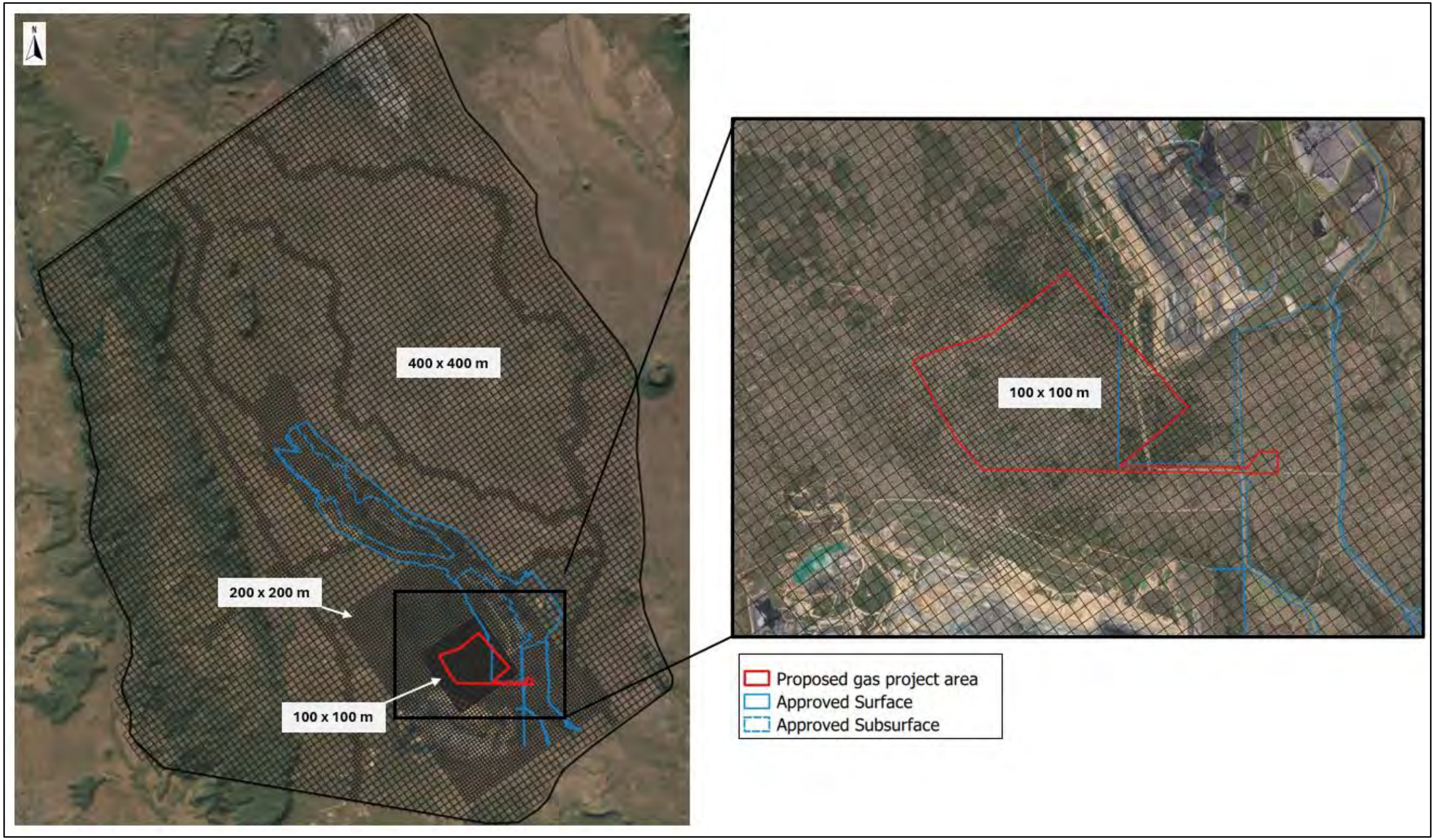


Figure 6.1 Model grid and extents

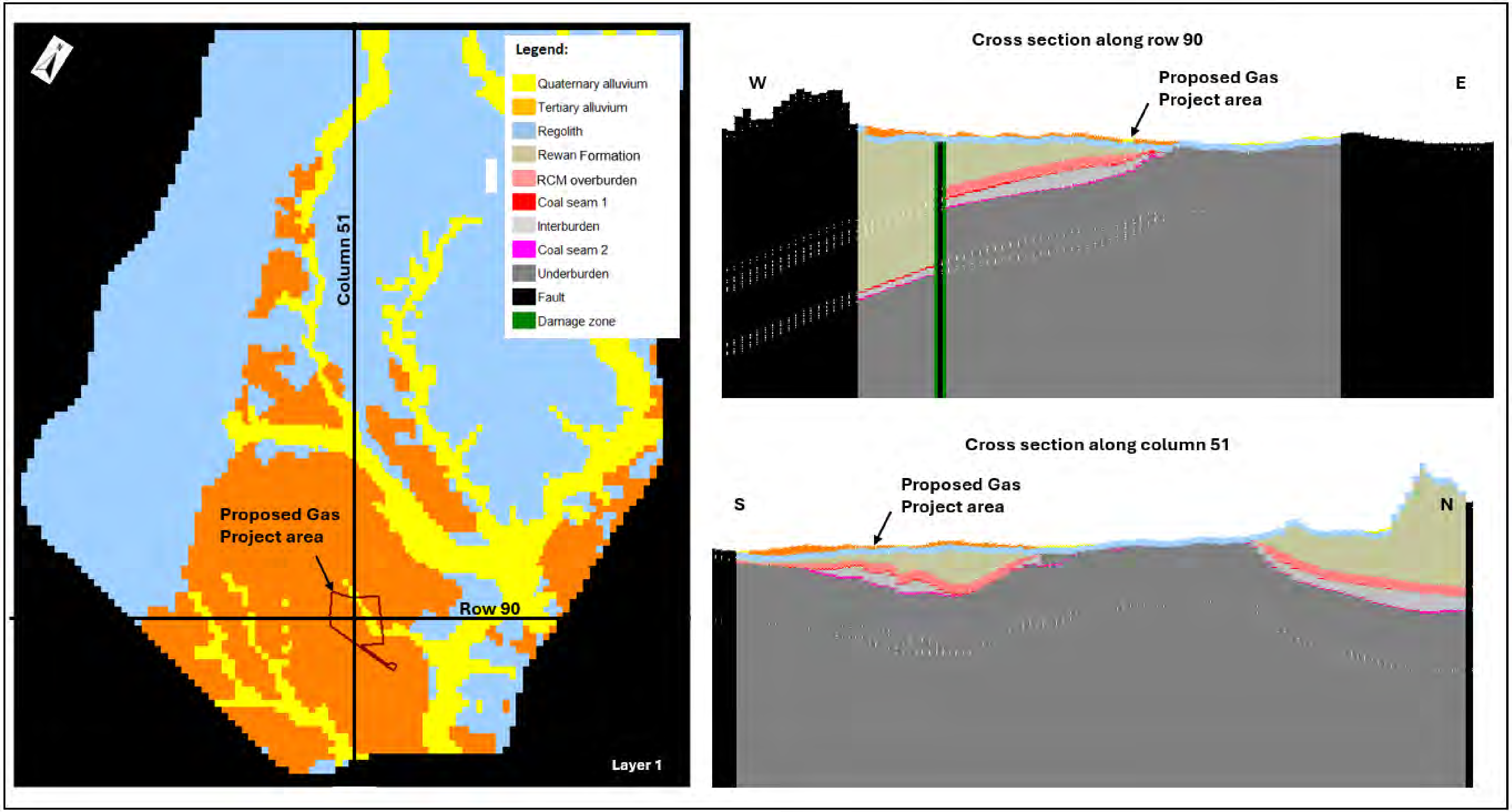


Figure 6.2 Groundwater Vistas numerical model cross-sections along column 51 and row 90

Table 6.2 Summary of conceptual hydraulic parameter ranges for use in calibration

HSU	Horizontal conductivity (m/day)	Vertical conductivity (m/day)	Specific yield (dimensionless)	Specific storage (1/m)	Comments
Alluvium	0.002 to 63	2.0×10^{-4} to 6.3	up to ~0.27	N/A	Horizontal hydraulic conductivity based on: 1. Hydraulic slug testing carried out by BMC in 2016. 2. Pumping tests carried out by Airwell Group in 2015. 3. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores. Specific yield: typical values applied in the Bowen Basin (AGE, 2015; Arris, 2017; CDM Smith, 2016).
Regolith	0.01 to 1.9	0.001 to 0.19	0.001 - 0.075	N/A	Horizontal hydraulic conductivity based on: 1. Hydraulic slug testing carried out by BMC in 2016. 2. Pumping tests carried out by Airwell Group in 2015. 3. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores. Specific yield: typical values applied in the Bowen Basin (AGE, 2015; Arris, 2017; CDM Smith, 2016).
Rewan Formation	1.5×10^{-5} to 5.0	1.5×10^{-6} to 0.5	N/A	$< \sim 1 \times 10^{-5}$	Horizontal hydraulic conductivity based on: 1. Aquitards adjacent to the Permian coal measures have hydraulic conductivities typically one to three orders of magnitude lower than coal measures (between 1.5×10^{-5} and 0.02 m/day; AGE, 2008; Heritage Computing, 2012; AGE, 2014b; CDM Smith, 2016). 2. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores (estimates between 0.2 and 0.5 m/day). Specific storage: maximum limit as per OGIA (2019).
Main Seam 1	5.0×10^{-4} to 0.5	5.0×10^{-5} to 0.05	N/A	$< \sim 1 \times 10^{-5}$	Horizontal hydraulic conductivity based on: 1. Injection falloff testing carried out by Douglas Partners (2014) (0.015 m/day). 2. Literature review (0.03 to 0.20 m/day) (AGE, 2014b; Douglas Partners, 2015). 3. Numerical modelling (0.05 m/d) (CDM Smith, 2016). 4. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores (estimates between 0.0005 and 0.5 m/day).

HSU	Horizontal conductivity (m/day)	Vertical conductivity (m/day)	Specific yield (dimensionless)	Specific storage (1/m)	Comments
Interburden	1.5×10^{-5} to 5.0	1.5×10^{-6} to 0.5	N/A	< ~1×10^{-5}	Horizontal hydraulic conductivity based on: 1. Aquitards adjacent to the Permian coal measures have typically hydraulic conductivities that are one to three orders of magnitude lower than coal measures (between 1.5×10^{-5} and 0.02 m/day) (AGE, 2008; Heritage Computing, 2012; AGE, 2014b; CDM Smith, 2016). 2. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores (between 0.2 and 0.5 m/day). Specific storage: maximum described by OGIA (2019).
Main Seam 2	5.0×10^{-4} to 0.5	5.0×10^{-5} to 0.05	N/A	< ~1×10^{-5}	Horizontal hydraulic conductivity based on: 1. Injection falloff testing carried out by Douglas Partners (2014) (0.015 m/day). 2. Literature review (0.03 to 0.20 m/day) (AGE, 2014b; Douglas Partners, 2015). 3. Numerical modelling (0.05 m/d) (CDM Smith, 2016). 4. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores (estimates between 0.0005 and 0.5 m/day).
Underburden	1.5×10^{-5} to 5.0	1.5×10^{-6} to 0.5	N/A	< ~1×10^{-5}	Horizontal hydraulic conductivity based on: 1. Aquitards adjacent to the Permian coal measures have typically hydraulic conductivities that are one to three orders of magnitude lower than coal measures (between 1.5×10^{-5} and 0.02 m/day) (AGE, 2008; Heritage Computing, 2012; AGE, 2014b; CDM Smith, 2016) 2. Hydraulic slug testing carried out by BMC in 15 newly constructed monitoring bores. Specific storage: maximum described by OGIA (2019).
Spoil	0.0864	0.00864	0.4	N/A	Previously conceptualised by Golder in 2018 (Golder, 2018; Fityus and Wells, 2008)

6.1.5 Boundary conditions

Boundary conditions are mathematical statements within the model domain and along boundaries of the domain that specify the dependent variable (head), or the derivative of the dependent variable (flux). Boundary conditions constrain flows into and out of the model domain. The boundary conditions applied to the model domain are shown in Figure 6.3 and summarised below.

— **No-flow boundary conditions were applied:**
  — along the western limit of the model to represent the contact between the Clematis Sandstone and the Rewan Group to the west of the unnamed major SSE-NNW fault
  — along faults intersecting the Rangal Coal Measures in the northern part of the Project area
  — parallel to Bee Creek in the eastern limit
  — within the aquitards where the flow is assumed to be primarily vertical, and
  — to the base (i.e. floor) of the model domain (given the rock mass permeability is assumed to be very low at significant depths below the lower seams with the downwards/upwards flow restricted by the low rock mass permeability).

— **General head boundary conditions** were assigned along the parts of the northern and southern domain boundaries where these are expected to follow regional equipotential lines in key water-bearing and aquifer units.

  General head boundary condition was assigned to:
  — Layers 1 to 3 (the alluvium and regolith) to represent regional flow in and out of the model domain along the main unconfined water bearing units, and
  — along layers 6, 8, 10 and 12 (Main Seam 1 and Main Seam 2) where the Main Seams occur on either side of the regional unnamed major SSE-NNW fault.

  These boundaries represent the regional basin-scale flow through the main confined aquifer.

  For the alluvium and regolith, a head value of 281 m AHD was applied along the northern boundary of the model, correlating to the groundwater level recorded at a nearby registered bore RN162072.

  A head value of 165 m AHD was considered at the southern boundary; this was based on the groundwater elevation observed in nearby registered bore RN13040112.

  For the Main Seams, a head value of 231 m AHD was considered at the northern boundary based on groundwater elevation observations from registered bore RN141675, whilst a head value of 150 m AHD was applied to the southern boundary based on similar observations in registered bore RN141675.

  Conductance values for the general head boundary condition cells were automatically calculated by the model, considering the saturated thickness and width of each cell, the distance from known groundwater level data to the boundary condition, and the hydraulic conductivity of the cell. These values were subsequently refined during the calibration process, resulting in the application of variable conductance values ranging from 75 to 1,530 m²/day.

— **River boundary condition** was assigned along the alignment of Bee Creek. The rate of leakage from the river cells in the model is controlled by the prescribed elevations of the river stage, riverbed and river conductance. The elevations assigned to the river cells followed topography, with the conductance values summarised in Table 6.3.

— **Constant head boundary conditions** were used to simulate the Bidgerley tailings storage facility (TSF) to the east of Walker and Toolah pits. A head value of 201.6 m AHD was applied to this boundary condition from 2003 onwards; this was based on a Digital Elevation Model (DEM) from a LiDAR capture taken in September 2021 and provided to Golder by Advisian in 2022.

— **Drain boundary condition** was assigned to Walker, Carborough and Kemmis Creeks to represent the ephemeral condition of the main drainage lines. Although these streams function as losing streams, leakage was not explicitly modelled due to its minor and difficult-to-measure nature. Instead, the effects of leakage were accounted for within the general recharge applied to the model area.

Drain boundary conditions are also applied to SWC and Coppabella pits to represent mine dewatering over the calibration period. Variable head values were applied to the SWC pit cells based on existing mine operations data.

Constant head values of between 100 and 150 m AHD were assigned to the Coppabella pit based on pit topography extracted from QTopo (2021) and groundwater levels extracted from QLD Globe (2021).

- **Well boundary condition** was assigned to the Project area to represent horizontal production wells during predictive simulation, with time-variable flow rates used replicate the proposed well installation and extraction schedule between 2026 and 2028; refer to Section 6.1.5.1 for more details on the coal seam water production.
- **Recharge** was assigned to the uppermost active cells and is represented by three different zones with steady-state values as follows:
  - Quaternary alluvium: 2.1 % of annual rainfall
  - Tertiary alluvium: 0.4% of annual rainfall, and
  - Permian rocks: 0.4 % of annual rainfall.

  In the transient model, the above recharge values were applied to the first stress period, albeit varying up and down following this stress period to replicate seasonality variations in recharge. Figure 6.4 presents those recharge zones applied to Layer 1 of the model.
- **Evapotranspiration (EVT)** was assigned uniformly to the top layer of the model, with groundwater extracted by EVT only when the water table lies above the prescribed EVT extinction depth, set at 10 m depth below ground level.

The above use of model boundary conditions was selected to best represent the HCM. Rainfall recharge drives groundwater flow through permeable surficial materials towards creeks and wetlands with a preferential flow towards the SSE, where it exits the system as throughflow or baseflow. Groundwater from the coal seam aquifer flows into the model domain through the NNW boundary and groundwater exits the system at the SSE boundary, establishing the regional throughflow in the confined aquifer, consistent with groundwater level information obtained from coal seam monitoring bores across the SWC mine area. Table 6.3 below presents a summary of the parameters (values) for those boundary conditions applied to the model.

Table 6.3 Summary of the boundary conditions applied

Parameter	Calibrated value
Recharge – Quaternary alluvium (m/day)	3.7×10^{-5} (2.1% of annual rainfall)
Recharge – Tertiary alluvium (m/day)	6.9×10^{-6} (0.4% of annual rainfall)
Recharge – Permian HSUs (m/day)	6.9×10^{-6} (0.4% of annual rainfall)
Evapotranspiration (m/day)	3.5×10^{-3}
Extinction depth (m)	10
Drain – creeks and river diversion conductance (m^2/day)	62.5
Drain – pits conductance (m^2/day)	1,000 – 4,000
River – deep creek conductance (m^2/day)	1.0
Constant head – TSF (m AHD)	201.6
General head boundary conductance (m^2/day)	75 – 1,530

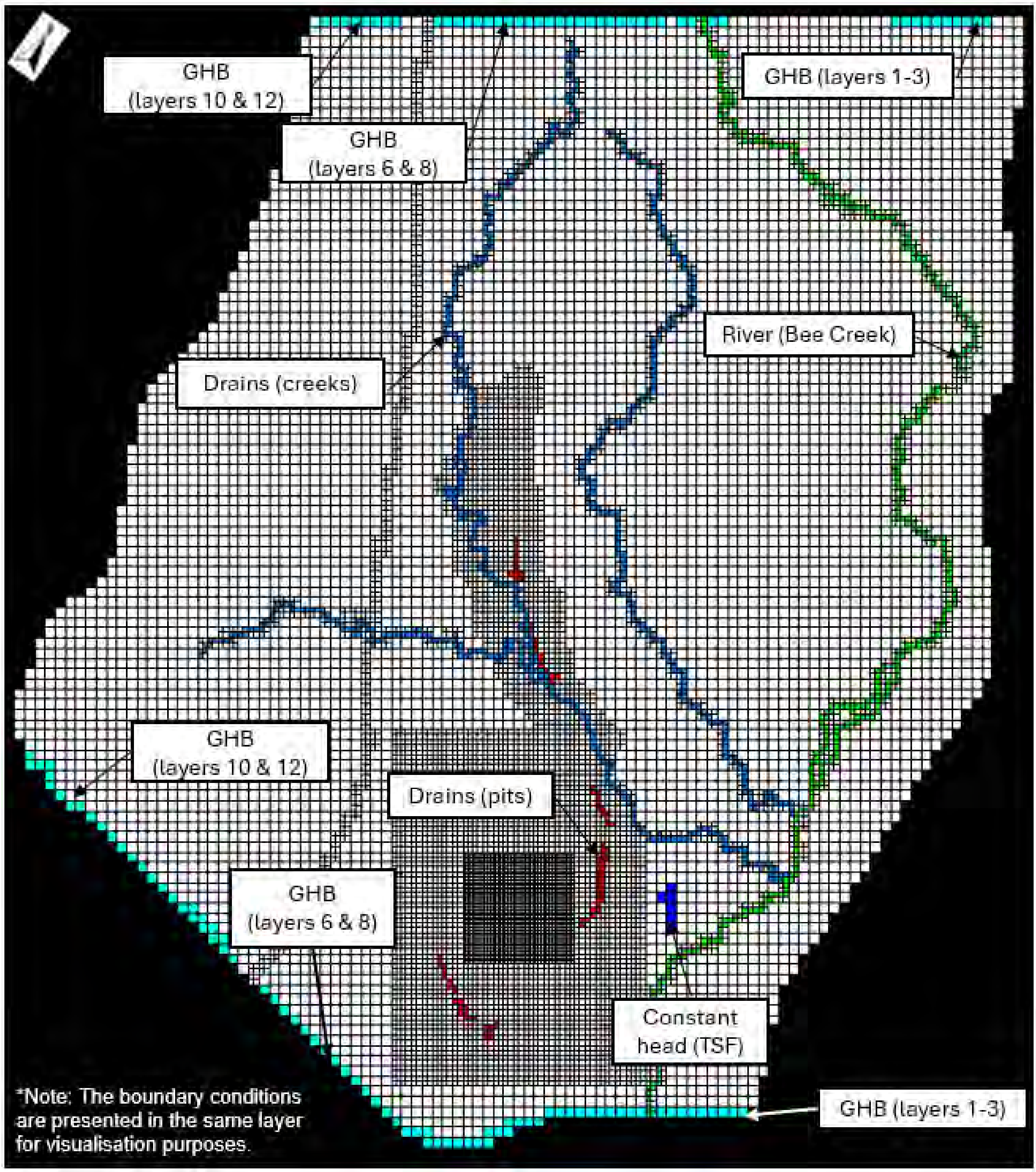


Figure 6.3 Boundary conditions applied to the numerical model

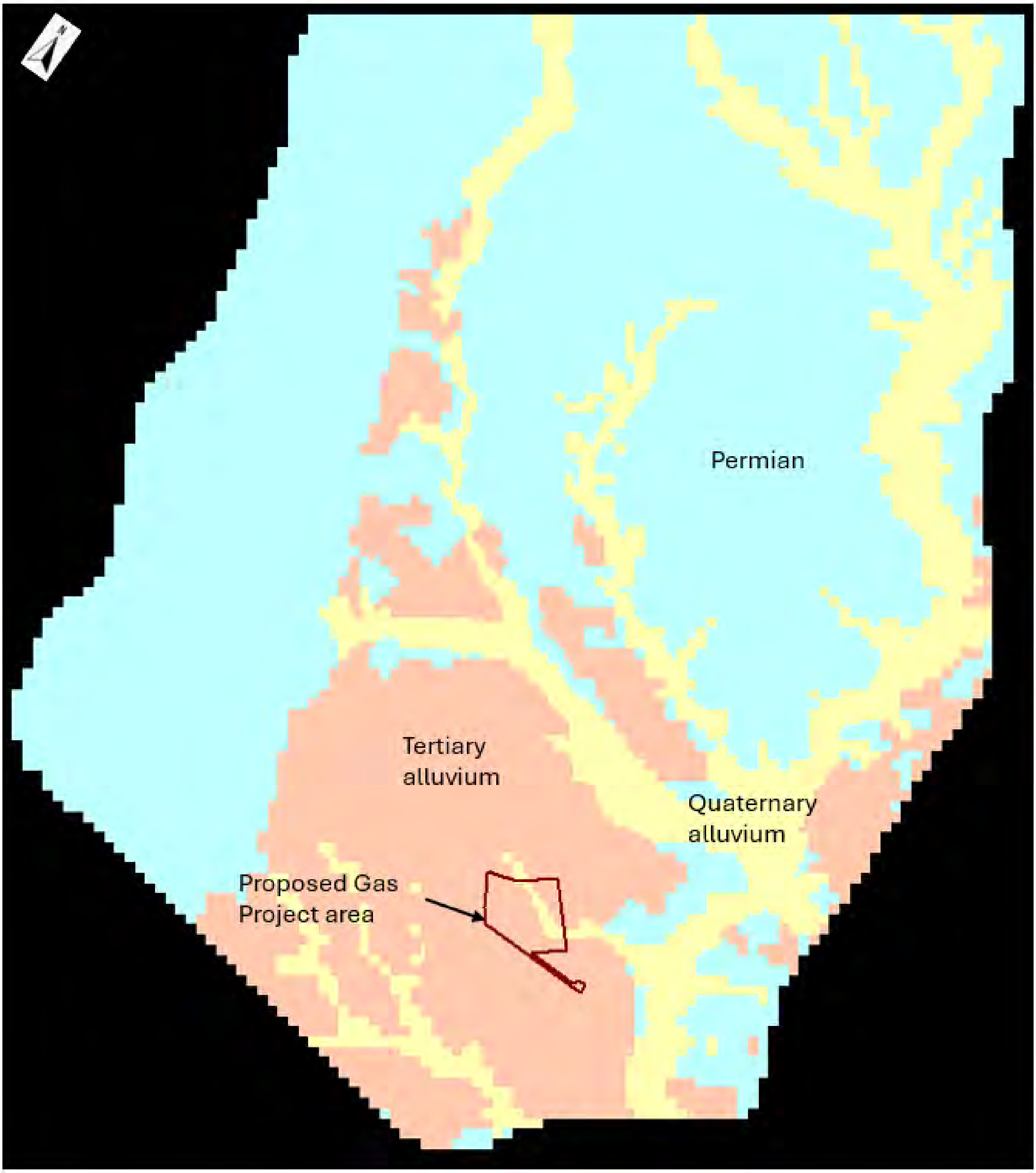


Figure 6.4 Recharge zones applied to the numerical model

6.1.5.1 Coal seam water production

The coal seam water production wells were represented by well boundary conditions with time varying flow rates applied to replicate (i) the proposed drilling scheduled (see Figure 1.3), and (ii) total production well profile (see Figure 1.2). The lifespan of each gas well is assumed to be 10 years, with the abstraction of gas and gas drainage water from the first well starting in starting in 2026, and from the final well in 2036. Project gas and accompanying groundwater abstraction will cease in 2046.

Each gas production well was represented in the model by a line of single well in the model, with the total flow rate for a well divided among the well boundary conditions representing that horizontal well (for example, if the total flow rate for a single horizontal well is 15 m^3/day in a stress period, and there are 15 well boundary conditions, each well will be assigned a water take of 1 m^3/day). Additionally, the wells are activated progressively following the drilling schedule, with those installed in the southeastern portion of the Project area installed and operated first, with additional wells installed in a progressive manner to the northwest with wells commissioned in the same sequence in which they are installed. Figure 6.5 shows the distribution of wells in the model, each demarcated by the adjoining and linear well boundary condition locations shown in this figure.

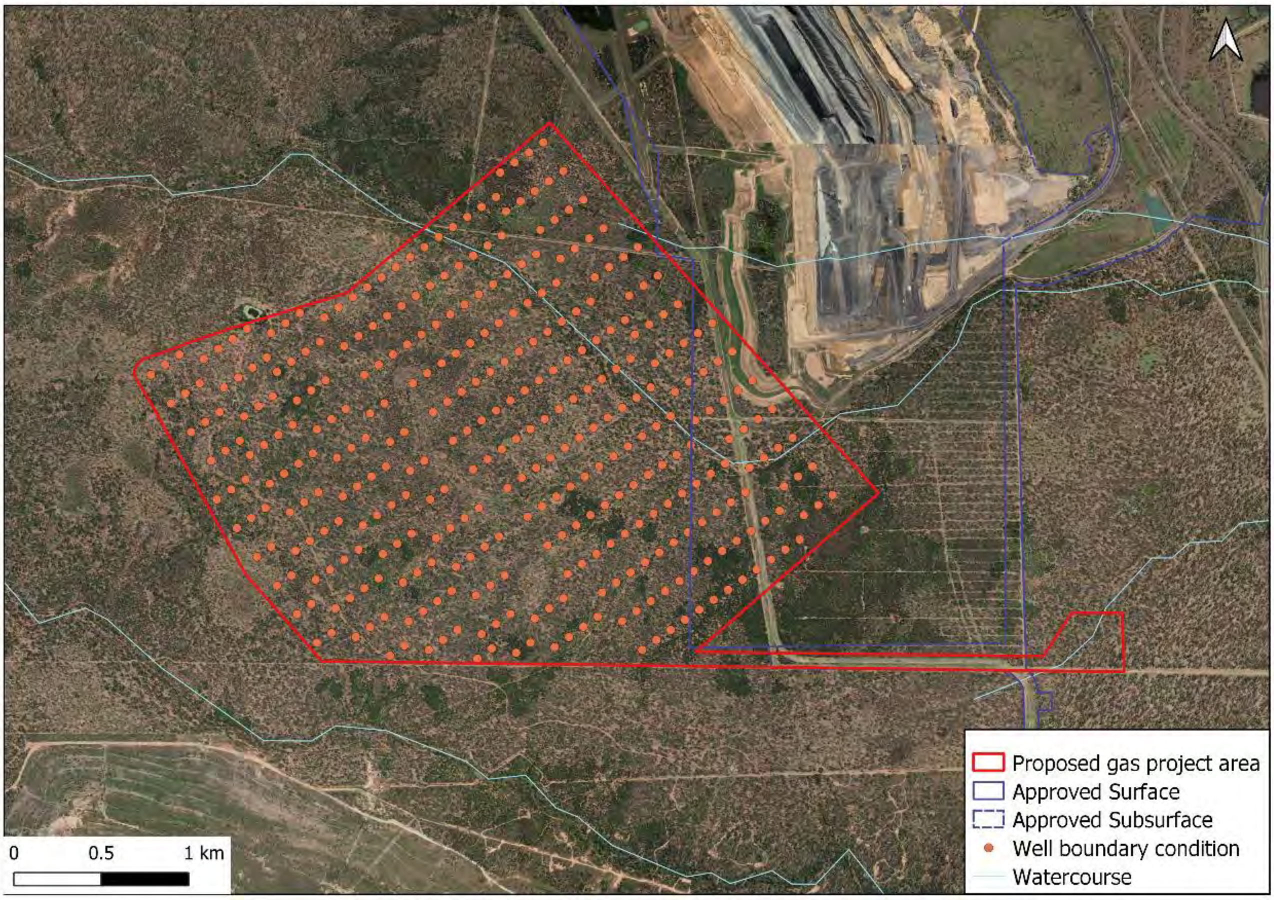


Figure 6.5 Well boundary conditions applied to the Project area

6.1.6 Timing setup

The numerical modelling considered the following timing setup:

— **Steady state calibration:** undertaken by Golder (2022) and validated by WSP against new grid refinement within the Project area. It is based on late 2015/early 2016 drought data for alluvium and regolith monitoring bores across SWC (when data was available).

For coal seams bores, the first monitoring data has been considered to minimise possible interference from pit dewatering.

Historic mining activities were also approximated in the steady-state calibration for all HSUs to generate conditions at the beginning of the transient calibration period (i.e., the year 2000).

— **Transient calibration:** undertaken by Golder (2022) and again validated by WSP considering the use of a refined model mesh for the Project area. It considered the period from March 2000 to June 2021 to represent the dynamic groundwater level response to rainfall and mining-related groundwater extractions.

  Transient calibration considers annual wet/dry stress periods to account for seasonality, with a period length of six months for each season occurring from October to March for the wet season and April to September for the dry season.

  The first stress period of the transient model is set as steady state, allowing for a coupled approach. This method is a best practice in calibration, ensuring that the starting conditions of the model are accurately captured for the transient simulation.

— **LOM simulation:** the life of mine scenarios considered the period from July 2021 to September 2043, when mining is scheduled to cease. This was based on wet/dry stress periods, consistent with the transient calibration setup.

— **Post-closure simulation:** the post-closure simulation considered the period from October 2043 to December 2534, encompassing 491 years of simulation. It followed a variable stress period setup (starting with yearly to 10-yearly towards the end of the simulation period).

6.1.7 Calibration approach

Calibration was undertaken by Golder (2022) and validated by WSP considering the refined model grid used within the Project area. No changes were made by WSP to Golder's parameters or boundary conditions.

A detailed description of the model calibration process and outcomes is provided in Golder (2022). The numerical model includes a steady state and a transient calibration (March 2000 to June 2021), with primary calibration targets being that groundwater elevation data collected from 34 monitoring bores at the SWC mine since 2003 (noting the number of monitoring events available for calibration purposes varies by bore).

The model calibration period spans 21 years, while the predictive period covers 22 years; this is a predictive period that is less than three times the duration of the calibration period, a characteristic of a Class 3 model (refer to Appendix A for details on the model confidence level).

Results of the calibration after the grid refinement are presented in Section 6.2.1.

6.1.8 Predictive simulations

The LOM pit dewatering and post-closure simulations were conducted across five predictive scenarios as detailed in Table 6.4 and shown in Figure 6.6. These scenarios consider:

— the current SWC mine approved mining plan, and

— third-party operations for the cumulative case, in this case both the Coppabella coal mine and Arrow Energy CSG wells.

Table 6.4 Scenarios considered

Scenarios	Project Stage	Activities considered
Case 1 (Base case)	Operation	— Current approved mining using the latest stage mining plan with maximum extraction of 9.4 Mtpa (from July 2021 to September 2043). — Coppabella coal mine (from July 2021 to September 2043).

Scenarios	Project Stage	Activities considered
Case 2 (Project case)		— Current approved mining using the latest stage mining plan with maximum extraction of 9.4 Mtpa (from July 2021 to September 2043). — Coppabella coal mine (from July 2021 to September 2043). — Project case, including the latest stage mining plan and the proposed gas harvesting plan (from April 2026 to September 2043).
Case 3 (Cumulative case)		— Current approved mining using the latest stage mining plan with maximum extraction of 9.4 Mtpa (from July 2021 to September 2043). — Coppabella coal mine (from July 2021 to September 2043). — Project case, including the latest stage mining plan and the proposed gas harvesting plan (from April 2026 to September 2043). — Arrow Energy CSG operations (from July 2021 to September 2043).
Case 4 (Project case – post closure)	Closure / post closure (500 years)	Starting heads from Case 2 (considering current mining and gas drainage Project case).
Case 5 (Base case – post closure)		Starting heads from Case 1 (considering only the current mining case). This scenario was compared to Case 4 to estimate those groundwater drawdowns attributable to the Project only.

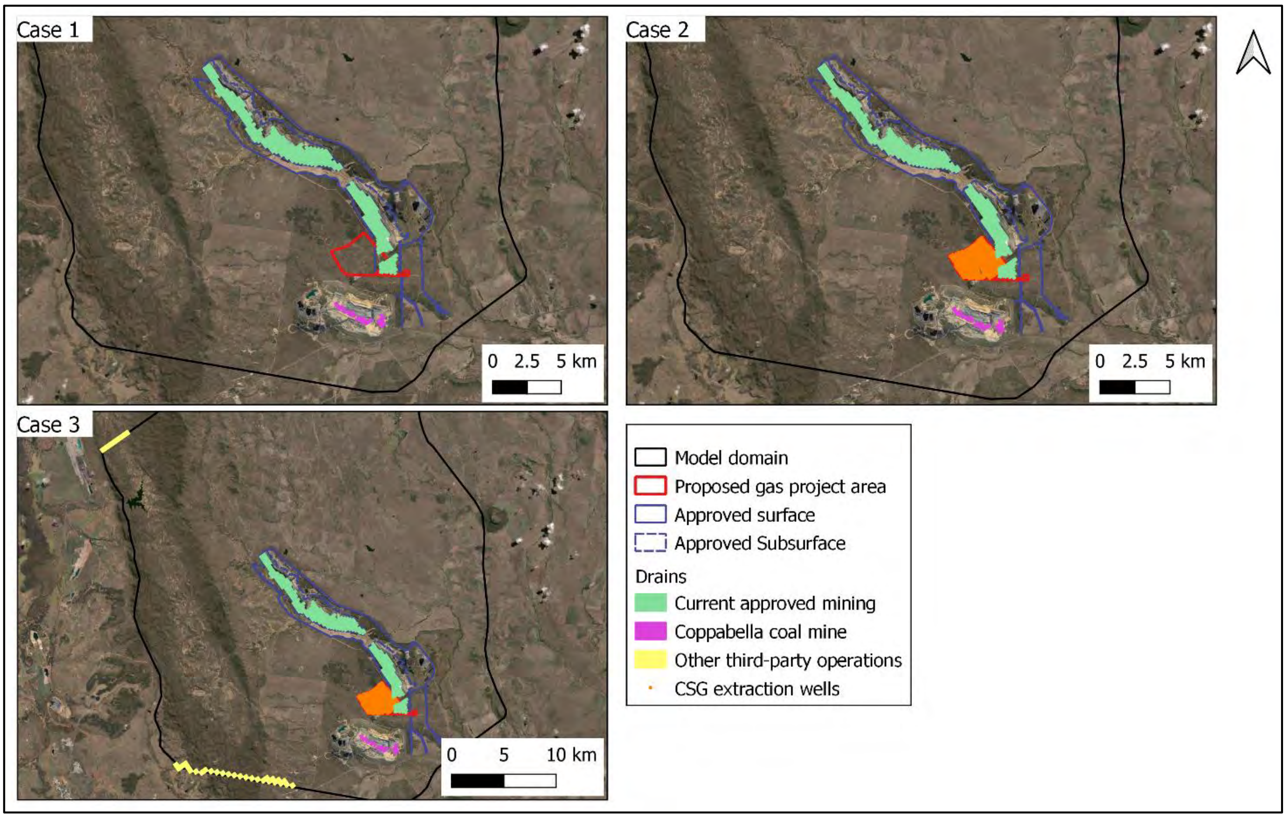


Figure 6.6 Simulated scenarios

Additional drawdown attributable to the abstraction of groundwater from the coal seams (i.e., the Project) has been estimated by comparing the outcomes of those scenarios detailed in Table 6.4 as follows.

- **Drawdown attributed solely to the gas drainage at the end of mining (September 2043**).

  This scenario represents the drawdown due to the gas extraction wells only and is estimated by subtracting hydraulic heads of Case 2 from those of Case 1 for the last stress period only. This is referred to as 'additional drawdown'.

- **Maximum drawdown attributed solely to the gas drainage across all stress periods**.

  This represents the highest drawdown values estimated across all simulation times for each model cell; i.e., the largest drawdown observed regardless of when it occurs in relation to the activation and deactivation of individual gas wells. It is estimated by subtracting hydraulic heads of Case 2 from those of Case 1 for all stress periods and representing the maximum value of all stress periods combined together.

- **Drawdown attributed solely to the gas drainage at the end of the post closure period (December 2534 – 500 year's time)**.

  This represents any remaining drawdowns due to the gas extraction wells after approximately 500 years of post-closure simulation. It is estimated by subtracting hydraulic heads from the last stress period of Case 4 from those of Case 5.

Additionally, computed drawdown for the cumulative scenarios was obtained as follows.

- **Cumulative drawdown ('Case 3'):**

  This scenario represents the drawdowns due to SWC mine operations plus gas wells and third-party operations and is referred to as the "cumulative drawdown" (Figure 6.11).

  For comparison purposes, Figure 6.11 also presents the "mining and gas drawdown", which excludes third-party operations to show their influence near the Project area. This has been estimated by subtracting hydraulic heads at the end of mining (September 2043) from those simulated in October 2022, with October 2022 set as the reference date to reflect when SMC acquired the SWC operations.

For the post closure scenario, Case 2 (SWC current approved mine plan plus gas wells) was set as the initial condition. Both the drain boundary conditions representing the SWC pits and the well boundary conditions representing the gas wells were 'switched off' at specific times following the LOM schedule, with SWC pit drains ceasing in September 2043, and gas wells in September 2048. The post closure simulation followed a variable stress period setup (starting with yearly for the first 100 years to 10-yearly towards the end of the simulation period) over approximately 500 years.

6.1.9 Sensitivity analysis cases

Three sensitivity scenarios were modelled by WSP for both LOM and post-closure cases. These were based on that sensitivity and uncertainty analysis carried out by Golder (2022), for which WSP reviewed the parameterisation and applicability for the Project area and were considered appropriate for this GIA. According to Golder (2022), key parameters driving changes in the model predictions were the Kv of the Rewan Formation, the Kv of the RCM overburden, and the Ss of the coal seams. These parameters have been carried forward in this GIA for the current sensitivity analysis with the following changes made to the calibrated parameter values:

- Sensitivity case 1: Kv of RCM overburden changed from 1.0×10^{-4} m/day to 1.0×10^{-3} m/day.
- Sensitivity case 2: Kv of the Rewan formation changed from 1.0×10^{-5} m/day to 1.0×10^{-4} m/day.
- Sensitivity case 3: Ss of coal seams changed from 1.0×10^{-5} m^{-1} to 1.0×10^{-6} m^{-1}.

The selected parameters have been reviewed by WSP and are considered relevant for the purpose of this GIA (i.e., they have the potential to change the drawdowns in the unconfined aquifer due to depressurisation in the coal seams, thereby allowing suitable assessment of the impacts of the Project on groundwater EVs).

Three separate transient model runs were conducted, each considering a different LOM and post-closure scenarios. For both the LOM and post-closure periods, additional model runs considered only the approved mining plan without the gas drainage project (Case 1); this allowed that drawdown attributable solely to the Project to be estimated.

The following sections present the model results.

6.2 Numerical model results

The following sections summarise the results of the modelling, including calibration after performing the grid refinement, predictions of potential changes to the hydrogeological system due to the proposed production, and sensitivity cases of these predictions.

6.2.1 Calibration results

Transient calibration for the model after the grid refinement achieved a 4.4 m root mean square (RMS) error (Figure 6.7), as opposed to 4.2 % achieved before the refinement. This equates to a 5.8 % scaled root mean square (SRMS) error, as opposed to 5.5 % obtained previously, which is still within the recommended range (i.e., 10%) in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012). The transient results confirm the suitability of the model for transient simulations and hydrogeological assessments. The monitoring bores utilised in the transient calibration are shown on Figure 6.8.

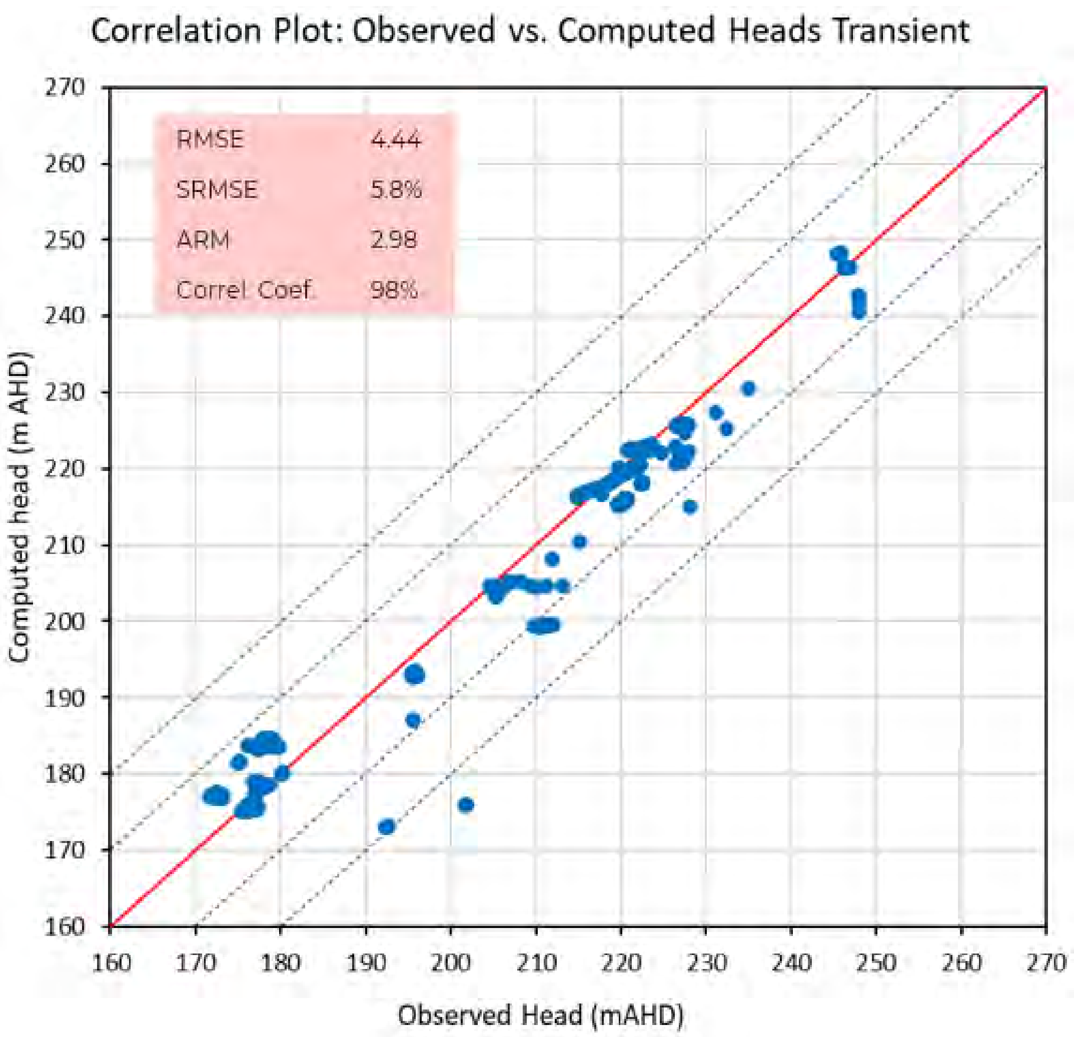
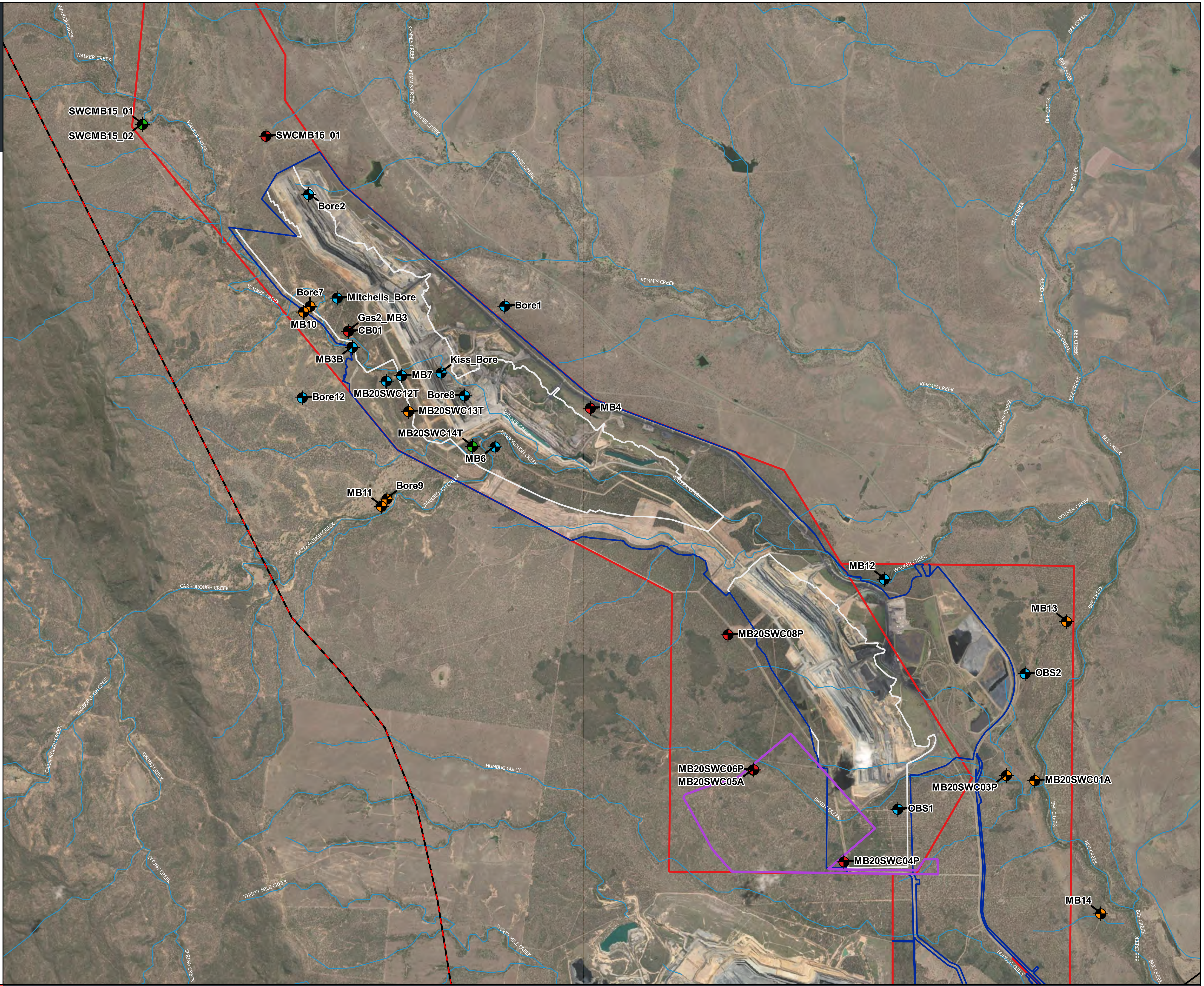


Figure 6.7 Scatter plot of transient modelled versus observed heads

PS209709
SWC Mine Gas Drainage Project

Figure 6.8
Groundwater bores used in model calibration



LEGEND

Monitoring bores

- Alluvium
- Regolith
- Overburden
- Coal seam
- Approximate Regional-Scale Fault Location
- Watercourses
- Model domain
- Proposed Gas Project Area
- Approved Surface Disturbance
- Approved Subsurface Disturbance
- Mining Leases

0 0.6 1 km

Coordinate System: GDA 1994 MGA Zone 55

Scale correct when printed at A3
1:77394

This map was created by:
FAC

Data Source: Geoscience Australia

6.2.2 Predictive results

6.2.2.1 Life of mine and post closure predictive results

Predicted groundwater drawdown attributed solely to the Project (Case 1 minus Case 2) at the end of mining (September 2043) across the shallow unconsolidated units (alluvium and regolith, model layers 2 and 3, respectively) and the coal seams (model layers 6 and 8) is presented in Figure 6.9 below. Additionally, Figure 6.10 below illustrates the maximum drawdown attributed solely to the Project, representing the greatest estimate of groundwater drawdown across all simulation times for each model cell within the same shallow unconsolidated units and coal seams.

Figure 6.11 presents the cumulative drawdown (Case 3) against the drawdown without third-party operations (SWC approved mining plus gas wells only – purple line) for comparison purposes. This gives an indication of the expected additional drawdown attributable to the third-party operations such as the Coppabella mine and Arrow Energy CSG extraction activities.

Post-closure results are shown in Appendix B (Figure B.9), which represents the predictive outcomes after approximately 500 years of simulation. These results are presented in Section 6.2.3 along with the sensitivity analyses results.

The predictive simulation outcomes suggest the following.

- Project-induced groundwater drawdown in both the alluvium and regolith layers is likely to be negligible, with maximum drawdown of about 0.1 m predicted where these units are saturated.

  In the alluvium, project-induced drawdown is predicted to be localised to the western margin of the Project area, while in the regolith drawdown is predicted to extend across the entire Project area due to the saturated nature of the regolith layer.

  Over the Life of Mine (LOM) period, predicted project-induced groundwater drawdown is largely less than 1 m at the Project area, and typically about 0.1 m within or in close proximity to the Project area boundary. In stating this, the maximum predicted project-induced drawdown in the regolith reaches about 1 m near the eastern boundary of the Project area and adjacent to the south-western corner of the Toolah Pit, with this drawdown expected to include the influence of groundwater drainage into the latter.

- Predicted groundwater drawdown in the coal seams at the EOM (September 2043) is 3 m in both the upper and lower seams. Over the LOM period, maximum predicted drawdown in the upper coal seam (Layer 6 in the model) is 13.3 m, with this predicted to occur in 2038. Similarly, the maximum predicted drawdown in the lower coal seam (Layer 8 of the model) is about 32.5 m, with this predicted to occur by 2027.

  Maximum groundwater abstraction rates from the extraction wells were applied in 2027, leading to the peak drawdown. As extraction rates gradually decreased after this time (as dewatering of the coal seams generates gas production coupled with much lower groundwater takes), predicted drawdown progressively decreases, reaching 3 meters by 2043.

- Predicted outcomes from the cumulative impact scenario suggest that groundwater-take activities at the Coppabella mine will influence groundwater elevations (in the way of additional drawdown) near the southern boundary of the proposed Project area. This scenario suggests additional drawdown of between about 1.5 and 2.0 m may occur in the coal seams during the operation of the Project in that area between the SWC and Coppabella mines. In stating this, however, additional drawdown in the alluvium in this area is not expected given these sediments are largely unsaturated and hydraulically disconnected from the coal seams (from which groundwater is removed from at both SWC and Coppabella, and will be extracted from the Project area).

Further insights into the predictive results can be found in the following section, along with the outcomes of the sensitivity analyses.

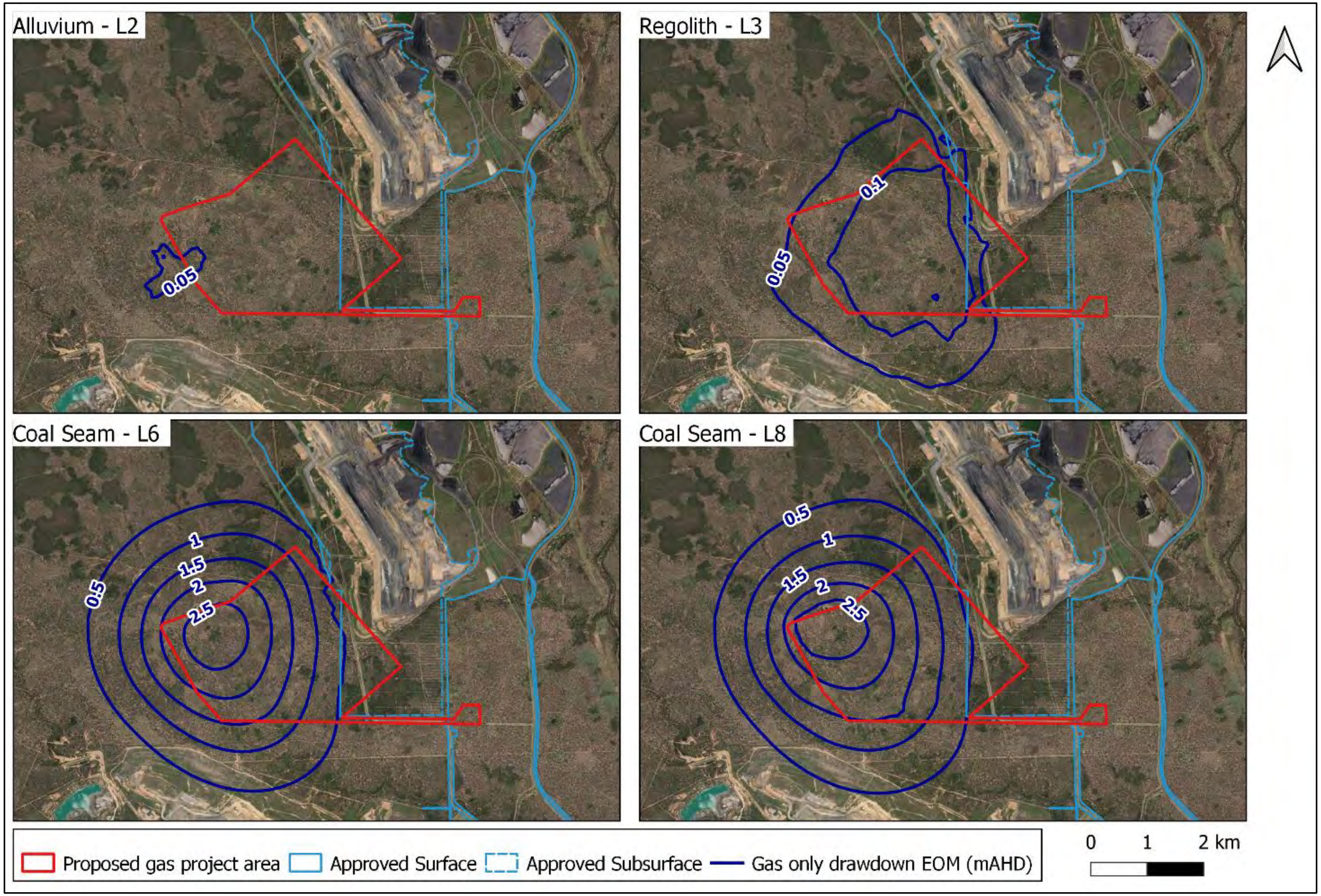


Figure 6.9 EOM drawdown as of September 2043 attributed to the Project only – Case 1 minus Case 2

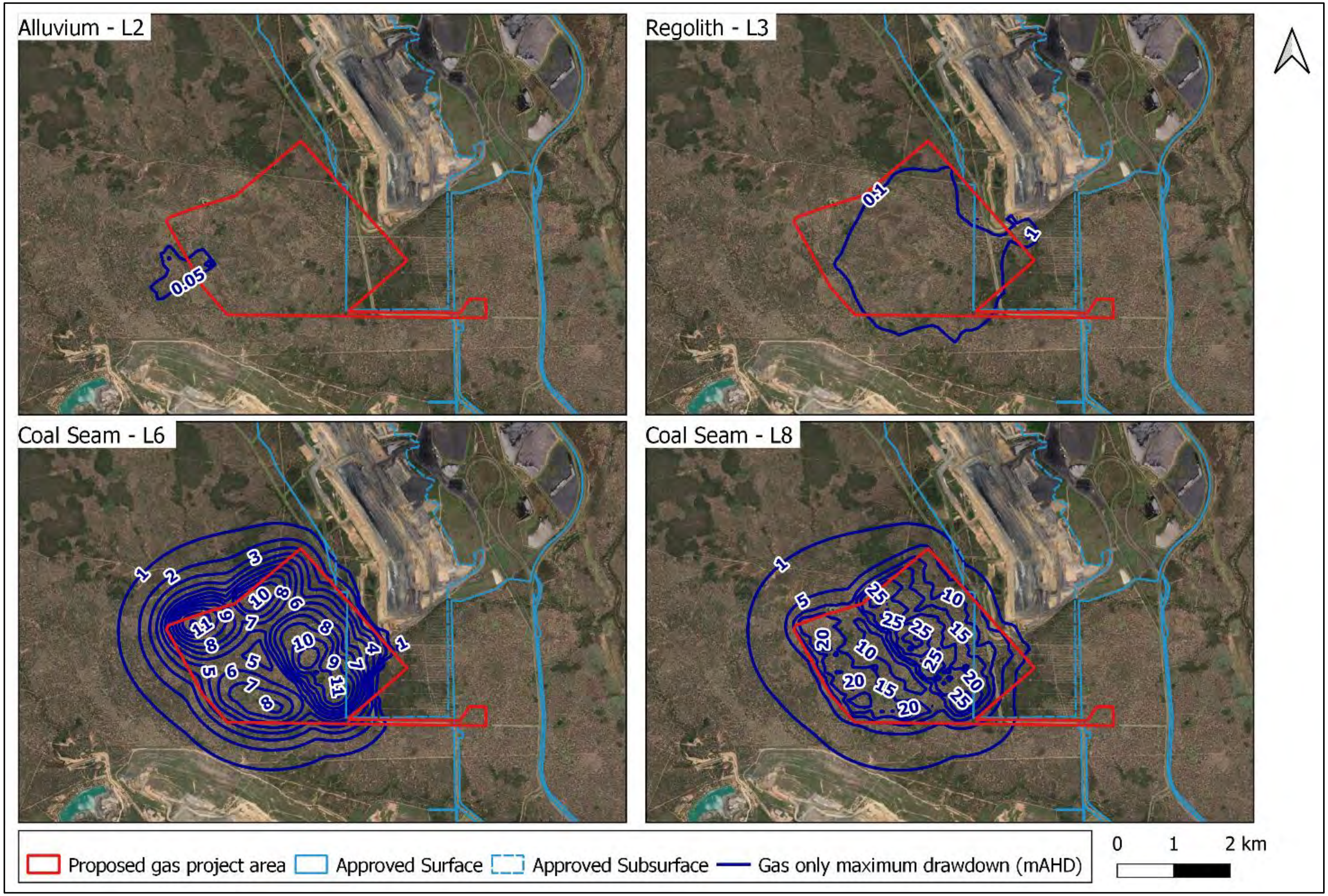


Figure 6.10 Maximum drawdown during LOM attributed to the Project only – Case 1 minus Case 2 (maximum)

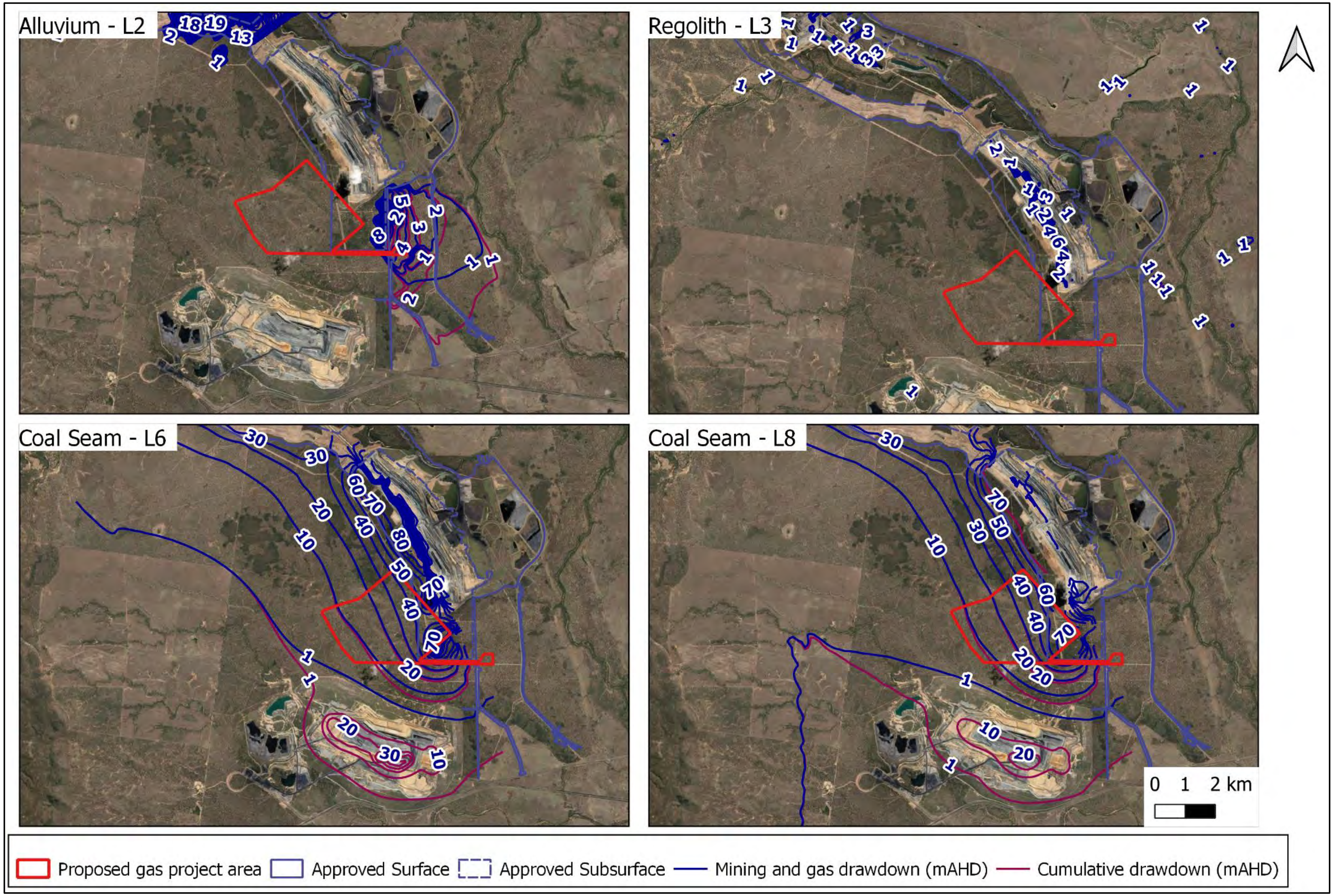


Figure 6.11 EOM cumulative drawdown as of September 2043 – Case 3 (purple contours) and Case 2 (blue contours)

6.2.3 Sensitivity analysis outcomes

Drawdown attributed solely to the Project (referred to as the "additional drawdown") was estimated for those sensitivity cases described in Section 6.1.9 and compared these outcomes against those of the base case. The results are presented in Appendix B and summarized in Table 6.5, which presents:

- The EOM drawdown as of September 2043 (Figure B.1to Figure B.4).
- The maximum drawdown across all stress periods during the LOM period (Figure B.5 to Figure B.8).
- The post closure drawdown after approximately 500 years of simulation (Figure B.9).

Comparison of the outcomes for each sensitivity scenario and the base case indicate the following.

- Negligible drawdown is predicted in the **alluvium** for all scenarios during both the LOM period and EOM. All scenarios project-induced groundwater drawdown will be in the order of 0.1 m, with exception of sensitivity case 2, which suggests groundwater drawdown of 0.3 m may occur in September 2043.
- Estimates of groundwater drawdown in the **regolith** during the LOM period is between 0.4 and 0.7 m less than those estimates from the base case, with a maximum groundwater drawdown of 0.5 m estimated from sensitivity case 1 and 0.8 m drawdown estimated from sensitivity cases 2 and 3. For comparative purposes, maximum groundwater drawdown estimated from the base case across all stress periods simulated was 1.2 m.

  EOM groundwater drawdowns are estimated to be between 0.1 and 0.5 m.
- Estimates of groundwater drawdown in the **coal seams** during the LOM period for all sensitivity case scenarios is generally less that those estimates from the base case. In this instance, estimates of maximum predicted groundwater drawdown during the LOM period are generally 0.1 to 2.7 m less than the base case, in which maximum predicted drawdown of 13.3 m was predicted in the main top coal seam (Layer 6 of the model), and 32.5 m of drawdown predicted in the main bottom coal seam (Layer 8). An exception to this was sensitivity case 3, which predicted a maximum drawdown during the LOM period of 1.3 m higher than the base case scenario.

  EOM predicted groundwater drawdowns vary between 1.5 and 2.9 m in the main top coal seam (Layer 6), and between 1.8 and 0.3 m in the main bottom coal seam (Layer 8).
- In the long-term **post-closure scenarios**, no drawdown was predicted. In stating this however, it's worth noting that sensitivity case 2 exhibits slightly lower heads compared to the other cases, despite project-induced groundwater drawdown being zero. This difference is notable as the equilibrium heads for both sensitivity cases, one considering only mining and the other considering mining and gas, were equally lower. Figure B.9 represents the distinction between the post-closure equilibrium head contours for all simulated cases (blue line) and those of sensitivity case 2 (purple line). The groundwater level contours shown represent the water table, calculated for all layers and displayed in model layer 1.

Table 6.5 Gas only maximum drawdown results

HSU (model layer)	Base case	Sensitivity case 1	Sensitivity case 2	Sensitivity case 3
End of Mine drawdown – September 2043 (m)				
Alluvium (L2)	0.1	0.1	0.3	0.0
Regolith (L3)	0.1	0.1	0.5	0.1
Main top coal seam (L6)	2.7	2.9	1.5	2.7
Main lower coal seam (L8)	3.0	3.0	1.8	2.8
Maximum drawdown across all stress periods (m)				
Alluvium (L2)	0.1	0.1	0.3	0.1
Regolith (L3)	1.2	0.5	0.8	0.8
Main top coal seam (L6)	13.3	11.2	10.6	13.2
Main bottom coal seam (L8)	32.5	32.0	32.3	33.8
Post closure drawdown (m)				
Alluvium (L2)	0	0	0	0
Regolith (L3)	0	0	0	0
Main top coal seam (L6)	0	0	0	0
Main lower coal seam (L8)	0	0	0	0

7 Groundwater impact assessment

This GIA has been prepared in accordance with those requirements of Division 3, Section 123 of the Environmental Protection Act 1994 (EP Act). This Act specifies the requirements for new 'site specific' environmental authority applications, with these requirements considered in the preparation of this GIA to support the EA amendment application) for the proposed gas drainage activities.

7.1 Project activities and potential impacts

Key potential impacts to groundwater systems, groundwater users and associated environmental values from on-site gas production will relate primarily to the withdrawal of water from the target coal seams as part of the gas production process. Depressurisation of water pressures in the target coal seam (which is achieved by removing water from production wells by pumping) causes desorption of methane which is adsorbed on the surfaces of micropores that pervade the coal matrix. Desorbed methane displaces water, and in the process of gas extraction, water is also withdrawn from the target coal seams. This therefore has the potential to also cause changes in groundwater elevations and pressures in both the target coal seam and other aquifers (i.e., other hydrostratigraphic units which are not the target for gas extraction), which may impact on various environmental values.

7.2 Key questions/issues to be considered

One of the main purposes of an impact assessment is to provide answers to questions that various stakeholders may have about how a project could impact environmental values of the local and regional study areas. These are expressed as 'key questions', and they form the basis of the investigations of potential effects and impacts of the Project. Guidance on the key questions to be addressed/potential impacts to be considered for the Project are described in the Technical Guidelines for each discipline published by the Queensland Department of Environment and Science[2].

Key questions addressed in this impact assessment include what impact the Project could have on:

- Groundwater users extracting water from groundwater bores
- Groundwater dependent ecosystems, including:
  - aquatic GDEs, such as wetlands, springs, river baseflow systems and lakes
  - terrestrial GDEs
  - subterranean GDEs
- groundwater geochemistry and quality (required by EP Act; see Table 2.1), and
- cumulative groundwater impacts.

7.3 Significance assessment

The significance of the impacts outlined through the assessment of key questions in Section 7.4 is a combination of the sensitivity of the environmental value and the magnitude of the predicted impact on that value.

Sensitivity is assessed according to the criteria in Table 7.1.

[2] (https://www.business.qld.gov.au/runningbusiness/environment/licences-permits/applying/technical).

Table 7.1 Sensitivity criteria

Sensitivity	Description
High	— The environmental value is listed on a recognised state, national or international register as being of significance. — The environmental value, whilst potentially under pressure, is intact and retains its intrinsic value. — The environmental value is unique to the environment in which it occurs and is isolated to the affected area and or is under-represented regionally, nationally or internationally.
Moderate	— The environmental value is recorded as being important at a regional level. — Whilst potentially under pressure, the environmental value is moderately intact and retains most of its intrinsic value. — The environmental value is relatively well represented in the region although its wider abundance outside of the Project Area is threatened.
Low	— The environmental value is not formally recognised. — The environmental value is in moderate to poor condition as a result of threats that have reduced its intrinsic value. — Numerous representative examples of the same or equivalent environmental value exist locally. — Should losses be unavoidable, the widespread nature of the environmental value results readily in replacement of that loss.

The magnitude of an impact incorporates the geographic extent of the potential impact, the duration of the effect and the reversibility of that effect as outlined in Table 7.2.

Table 7.2 Impact magnitude criteria

Magnitude	Description
High	— The impact occurs over a large geographic area, is long lasting and possibly irreversible and results in a substantial change to the environmental value. — The impact needs to be either avoided of managed through site-specific management measures. — In the case of impacts associated with aquifer drawdown, the impact is predicted to exceed the trigger thresholds as specified in the Water Act 2000.
Moderate	The impact is beyond the immediate area, although within the region. Impacts are temporally bound and reversible and can be managed through specific environmental controls.
Low	An impact that is localised both spatially and temporally and results in changes to the environmental value that are either undetectable or insignificant.

Sensitivity and magnitude are then combined to form an assessment of the significance of that impact as shown in Table 7.3.

Table 7.3 Impact significance

Magnitude	Sensitivity		
	High	**Moderate**	**Low**
High	Major	High	Moderate
Moderate	High	Moderate	Low
Low	Moderate	Low	Negligible

7.4 Impact assessment: key questions

7.4.1 Groundwater users extracting water from groundwater bores

All registered bores predicted to be impacted by Project-induced changes in groundwater elevations and pressures are either:

— owned by SMC, namely bores MB20SWC04P (RN182781), MB20SWC05A (RN182785), and MB20SWC06P (RN182784), or

— located at the nearby Coppabella Mine to the south of the Project area, namely Coppabella MB1 (RN141664), Coppabella MB2 (RN141665) and Coppabella MB4 (RN141668).

All of these bores are registered and used for groundwater monitoring purposes and are not suitable or equipped for groundwater extraction purposes.

As Project-induced changes in groundwater elevations in all HSUs is likely to be limited to that area close to the Project area and the existing SWC mine, with the greatest drawdown occurring within the Project area itself, it is considered unlikely that the construction and/or operation of the Project would affect the availability of water (either surface water or groundwater) for future use. Notably Project-induced estimates of groundwater drawdown in the alluvium and regolith is likely to be less than 0.5 m (and therefore less that the 2.0 m bore trigger threshold for the alluvium, and 5.0 m threshold for the remaining HSUs) indicating the Project is unlikely to present a risk to future bore water supply from these HSUs.

7.4.2 Groundwater dependent ecosystems

Ecology surveys and expert advice provided indicates that aside from subterranean GDEs (stygofauna), there are no other GDEs either within the Project area or within the wider regional study area used for the assessment of GDEs.

In stating the above, that riparian vegetation along Sandy Creek and Humbug Gully may intermittently use groundwater during and following rainfall events when water is infiltrating to the water table aquifer along the alignment of the waterways. This process of intermittent recharge along the line of these creeks is not expected to change as a result of the proposed Project, with a maximum predicted drawdown of 0.1 m where the alluvium and regolith are saturated. These drawdowns are temporary and considered negligible, representing 1 to 2% reduction of the saturated thickness of the alluvium which is considered unlikely to impact either stygofauna and/or riparian vegetation along Sandy Creek and Humbug Gully.

Stygofauna occurrences at the SWC mine has been assessed by frc environmental following four monitoring events between 2019 and 2021. Whilst monitoring was not carried out in any of those bores at SWC within the Project area, monitoring was carried out on two occasions in bore OBS1, which is screened in the regolith HSU about 1 km east of the Project area, with no stygofauna found during either survey of this bore.

Various stygofauna species have been identified in several groundwater monitoring bores elsewhere at the SWC mine, all of which are screened in the alluvial or regolith HSUs. Stygofauna have been identified in:

— Bore 10 screened in the alluvial sediments of Carborough Creek to the west of the Mulgrave pit
— Bore 6 ('Plum Tree Creek Bore'), Bore 7 ('Scott's well') and MB10, all of which are screened in the alluvial sediments of Walker Creek immediately west of the Kemmis pit
— Bore 11 screened in the alluvial sediments of an unnamed tributary of Walker Creek to the west of the Mulgrave pit
— Bore 12 screened in the regolith to the west of the Mulgrave pit, and
— OBS2 screened in the regolith near Bee Creek to the east of the Walker pit.

frc environmental also noted stygofauna was not observed where depth to groundwater exceeded 15 m bgl, irrespective of the HSU.

In the absence of stygofauna monitoring in the Project area and considering the above, it is reasonable to consider stygofauna may also be present in the alluvial and regolith HSUs at and surrounding the Project area, including along the alignment of Sandy Creek and Humbug Creek. However, given the negligible Project-induced changes in groundwater elevations predicted in the alluvial and regolith HSUs, as shown in Figure 6.9 and Figure 6.10, the significance of any potential impact of the project on any stygofauna in this area is considered low to negligible.

7.4.3 Springs

Spring mapping indicates there are no spring vents or watercourse springs within the Project Area, nor are spring vents or watercourse springs known at the SWC mine.

The closest known spring is Bore 4 situated about 16 km northwest of the Project area. It is located on the western ('opposite') side of the unnamed major SSE-NNW oriented fault which (as discussed in Section 4.3.3.1) is thought to act as a regionally significant hydraulic 'barrier', thereby limiting the lateral flow of groundwater within the various hydrostratigraphic units either side of this fault.

In light of the above, the Project is not expected to impact groundwater elevations, yields, geochemistry or uses of that water emanating from this spring.

7.4.4 Pink Lily Lagoon

Pink Lily Lagoon is located about 3.5 km to the northeast of the closest planned gas extraction well of the Project. It is situated along the alignment of an unnamed tributary of Bee Creek and is underlain by regolith derived from the weathering of the underburden HSU. Owing to the structural orientation of the Permo-Triassic bedrock units, the underburden and regolith HSUs are not expected to be significantly dewatered or depressurised as a result of either ongoing mining and/or operation of the Project (refer to Section 6.2.2), hence the Project is not expected to impact elevations, throughflow rates, geochemistry or use of water in Pink Lily Lagoon.

7.4.5 Groundwater quality

Without appropriate control, drilling and construction of wells that cross aquitards and span multiple hydrogeological units have the potential to introduce preferential migration pathways. These pathways can impact water quality in an aquifer by introducing water of different quality from a vertically adjacent aquifer, however construction controls will be employed during the development of the Project, mitigating the potential occurrence of such cross-aquifer migration.

As gas and groundwater is extracted during Project operation, inflow of groundwater is likely to occur from adjoining structures and hydrostratigraphic units. This inflow can occur either vertically from other hydrogeological units above or below the coal seam or laterally from adjacent areas of the coal seam and is therefore likely to be of similar quality to that removed during the operation of the Project.

The Project does not propose reinjecting produced water or brine, nor does it propose the use of hydraulic fracking. As such these do not represent a potential risk to groundwater quality requiring assessment.

Following the cessation of gas extraction, groundwater levels in the coal seams and adjoining hydrostratigraphic units will recover. This water is expected to largely be of similar or equivalent geochemistry and quality of that groundwater inflow to the coal seams during Project operation, although that groundwater in the coal seam between the Project and nearby CWT pit may also exhibit similar geochemistry and quality of that water in this pit.

In light of the above, any impact of the Project on groundwater geochemistry, quality or use is likely to be limited and localised and assessed as being of low magnitude. Combining a medium sensitivity with a low magnitude impact, the overall significance of the Project impacting groundwater quality is assessed as low.

7.4.6 Cumulative impacts

Predicted outcomes from the cumulative impact scenario suggest that groundwater-take activities at the Coppabella mine may result in:

— between about 1.5 and 2.0 m of additional groundwater drawdown in the coal seams in the southern portion of the Project area, and

— negligible to no predicted additional drawdown in the alluvium or regolith HSUs in this area.

Given (i) groundwater in the coal seams is not used, and (ii) the predicted change in groundwater elevations is less than the groundwater drawdown trigger thresholds for a consolidated aquifer in the Water Act (i.e., 5 m), the Project is not considered likely to contribute to any cumulative impacts to groundwater within the region.

7.5 Assessment of potential impacts of exploration boreholes on groundwater

SMC will carry out both coal and gas exploration drilling across the SWC mine to inform both the mine planning and the design and development of the Gas Collection Project. Drilling will be carried out between 2025 to 2028 (and beyond, if required) on ML4750 and ML70131 in areas beyond those authorised by the EA. Figure 7.1 presents the planned locations of exploration drillholes across SWC mine.

To assess the magnitude of any potential impacts of exploration drilling on the groundwater system near the Project area, two additional scenarios were simulated in the numerical groundwater flow model[3]. Both scenarios assessed the impacts of a single exploration drillhole drilled through all HSUs down to and including the main bottom (coal) seam, with boreholes located:

— in the eastern portion of the Project areas near the SWC pit (and identified as Drillhole 1 on Figure 7.2), and

— in the northern portion of the Project area further away from the active pits (Drillhole 2 on Figure 7.2).

Both boreholes were located along the alignment of Sandy Creek, allowing these scenarios to consider the impacts of any additional loss of water from any of the alluvial sediments in response to:

— lower groundwater elevations in the coal seams as a result of nearby mining and mine pit dewatering activities, and

— these boreholes acting as long-term localised drains for groundwater to drain from the alluvium, regolith and overburden HSUs.

Figure 7.2 presents the location of these drillholes in the model, noting that although they are displayed together for visualization purposes, each was simulated separately to prevent drawdown interference. Figure 7.2 also displays the drawdown contours in the end of the LOM period. The model outcomes indicate that:

— No additional drawdown is likely from the alluvium (model Layers 1 and 2) as these layers were (originally) unsaturated.

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[3] Simulation of exploration drilling impacts assumes drillholes will remain open (i.e., without grouting) throughout the entire LOM period. Results are plotted for the final year of the simulation, September 2043.

- Additional drawdown may occur in the regolith (model Layer 3) in response to the depressurisation of the coal seams, with drawdown ranging from about 4.5 m in Drillhole 1, to about 13.3 m in Drillhole 2.
- Predicted differences of additional drawdown amounts between Drillhole 1 and Drillhole 2 are attributed to:
  - **The proximity of each drillhole to the SWC pit:** the closer a drillhole will be to the SWC pit, the less additional drawdown may occur in the regolith owing to the already lower groundwater elevations and pressures in this HSU from ongoing mine operations, and
  - **Distance to the west of the SWC pit:** the further west the drillhole is located, the more pronounced additional drawdown will likely be given the structural dip of the Main Coal Seam to the west, with exploration boreholes thereby getting deeper with greater distance from the SWC pits, and thereby encountering higher groundwater pressures.

It is important to note that the drains used in the numerical groundwater flow model to simulate exploration boreholes were assigned heads equivalent to the floor elevation of the main bottom (coal) seam for the entire simulation period. As such the results of these simulations are considered conservative (i.e., represent worst-case) predictions of groundwater elevation change occurring in the regolith HSU around these modelled boreholes. In reality, groundwater elevations and pressures at the modelled locations are likely to be higher than those present, and following mine closure will tend recover to elevations reflective of regional groundwater flow directions and gradients across the SWC mine, albeit with some influence from and close to the former pits themselves.

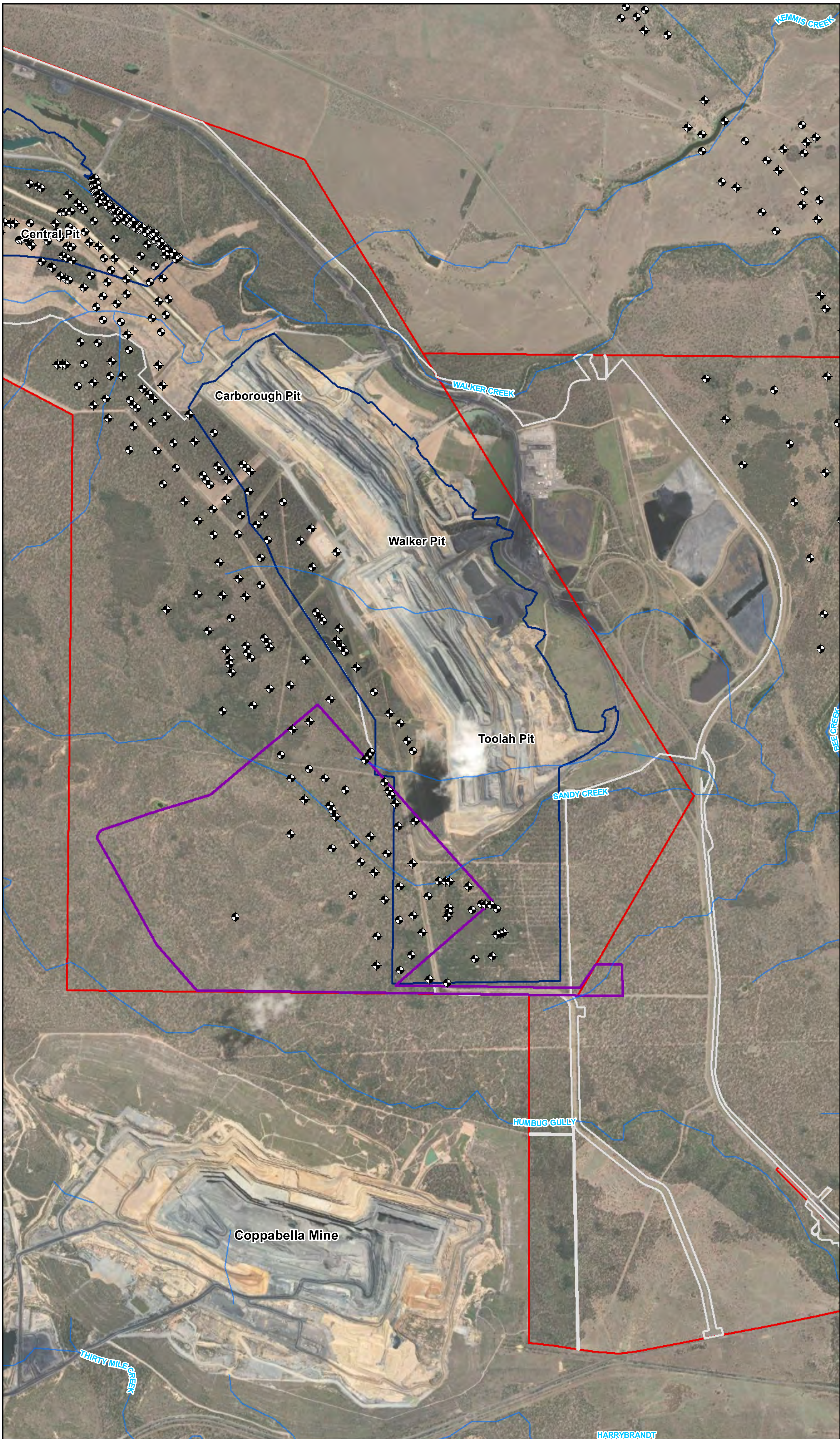
When considering the outcomes of that modelling discussed in this section, it should also be noted that the focus of this assessment was to consider the potential impacts of exploration boreholes on those groundwater resources that may occur intermittently in the alluvial sediments following notable rainfall and/or flooding events, and how these boreholes may influence any GDEs along these waterways. As such any additional depressurisation of the deeper overburden and coal seam HSUs as a result of the drilling of exploration boreholes has not been considered.

Outcomes of the numerical modelling suggest groundwater elevations in the top of the regolith HSU will decline around open exploration boreholes. This will allow the passive underdrainage (downward leakage) of some groundwater from the alluvial sediments to the (now lower) water table in the regolith, thereby either partially or fully dewatering any basal water-bearing zones in these sediments. In stating this however, it is expected this change will have a negligible influence on any GDEs along the alignment of these waterways given:

- the often-dry nature of these streambeds (i.e., long durations of lack of baseflow occurring along these waterways)
- the general absence of groundwater in the shallow alluvial sediments (with groundwater, if present, typically occurring towards the base of these alluvial sediments), and
- the demonstrated disconnection of creekbeds from groundwater in the alluvium (refer to Sections 4.8.4 and 5.2.2.2).

Groundwater drawdown in the regolith is likely to occur as a result of the long-term passive drainage of groundwater from this HSU to these boreholes. Drawdown will likely be greatest where the number and density of open boreholes is greatest, with cumulative borehole impacts expected to result in project-long sustained pressure drops in the water table in the regolith. This is expected to reduce the saturated thickness of the regolith HSU, which could impact yields of any future groundwater abstraction bores installed in this HSU in the cumulative (i.e., area of multiple open exploration boreholes) area of influence.

Exploration drill holes are to be decommissioned and/or rehabilitated in accordance with the conditions of the SMC EA and any/or any other applicable legislative requirements.



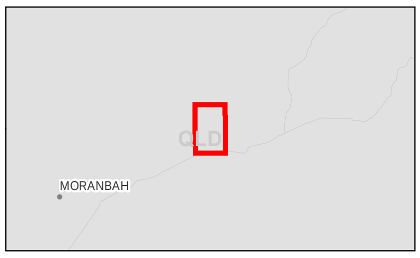
PS209709
SWC Mine Gas Drainage Project

Figure 7.1
Planned exploration drillholes

Legend

- Proposed drillhole
- Watercourses
- Proposed Gas Project Area
- Mining Leases
- Approved Subsurface Disturbance
- Approved Surface Disturbance

Source of the tif: provided by SMC



0 1,000 2,000
Meters

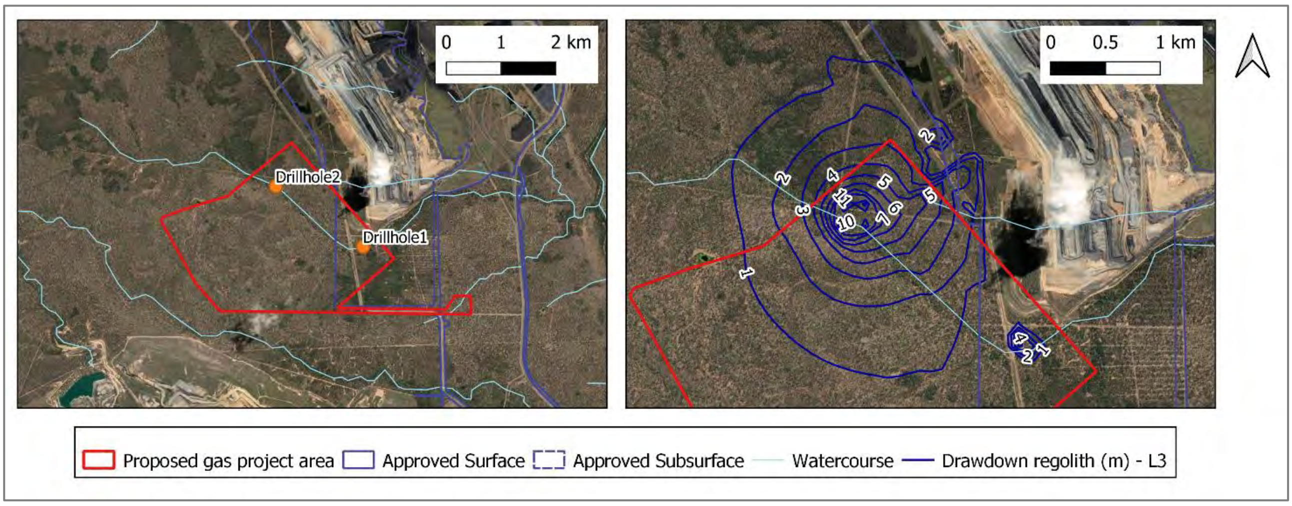
Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

1:40,000 Date: 18/07/2024

Data sources: DELWP, Geoscience Australia

Figure 7.2 Drawdown in the regolith (m) – simulated exploration drillholes



7.6 Summary of potential impacts

Project-induced changes in groundwater elevations across all HSUs are expected to be negligible and confined to areas close to the Project.

Groundwater drawdown in the alluvium and regolith is predicted to be less than 0.5 m, well below the trigger thresholds, indicating minimal risk to future bore water supply.

Along those reaches of Sandy Creek within and immediately surrounding the Project area, groundwater drawdown is predicted to be less than 0.1 m. This though is expected to be temporary and therefore considered negligible, posing low to negligible risk to stygofauna and unlikely to affect intermittent recharge processes.

No springs are expected to be impacted by the Project. The nearest spring is located 16 km to the west-north-west of the Project on the western ('opposite') side of an unnamed fault. This fault is thought to act as a regionally significant hydraulic 'barrier', thereby limiting the lateral flow of groundwater within the various hydrostratigraphic units either side of this fault. As such the Project is not expected to impact groundwater elevations, yields, geochemistry or uses of that water emanating from this spring.

The Project is also not expected to affect groundwater elevations, throughflow rates, or geochemistry, or potential uses of that water in Pink Lily Lagoon. Any potential impacts on groundwater geochemistry, quality, or use are likely to be minor and localized, with an overall low significance due to similar water quality between adjacent aquifers and the coal seams.

Cumulative impacts from groundwater extraction at the Coppabella mine suggests:

— negligible additional drawdown in the alluvium and regolith HSUs, and

— drawdown of between about 1.5 to 2 m in the coal seams.

Estimates of drawdown in the coal seams are below regulatory thresholds and unlikely to contribute to regional cumulative impacts. For exploration drillholes, the drawdown in the regolith (4.5 to 13.3 m) is expected to have a negligible impact on GDEs due to the dry nature of streambeds and disconnection from groundwater. However, there is a risk of inter-aquifer water mixing if boreholes are not grouted.

8 Mitigation and management measures

As discussed in Section 7.0, identified potential impacts are either negligible or low. The potential impact on a specific area of terrestrial GDEs, although considered unlikely to occur, warrant specific monitoring to determine whether any connection to groundwater exists. This is discussed below in Section 8.2.2.

8.1 Groundwater

8.1.1 Overview

Potential impacts on groundwater resources and associated sensitive receptors have been determined to be negligible (refer to Section 6.0). This is largely supported by the current activities approved on the site, bores being within SMC leased areas and either owned by SMC or subject to existing Agistment / Compensation agreements that already account for future impacts.

The effectiveness of the management of the mining operation in limiting impacts to sensitive receptors requires monitoring. This includes monitoring groundwater resources in both the shallow and deep aquifer systems upgradient and downgradient of the Project area to confirm potential impacts are consistent with simulation predictions, or that future (yet unknown) changes in site conditions do not cause impacts to be realised. SMC already undertakes quarterly groundwater monitoring across the site. It has been determined that the existing monitoring network is sufficient to monitor for potential impacts. In particular, the following bores would provide a good indication of a change in magnitude from model predictions:

— MB20SWC04P (coal seam groundwater monitoring bore)

— MB20SWC05A (overburden groundwater monitoring

— MB20SWC06P (coal seam groundwater monitoring bore)

— MB20SWC068 (coal seam groundwater monitoring bore), and

— OBS1 (regolith groundwater monitoring bore).

The monitoring of groundwater elevations will also be carried out at several monitoring points which are yet to be installed. These will include:

— two groundwater monitoring wells installed adjacent to MB20SWC04P, one of which will be screened in the alluvial sediments of Sandy Creek and the other screened at the top of the underlying regolith HSU

— a vibrating wire piezometer grouted into position within the overburden HSU adjacent to MB20SWC04P

— two groundwater monitoring wells midway between MB20SWC04P and MB20SWC06P, one of which will be screened in the alluvial sediments of Sandy Creek, and the other at the top of the underlying regolith HSU

— two groundwater monitoring wells installed in the western and southwestern corner of the Project area, both of which will be screened at the top of the regolith HSU, and

— two vibrating wire piezometers grouted into the overburden and coal seams in the western corner of the project area, and

— two vibrating wire piezometers grouted into the overburden and coal seams in the southwestern corner of the project area.

To comply with the EA monitoring requirements, the following parameters for analysis will include:

— electrical conductivity (i.e., salinity)

- pH
- sulphate
- selected dissolved metals (aluminium, antinomy, arsenic, iron, manganese, mercury, molybdenum, selenium, silver)
- volatile fractions of total recoverable hydrocarbons (i.e., TPH C_6-C_{10}), and
- semi-volatile fractions of total recoverable hydrocarbons (i.e., TPH >C_{10}-C_{40}).

8.1.2 Performance objectives

Under the EP Reg, a project must demonstrate that it can meet the relevant objectives and performance outcomes as set out in Schedule 8. The objectives and the associated performance outcomes relevant to groundwater, as covered by the scope of this groundwater impact assessment are set out in Table 8.1, with a summary of how the project meets each performance outcome.

Table 8.1 EP Reg environmental objectives and performance outcomes summary

ID	Objectives and performance outcomes	Project detail
Groundwater		
Objective	The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.	
Performance outcomes		
1	Both of the following apply:	
	(a) there will be no direct or indirect release of contaminants to groundwater from the operation of the activity;	Based on the outcomes of those numerical groundwater flow modelling simulations carried out and discussed in Section 6.2.2, the Project is expected to act as a groundwater sink (rather than be a source for the migration of groundwater), hence there will be no release of contaminants to groundwater resulting from the operations.
	(b) there will be no actual or potential adverse effect on groundwater from the operation of the activity.	Based on the outcomes of those numerical groundwater flow modelling simulations carried out and discussed in Section 6.2.2, Project impacts on groundwater resources and associated sensitive receptors are expected to be negligible.
2	The activity will be managed to prevent or minimise adverse effects on groundwater or any associated surface ecological systems.	Modelling indicates that impacts on groundwater resources and associated sensitive receptors are negligible risk. Groundwater monitoring will be carried out during Project operation to confirm potential impacts do not occur and allow for adaptive management, if necessary.

Note: Some activities involving direct releases to groundwater are prohibited under section 41 of this regulation.

8.2 Gas production wells and other project activities

Measures to minimise impacts to groundwater quality and avoid introducing connectivity between formations during the construction of gas production wells include the following:

Gas production wells will be designed, constructed and decommissioned in accordance with the "Code of Practice for constructing and abandoning coal seam gas wells and associated bores in Queensland" (DNRME, 2018b). This code outlines mandatory requirements and good practice to ensure operators comply with their obligations which reducing the risk of environmental harm. It requires that production wells be lined with steel casing, which is cemented in place to isolate aquifers overlying the coal seam, and are pressure cemented to surface once they are no long producing commercial quantities of gas.

- Gas production wells will be designed to:
  - Prevent any interconnection between hydrocarbon bearing formations and aquifers
  - Ensure that gas is contained within the well and associated pipework and equipment without leakage
  - Ensure zonal isolation between different aquifers is achieved, and
  - Not introduce substances that may cause environmental harm.
- Drilling fluids and additives used during drilling activities will be water-based, appropriate for the well design and local geological conditions, and will be used in accordance with the mandatory requirements and good practice guidelines outlined in the code of practice (DNRME, 2018b). They will be identified as being approved for import, manufacture or use in Australia (confirmed by NICNAS as being listed in the Australian Inventory of Chemical Substances).
- All applicable materials will be stored and handled in accordance with the relevant legislative requirements and Australian Standards including, but not limited to the provisions of:
  - AS 3780:2008, the storage and handling of corrosive substances
  - AS 1940:2017, the storage and handling of flammable and combustible liquids, and
  - AS 3833:2007, storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers.

8.3 Bore impact management measures

Potential impacts on groundwater resources and associated sensitive receptors have been estimated to be negligible (refer to Section 6.2). The outcomes of the impact assessment suggest there are no external bores that would potentially experience water level decline greater than 5 m.

The effectiveness of the management of the gas drainage field operation in limiting impacts to sensitive receptors requires monitoring. This includes monitoring groundwater resources in both the alluvial and regolith HSUs upgradient and downgradient of the Project area to confirm the potential impacts are consistent with model predictions, or that changes in site conditions do not cause impacts to be realised. SMC already undertakes quarterly groundwater monitoring across the site for regulatory EA monitoring and this will continue for the Project. It will though be supplemented by groundwater elevation and pressure monitoring in those yet to be installed groundwater monitoring wells and vibrating wire piezometers discussed in Section 8.1.1.

8.4 Surface activities

To minimise the potential risk of impacts of surface operations on shallow groundwater resources, the storage and management of fuels and chemicals will occur in accordance with regulatory requirements. In the event of a spill or release, a site-specific Emergency Management and Response Procedure will be employed.

The production operator will develop Emergency Management and Response procedures that details the internally specified mandatory response, notification, recording, investigation, corrective and preventative actions, review, and analysis and reporting requirements for all incidents which fall within the responsibility of production operator. The procedures will set out the six stages in incident management processes:

- Stage 1: Response and notification
- Stage 2: Incident recording
- Stage 3: Incident investigation
- Stage 4: Corrective and preventive actions
- Stage 5: Incident sign-off
- Stage 6: Review, analysis and reporting.

In the event of a spill that could potentially impact shallow groundwater resources, the general response will be to:

- Eliminate potential sources of ignition and eliminate non-essential personnel.
- Contain the source of the spill or incident and coordinate the shut-down of the relevant equipment or infrastructure, if possible.
- Notify the appropriate parties as required, including internal staff and emergency services personnel, and undertake regulatory notification as required.
- Identify the material (if possible) and the corresponding personal protective equipment, hazards and response procedure using safety data sheets.
- Contain released material using spill kit boom or other suitable emergency response equipment and isolate the area.
- Stabilise and neutralise spill material, e.g. using absorbents.
- Clean-up released materials and spill response materials and any surrounding affected media prior to disposal by a suitably qualified contractor to a suitably licenced facility, if required.
- Evaluate and document the incident.
- Investigate and remediate if necessary.

8.5 Reporting

SMC will report to the government in compliance with:

- Relevant conditions and approvals issued by DoEE and DES.
- Relevant Beneficial Use Approvals.

Additionally, the production operator will undertake groundwater assessments, and other hydrogeological studies to enhance knowledge, and make them available as required.

9 Assumptions and limitations

— Due to uncertainty regarding their location, displacements and hydrogeologic behaviour, those ‘minor’ faults in the Project area shown on the ‘Solid Geology’ 1:100,000 scale geological map sheet and QLD Globe have been excluded from the model and would likely result in less impact than those estimated using the model.

— Modelling of processes specific to coal seam gas production such as dual domain flow, gas desorption, dual phase flow, and geomechanical deformation have been excluded as these are typically insignificant or not well understood at the regional scale, so are unlikely to significantly affect this impact assessment, particularly considering the planned production volumes and distances to environmental values.

— Other groundwater activities (e.g., irrigation, groundwater extraction, mining) have not been included in the modelling due to unknown volumes and rates associated with these activities.

— Bore well induced inter-aquifer connectivity has not been explicitly assessed though likely falls within the range of the uncertainty analysis results.

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Appendix A

Model confidence class characteristics

The Australian Groundwater Modelling Guidelines builds on the Murray Darling Basin Commission Groundwater Flow Modelling Guideline (MDBC, 2001) and has the concept of "model confidence level", which is defined using a number of modelling criteria. These criteria relate to data availability, design, calibration and performance (predictions). A summary of model confidence class characteristics is provided in Table 9, where:

- those cells highlighted in green indicates that criteria met for this modelling item
- cells highlighted in yellow indicates that criteria partially met, whilst
- cells not highlighted indicate those criteria not met.

Table A.1 Groundwater model confidence level classification

Class	**Data**	**Calibration**	**Prediction**	**Quantitative Indicators**
1 (simple, lower level of confidence in model predictions)	Not much / sparse coverage	Not possible	Timeframe >> calibration	Timeframe >10x
	No metered usage	Large error statistic	Long stress periods	Stresses >5x
	Low resolution topographic DEM	Inadequate data spread	Poor / no validation	Mass balance > 1% (or one-off 5%)
	Poor aquifer geometry	Targets incompatible with model purpose	Targets incompatible with model purpose	Properties <> field values
	Basic / initial conceptualisation			No review by hydrogeologist / modeller
2 (impact assessment)	Some data / OK coverage	Weak seasonal match	Timeframe > calibration	Timeframe = 3-10x
	Some usage data/low volumes	Some long-term trends incorrect	Long stress periods	Stresses = 2-5x
	Baseflow estimates. Some K & S measurements	Partial performance (e.g., some stats / part record / model-measure offsets)	OK validation	Mass balance < 1%
	Some high-resolution topographic DEM and/or some aquifer geometry	Head and flux targets used to constrain calibration	Calibration and prediction consistent (transient or steady state)	Some properties <> field values. Review by hydrogeologist
	Sound conceptualisation, reviewed and stress-tested	Non-uniqueness and qualitative uncertainty partially addressed	Significant new stresses not in calibration	Some coarse discretisation in key areas of grid or at key times
3 (higher level of confidence in	Plenty data, good coverage	Good performance stats	Timeframe ~ calibration	Timeframe < 3x
	Good, metered usage info	Most long-term trends matched	Similar stress periods	Stresses < 2x

Class	Data	Calibration	Prediction	Quantitative Indicators
model predictions)	Local climate data	Most seasonal matches OK	Good validation	Mass balance < 0.5%
	Kh, Kv and Sy measurements from range of tests	Present day head / flux targets, with good model validation	Transient calibration and prediction	Properties ~ field measurements
	High resolution topographic DEM all areas and good aquifer geometry	Non-uniqueness minimised and qualitative uncertainty justified	Similar stresses to those in calibration	No coarse discretisation in key areas (grid or time)
	Mature conceptualisation			Review by experienced modeller

Appendix B

Sensitivity analysis outcomes

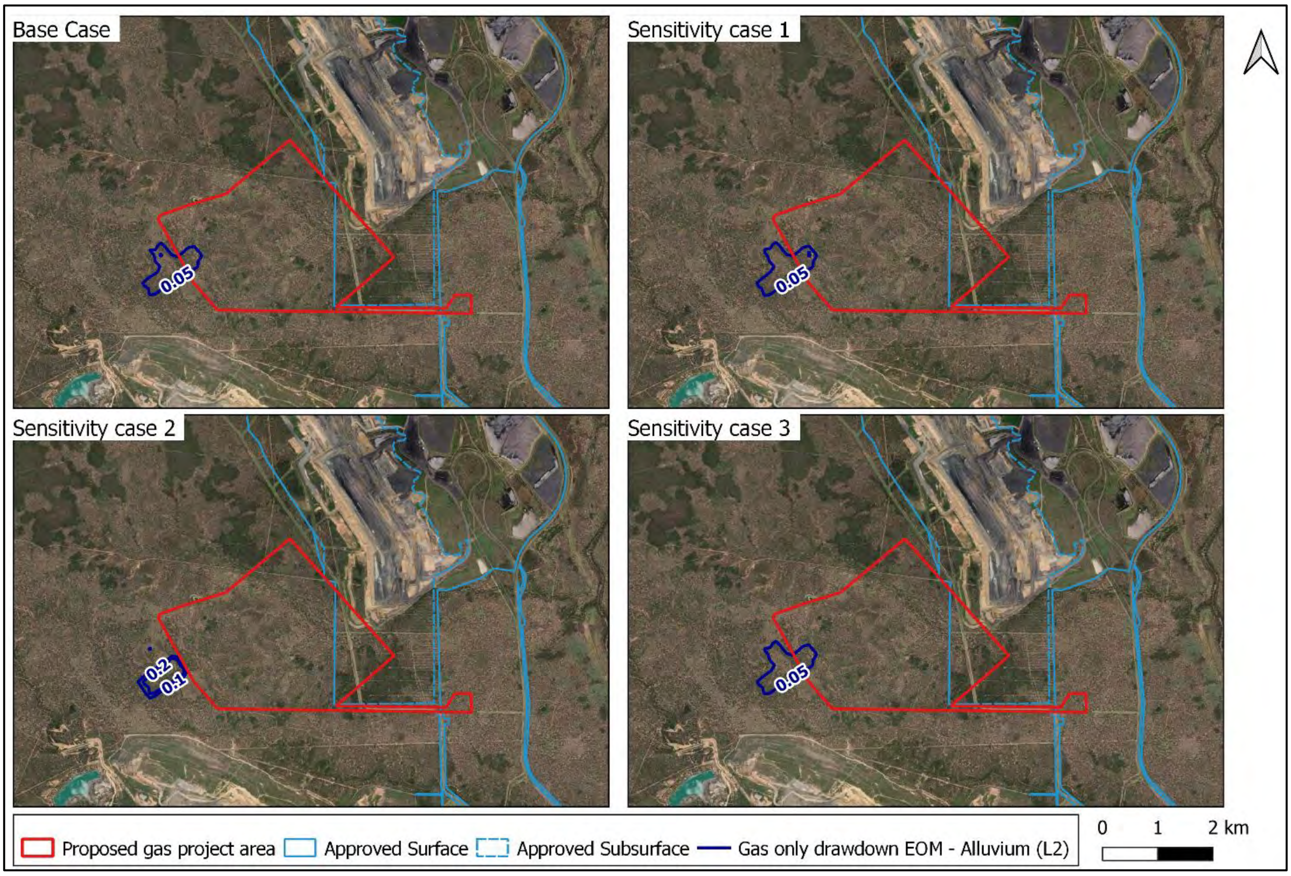

Figure B.1 EOM drawdown as of September 2043 – Alluvium (Layer 2)

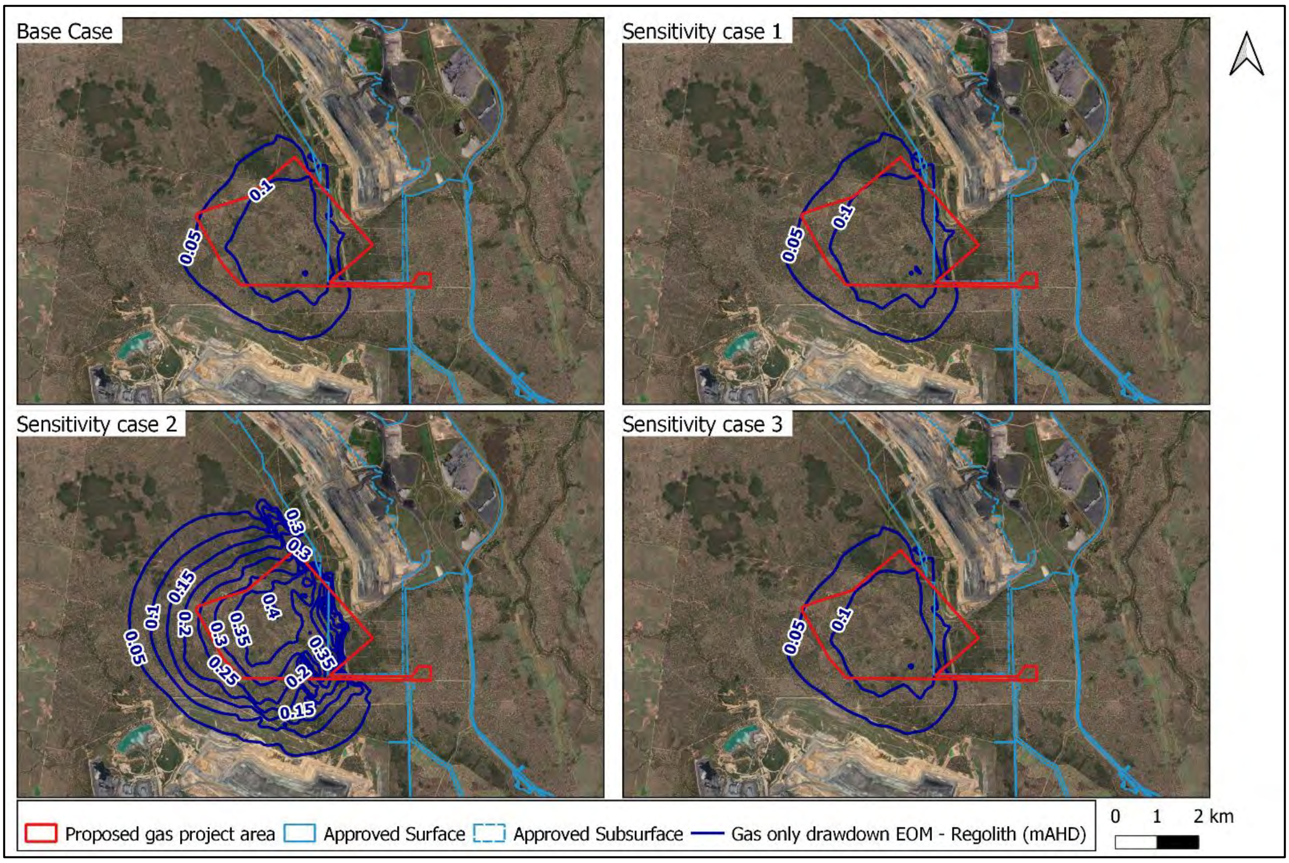

Figure B.2 EOM drawdown as of September 2043 – Regolith (Layer 3)

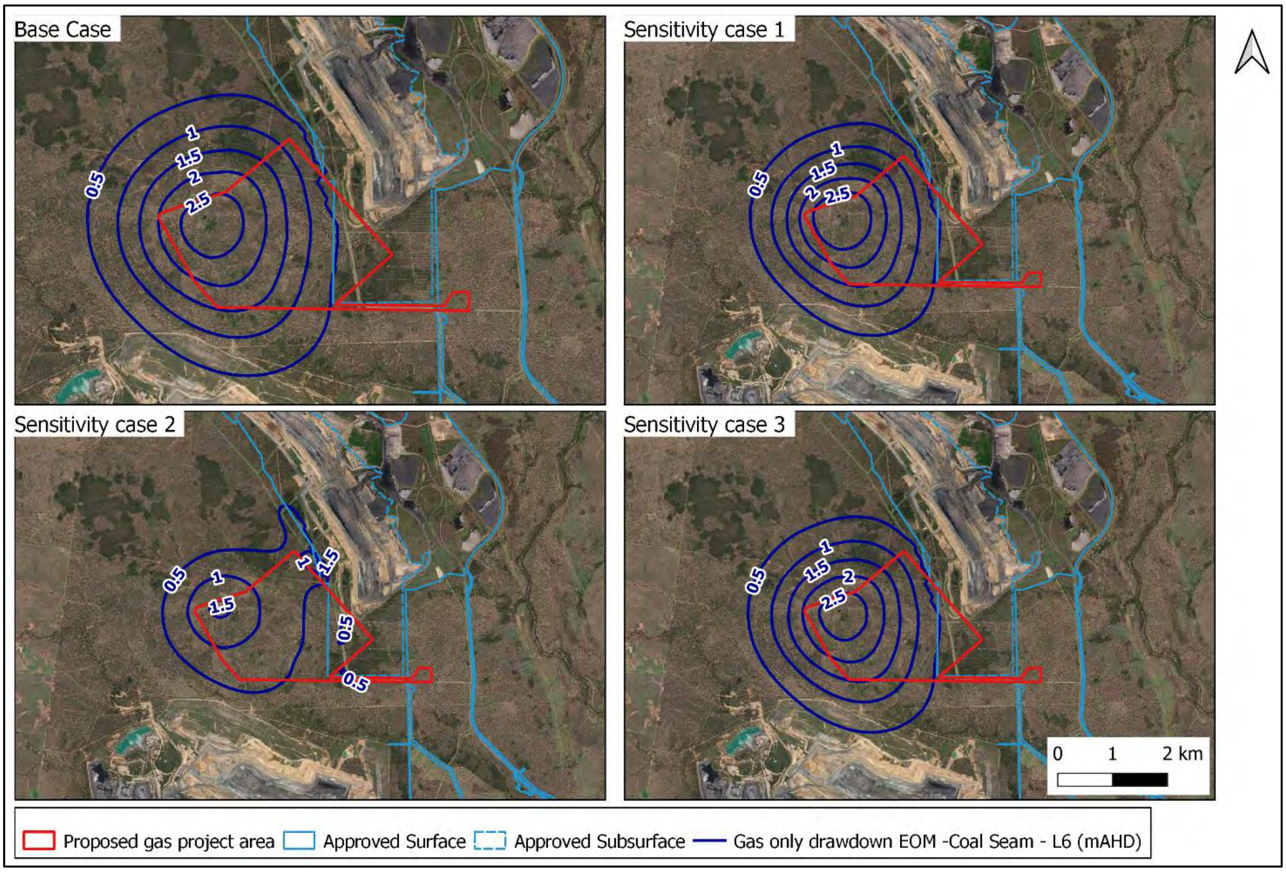

Figure B.3 EOM drawdown as of September 2043 – Coal Seam (Layer 6)

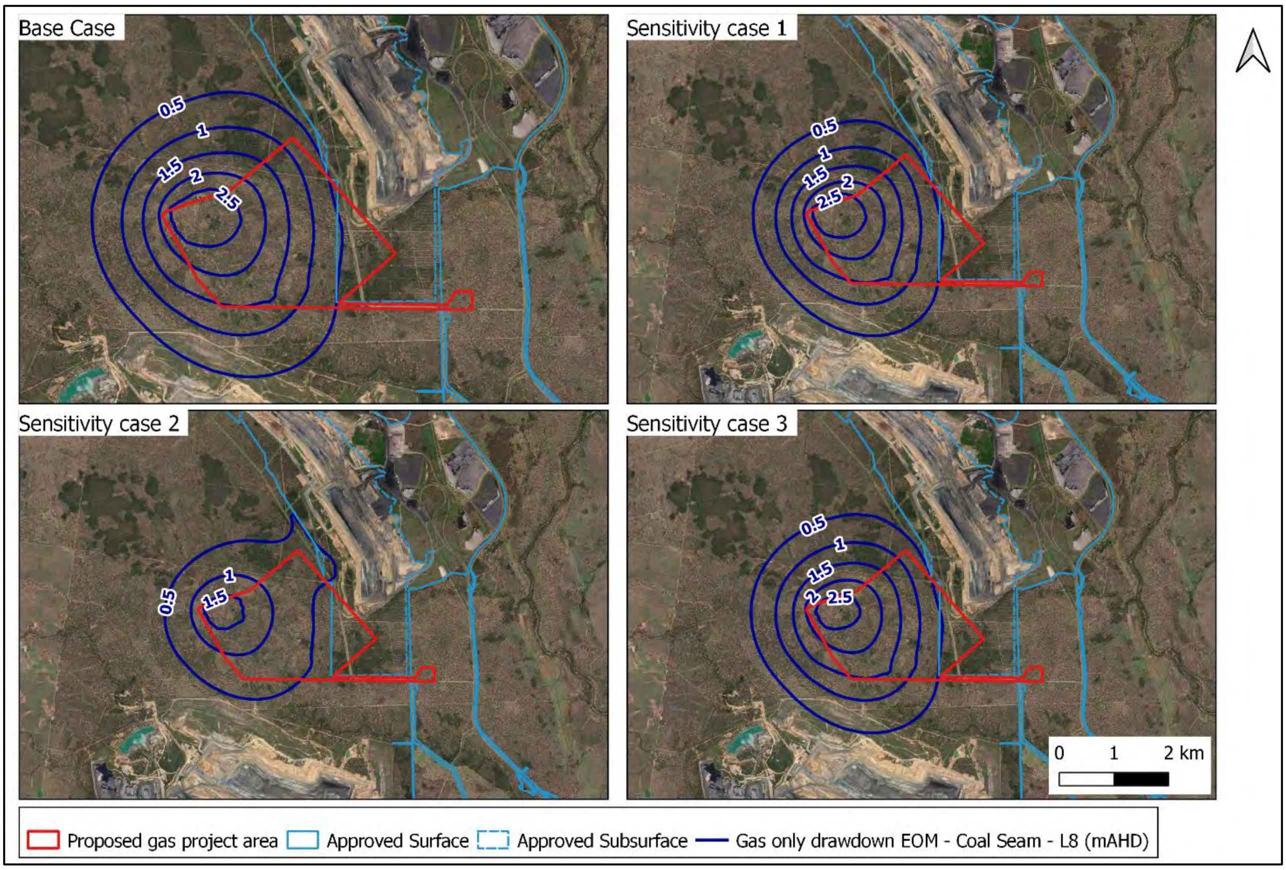

Figure B.4 EOM drawdown as of September 2043 – Coal Seam (Layer 8)

Figure B.5 Maximum drawdown during LOM – Alluvium (Layer 2)

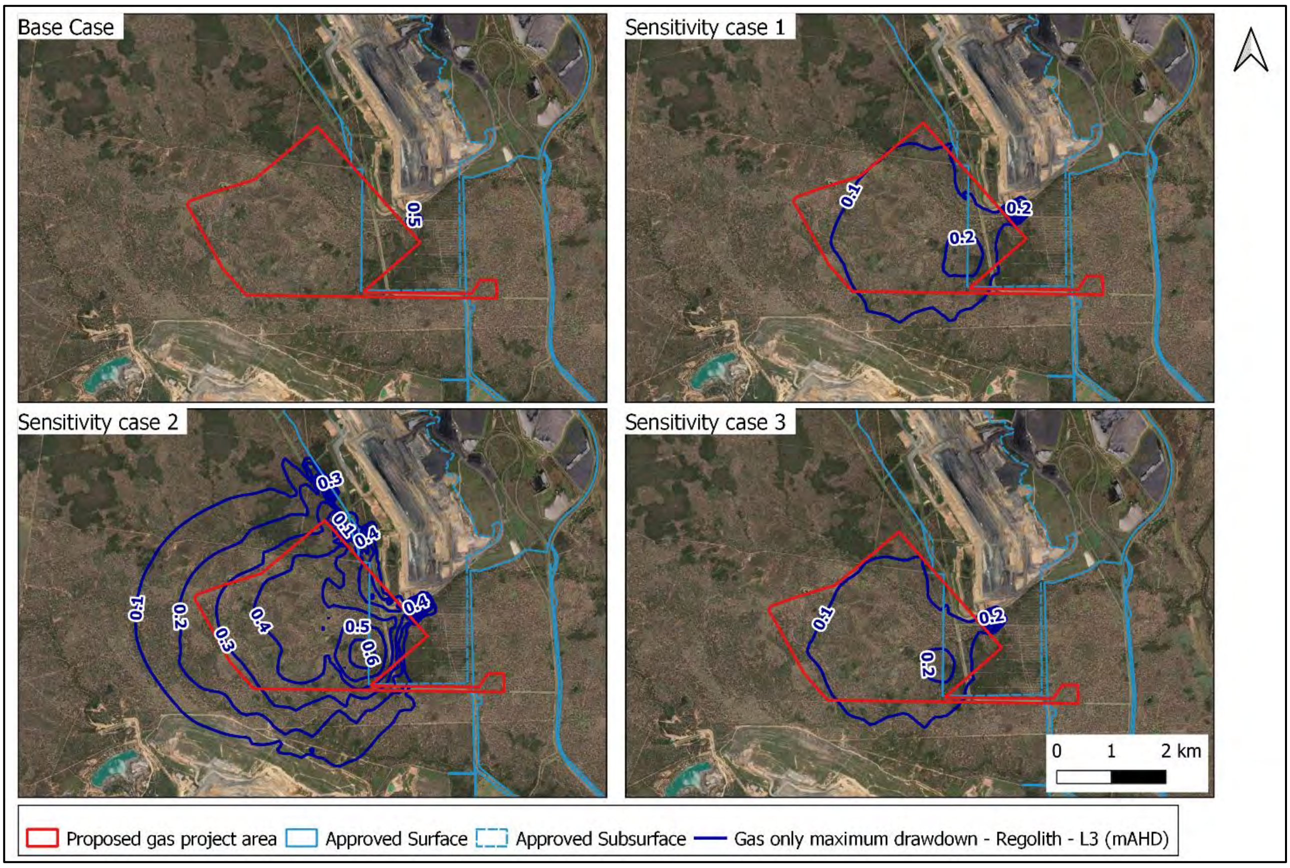

Figure B.6 Maximum drawdown during LOM – Regolith (Layer 3)

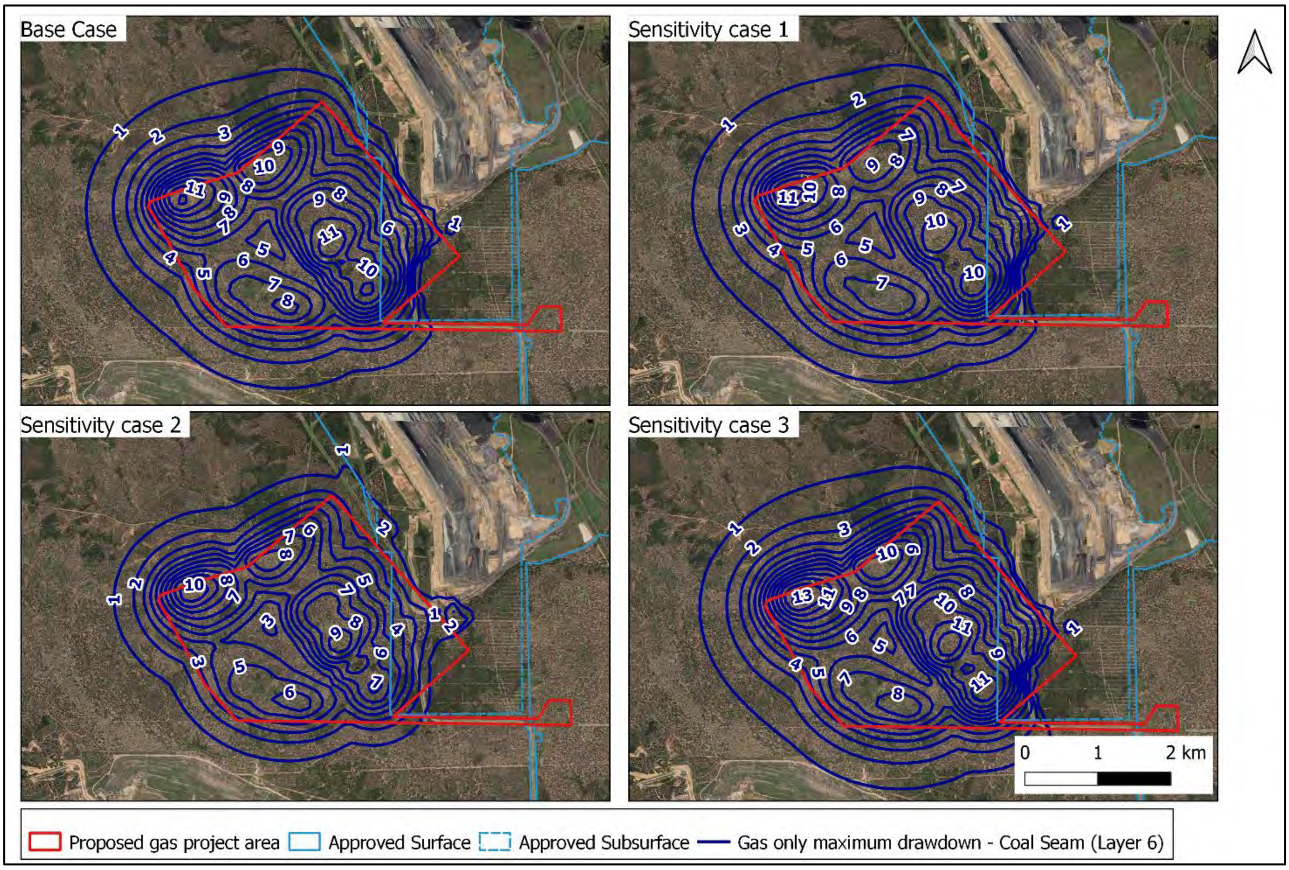

Figure B.7 Maximum drawdown during LOM – Coal Seam (Layer 6)

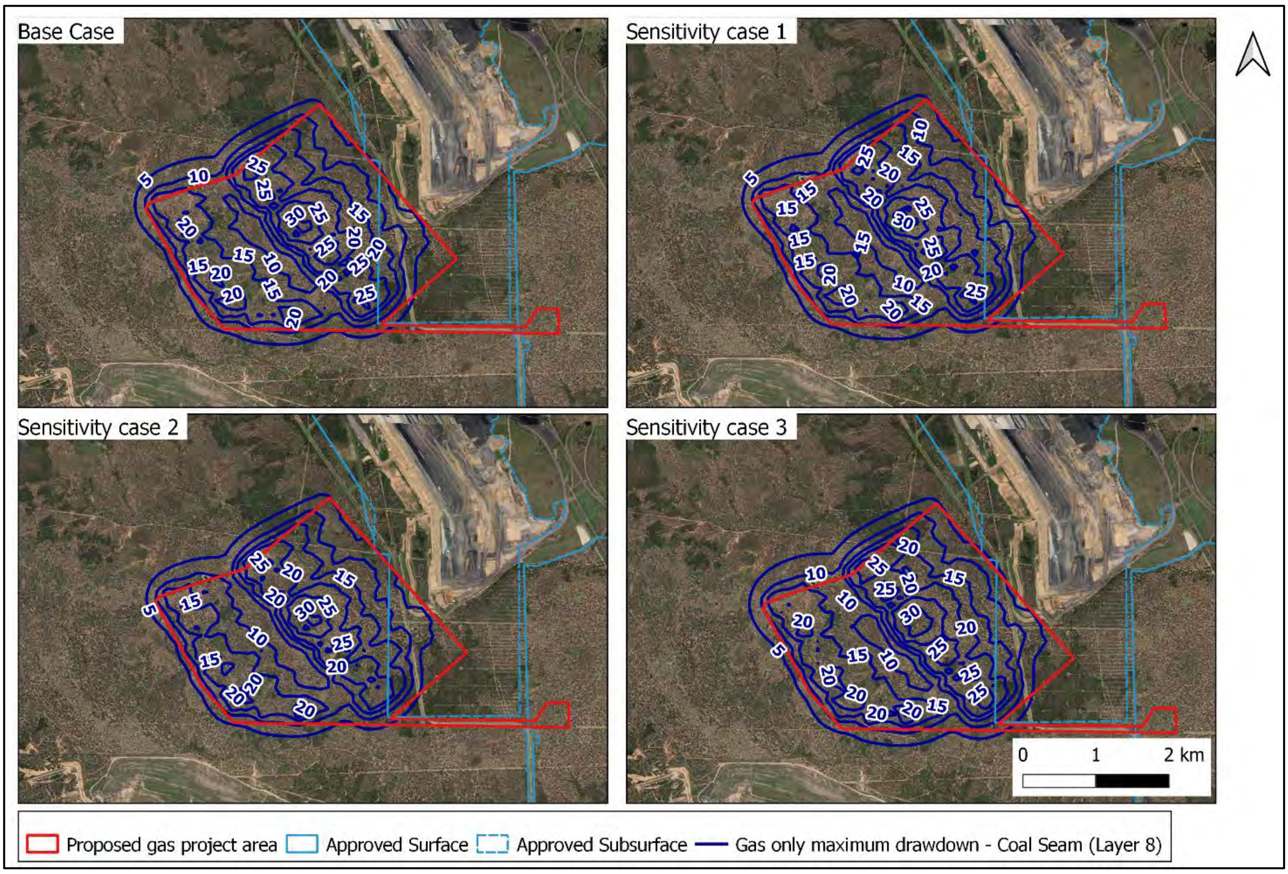

Figure B.8 Maximum drawdown during LOM – Coal Seam (Layer 8)

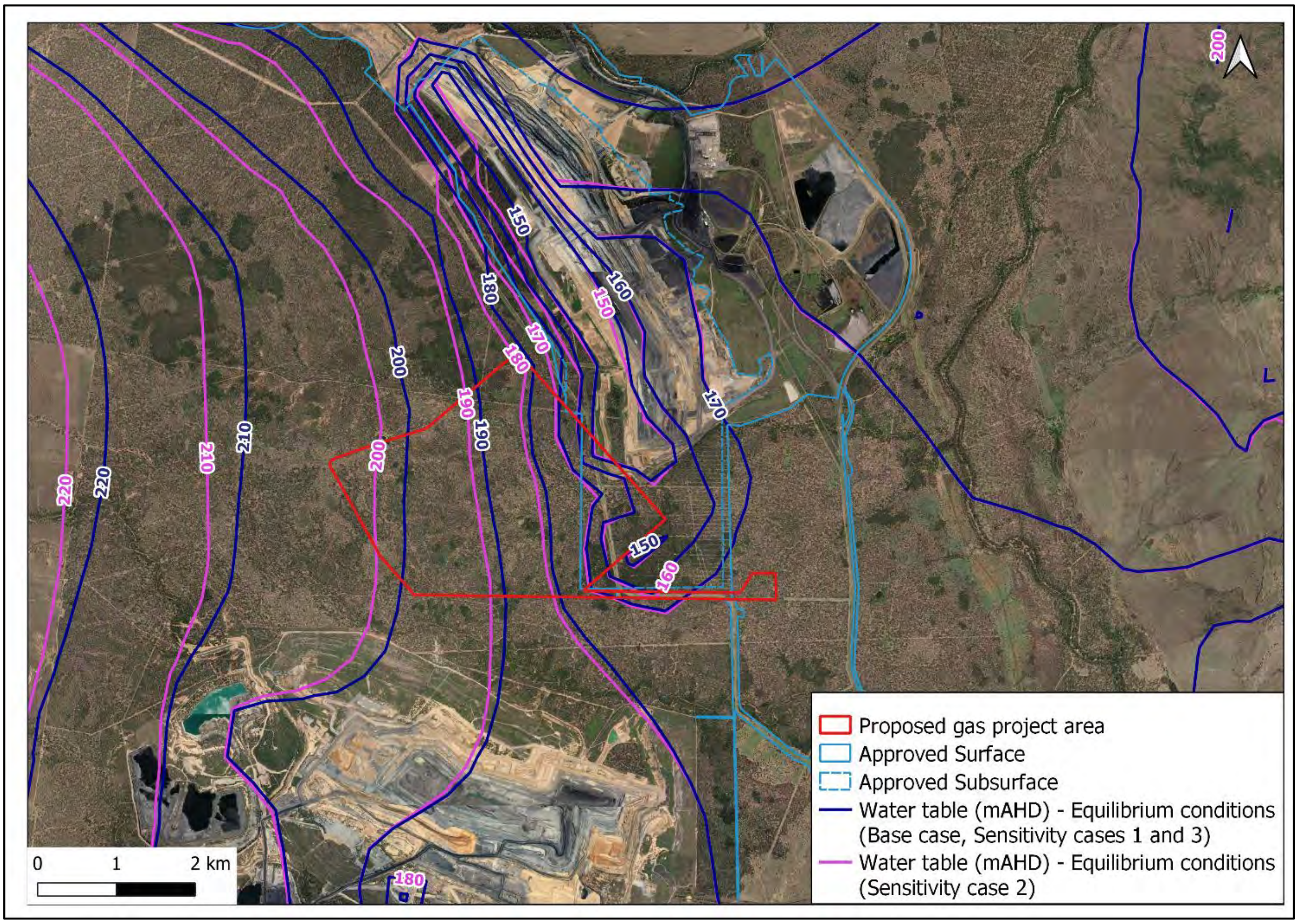

Figure B.9 Equilibrium heads post closure - water table representing all model layers in Layer 1

APPENDIX C
SURFACE WATER ASSESSMENT

South Walker Creek CSG Collection Project

Surface Water Assessment

Stanmore Resources Limited

Doc. Ref.: SWC-003-B1

Date: 26 June 2024

Rev. No.	Doc Ref.	Report Date	Report Author	Reviewer
1	SWC-003-B1	26 June 2024	AH	MGB

For and on behalf of **Hydro**Balance
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1 Introduction

1.1 Background

Stanmore Resources Limited (Stanmore) proposes to develop a Coal Seam Gas (CSG) collection network (the Project) in the vicinity of the existing South Walker Creek (SWC) mine. SWC is an open-cut metallurgical coal mine located 35 kilometres west of Nebo in Queensland's Bowen Basin (refer to Figure 1.1). The mine has been operating since 1996 and adopts a multi-bench, open-cut mining method utilising a dragline, and truck and hydraulic excavators.

The works associated with the Project would be undertaken on the existing mine leases; ML4750 and ML70131 and would require approval from the following:

- State under the EP Act, through a major amendment to the existing SWC Environmental Approval EPML00712313 (the EA).
- Commonwealth through referral under the Environment Protection and Biodiversity Conservation (EPBC) Act (with review by the Independent Expert Scientific Community (IESC)).

HydroBalance was commissioned by Stanmore to undertake a Surface Water Assessment (SWA) for the Project. This SWA report forms part of the approval submission for the Project.

1.2 Project description

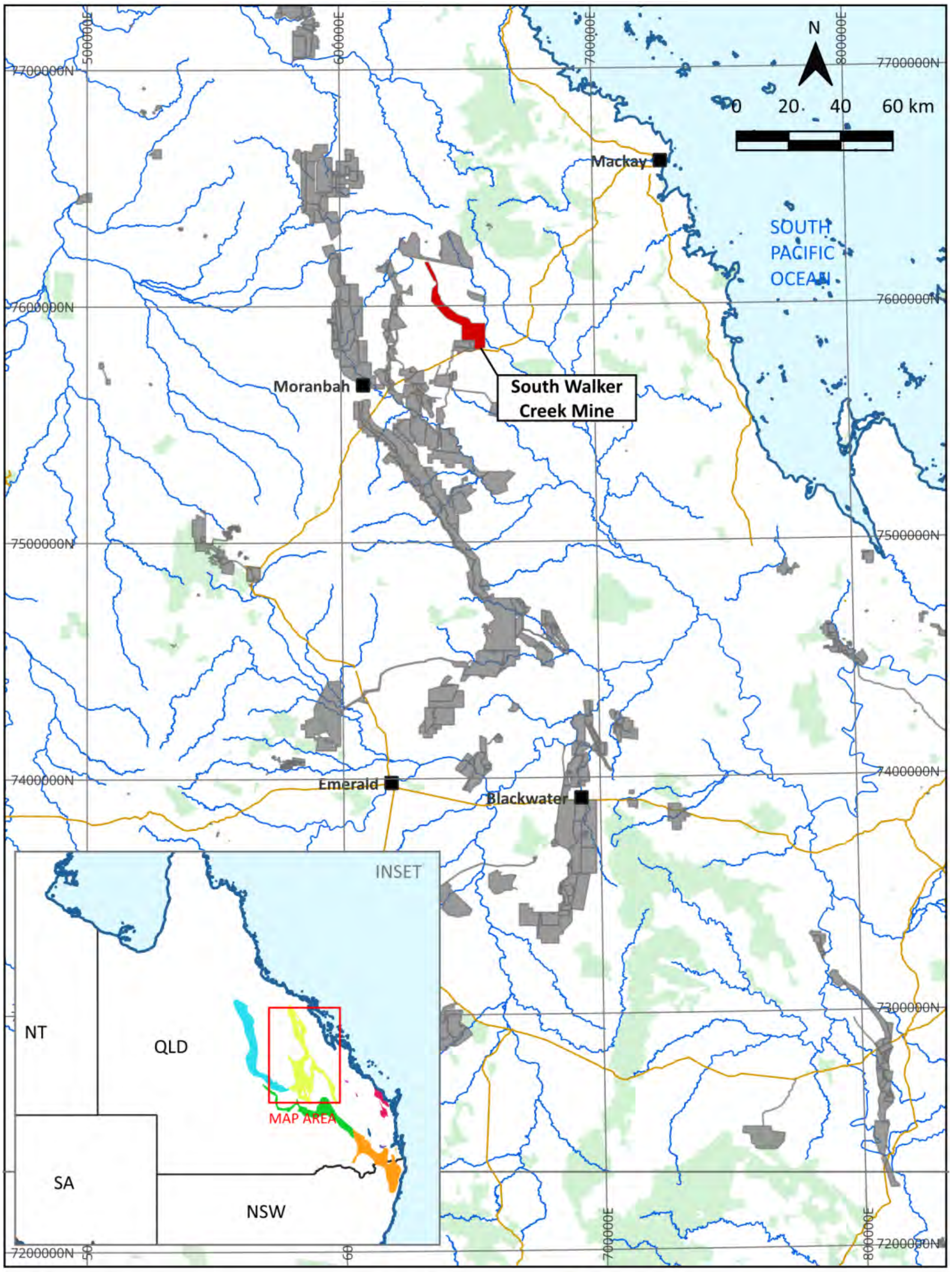
The Project layout, including temporal staging is shown in Figure 1.2. The Project includes two distinct stages:

- Exploration Stage: coal and CSG exploration drilling is proposed across ML4750 and ML70131.
- Collection Stage: a CSG collection field will be developed on ML4750.

The Exploration Stage will occur between 2024 and 2028. The drilling locations proposed for 2024 are within the approved areas for continuous drilling per the EA, hence additional approval would only be required for works from 2025 onwards. Core, Reverse Circulation (RC) and gas drilling will be undertaken across the site using a rig and supports (small truck and two to three light vehicles). Each of the drill holes will consist of 1,400 m^2 pads, 3 m wide seismic exploration lines and 4.5 m wide access tracks (noting that existing assess tracks used where possible.)

The CSG collection field will be completed following the Exploration Stage and will feed the proposed Gas Fired Power Station (the Power Station). The CSG collection system will have a 15-year project life may comprise a series of production wells and single or dual lateral collection lines (or combination thereof). The CSG drilling will liberate water from underground coal seams and bring this water to the surface. The CSG water will be managed within the existing SWC mine water system.

Note that approval for the Power Station is subject to a separate Planning Act Development Approval, which will be prepared in isolation to this report. Hence, the Power Station will not be discussed from an approval perspective in this report.



Title:	Project Locality
Project:	SWC CSG Project Surface Water Assessment

HydroBalance

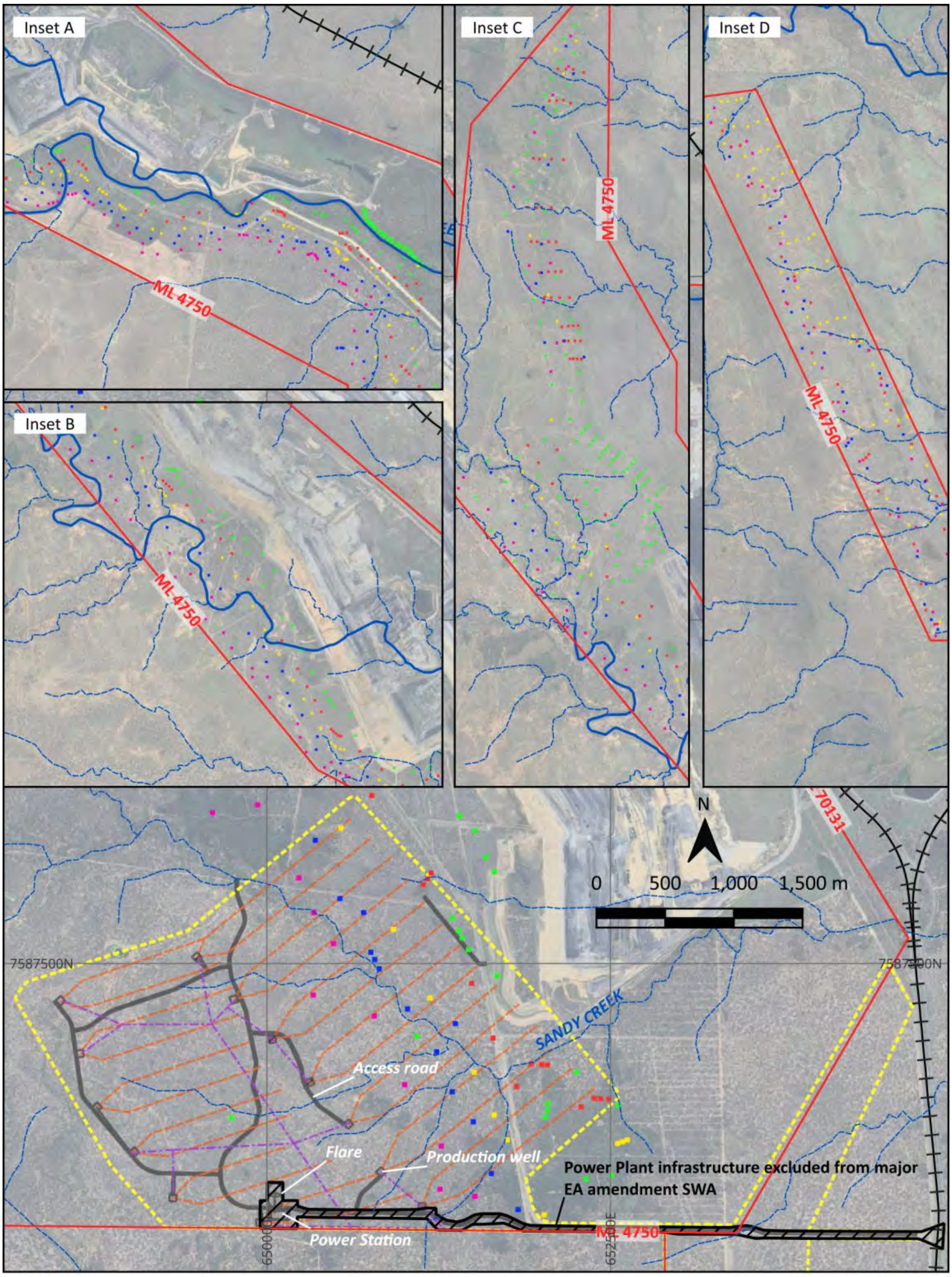
Legend

- Major watercourse
- National park
- Highway
- Surrounding MLs
- SWC ML

QLD coal measures

- Bowen Basin
- Callide Basin
- Galilee Basin
- Clarence-Moreton Basin
- Surat Basin
- Ipswich Basin
- Maryborough Basin
- Mulgildie Basin
- Tarong Basin

Figure 1.1 - Project locality



Title:	Proposed layout
Project:	SWC CSG Project Surface Water Assessment

HydroBalance

Legend
- Mining lease boundary
- Dual laterals
- Gas gathering line
- Infrastructure
- Gas Project Study Buffer

Drill pads
- CY24
- CY25
- CY26
- CY27
- CY28

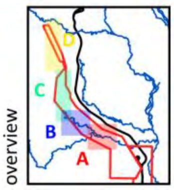


Figure 1.2 - Project general arrangement

1.3 Report structure

This report is structured as follows:

- Section 2 describes the environmental values of the regional receiving waters;
- Section 3 describes the existing surface water environment including the regional and local drainage characteristics;
- Section 4 describes the proposed surface water management system including the management objectives and principles;
- Section 5 describes the site water balance model configuration and outcomes;
- Section 6 presents the outcomes from the flood modelling assessment.
- Section 7 describes the outcomes from the impact assessment for surface water, with proposed mitigation and management measures.
- Section 8 provides a list of references.
- Appendix A describes the setup and configuration of the hydraulic model.
- Appendix B provides the flood maps for the 10%, 5% and 2% design flood events.

2 Environmental values

The *Environmental Protection Policy (Water and Wetland Biodiversity) 2019* (EPP [Water]), which is subordinate legislation to the Environmental Protection Act 1994, provides a framework for identifying environmental values (EV) for a waterway and deciding water quality objectives (WQO) to protect or enhance those EV's. EV's for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs need to be protected from the effects of habitat alteration, contaminated runoff and releases and changed flow to ensure healthy aquatic ecosystems and waterways that are safe for community use.

The waterways in the vicinity of the Project (Bee Creek, Carborough Creek, Sandy Creek and Walker Creek) are located within the central tributaries region of the Isaac River Sub-Basin (WQ1301).

The EVs selected for protection of uncontrolled streams include:

- Aquatic ecosystems;
- Irrigation water supply;
- Farm water supply;
- Stock water;
- Human consumer;
- Primary contact recreation;
- Secondary contact recreation;
- Visual recreation;
- Drinking water;
- Industrial use; and
- Cultural and spiritual values.

In summary, the key EV's for water that are to be protected are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems;
- the qualitive and quantitative integrity of local groundwater as a potential water source for agriculture or other suitable uses; and
- the integrity of raw water supplies and associated infrastructure in the region.

2.1 Water quality objectives

The indicators and water quality guidelines relevant to the above environmental values are listed in the Queensland Water Quality (QWQ) Guidelines and ANZG (2018). The conditions of waterways located in the vicinity of the Project are classified as slightly to moderately disturbed ecosystems under the QWQ Guidelines (DEHP, 2013).

The downstream water quality triggers listed in Table F2 and Table F3 of the EA have been reproduced in Table 2.1. These values are generally based on the trigger values or Default Guideline Values (DGVs) nominated in the QWQ guidelines and ANZG, or regional values. WQOs/DGVs are displayed for physio-chemical parameters only.

Table 2.1 – Downstream water quality triggers (Table F2 and Table F3 EPML00712313)

Parameter	WQO/DGV	Relevant EV
Electrical conductivity	700 µS/cm (low flow) to 5,500 µS/cm (high flow)	
pH	6.5 to 9.2 (low flow) 6.5 to 9.6 (high flow)	
Turbidity	500 NTU	Turbidity is required to assess ecosystem impacts and can provide instantaneous results.
Suspended solids	N/A	Suspended solids are required to measure the performance of erosion and sediment control measures.
Sulphate	250 mg/L (low flow) to 750 mg/L (high flow)	Drinking water environmental values from NHMRC 2006 guidelines or ANZECC.
Aluminium	55 µg/L	For aquatic ecosystem protection, based on SMD guideline
Arsenic	13 µg/L	For aquatic ecosystem protection, based on SMD guideline
Cadmium	0.2 µg/L	For aquatic ecosystem protection, based on SMD guideline
Chromium	1 µg/L	For aquatic ecosystem protection, based on SMD guideline
Copper	2 µg/L	For aquatic ecosystem protection, based on LOR for ICPMS
Iron	300 µg/L	For aquatic ecosystem protection, based on low reliability guideline
Lead	4 µg/L	For aquatic ecosystem protection, based on SMD guideline
Mercury	0.2 µg/L	For aquatic ecosystem protection, based on LOR for CV FIMS
Nickel	11 µg/L	For aquatic ecosystem protection, based on SMD guideline
Zinc	8 µg/L	For aquatic ecosystem protection, based on SMD guideline
Boron	370 µg/L	For aquatic ecosystem protection, based on SMD guideline
Cobalt	90 µg/L	For aquatic ecosystem protection, based on low reliability guideline
Manganese	1,900 µg/L	For aquatic ecosystem protection, based on SMD guideline
Molybdenum	34 µg/L	For aquatic ecosystem protection, based on low reliability guideline
Selenium	10 µg/L	For aquatic ecosystem protection, based on LOR for ICPMS
Silver	1 µg/L	For aquatic ecosystem protection, based on LOR for ICPMS
Uranium	1 µg/L	For aquatic ecosystem protection, based on LOR for ICPMS
Vanadium	10 µg/L	For aquatic ecosystem protection, based on LOR for ICPMS
Ammonia	900 µg/L	For aquatic ecosystem protection, based on SMD guideline
Nitrate	1,100 µg/L	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for TN
TPH (C6-C9)	20 µg/L	
TPH (C10-C36)	100 µg/L	
Fluoride (total)	2,000 µg/L	Protection of livestock and short-term guideline
Sodium	TBA	To be determined following collection of sufficient site specific data

Notes:
SMD – slightly moderately disturbed level of protection, guideline refers ANZECC & ARMCANZ (2000).
LOR – typical reporting for method stated. ICPMS/CV FIMS – analytical method required to achieve LOR.

3 Existing surface water environment

3.1 Regional drainage network

The Project is located within the headwaters of the Isaac sub-catchment of the greater Fitzroy Basin. Bee Creek is the main watercourse in the vicinity of the Project area, and flows in the north-west to south-east direction to the east of the Project.

Bee Creek commences approximately 40 km north of SWC Mine and joins Funnel Creek 60 km downstream of the Project. Funnel Creek eventually flows into the Connors River. The Conners River flows in a westerly direction into the Isaac River, approximately 110 km downstream of the Project. The Isaac River finally converges with the Mackenzie River a further 53 km downstream.

Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton near Port Alma. Figure 3.1 presents the location of the Project and Isaac River catchment upstream of the Connors River confluence.

The greater Isaac-Connors sub-catchment area is approximately 22,364 km^2 (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km^2. That is, it represents around 15% of the overall Fitzroy River catchment.

The catchment area of Bee Creek to the Project area is around 911 km^2. This represents around 0.6% of the overall Fitzroy River catchment and 4.1% of the Isaac-Connors sub-catchment.

The Project study area (of which less than 10% will be disturbed by mining) is approximately 9.9 km^2 and represents 0.01% and 0.04% of the overall Fitzroy River and Isaac-Connors catchment areas, respectively.

Bee Creek is an ephemeral watercourse and experiences flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with most channels drying out during winter to early spring when rainfall and runoff is historically low, although with some pools expected to hold water for extended periods. Therefore, physical attributes, water quality, and the composition of aquatic flora and fauna communities are also expected to be highly variable over time.

The Bee Creek catchment upstream of the Project comprises mainly scattered to medium dense bushland and grazing land. The Hail Creek mine is the only existing coal mine located upstream of the Project in the Bee Creek catchment.

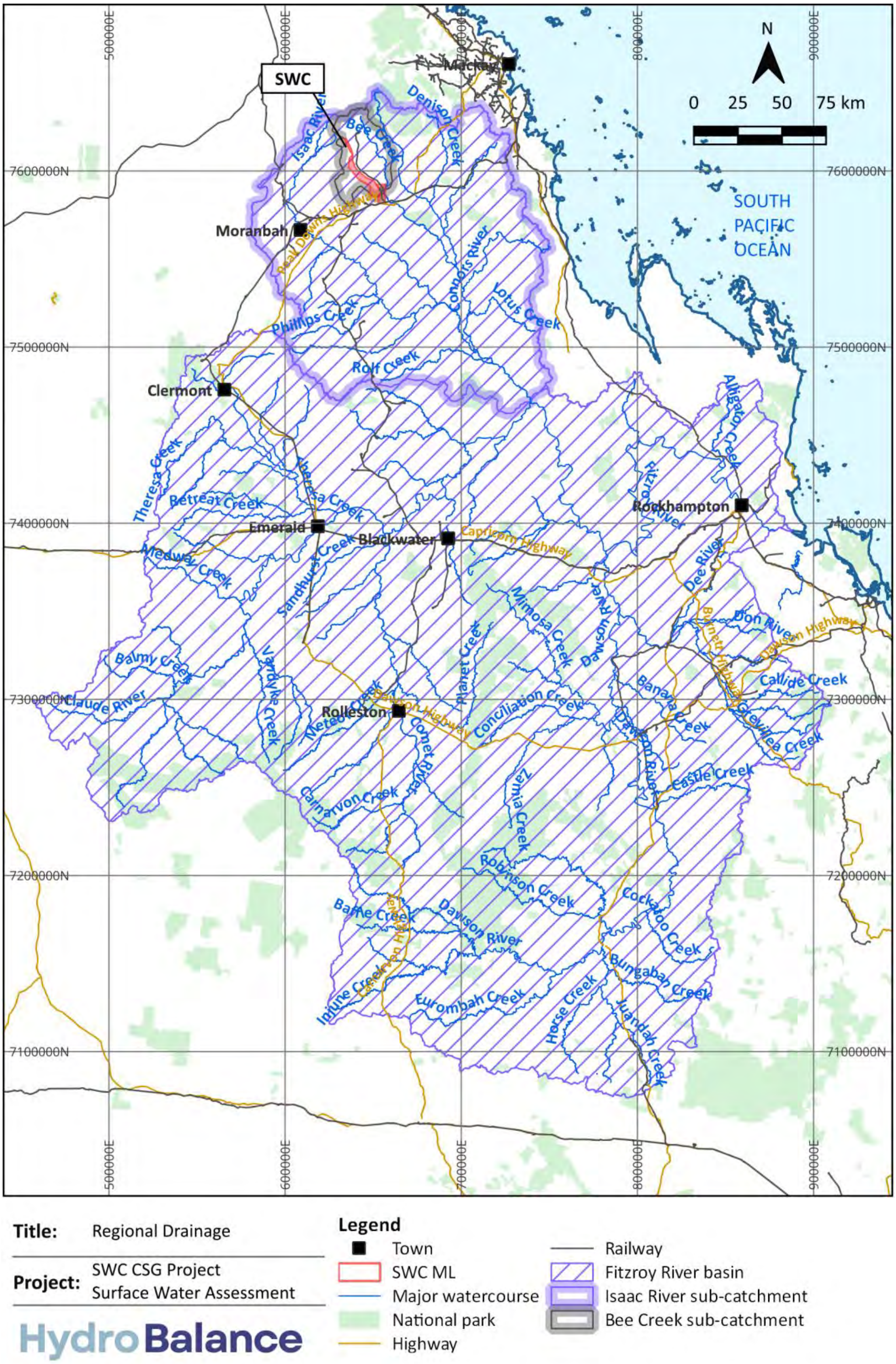


Figure 3.1 – Regional drainage characteristics

3.2 Local drainage network

The following ephemeral drainage systems (shown in Figure 3.2) are located in the vicinity of the SWC:

- Bee Creek;
- Carborough Creek;
- Sandy Creek; and
- Walker Creek.

BMT undertook a characterisation of the local creeks as part of the *'South Walker Creek and Poitrel Mines Salt Assimilation Study – Environmental Values and Water Quality Objectives'* (BMT, 2011). The outcomes from the field assessment are presented below.

3.2.1 Bee Creek

Bee Creek extends from its headwaters, located approximately 40 km north of SWC Mine, to Funnel Creek which eventually flows into the Connors River. Hail Creek and SWC Mines are both authorised to discharge mine-affected into Bee Creek (in accordance with their respective Environmental Authority conditions). Bee Creek forms the western border of Dipperu National Park, approximately 18 km south-east of the SWC Mine.

Stream sediments were typically comprised of coarse sand, although boulders and cobble were present in places (e.g. southern site on Bee Creek at Dipperu NP), with occasional bedrock exposures. Several of the sites on Bee Creek had moderate levels of instream micro-habitat diversity, mostly in the form of log jams and scour holes around tree roots. There was little leaf litter and small woody debris, with most instream habitat consisting of tree roots and scours, large woody debris and sandy banks.

Some of the larger scour holes were up to 2 m deep in places, and may represent dry season refugia for fish and macroinvertebrates during non-flow periods. These more complex habitats typically occurred at river bends. The straighter sections of Bee Creek were relatively shallow and contained more simplified and homogenous instream run type habitats. These areas did not contain waterholes and are unlikely to support water during non-flow periods.

The riparian upper story vegetation of Bee Creek was mostly intact and composed of large eucalypts, Casuriana and occasional Callistemon. Dawson River gums and forest red gums sometimes exceeded 30 m in height. The creek banks were benched in places, and typically had a tow of unconsolidated sandy sediment. Cattle access tracks were present at several sites and constituted the most notable form of bank disturbance. Some of the steeper banks were free of cattle access tracks and typically had a high cover of grass and shrubs.

Based on the instream and riparian habitat conditions, Bee Creek is considered to be in a slightly to moderately disturbed condition.

3.2.2 Carborough Creek

The upper part of the Carborough Creek catchment is located approximately 20 km west of SWC Mine. Carborough Creek flows more regularly than Walker Creek and Sandy Creek due to its larger catchment area. Carborough Creek joins Walker Creek at the downstream reach of the diverted reach of Walker Creek and does not receive mine-affected water from SWC Mine.

During periods of flow, the creek would support relatively simplified and homogenous aquatic habitat, similar to that found in the 'straight' sections of Bee Creek. Instream habitat would consist of sand banks (with limited undercutting), trailing vegetation and sandy bottom run habitat. Small amounts of leaf litter and small woody debris occurred at the stream margins, but essentially the creek was straight and had a homogenous bed.

The riparian upper story vegetation of Carborough Creek was mostly intact and composed of large eucalypts (some up to 30 m height), Casuarina and occasional Callistemon. The creek banks had a high cover of grasses and shrubs. The banks were slightly benched and the channel had a flat 'U' shape. Cattle access tracks occurred throughout the site, and pig tracks and wallows were also observed.

Based on the likely regularity of inundation, modification to its catchment, quality of aquatic habitat, and overall stream condition, Carborough Creek is considered to be in a moderately disturbed condition.

3.2.3 Sandy Creek

The headwaters of Sandy Creek begin approximately 6 km west upstream of SWC Mine. Due to the small catchment area, creek flows are relatively short-lived and small in magnitude compared to those in Carborough and Walker Creeks. SWC Mine discharges water from the eastern sediment dam into Sandy Creek via a small (first order) drainage. Sandy Creek receives mine-affected water 1.5 km upstream of its confluence with Bee Creek.

During periods of flow, the downstream reach of Sandy Creek would support a range of instream micro-habitats including small and large woody debris, tree scours and trailing vegetation. Leaf litter and small woody debris occurred around larger woody debris and tree roots. Coarse sands dominated the stream bed; however, gravel and pebble fractions were also more abundant in Sandy Creek than in Bee Creek.

The riparian upper story vegetation of Sandy Creek was mostly intact and composed of large eucalypts, casuarinas and occasional Callistemon. In the lower reaches of Sandy Creek near its confluence with Bee Creek, eucalypts occasionally exceeded 30 m in height. The upper banks were benched with a slight to moderate grade on the lower banks, becoming more vertical with proximity to Bee Creek. Cattle access tracks were less prominent in the surveyed reach of Sandy Creek than elsewhere in the study area.

Based on the modification to its catchment, quality of aquatic habitats, and overall stream condition, Sandy Creek is considered to be in a slightly to moderately disturbed condition.

3.2.4 Walker Creek

The headwaters of Walker Creek begin approximately 25 km north-west of SWC Mine. A reach of Walker Creek has previously been diverted to accommodate SWC Mine. Carborough Creek joins Walker Creek downstream of this diversion. Walker Creek receives mine-affected discharge water through a small gully fed by C-dam on SWC Mine, and from F dam as well. The distance from the discharge on Walker Creek to its confluence with Bee Creek is 8.1 km.

Aquatic habitat consisted primarily of overhanging vegetation and undercut banks. During periods of low flow, aquatic habitat at the sites downstream of the Carborough Creek confluence would consist of sand banks, large woody debris, tree roots and overhanging vegetation. Baseline and REMP surveys conducted by others have not investigated fish communities in Walker Creek. Coarse sands dominated the stream bed with occasional patches of mud where water had pooled. Trace amounts of leaf litter and small woody debris could be found at the stream margins, but the substrates were dominated by sand. Several large erosive scarps were observed at the upstream data station and at the confluence of the Carborough and the diverted section of Walker Creek.

The riparian upper story vegetation of Walker Creek is mostly intact in the non-diverted reaches of the creek and composed of large eucalypts, casuarinas and occasional Callistemon, and eucalypts occasionally exceeded 30 m in height. The upper banks were benched with slight to vertical grade on the lower banks. Cattle access tracks were observed over the surveyed reach of Walker Creek.

Banks had a high cover of grasses and occasional shrubs. Based on the degree of modification to its catchment, quality of aquatic habitat, and overall stream condition, Walker Creek is considered to be in slightly to moderately disturbed condition.

3.3 Project area watercourse identification

Figure 3.3 shows the watercourse identification mapping within the Project area per the DoR (2017) mapping. A number of drainage features traverse through the site towards Sandy Creek, interacting with the proposed access roads in four locations. This figure also shows that there are no identified watercourses within the Project area. Sandy Creek and its minor tributary to the south are classified as “unmapped” but do not interact with any infrastructure proposed as part of the CSG gas collection field.

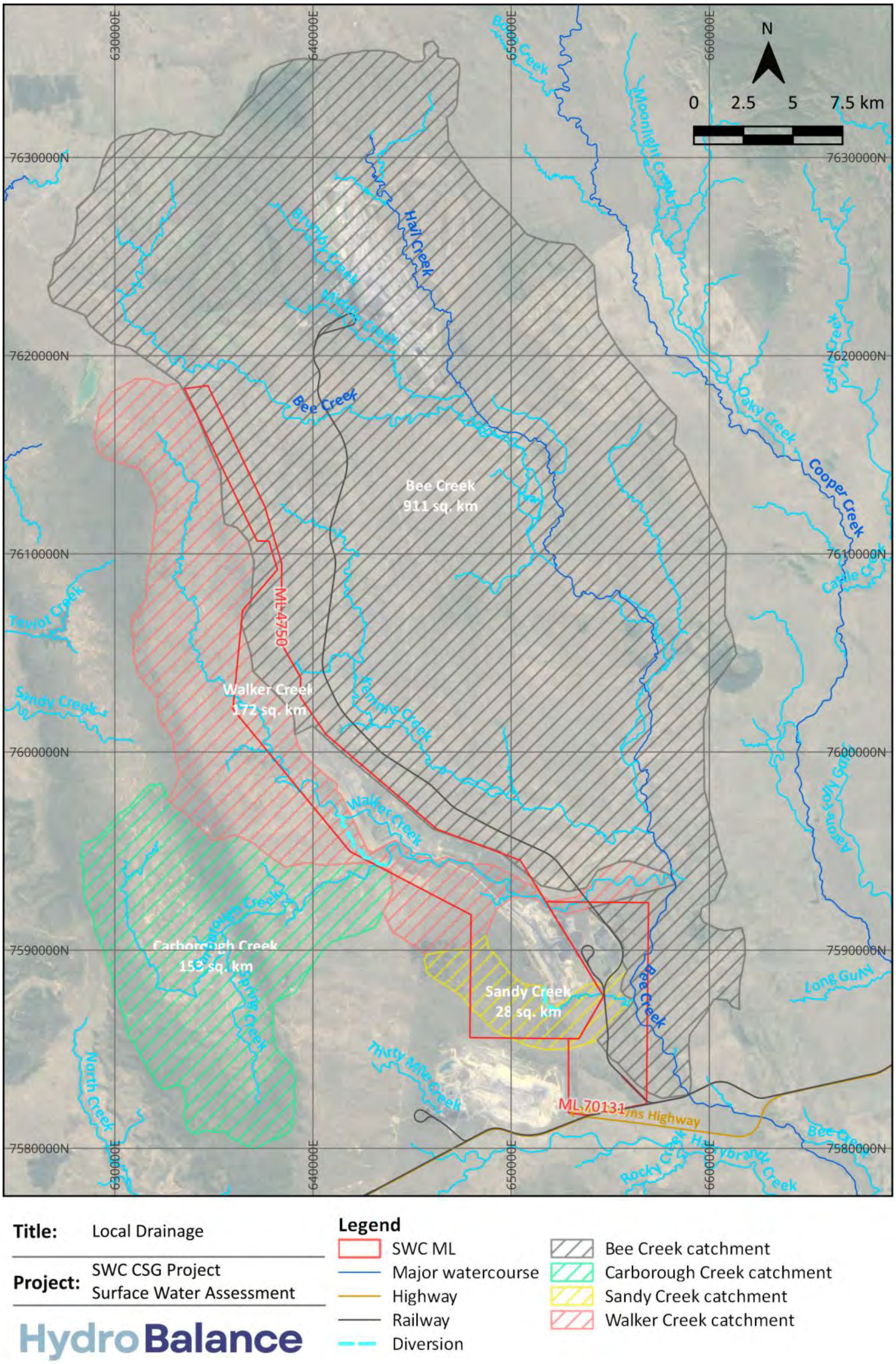


Figure 3.2 – Local drainage characteristics

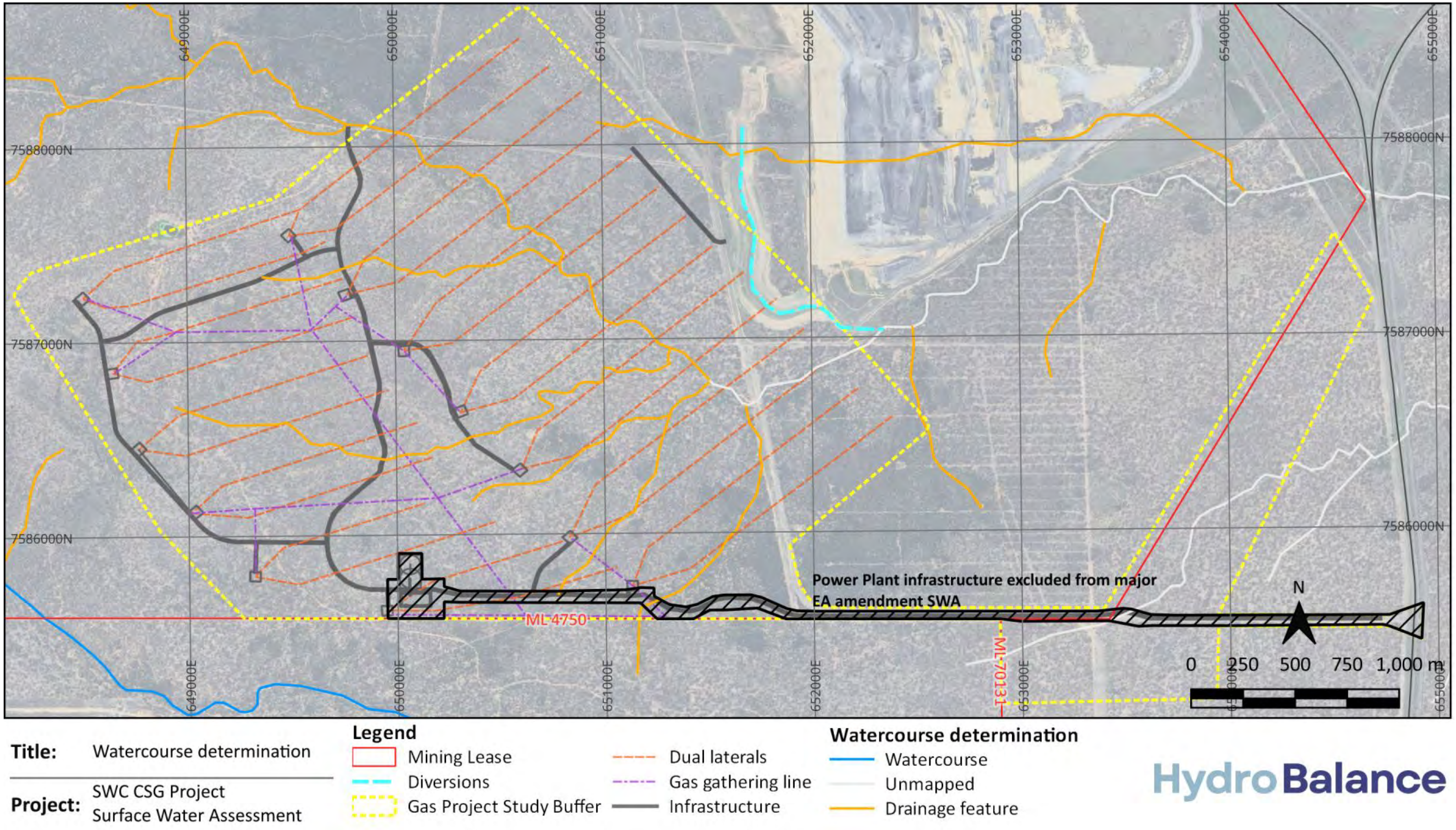


Figure 3.3 – Project area watercourse determination

3.4 Streamflow

Water depth and streamflow data have been recorded at the Bee Creek Upstream gauging station for the period between December 2019 and August 2023 and is presented in Figure 3.4. The following is of note:

- The flows in Bee Creek are ephemeral, with the majority of flows generally occurring between January and March.
- Bee Creek generally experiences flows more than a week following rainfall events, which is characteristic of the large catchment reporting to the gauging location.
- Flows reached up to 250 m³/s and 9 m deep during the December 2019 and August 2023 recording period.

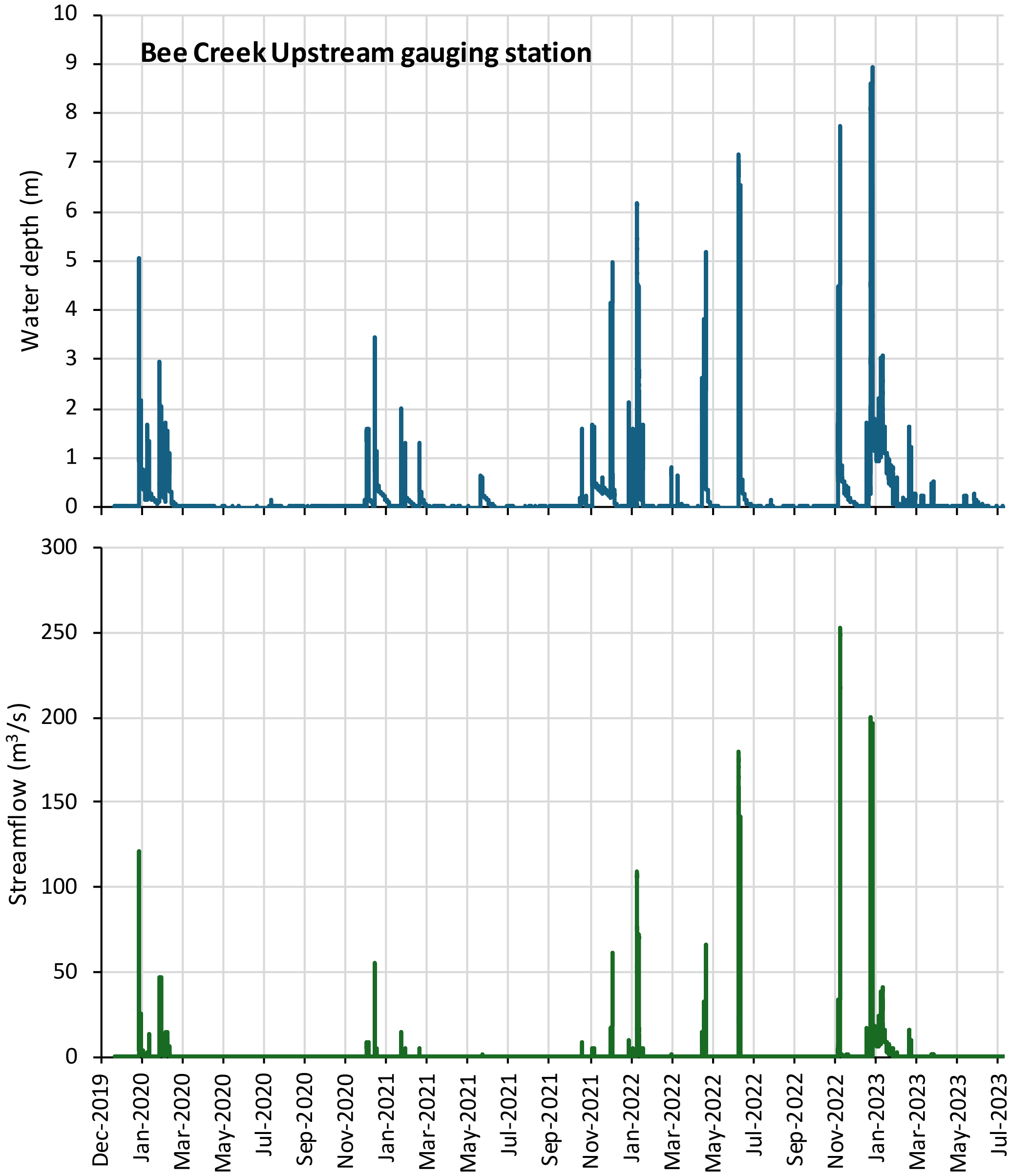


Figure 3.4 – Bee Creek Upstream gauging station recorded streamflow data

3.5 Geological setting

Douglas Partners (2013) describes the regional geological setting at SWC as follows:

- Generally comprises Triassic and Permian sedimentary units overlain by surficial deposits of Tertiary and Quaternary age.
- The geology in the vicinity of SWC is characterised by the following stratigraphic units (from youngest to oldest):
    - Unconsolidated alluvium and colluvium (Quaternary and Tertiary);
    - Rewan Group (Triassic);
    - Rangal Coal Measures (Permian); and
    - Fort Cooper Coal Measures (Permian).
- Drilling records suggest that the Quaternary and Tertiary alluvium sediments (where present), are generally <20 m thick and comprise of clays, sandy clays and sands. Information concerning this unit is limited, however it is apparent that the unit attains a maximum thickness in proximity to present and past palaeochannels associated with Walker and Carborough Creeks.
- The Triassic Rewan Group consists of thinly interbedded green to reddish brown mudstone, siltstone and fine lithic sandstone. The Rewan Group generally conformably overlies the Rangal Coal Measures. The transition between the Rewan Group and the Rangal Coal Measures is sometimes difficult to define and is often based on a change in colour.

3.6 Groundwater

Douglas Partners (2013) described the main groundwater water bearing units in the study area as:

- Alluvium: Unconsolidated Quaternary and Tertiary Alluvium aquifers associated with creek systems. Sands, sandy clays and clay substrates generally <20m thick, which are most likely recharged from stream surface water during flows.
- Permian: Permian fractured rock aquifer comprises grey mudstone and siltstone, fine-grained lithic sandstone, tuff, carbonaceous shale and coal seams.

Groundwater quality collected at groundwater monitoring locations in the vicinity of SWC during the period between 2018 and 2024 is presented in Table 3.1. The following water quality parameters appeared to be elevated, relative to the receiving water WQOs:

- Electrical conductivity;
- Iron (filtered);
- Boron (filtered) – note that the updated DGV for Boron is 940 µg/L, per the ANZG (2018) guidelines, which is greater than the 80th percentile recorded concentration; and
- Ammonia.

Table 3.1 – Local groundwater quality data

Parameter	Units	SWC groundwater bores				WQO (see Table 2.1)
		No. samples	20%ile	Median	80%ile	
Electrical conductivity	µS/cm	299	1,270	2,630	8,670	700 - 5,500
pH	-	299	7.35	7.77	8.20	6.5-9.2
Turbidity	NTU	2	-	26	-	500
Suspended solids	mg/L	126	5	10	30	N/A
Sulphate	mg/L	299	6	22	55	250-750

Parameter	Units	SWC groundwater bores				WQO (see Table 2.1)
		No. samples	20%ile	Median	80%ile	
Aluminium	µg/L	299	<10	<10	<10	55
Arsenic	µg/L	299	<1	<1	5	13
Cadmium	µg/L	185	<0.1	<0.1	<0.1	0.2
Chromium	µg/L	185	<1	<1	<1	1
Copper	µg/L	185	<1	<1	<1	2
Iron	µg/L	299	50	80	720	300
Lead	µg/L	185	<1	<1	<1	4
Mercury	µg/L	299	<0.1	<0.1	<0.1	0.2
Nickel	µg/L	185	<1	<1	2	11
Zinc	µg/L	185	<5	<5	7	8
Boron	µg/L	185	172	270	428	370
Cobalt	µg/L	185	<1	<1	3	90
Manganese	µg/L	185	6	129	435	1,900
Molybdenum	µg/L	223	<1	2	5	34
Selenium	µg/L	211	<10	<10	<10	10
Silver	µg/L	211	<1	<1	<1	1
Uranium	µg/L	0	-	-	-	1
Vanadium	µg/L	185	<10	<10	<10	10
Ammonia	µg/L	185	20	250	2,360	900
Nitrate	µg/L	299	<10	<10	20	1,100
TPH (C6-C9)	µg/L	299	<20	<20	<20	20
TPH (C10-C36)	µg/L	250	<50	<50	<50	100
Fluoride (total)	µg/L	185	200	400	600	2,000
Sodium	mg/L	299	159	479	1,470	TBA

3.7 Water quality

3.7.1 Regional water quality

Publicly available regional water quality data for Bee Creek at Smiths Yard gauge has been analysed and a comparison of 20th percentile, median and 80th percentile water quality at these sites to the WQOs/DGV's are displayed in Table 3.2. The gauge is located downstream of SWC and Hail Creek Mine and therefore potentially includes mine release water quality.

Table 3.2 shows that some readings at the Bee Creek gauge are at or above the regional DGVs, including the following:

- Dissolved iron (80th percentile); and
- Nitrate (50th percentile [median] and 80th percentile).

The review of the regional water quality data indicates that there are some water quality indicators that are y above the DGVs (dissolved iron and nitrate).

This indicates that the current DGV's may not necessarily reflect the typical background water quality within Bee Creek.

Table 3.2 – Regional Bee Creek water quality data

Parameter	Units	Bee Creek at Smiths Yard (130411A)				WQO (see Table 2.1)
		No. samples	20%ile	50%ile	80%ile	
Electrical conductivity	µS/cm	20	150	245	440	700
pH	pH units	18	7.1	7.55	7.84	6.5 to 9.2
Turbidity	NTU	6	81.4	100	100	500
Suspended solids	mg/L	17	11.2	40	532	N/A
Sulphate	mg/L	9	2	2.9	4.7	250
Iron	mg/L	6	0.104	0.23	0.316	0.3
Boron	mg/L	6	0.02	0.03	0.03	0.37
Manganese	mg/L	1	-	0.01	-	1.9
Nitrate	mg/L	7	0.74	1.3	1.98	1.1
Fluoride (total)	mg/L	19	0.1	0.2	0.3	2
Sodium	mg/L	19	12	16.5	26	TBA

3.7.2 Local water quality

Water quality sampling was undertaken in Bee Creek at the upstream and downstream gauging stations between 2018 and 2024. The Bee Creek monitoring data is summarised in Table 3.3. Water samples were also collected at the full suite of monitoring locations (MP1, MP2, MP3, MP4, MP7, MP8 and MP9) in February 2024. MP2 is located in upstream Sandy Creek and MP8 is located in downstream Sandy Creek. The local creek February 2024 water quality data is presented in Table 3.4.

The location of the water quality monitoring points is shown in Figure 3.5

Review of Table 3.3 and Table 3.4 shows that the following water quality parameters are elevated, relative to the site WQOs:

- Turbidity in Bee Creek;
- Aluminium (dissolved) in Bee Creek downstream and Sandy Creek downstream;
- Copper (dissolved) in Sandy Creek and Bee Creek upstream;
- Molybdenum (dissolved) in Bee Creek downstream;
- Uranium (dissolved) in Walker Creek upstream and Bee Creek downstream; and
- Vanadium (dissolved) Bee Creek downstream.

The water quality data suggests that the downstream water quality in Bee Creek and Walker Creek is generally slightly elevated compared to the upstream water quality. The upstream and downstream Sandy Creek water quality appears to be similar, based on the February 2024 sample.

3.8 Existing water use entitlements

The existing SWC operation imports water from the Braeside Pipeline. The imported water is used to supply potable and raw water demands on site.

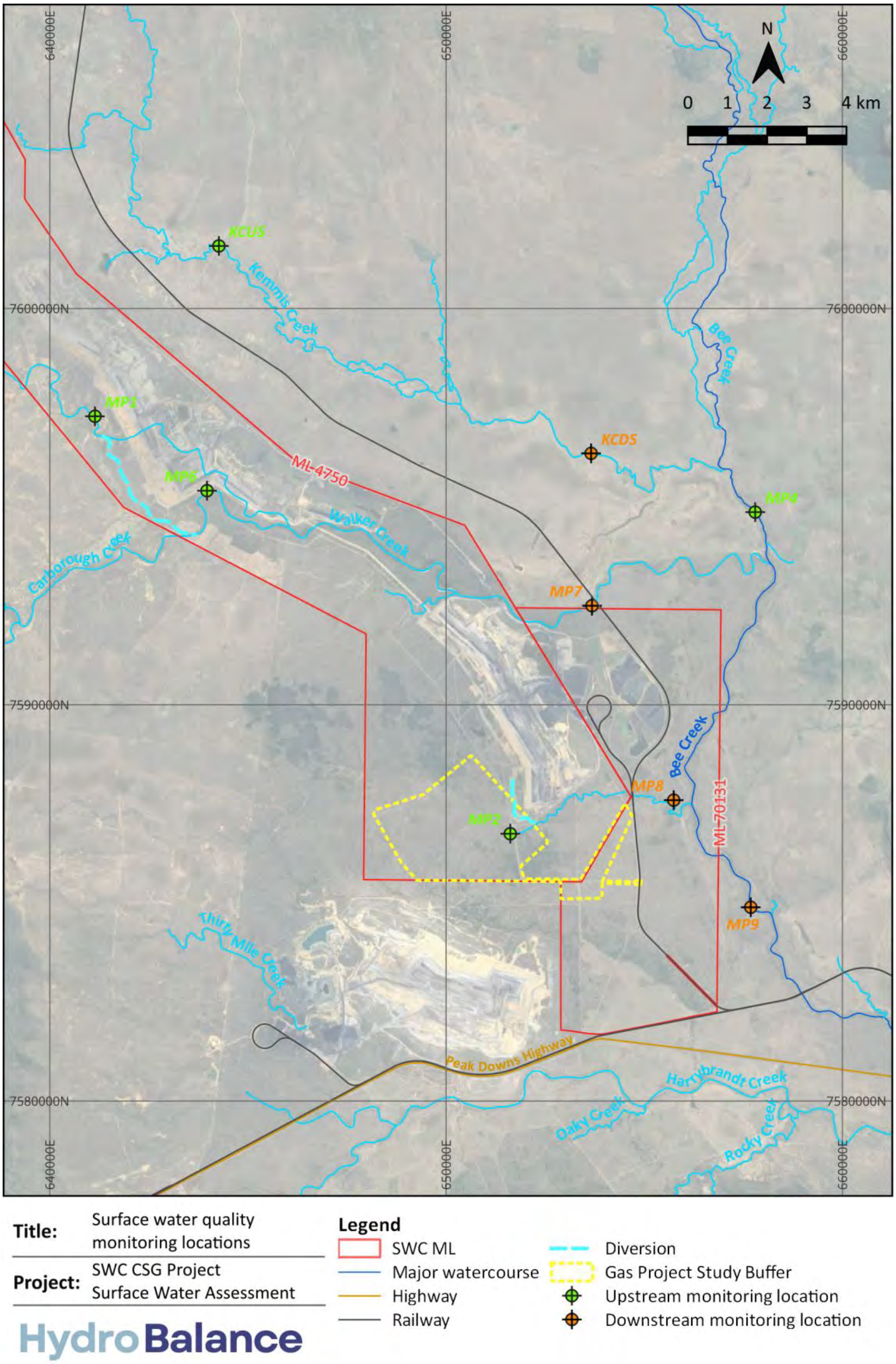


Figure 3.5 – Water quality monitoring locations

Table 3.3 – Local Bee Creek receiving water quality

Parameter	Units	Bee Creek upstream				Bee Creek downstream				WQO (see Table 2.1)
		No. samples	20%ile	Median	80%ile	No. samples	20%ile	Median	80%ile	
Electrical conductivity	µS/cm	17	110	151	293	31	168.2	1,180	3,264	700 - 5500
pH	-	17	7.46	7.76	8.02	31	7.58	8.24	8.93	6.5-9.2
Turbidity	NTU	18	921	1,880	6,196	32	28	369	3,792	500
Suspended solids	mg/L	17	608	1,550	5,022	31	23	125	2,244	N/A
Sulphate	mg/L	17	<1	<1	15	31	4.4	138	293	250-750
Aluminium	µg/L	17	<10	<10	20	31	<10	20	188	55
Arsenic	µg/L	17	<1	<1	1.4	31	<1	2	5	13
Cadmium	µg/L	17	<0.1	<0.1	<0.1	31	<0.1	<0.1	<0.1	0.2
Chromium	µg/L	17	<1	<1	<1	31	<1	<1	<1	1
Copper	µg/L	17	2	3	3	31	<1	2	3	2
Iron	µg/L	17	<50	<50	100	31	<50	60	110	300
Lead	µg/L	17	<1	<1	<1	31	<1	<1	<1	4
Mercury	µg/L	17	<0.1	<0.1	<0.1	31	<0.1	<0.1	<0.1	0.2
Nickel	µg/L	17	<1	<1	<1	31	<1	<1	1.6	11
Zinc	µg/L	17	<5	<5	<5	31	<5	<5	<5	8
Boron	µg/L	17	<50	<50	<50	31	<50	80	146	370
Cobalt	µg/L	17	<1	<1	<1	31	<1	<1	<1	90
Manganese	µg/L	17	<1	<1	<1	31	<1	<1	12	1900
Molybdenum	µg/L	17	<1	<1	4.4	31	1.4	26	69	34
Selenium	µg/L	17	<10	<10	<10	31	<10	<10	<10	10

Parameter	Units	Bee Creek upstream				Bee Creek downstream				WQO (see Table 2.1)
		No. samples	20%ile	Median	80%ile	No. samples	20%ile	Median	80%ile	
Silver	µg/L	17	<1	<1	<1	31	<1	<1	<1	1
Uranium	µg/L	17	<1	<1	<1	31	<1	2	5	1
Vanadium	µg/L	17	<10	<10	<10	31	<10	<10	16	10
Ammonia	µg/L	17	<10	<10	88	31	<10	20	70	900
Nitrate	µg/L	17	22	60	368	31	<10	50	268	1100
TPH (C6-C9)	µg/L	10	<20	<20	<20	25	<20	<20	<20	20
TPH (C10-C36)	µg/L	10	<50	<50	<50	25	<50	<50	<50	100
Fluoride (total)	µg/L	17	0.2	0.2	0.3	31	0.2	0.4	0.86	2000
Sodium	mg/L	17	8	10	43.4	31	20.2	229	699	TBA

Table 3.4 – Local receiving water quality, February 2024

Parameter	Units	Walker Creek		Sandy Creek		Bee Creek				WQO (see Table 2.1)
		MP1	MP7	MP2	MP8	MP3 (R1)	MP3 (R2)	MP4	MP9	
Electrical conductivity	µS/cm	437	647	338	153	247	236	165	233	700 - 5500
pH	-	8.39	8.04	7.95	7.83	7.89	8.03	7.76	8.13	6.5-9.2
Turbidity	NTU	10	289	249	94	302	301	293	53	500
Suspended solids	mg/L	12	58	74	40	172	171	210	15	N/A
Sulphate	mg/L	<1	58	3	<1	6	6	<1	5	250-750
Aluminium	µg/L	<10	<10	<10	110	<10	<10	100	40	55
Arsenic	µg/L	<1	3	<1	<1	<1	<1	2	<1	13
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Chromium	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	1

Parameter	Units	Walker Creek		Sandy Creek		Bee Creek				WQO (see Table 2.1)
		MP1	MP7	MP2	MP8	MP3 (R1)	MP3 (R2)	MP4	MP9	
Copper	µg/L	<1	2	3	3	2	2	3	2	2
Iron	µg/L	<50	<50	<50	200	<50	<50	170	80	300
Lead	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	4
Mercury	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Nickel	µg/L	<1	<1	3	3	<1	<1	<1	<1	11
Zinc	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	8
Boron	µg/L	80	<50	130	60	<50	<50	<50	<50	370
Cobalt	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	90
Manganese	µg/L	2	<1	2	6	<1	<1	2	4	1900
Molybdenum	µg/L	<1	7	<1	1	2	2	<1	<1	34
Selenium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	10
Silver	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	1
Uranium	µg/L	3	<1	<1	<1	<1	<1	<1	<1	1
Vanadium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	10
Ammonia	µg/L	<10	20	100	20	<10	<10	<10	<10	900
Nitrate	µg/L	<10	440	<10	<10	<10	<10	<10	<10	1100
TPH (C6-C9)	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	20
TPH (C10-C36)	µg/L	<50	<50	170	170	<50	60	<50	<50	100
Fluoride (total)	µg/L	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.2	2000
Sodium	mg/L	36	123	30	13	31	31	13	25	TBA

4 Surface water management strategy and infrastructure

4.1 Overview

This section describes the objectives and principles of the existing and proposed water management system (WMS), including a description of the infrastructure and systems that have been designed to achieve the objectives and principles.

This surface water assessment is being prepared in support of the EA Amendment, and the potential impacts resulting from its proposed activities. However, as the SWC WMS will function as an integrated system, the existing parts of the site that may interact with the Project are also covered below.

4.2 Types of water generated on-site

Land disturbance associated with CSG exploration and collection, if not suitably managed, has the potential to adversely affect the quality of surface runoff in downstream receiving waters through increased sediment loads. In addition, CSG water extracted from the collection system, if not suitably managed, may have increased concentrations of salts and other pollutants when compared to natural surface water. The strategy for the management of surface water at the Project is based on the separation of water from different sources based on anticipated water quality.

Definitions of the types of water generated by the Project are shown in Table 4.1.

Table 4.1 – Surface water types

Water type	Definition
Mine-affected water (also referred to as CSG water)	In accordance with the DES's Model Mining Conditions, mine-affected water includes water contaminated by a mining activity which would have been an environmentally relevant activity under Schedule 2 of the Environmental Protection Regulation 2008 if it had not formed part of the mining activity **(which includes CSG extraction)**.
Sediment water	Surface water runoff from areas that are disturbed by mining operations (including out-of-pit waste rock emplacements). This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain elevated level of other water quality parameters (e.g. EC, pH, metals, metalloids, non-metals). This runoff must be managed to ensure adequate sediment removal prior to release to receiving waters.
Clean catchment water	Surface runoff from areas unaffected by mining operations. Clean catchment water includes runoff from undisturbed areas and fully rehabilitated areas.
Contaminated water	Contaminated water includes runoff from areas containing explosives, hazardous chemicals, corrosive substances, toxic substances, gases and dangerous goods, as well as flammable and combustible liquids (including petroleum products).

4.3 Surface water management objectives

The objective of the site WMS is to manage all types of water onsite to meet operational, social and environmental objectives.

The are three key WMS objectives are as follows:

- Manage CSG water generated by the collection field within the existing SWC WMS;
- Maintain sediment laden runoff generated by the Project; and
- Successfully engage with external stakeholders to be a good custodian of society's water resources. The priority issues are the Project's impact on surface water and groundwater.

Specific objectives for each water type are as follows:

- ***Mine-affected water***:
    - Manage mine-affected water to minimise the risk of uncontrolled discharges to the receiving environment.
    - Understand, manage and minimise the potential impact of the water management system on the regional groundwater system.
- ***Sediment water***: Maintain the quality of water discharging from erosion and sediment control structures to as close to background levels as reasonably possible.
- ***Clean/diverted water***: Separate from the mine-affected and sediment water systems as much as reasonable and feasible and allow it to pass uninterrupted through the catchment.
- ***Contaminated water***: Ensure full separation from other water sources and manage under the requirements of *AS1940 – Storage and Handling of Flammable and Combustible Liquids*.

4.4 Surface water management principles

The general principles to manage surface water for the site are as follows:

- The fullest separation possible of clean, sediment water and mine-affected water runoff within the limitations of operational requirements.
- Minimise the area of surface disturbance, thus minimising the volume of sediment or mine-affected runoff.
- Collect and contain on site all potential mine-affected water and transfer it to the SWC WMS.
- Release sediment water in a controlled manner (i.e. following settlement) in compliance with the EA requirements for an erosion and sediment control plan.

4.5 Existing water management infrastructure at SWC

Figure 4.1 shows the locations of the key features of the existing SWC WMS. The main components of water-related infrastructure include:

- active open-cut mining areas;
- sediment dams to collect and treat runoff from out-of-pit waste rock emplacement areas;
- drains to divert sediment-laden runoff from out-of-pit spoil dumps to sediment dams;
- a mine-affected water system to store water pumped out of the open cut mining areas and to collect runoff from the ROM coal stockpile, Mine Infrastructure Area (MIA) and other hardstand areas that could potentially generated mine-affected water runoff; and
- a clean water management system, including creek diversions, to divert clean water away from the active mining areas.

The Main Pit Storages (FN FS, EN and GN) would have a total combined capacity of 15.48 GL.

Additional details relating to the SWC WMS infrastructure can be found in the site Water Management Plan (BHP, 2018).

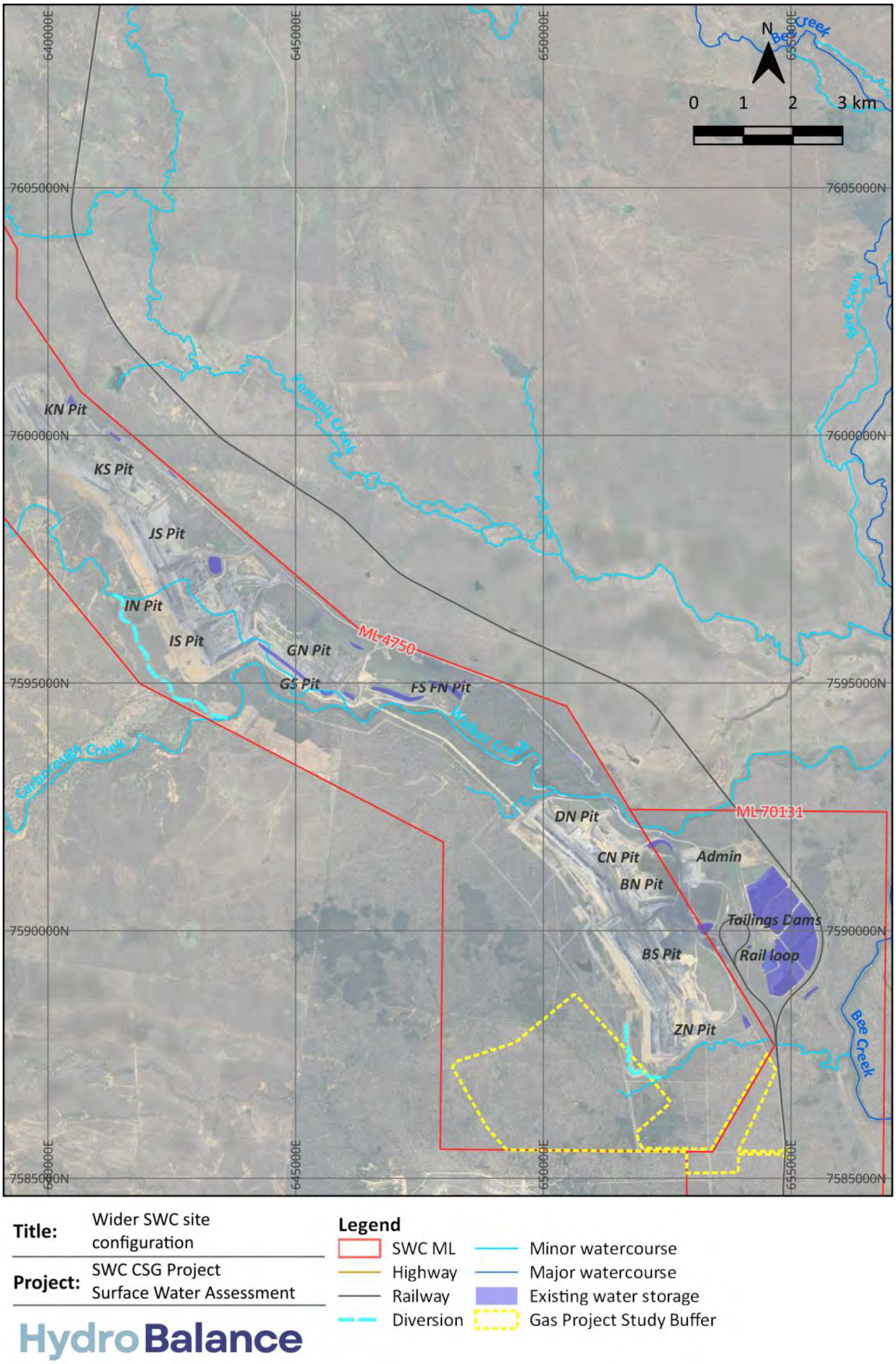


Figure 4.1 – Existing SWC site configuration

4.6 Proposed water management infrastructure

Figure 4.2 shows the locations of the key features of the Project WMS. The existing SWC WMS infrastructure will remain unchanged as part of the Project.

The main components of proposed water-related infrastructure include:

- Development of CSG exploration drill pads between 2025 and 2028, as well as associated sediment control infrastructure;
- Development of a CSG collection field, including well pads and access roads;
- A Transfer Tank located at the collection field to pump extracted CSG water to the wider SWC WMS for containment;
- Drains and outlet structures to manage runoff from the well pads and access roads; and
- Various pump and pipeline systems to manage mine-affected water and sediment water within Project area, connecting into the existing SWC WMS.

Details of proposed water storages, including storage sizes and pumping rules are provided in Section 4.8.

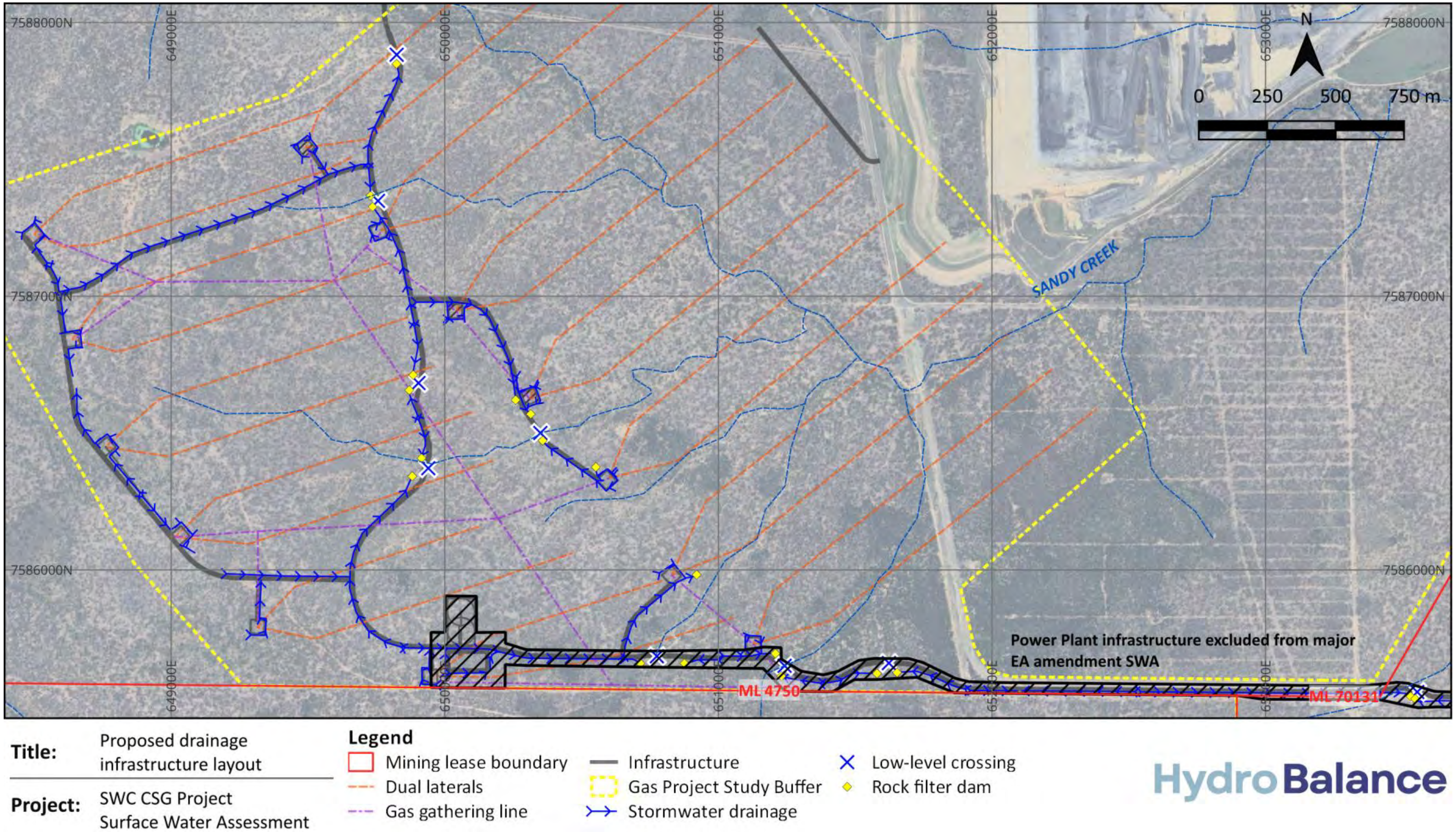


Figure 4.2 – Proposed site water management system configuration

4.7 Sediment water management system

4.7.1 Overview

Sediment water containment (runoff from cleared and disturbed areas) will be managed in accordance with an ESCP. The ESCP will adopt the three cornerstones of erosion and sediment control.

- Drainage control – prevention or reduction of soil erosion caused by concentrated flows and appropriate management and separation of the movement of diverted and surface water through the area of concern.
- Erosion control – prevention or minimisation of soil erosion (from dispersive, nondispersive or competent material) caused by rain drop impact and exacerbated overland flow on disturbed surfaces.
- Sediment control – trapping or retention of sediment either moving along the land surface, contained within runoff (i.e. from up-slope erosion) or from windborne particles.

The Project will require a combination of the three control measures to effectively manage sediment and erosion at the site. The locations and number of sediment control infrastructure provided in this assessment is conceptual only. Details of sizing and placement of sediment control infrastructure would be finalised during detailed design of the Project.

Detailed information relating to the proposed ESC measures will be developed prior to the commencement of operations. This will include the development of ESC implementation plans during both the construction phase and operations.

4.7.2 Exploration drill pad management

Each of the exploration drill pad disturbance areas would have a surface area of approximately 0.14 ha. Sediment fences will be used as the primary sediment control measure for the drill pad disturbance areas. The ESC measures will be installed progressively, in line with the drill pad disturbance between 2025 and 2028.

Sediment fences are primarily used to capture coarse sediments. Treatment is typically achieved through gravity-induced settlement resulting from temporary ponding of sediment-laden water upslope of the fence. Filtration is only a secondary function of the fabric, if at all. Therefore, to achieve optimum performance, sediment fences should be installed such that the total surface area ponding upslope of the fence is maximised. Figure 4.3 shows the typical sediment fence installation.

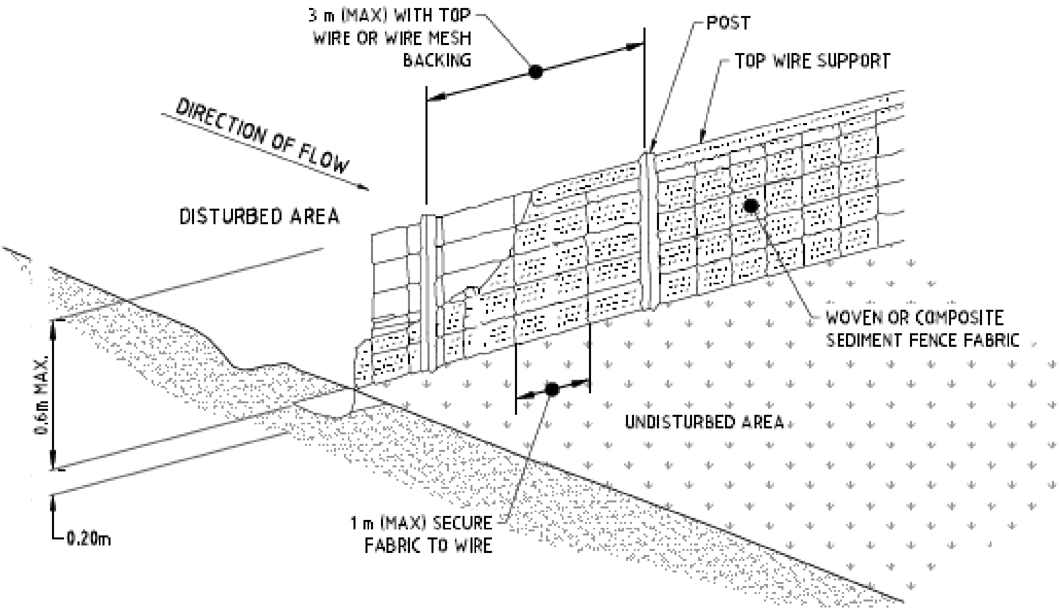


Figure 4.3 – Typical sediment fence installation

Earthen bunds will be constructed upslope of the drill pads, to reduce the magnitude of clean catchment runoff interacting with the disturbed areas. Figure 4.4 shows the recommended typical layout for the drill pad ESC measures.

The drill pad disturbance areas would be revegetated subsequent to the completion of exploration activities.

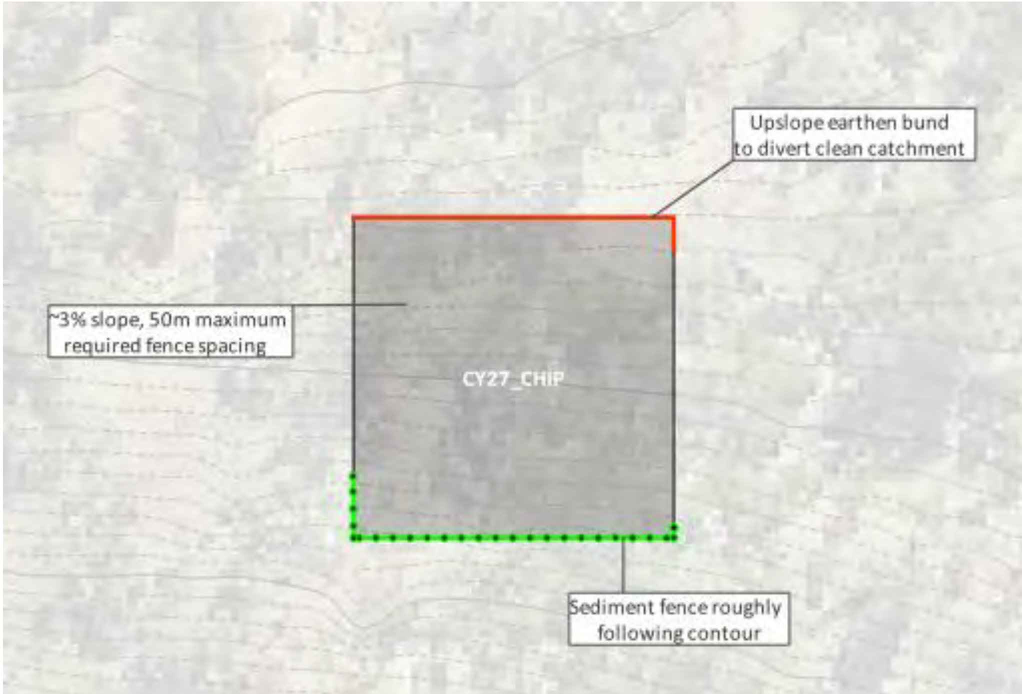


Figure 4.4 – Conceptual drill pad sediment management

4.7.3 CSG collection field management

Runoff from the well pad and access roads will be collected by sediment drains. The indicative locations of the proposed drains are shown on Figure 4.1. The drains will have the following indicative dimensions:

- 0.4 m minimum depth;
- 0.6 m base width; and
- 1V:4H batter slope.

Runoff collected by the roadside drains will be treated and discharged by rock filter dams at the end of each of the drains. Discharges from the rock filter dams will enter the natural drainage line, before traversing the access road via low-level crossings. The typical rock filter dam configuration is presented in Figure 4.5.

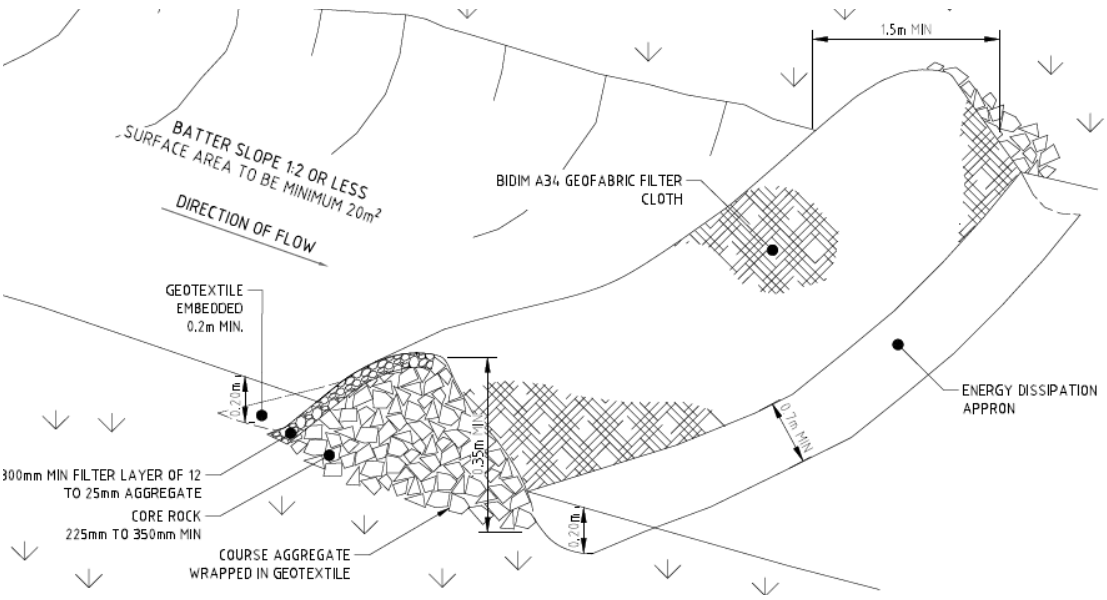


Figure 4.5 – Typical rock filter dam configuration

Runoff collected by the well pad drains will be passively treated and discharged through sediment fences at the end of each drain. Level spreaders will be constructed upstream of the sediment fences, to disperse the flows and enhance the effectiveness of the sediment fences. Figure 4.3 shows the typical sediment fence installation.

4.8 Mine-affected water management

CSG water extracted alongside gas production will be collected in the Transfer Tank. The Transfer Tank will have an emergency overflow, but has been oversized to minimise the risk of overflow occurring. CSG water collected in Transfer Tank will be pumped to the SWC WMS, for management within the existing mine water storages. The potential impact due to the inflow of the additional CSG water on the SWC WMS is discussed in Section 5.

4.9 Clean water management system

Several minor drainage lines flow through the proposed site. Clean water runoff would be directed through the site via the roadside drains and low-level crossings, towards Sandy Creek. The indicative locations of the proposed drains are shown on Figure 4.2.

4.10 Release of water to the receiving environment

Water from the Project may only enter the receiving environment via sediment drain outlet structures.

Whilst the release of mine affected water to receiving waters is permitted under the approved EA (EPML00712313), controlled releases are not proposed as part of the water management strategy. That is, the water management system does not rely on using controlled releases to manage water inventories.

5 Water balance modelling

5.1 Overview

The CSG water extraction process will generate a relatively small volume of mine-affected water. This mine-affected water will be collected in a Transfer Tank, and then pumped to the SWC WMS where it will be managed within the existing mine water storages.

The latest SWC water balance model has been used to assess the potential impact of the CSG extraction water generated by the Project on the SWC WMS. The SWC water balance model was last updated in October 2023. Refer to the SWC Water Balance Model Update report (Hatch, 2023) for full details of the model setup and configuration.

5.2 Model configuration and schematic

5.2.1 Water balance schematic

A schematised plan of the modelled SWC water management system is presented in Figure 5.1. This schematic shows that primary storage of mine-affected water for the system is within "*Main Pit Storage*", which is comprised of F North and F South (FN FS) Pits, E North (EN) Pit and G North (GN) Pit.

5.2.2 Storage inventory and starting volumes

The Main Pit Storage has a combined capacity of around 15,480 ML.

Based on July 2023 water levels, the initial total mine-affected water inventory in the model has been set at 4,200 ML.

5.2.3 Gas collection field extraction inflows

The gas collection field extraction water will be collected in a Transfer Tank, before being pumped to the SWC mine water management system and ultimately ending up in Main Pit Storage.

Stanmore have advised that the water make from the gas collection field will be as follows:

- Average: 35 m^3/day (or 13 ML/year)
- Peak: 60 m^3/day (or 22 ML/year)

Over the 4-year drilling program, the predicted water make is around 52 ML. The impact of this water make on the existing SWC WMS has been assessed in Section 5.3.

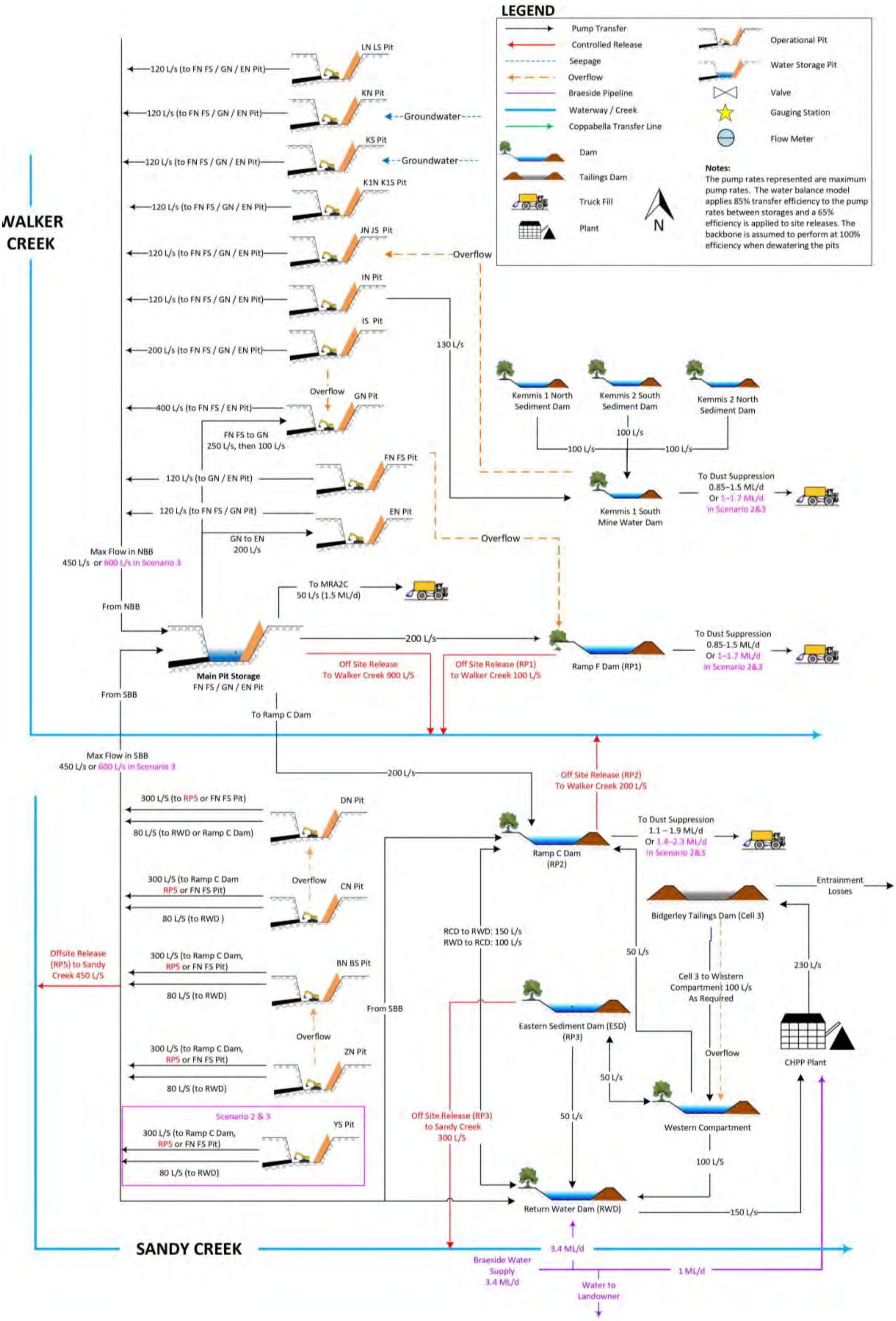


Figure 5.1 – SWC water balance model schematic

5.3 Impact of water make on SWC WMS

5.3.1 Interpretation of water balance model results

The SWC water balance model was developed as a stochastic model. The stochastic model utilises 500 generated rainfall sequences, based off the historical rainfall sourced from the SILO database ((https://www.longpaddock.qld.gov.au/silo/) for the period 1960-2018 at the site location (21.75°S, 148.45°E).

The purpose of running 500 realisations is to simulate the hydrological cycle over the short-term (two-year) forecast period and consider potential variability in rainfall as a Monte Carlo application. The results from the 500 realisations are compiled internally to calculate percentiles, which reflect a percentile measure based on the 500 samples. Seven percentile values were used as the main measure of the results (P1, P5, P10, P50, P90, P95 & P99). These percentiles are used to represent associated risk, where for example, 10 % of 500 samples are lower than the P10 value.

5.3.2 Mine-affected water inventory forecast – baseline conditions

The SWC water balance model has been run from July 2024 for a period of two years as a short-term forecast. The model has been run without the predicted gas collection field extraction inflows as baseline conditions.

The forecast total mine-affected water inventory under baseline conditions is presented in Figure 5.2, which shows that:

- Under median (50^{th} %ile) climatic conditions, the site inventory is declining, reducing in volume by around 2,150 ML over the two-year forecast.
- Under dry (90^{th} %ile) climatic conditions, the site inventory draws down over the first 18 months of the simulation, reaching a minimum inventory for the remainder of the run.
- Under wet (10^{th} %ile) climatic conditions, the site inventory increases steadily over the two-year forecast, reaching a volume of around 6,630 ML. That is, a predicted increase of around 2,400 ML over the two-year period.
- Under very wet (1^{st} %ile) climatic conditions, the site inventory increases rapidly over the two-year forecast, reaching a volume of around 11,130 ML. That is, a predicted increase of around 6,900 ML over the four-year period.
- Even under the wettest climatic conditions, the peak inventory is around 4,350 ML below the combined mine-affected water storage capacity of 15,480 ML.

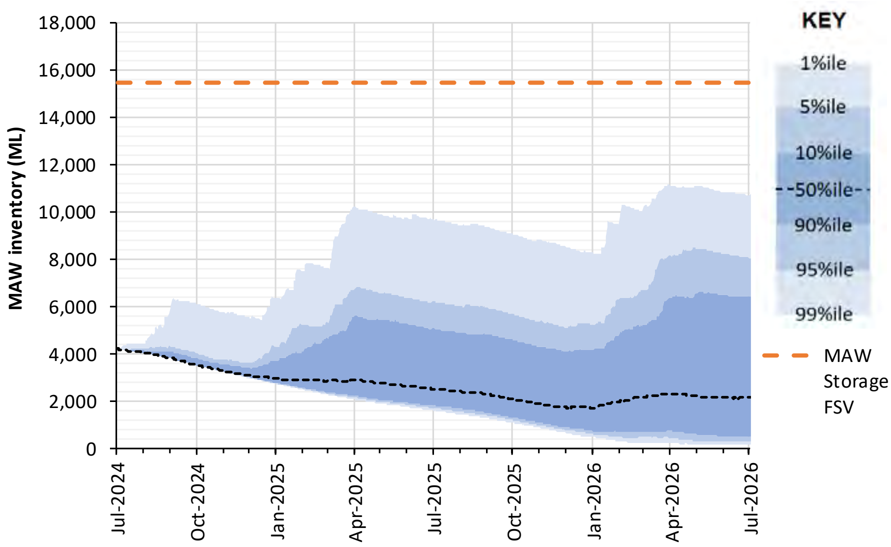


Figure 5.2 – Forecast SWC mine-affected water inventory – baseline conditions

5.3.3 Mine-affected water inventory forecast – including gas collection field extraction water

The SWC water balance model has been re-run with the inclusion of the gas collection field extraction water to assess its impact on the SWC WMS.

The forecast total mine-affected water inventory including gas collection field extraction water is presented in Figure 5.3, which shows that the addition of the gas collection field extraction water results in a negligible change to the forecast SWC mine affected water inventory.

That is, the inflows from the proposed project will have no measurable impact on the existing SWC WMS.

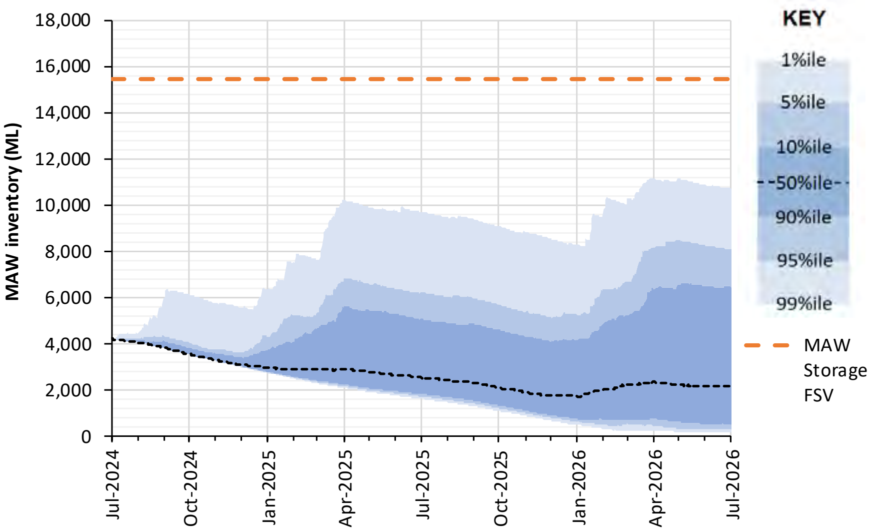


Figure 5.3 – Forecast SWC mine-affected water inventory – including gas collection field extraction water

5.3.4 Mine-affected water salinity

The impact of the additional salt load in the SWC WMS as a result of the Project has been assessed using the water balance model. The salinity of the gas collection field extraction water has been assumed to be 8,670 µs/cm, which is based on the 80th percentile value for electrical conductivity from the available groundwater quality data (see Section 3.6).

The impact of the extraction water on the SWC WMS has been assessed by predicting the average EC in the combined site mine-affected water inventory (for a range of percentiles) for baseline and proposed operating conditions. This approach takes into account the impact of the prevailing climatic conditions on the site water quality.

The predicted average EC over the two-year simulation (and the relative impacts) for each assessed percentile is presented in Table 5.1. The results show that the extraction water will have a very small impact on the site water quality, with average EC increases of around 0.3% for median and wetter climatic conditions. During dry and very dry conditions, the average EC increase is up to 0.8%. These increases would have a negligible impact on the performance of the SWC WMS.

Table 5.1 – Predicted impact of the Project on SWC mine-affected water salinity

Percentile	Baseline EC µS/cm	Project EC µS/cm	Difference (% increase)
1%ile (very wet climatic conditions)	1,478 µS/cm	1,483 µS/cm	0.3%
10%ile (wet climatic conditions)	1,840 µS/cm	1,846 µS/cm	0.3%
50%ile (median climatic conditions)	2,288 µS/cm	2,296 µS/cm	0.3%
90%ile (dry climatic conditions)	2,568 µS/cm	2,578 µS/cm	0.4%
99%ile (very dry climatic conditions)	2,751 µS/cm	2,773 µS/cm	0.8%

6 Flood modelling assessment

6.1 Overview

A TUFLOW hydraulic model was used to assess the impacts of the Project on flooding for a range of design flood events. The following development scenario/event combinations were modelled:

- Existing conditions:
  - 10%, 5%, 2%, 1% and 0.1% AEP
- Developed conditions:
  - 10%, 5%, 2%, 1% and 0.1% AEP

The developed conditions include the proposed infrastructure associated with the CSG collection field. The CSG exploration drill pad areas are not expected to involve significant bulk earthworks and will be managed through best practice Erosion and Sediment Control (ESC) measures. The ESC infrastructure will be minor (Type 3 controls), hence the CSG exploration drill pads will have negligible impact on flood behaviour.

For impact assessment, the modelled existing conditions flood levels and velocities were subtracted from the flood levels and velocities modelled under the developed scenarios. A positive value of impact therefore represents an increase in peak flood levels and velocities and conversely a negative value of impact represents a reduction in peak flood level or velocity.

The results of modelling of existing conditions and the impacts of each development scenario are described in detail in the following sections.

6.1.1 Hydrological model configuration

The TUFLOW hydraulic model inputs have been adapted from the Sandy Creek Diversion Flood Study, undertaken by Forward Hydro in 2024 (Forward Hydro, 2024). Forward Hydro (2024) developed a RORB hydrological model to estimate the 10%, 5%, 2%, 1%, and 1 in 1,000 AEP (0.1% AEP) peak design discharges in Sandy Creek for a range of durations. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) were applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (ARR) (Ball et al., 2019).

Table 6.1 – Adopted hydraulic model local inflows

Event AEP (%)	Critical duration	Temporal pattern
10%	2	2
5%	2	2
2%	2	5
1%	2	5
0.1%	2	5

Details of the RORB model configuration is provided in Forward Hydro (2024).

6.1.2 Hydraulic model configuration

The TUFLOW hydraulic model configuration is described in Appendix A.

6.2 Existing conditions

Modelled 1% AEP and 0.1% AEP flood depths and extents for the existing conditions scenario are shown in Figure 6.1 and Figure 6.2 respectively. The flows in Sandy Creek are generally well confined, with typical flow depths of less than 4 m. Sandy Creek is fed by a number of minor drainage lines which convey low flows and depths. Sandy Creek would not overtop into the existing ZN Pit for any of the modelled events.

Modelled flood velocities for the existing conditions for the 1% AEP and 0.1% AEP events are shown in Figure 6.3 and Figure 6.4 respectively. The velocities across the site are generally less than 1.0 m/s, with some areas of localised high velocities (around 3 m/s) in the Sandy Creek main channel and the clean water drain upslope of ZN Pit.

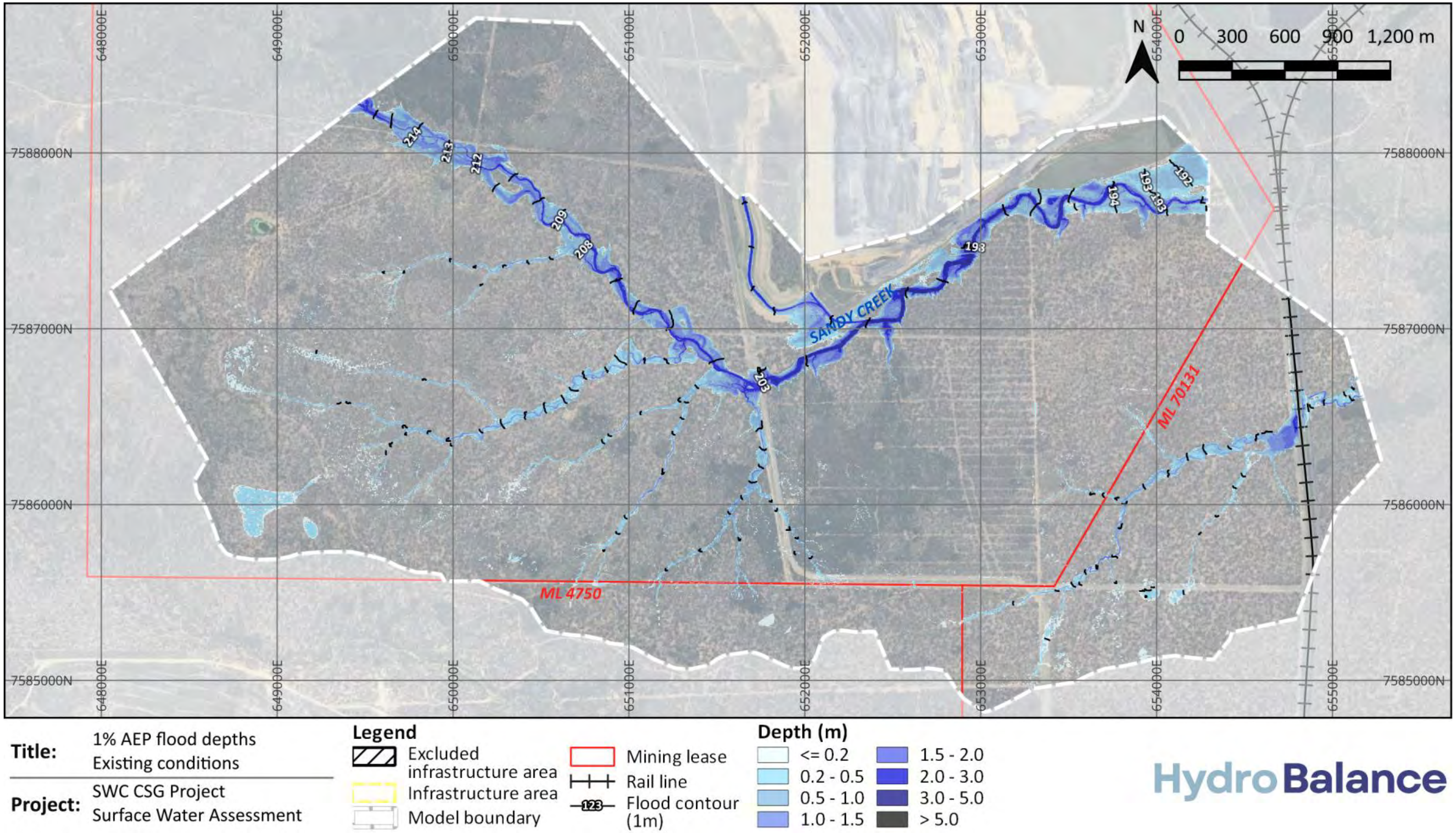
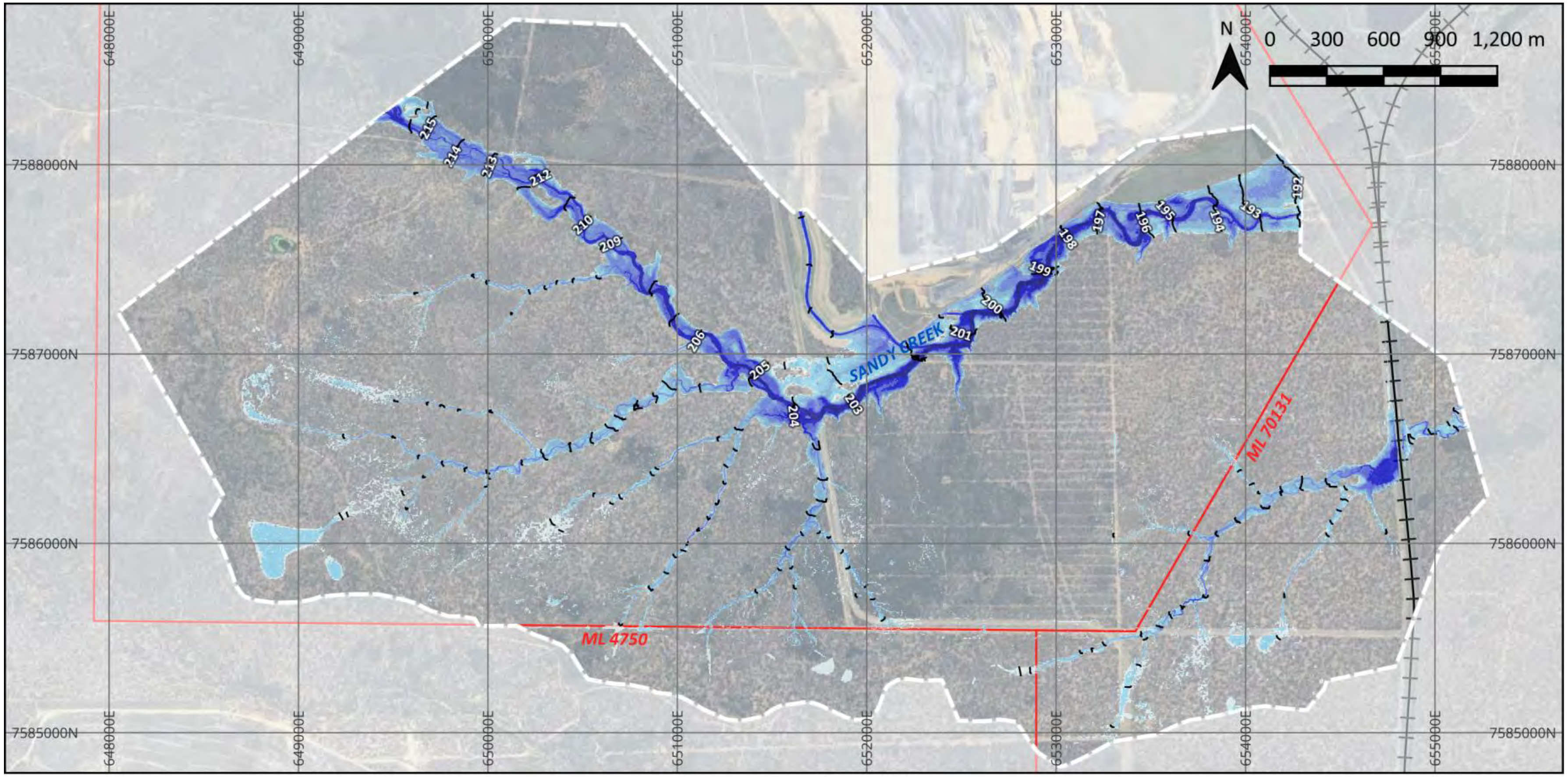


Figure 6.1 – Existing conditions 1% AEP flood depths and heights



Title: 0.1% AEP flood depths
Existing conditions

Project: SWC CSG Project
Surface Water Assessment

Legend
- Excluded infrastructure area
- Infrastructure area
- Model boundary
- Mining lease
- Rail line
- Flood contour (1m)

Depth (m)
- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

HydroBalance

Figure 6.2 – Existing conditions 0.1% AEP flood depths and heights

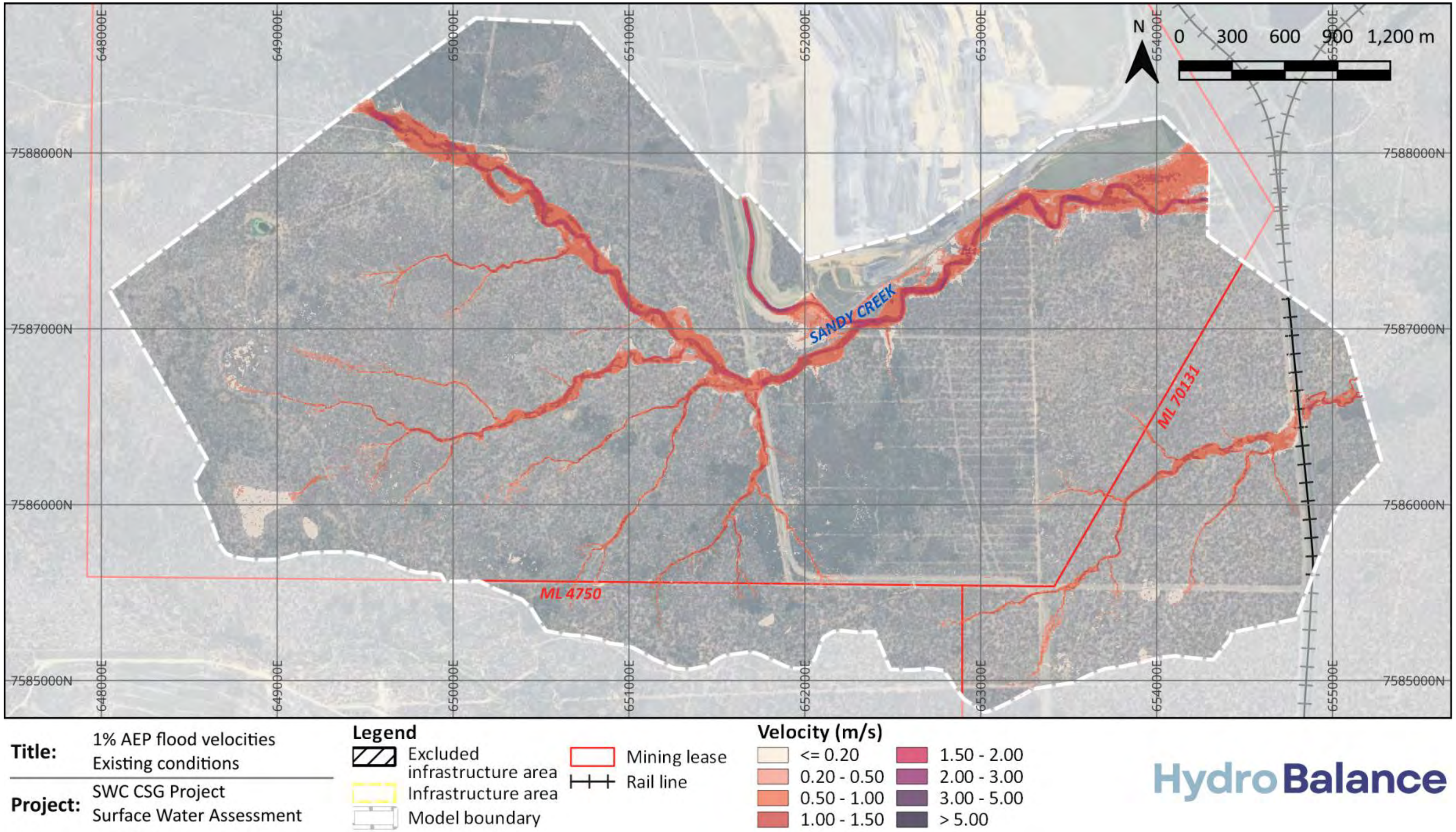


Figure 6.3 – Existing conditions 1% AEP flood velocity

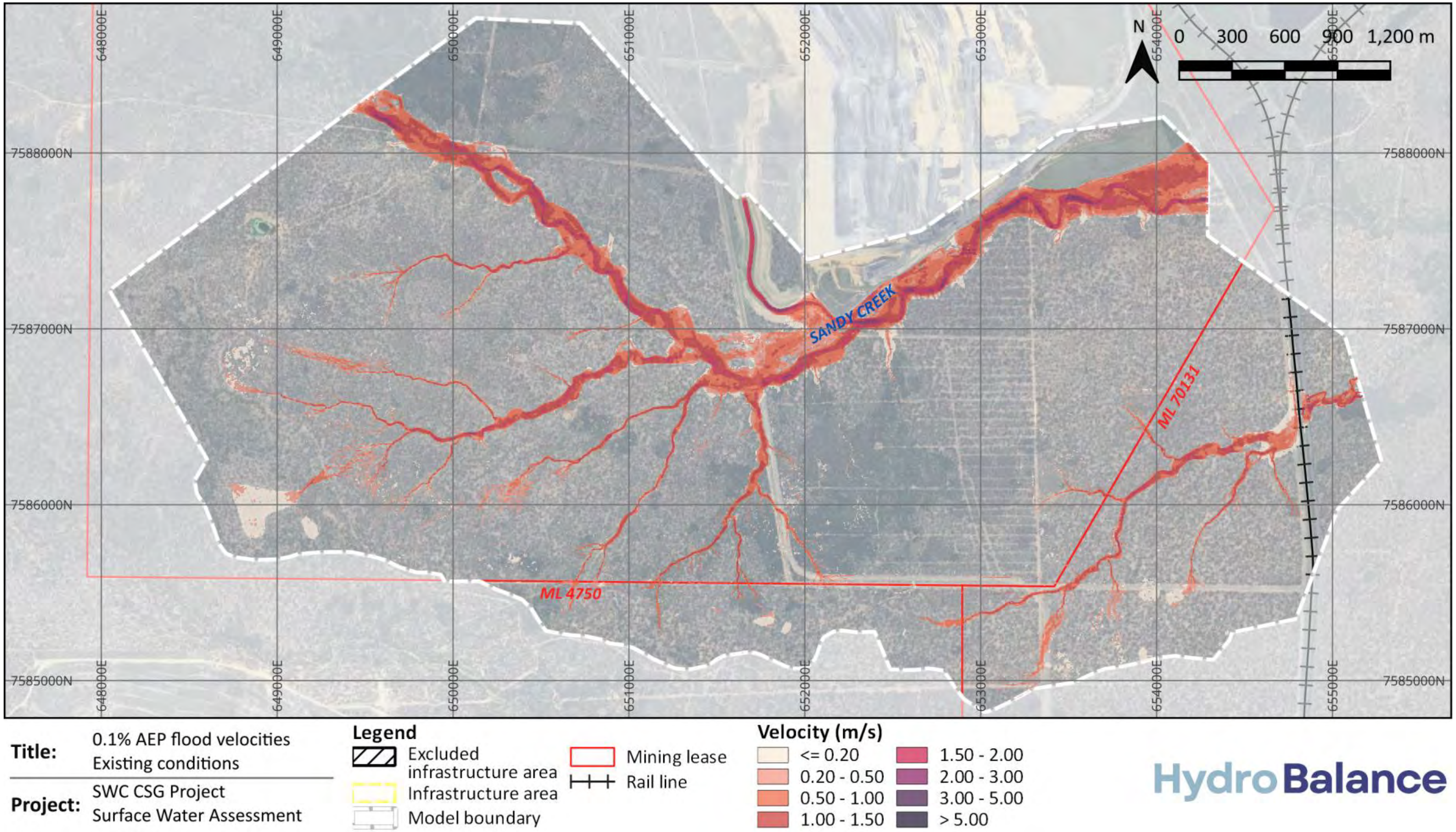


Figure 6.4 – Existing conditions 0.1% AEP flood velocity

6.3 Developed conditions

Full mapping of results of the flood modelling for developed conditions are presented in Appendix B. The proposed works may potentially alter flood conditions via interaction with the proposed access roads and well pads. Model results show that the flood impacts due to the Project would be minimal and would not extend downstream.

The model results show the proposed wells would be located above the flood water levels for all of the modelled events up to the 0.1% AEP. The roadside drains will divert upstream flows towards the designated low-level crossings. The low-level crossings would be overtopped for all events assessed.

6.3.1 Flood level impacts

Developed conditions modelled flood depths/heights and extents for the 1% AEP and 0.1% AEP events are shown in Figure 6.5 and Figure 6.6 respectively. The modelled flood level afflux for developed conditions for the 1% AEP and 0.1% AEP events are shown in Figure 6.7 and Figure 6.8 respectively. This section summarises the impacts across all modelled events. A full set of impact maps for all modelled events is presented in Appendix B.

There are no significant modelled water level impacts due to the proposed infrastructure, for any of the events assessed.

6.3.2 Velocity impacts

Developed conditions modelled flood velocities for the 1% AEP and 0.1% AEP events are shown in Figure 6.9 and Figure 6.10 respectively. The modelled flood velocity impacts for developed conditions for the 1% AEP and 0.1% AEP events are shown in Figure 6.11 and Figure 6.12 respectively. This section summarises the impacts across all modelled events. A full set of impact maps for all modelled events are presented in Appendix B.

There are no significant modelled velocity impacts due to the proposed infrastructure, aside from minor localised impacts in minor drainage lines downstream of the low-level crossings. The modelled velocity impacts in the receiving waterways downstream and state infrastructure of the Project are negligible.

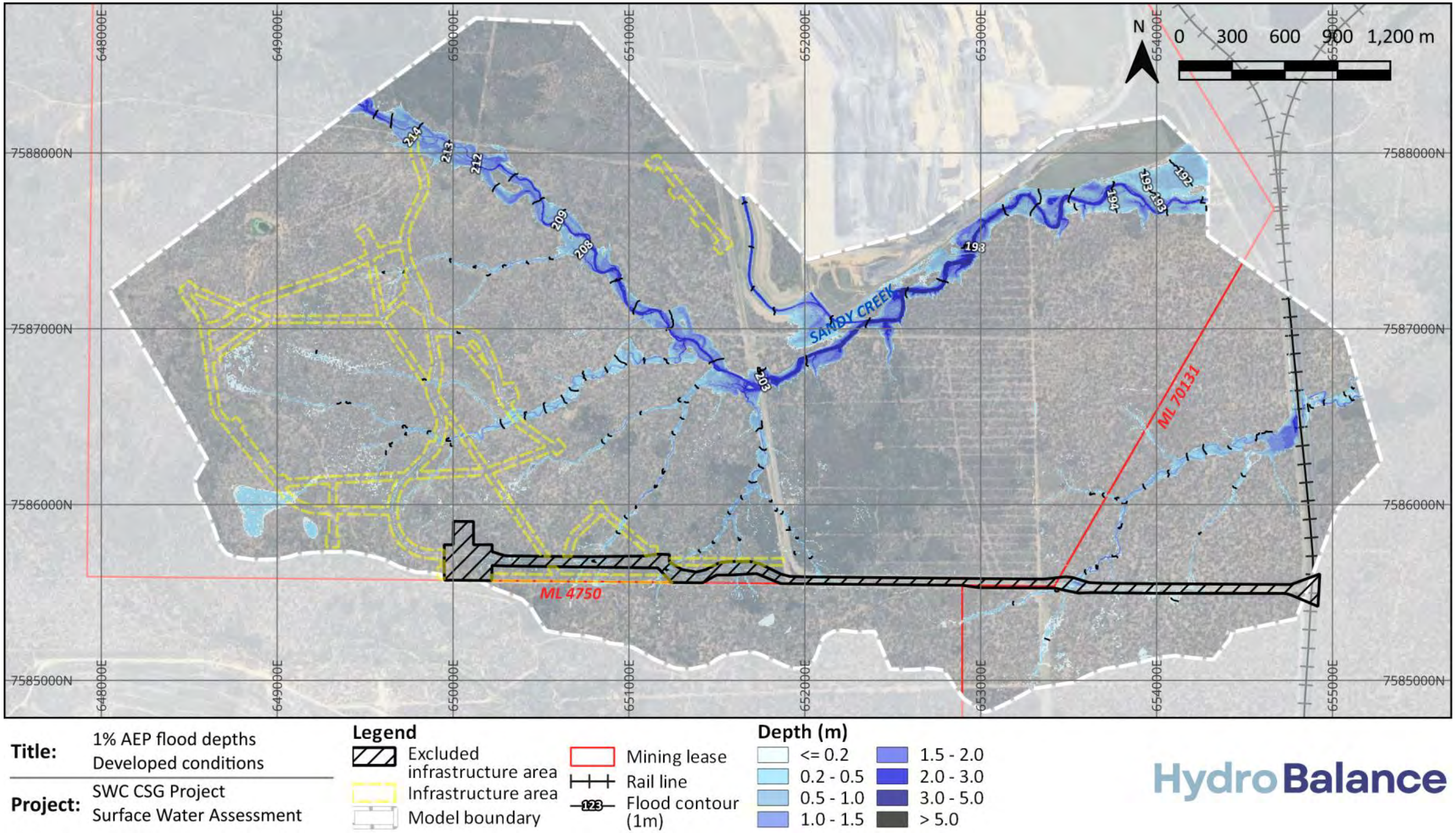


Figure 6.5 – Developed conditions 1% AEP flood depths and heights

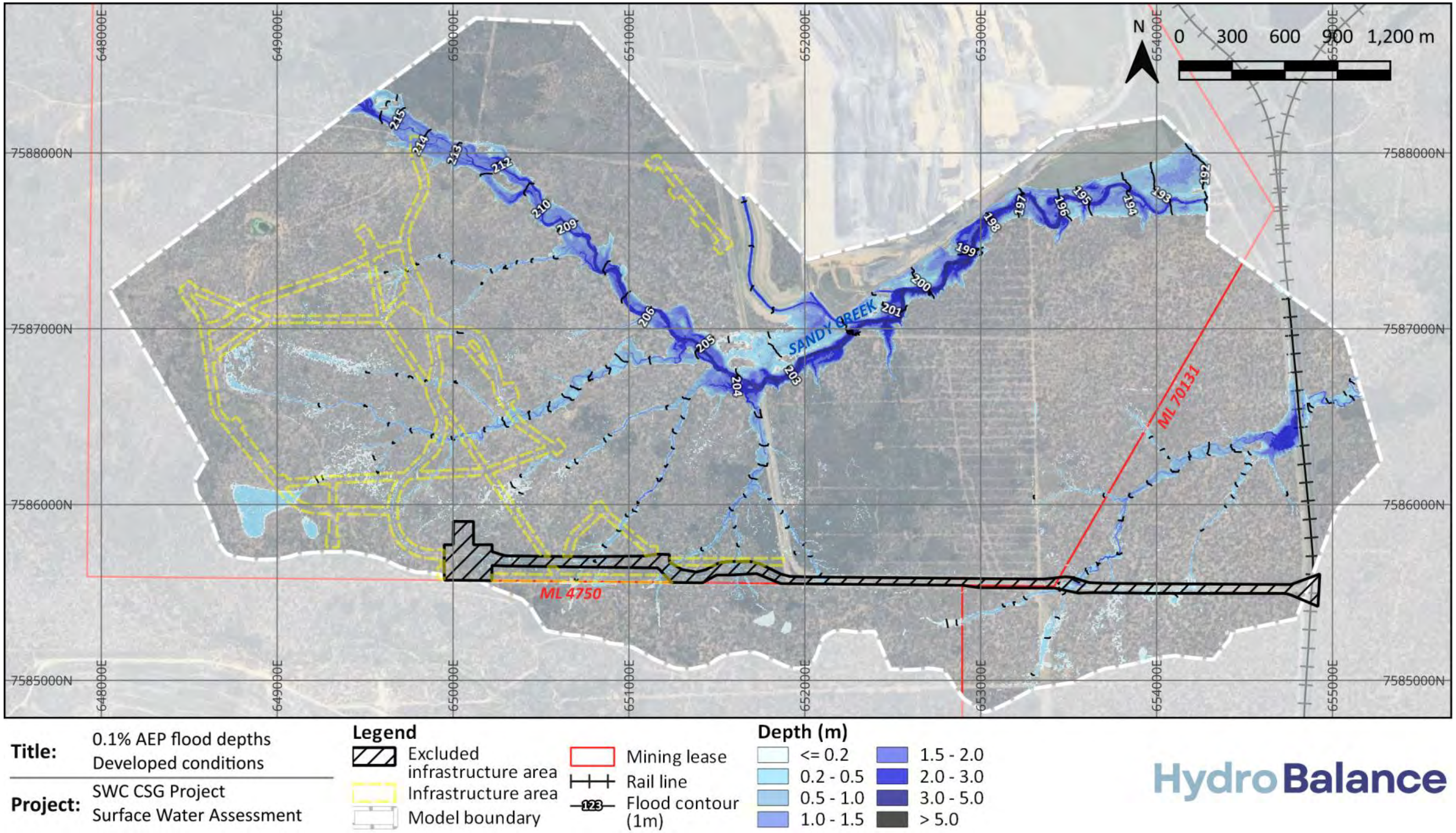


Figure 6.6 – Developed conditions 0.1% AEP flood depths and heights

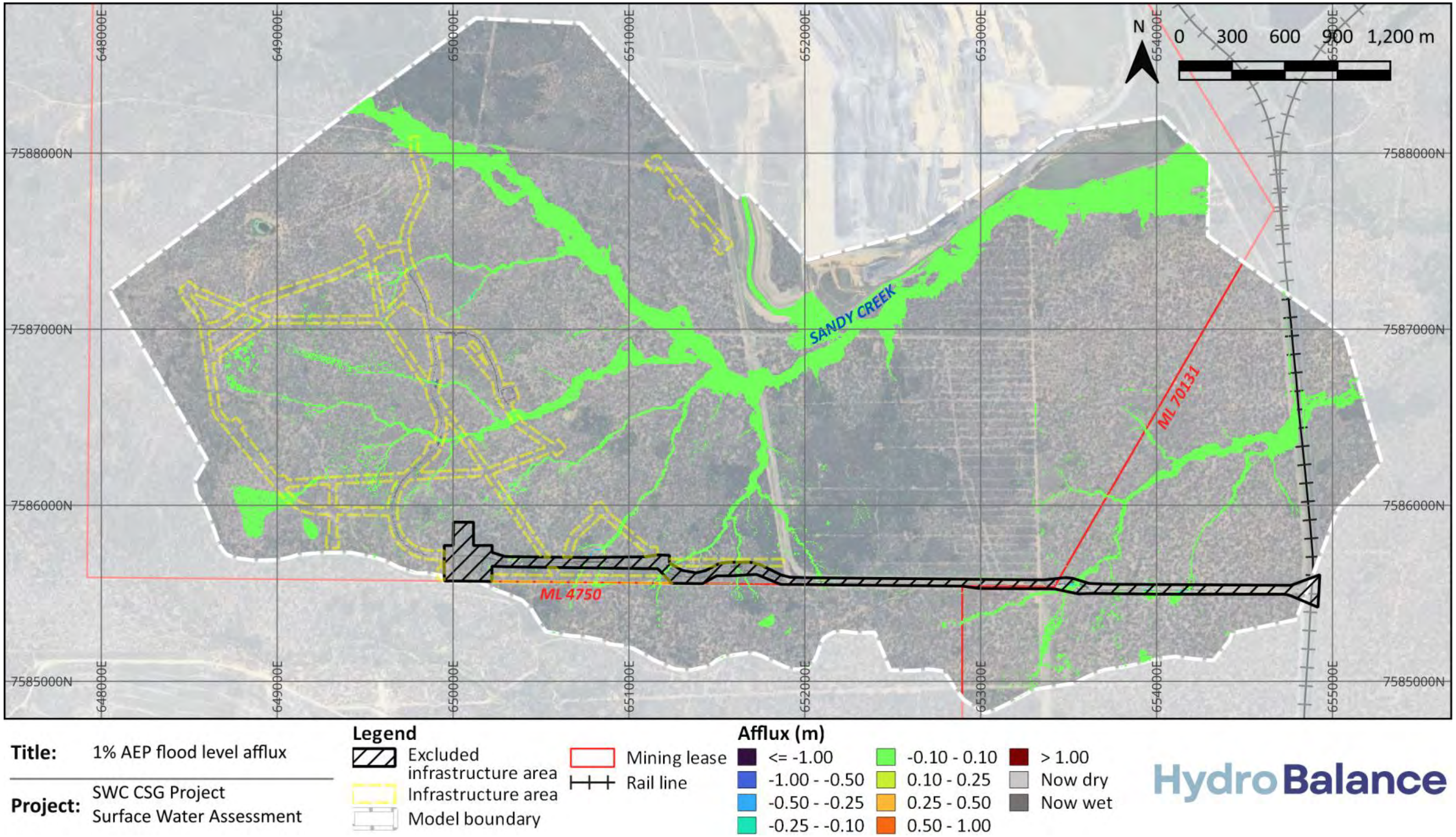


Figure 6.7 –1% AEP flood level afflux (developed minus existing conditions)

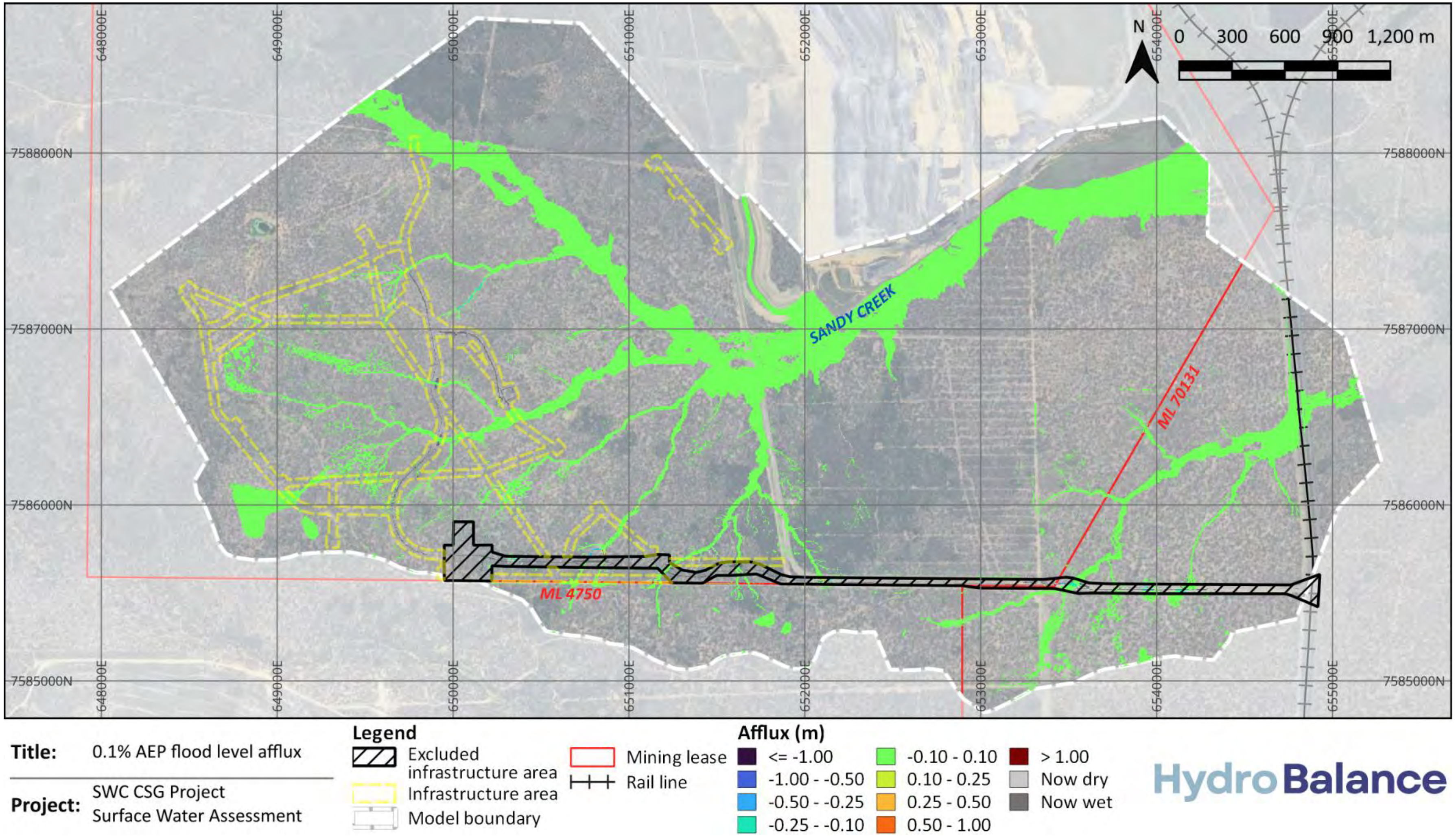


Figure 6.8 –0.1% AEP flood level afflux (developed minus existing conditions)

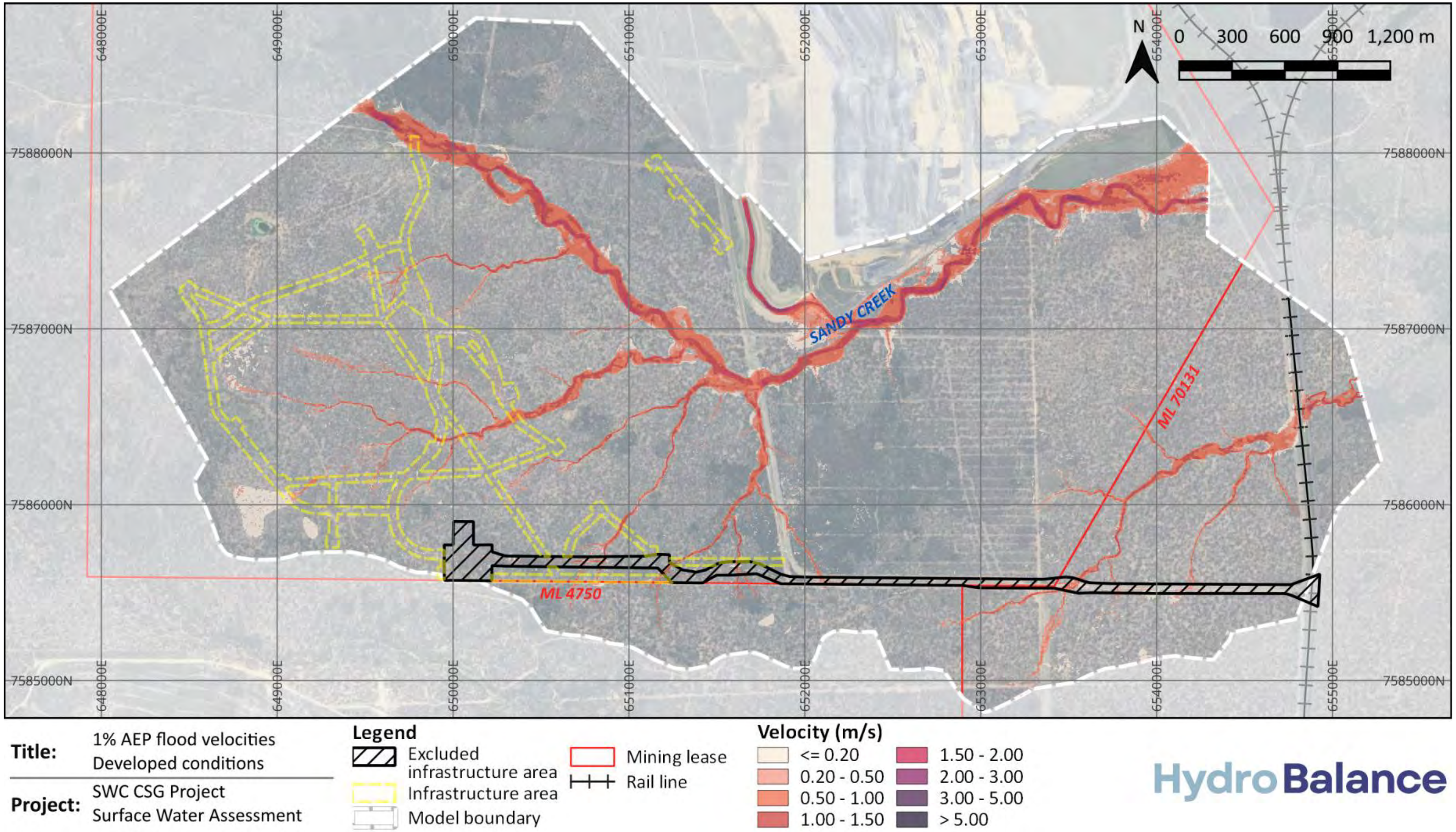


Figure 6.9 – Developed conditions 1% AEP flood velocities

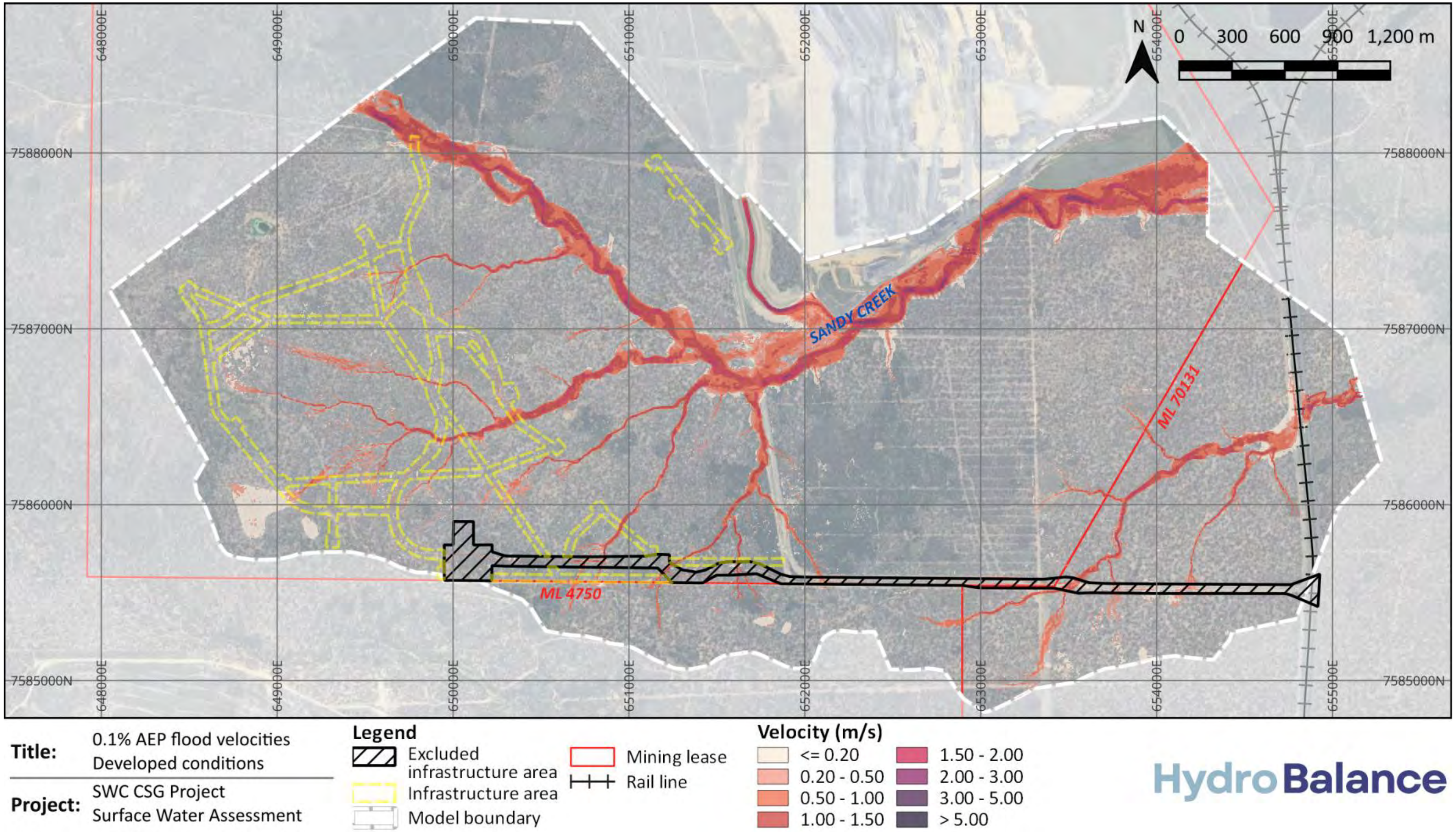


Figure 6.10 – Developed conditions 0.1% AEP flood velocities

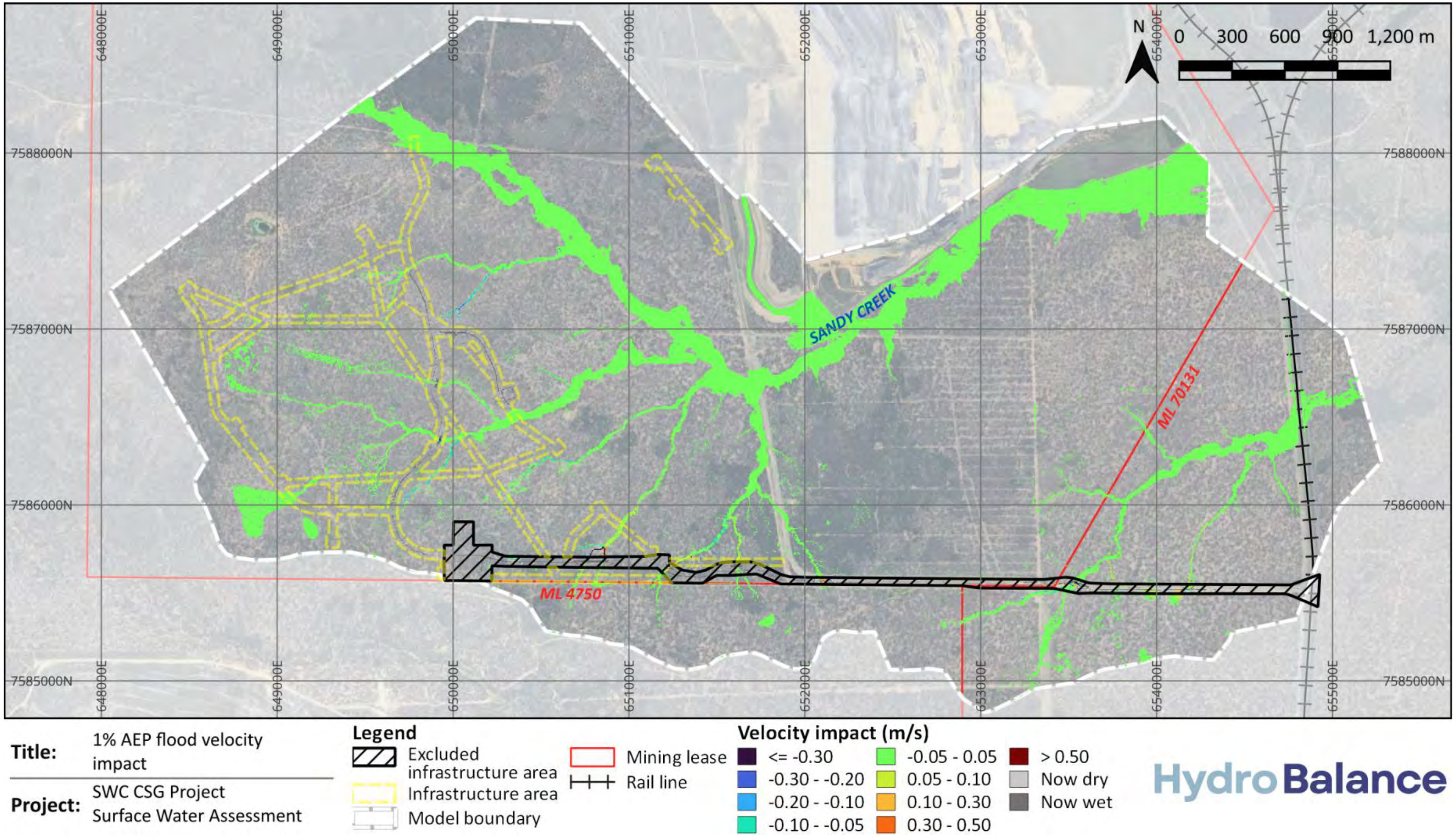


Figure 6.11 – 1% AEP flood velocity impact (developed minus existing conditions)

gh

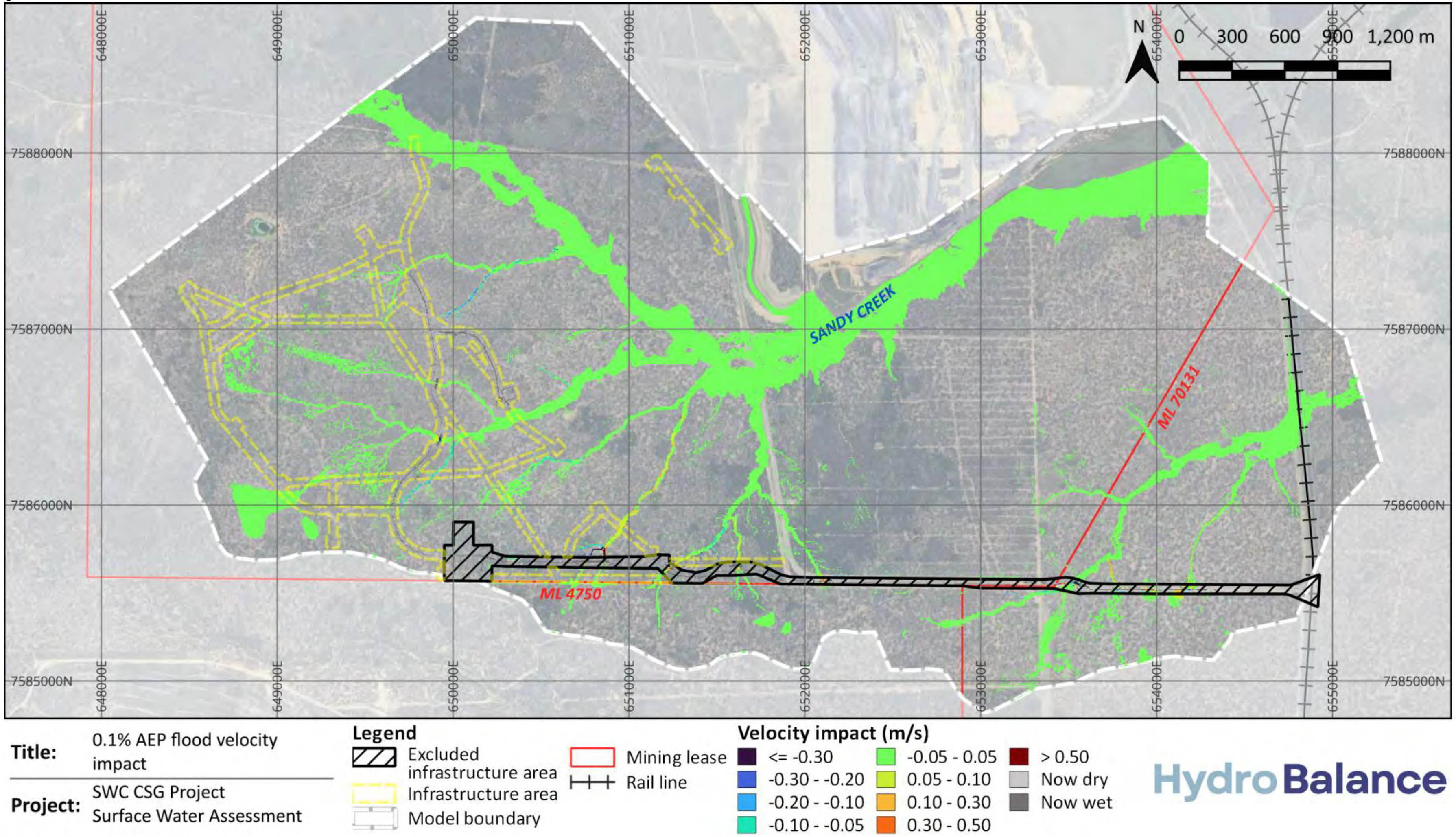


Figure 6.12 – 0.1% AEP flood velocity impact (developed minus existing conditions)

7 Assessment of potential impacts, and mitigation and management measures

7.1 Potential impacts

The potential impacts of the Project on surface water resources include:

- impacts on flows and the flooding regime in the downstream receiving waters;
- impacts on regional water availability due to the need to obtain water from external sources to meet operational water requirements of the Project;
- impacts on stream flows due to catchment area excision;
- adverse impacts on the quality of on-site stormwater runoff draining from the disturbance areas to the various receiving waters surrounding the Project, during both construction and operation of the Project;
- adverse impacts on the SWC water management system as a result of the imported gas extraction water; and
- cumulative impacts of all projects in the region on the environmental values of the receiving waters.

An assessment of each of these potential impacts of the Project is provided in the following sections.

The assessment of surface water impacts has been undertaken based on commonly applied methodologies for the simulation of hydrologic and hydraulic processes using currently available data. The adopted approach is considered suitable for quantifying impacts to a level of accuracy consistent with current industry practice.

7.2 Flooding impacts

Potential impacts of the Project on flood levels, velocities in the receiving waters are addressed in Section 6 of this report. There are no other significant impacts on flood levels and velocities in Sandy Creek downstream of the Project.

7.3 Regional water availability impacts

No external supply of water will be required as part of the Project during operations. As such, the Project will have no impact on regional water availability.

7.4 Stream flow impacts

The Project will not excise any areas from the Sandy Creek catchment, hence the downstream Sandy Creek flow volumes are not expected to be impacted.

7.5 Regional water quality and environmental values

7.5.1 Disturbed area management

The disturbed areas (including exploration well pads, production wells pads, access roads and ancillary infrastructure) will be managed to mitigate any potential impacts on regional water quality and environmental values through the preparation of a Surface Water Management Plan (SWMP). The SWMP and associated Erosion and Sediment Control Plans (ESCPs) will comprise a practical guide manage risks to soil and water associated with specific management measures for all discrete disturbance areas.

Any potential impacts on downstream water quality due to the disturbed areas will be mitigated through best-practice runoff management methods as described in Section 4.7.

7.5.2 CSG production water

CSG water produced by the collection field wells will be managed within the wider SWC WMS. Water balance modelling presented in Section 5 demonstrates that the existing mine water spill risk at SWC would not be impacted by the CSG water inflows.

7.6 Impact on the SWC water management system

Only a relatively small volume of gas extraction water will be transferred from the Project to the SWC water management system (13 ML/year, on average).

The water balance modelling assessment presented in Section 5.3 demonstrates that the transfer of the extraction water will have a negligible impact on the SWC water management system, from both a containment and quality perspective.

There is ample capacity available in the mine-affected water storages to accommodate this minor inflow, and it will have a negligible impact on water quality within the mine-affected water storages.

7.7 Cumulative impacts – surface water

7.7.1 Flooding impacts

The impacts of the Project on flooding behaviour are isolated to the minor drainage lines within the Project boundary, and would not propagate into Sandy Creek all events up to and including the 0.1% AEP event.

There are no predicted cumulative impacts with other activities upstream or downstream of the Project.

7.7.2 Streamflow and water quality impacts

There are no expected streamflow or water quality impacts on the downstream receiving environment due to the Project. As such, there are no predicted cumulative impacts with other activities upstream or downstream of the Project.

8 References

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Jeffrey, et al., 2001	*Using Spatial Interpolation to Construct a Comprehensive Archive of Australian Climate Data*, Environmental Modelling & Software, Vol 16/4, pp 309-300, 2001.

Appendix A. Hydraulic modelling

Overview

The two-dimensional TUFLOW hydrodynamic model (BMT, 2023) was used to simulate the flooding behaviour of Sandy Creek and the local drainage lines in the vicinity of the Project including flood extents, depths and velocities.

TUFLOW represents hydraulic conditions on a fixed grid by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow (BMT, 2023). The model automatically calculates breakout points and flow directions within the model area. The most recent version of the TUFLOW software (Build 2023-03-AC) was used for this study.

The TUFLOW model was run using the Heavily Parallelised Compute (HPC) CPU solver which uses adaptive time stepping.

Hydraulic models were prepared for the following scenarios:

- Existing Conditions; and
- Developed Conditions (including the CSG collection field infrastructure).

The configuration of the TUFLOW model is presented in Figure A.1.

Topographic data

Existing conditions

The TUFLOW model uses Light Detecting and Ranging (LiDAR) topographic data provided by the Stanmore, covering the majority of model extent. Small regions along the model boundary where not covered by LiDAR. Topographic data obtained from Geosciences Australia was used to cover the remaining areas of the TUFLOW model extent.

Developed conditions

The developed surface was provided by Stanmore, which includes well pads, access road and site drainage.

Model extent and resolution

Figure A.1 shows the configuration of the TUFLOW model. The hydraulic model includes Sandy Creek, as well the minor drainage lines in the vicinity of the Project. The section of Sandy Creek extends to 2.5 km downstream of the Project area.

A grid size (resolution) of 4 m was adopted for the TUFLOW model.

Hydraulic structures

There are three sets of culverts within the model extent. The location of the modelled structures is shown in Figure A.1. The adopted culvert parameters are given in Table A.1.

Table A.1 – Adopted culvert parameters

ID	Type	Length	Longitudinal slope	Dimension	Number of units
C01	Circular pipe	25	0.7%	2.4m dia.	2
C02	Circular pipe	32	2.0%	1.2m dia.	2
C03	Circular pipe	58.7	0.4%	2.1m dia.	4

Minor culverts would also be included in the developed configuration, connecting the proposed roadside drainage under the access road embankments. All of the access road culverts would be 0.2 m diameter pipes in sets of 2.

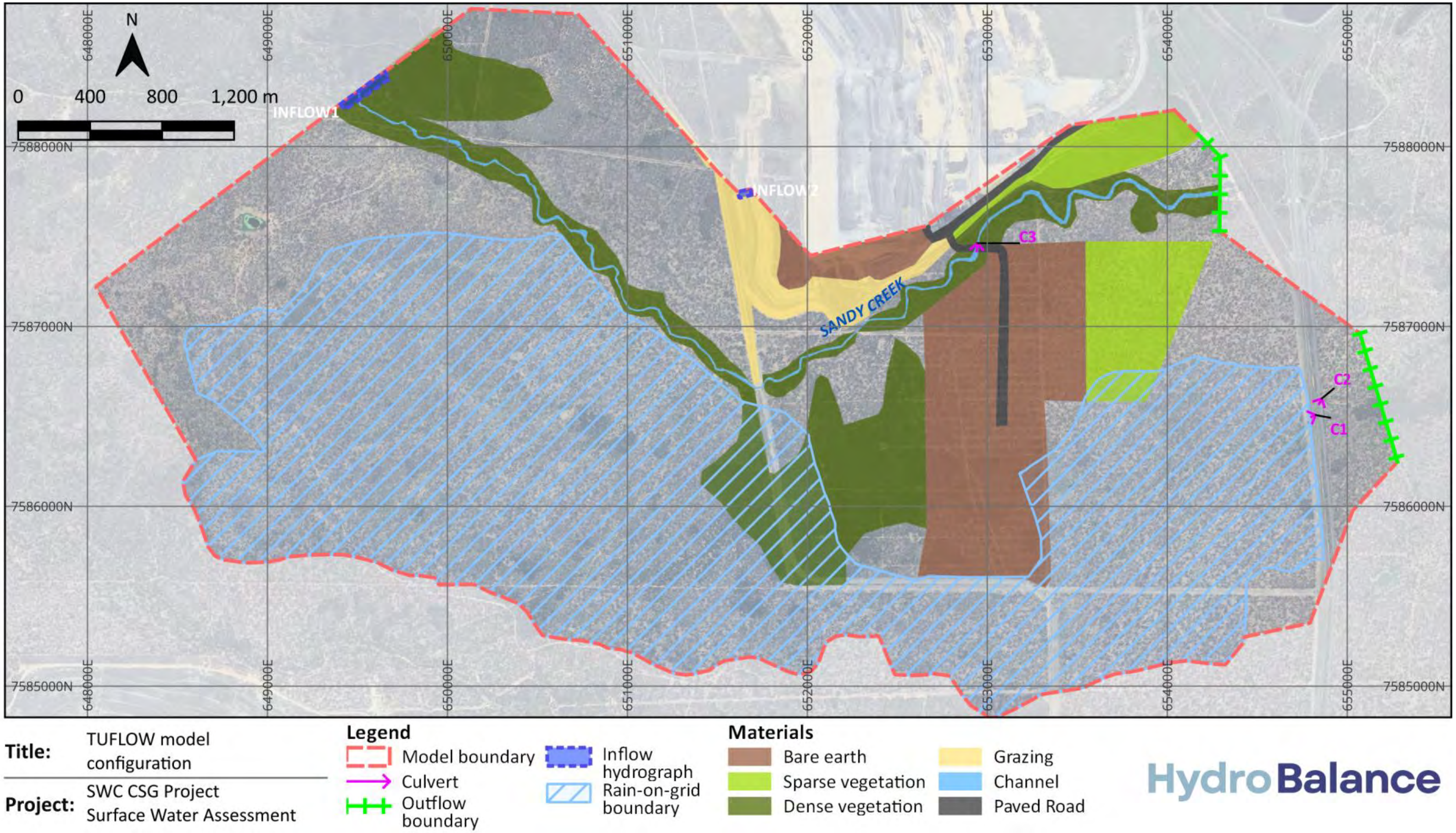


Figure A.1 – TUFLOW model configuration

Inflow and outflow boundaries

Figure A.1 shows the locations of the 2D inflow and outflow boundaries used in the TUFLOW model. Two inflow types were used in the hydraulic modelling:

- **Inflow hydrographs:** The discharge hydrographs estimated using the RORB runoff-routing model were adopted as inflows to Sandy Creek (INFLOW1) and the upslope clean water drain (INFLOW2). The TUFLOW inflow location have been located upstream of the identified potential impacts associated with the proposed Project infrastructure.
- **Rain-on-Grid (ROG):** Rainfall was directly applied to each grid cell within the ROG boundary using an input rainfall hyetograph, selected using the RORB model. The ROG method allows for improved model definition within the minor drainage lines.

The inflow hydrographs are appropriate to represent large, defined channels such as Sandy Creek. The ROG was used to capture the complexity of the minor drainage line behaviour within the Project area.

Inflow hydrographs from the RORB model draining to the upstream extents of the hydraulic model were applied as total hydrograph inflows at these locations. The positions of these inflow boundaries were chosen so that flows were as confined as possible at their point of entry into the hydraulic model, with minimum flow break out. These source areas apply the flow to the lowest cells within the source area polygons.

The primary outflow boundary is located on Sandy Creek, 2.5 km downstream of the Project area. A secondary outflow boundary is located on a minor tributary to Sandy Creek, 250 m downstream of the existing rail line. The outflow boundaries were placed to be sufficiently downstream of the Project, such that no boundary anomalies would propagate upstream enough to impact results in the vicinity of the Project.

Adopted Mannings ‘n’ roughness

The TUFLOW model uses Manning’s ‘n’ values to represent hydraulic resistance. Manning’s ‘n’ values were adopted based on previous hydraulic modelling undertaken by Forward Hydro (2024).

Table A.2 shows the adopted Mannings ‘n’ values for the TUFLOW model and Figure A.1 shows the location of each landuse. The default landuse (i.e. unmapped areas) is moderate vegetation.

Table A.2 – Adopted Mannings ‘n’ values

Land use	Mannings ‘n’
Bare earth	0.05
Sparse vegetation	0.05
Moderate vegetation	0.05
Dense vegetation	0.08
Grazing	0.05
Channel	0.035
Paved road	0.02

Appendix B. Flood maps

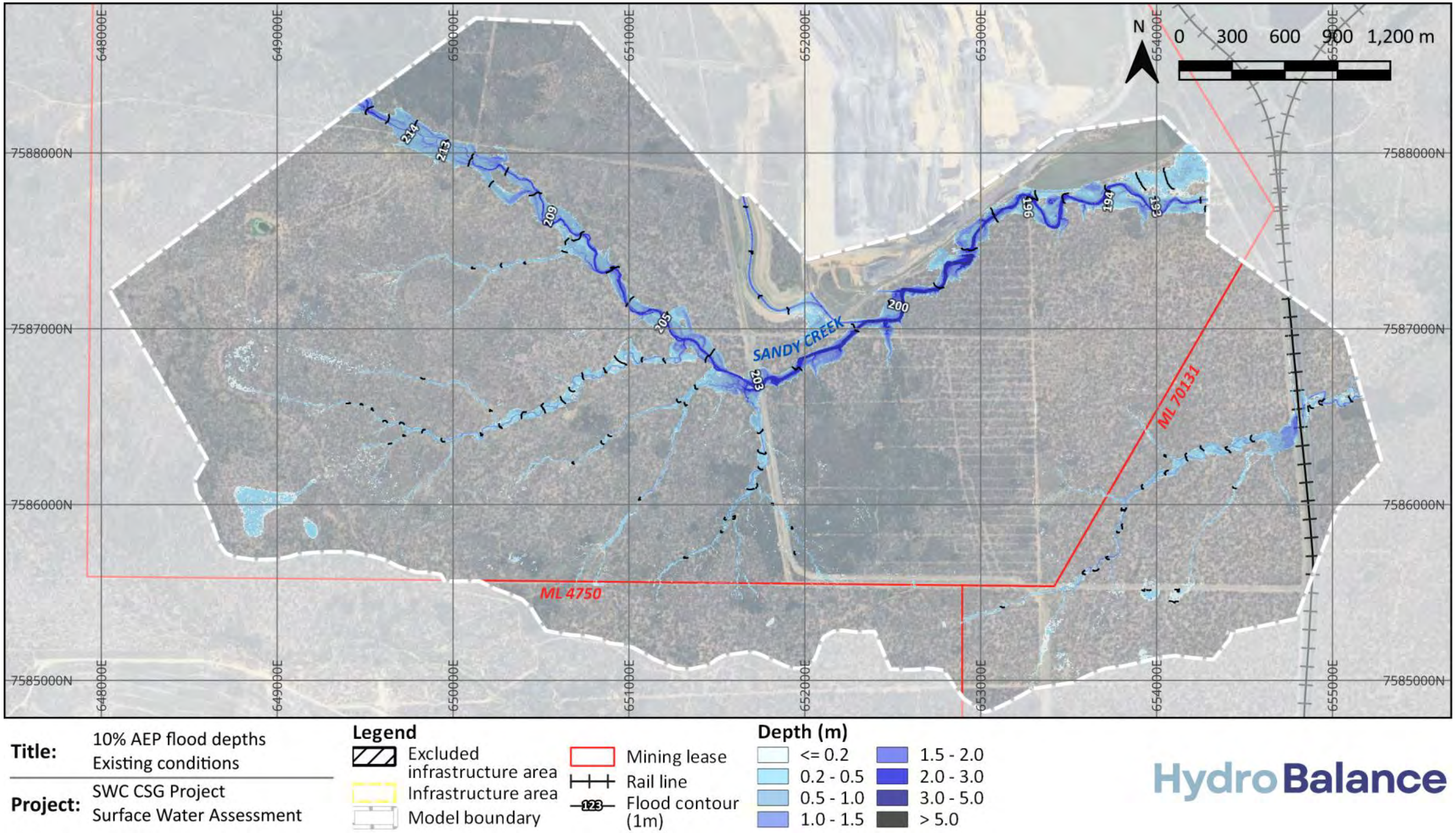


Figure B.1 – Existing conditions 10% AEP flood depths and heights

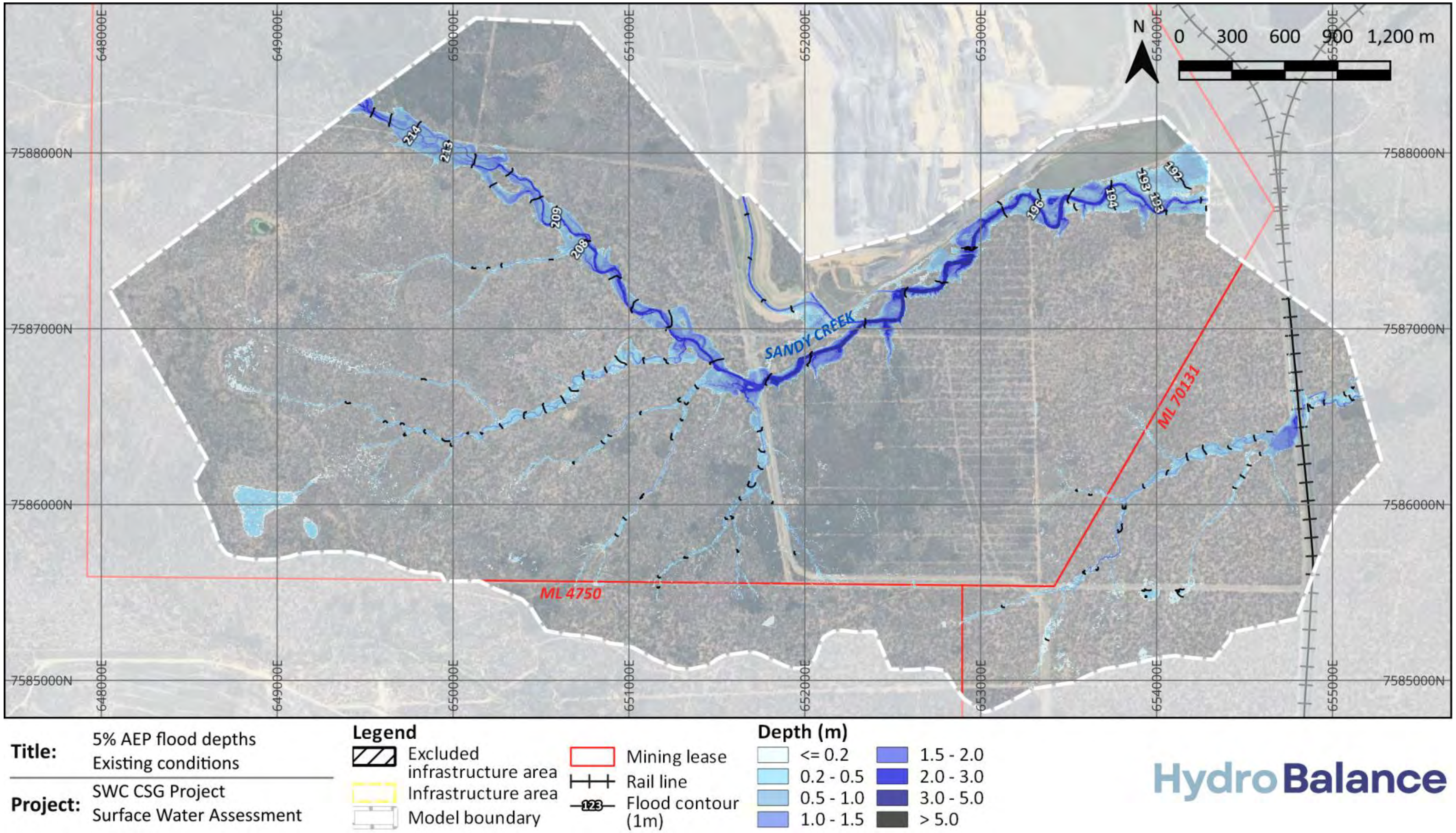
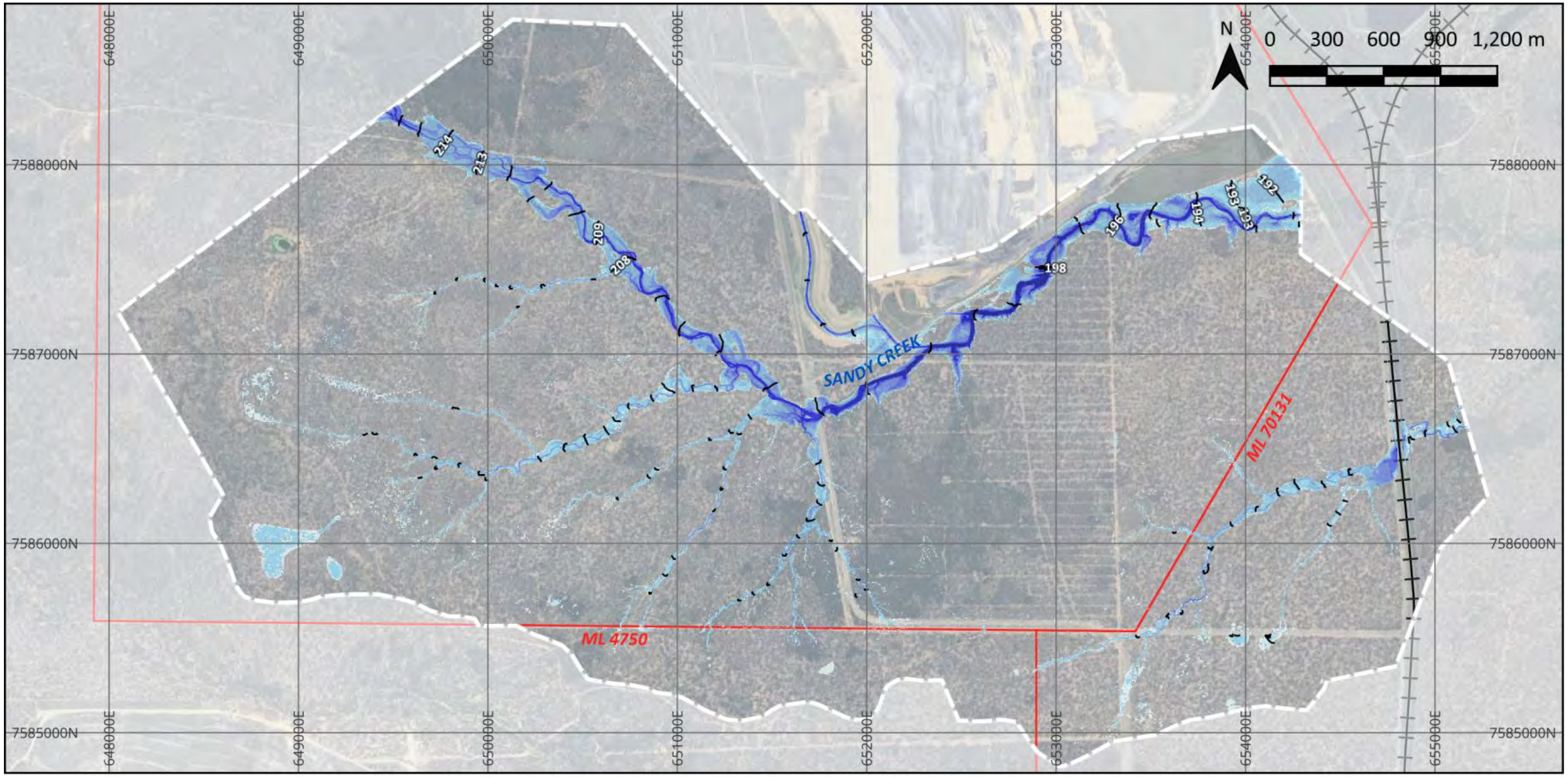


Figure B.2 – Existing conditions 5% AEP flood depths and heights



Title:	2% AEP flood depths Existing conditions
Project:	SWC CSG Project Surface Water Assessment

Legend
- Excluded infrastructure area
- Infrastructure area
- Model boundary
- Mining lease
- Rail line
- Flood contour (1m)

Depth (m)
- <= 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 5.0
- > 5.0

HydroBalance

Figure B.3 – Existing conditions 2% AEP flood depths and heights

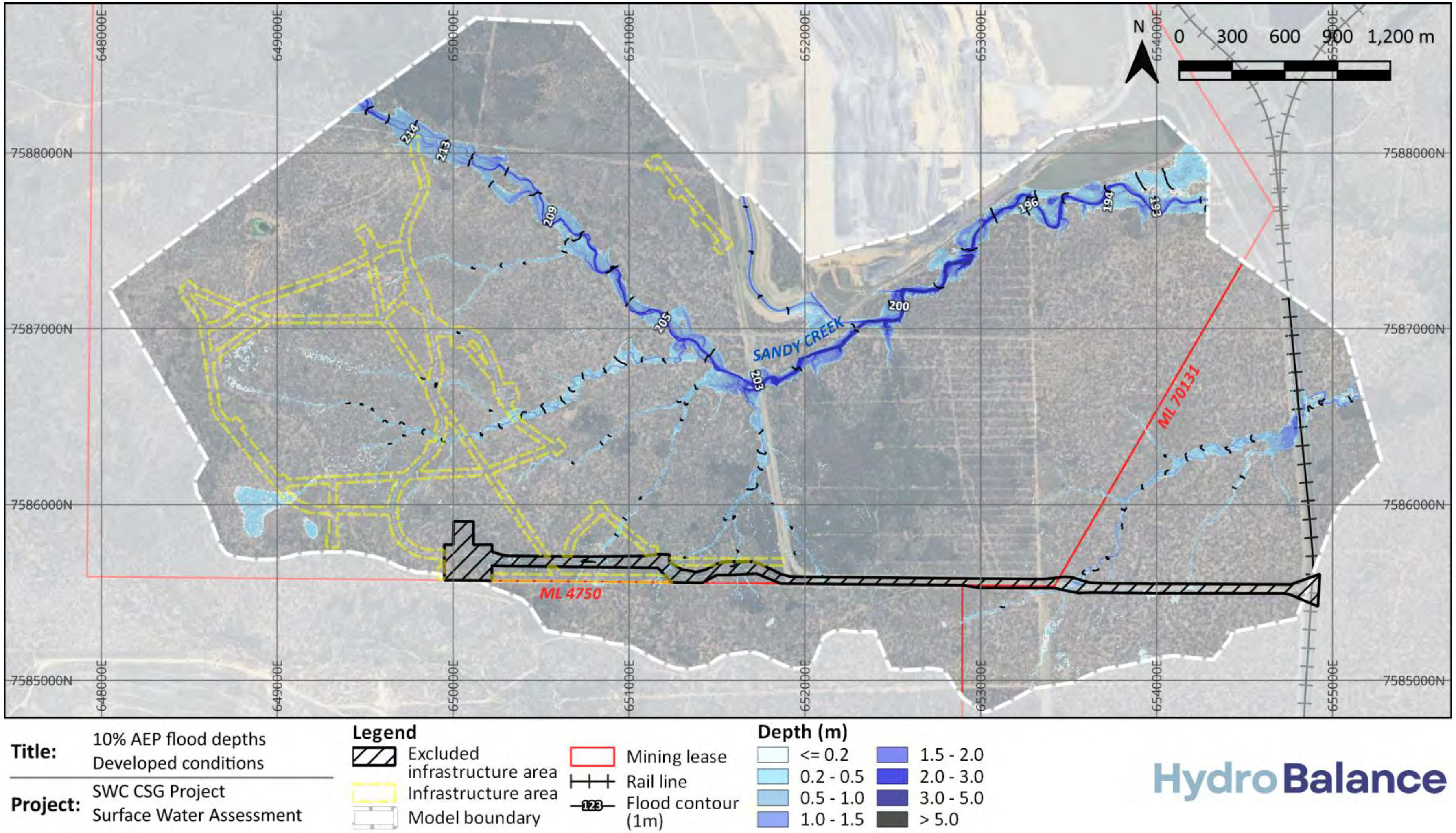


Figure B.4 – Developed conditions 10% AEP flood depths and heights

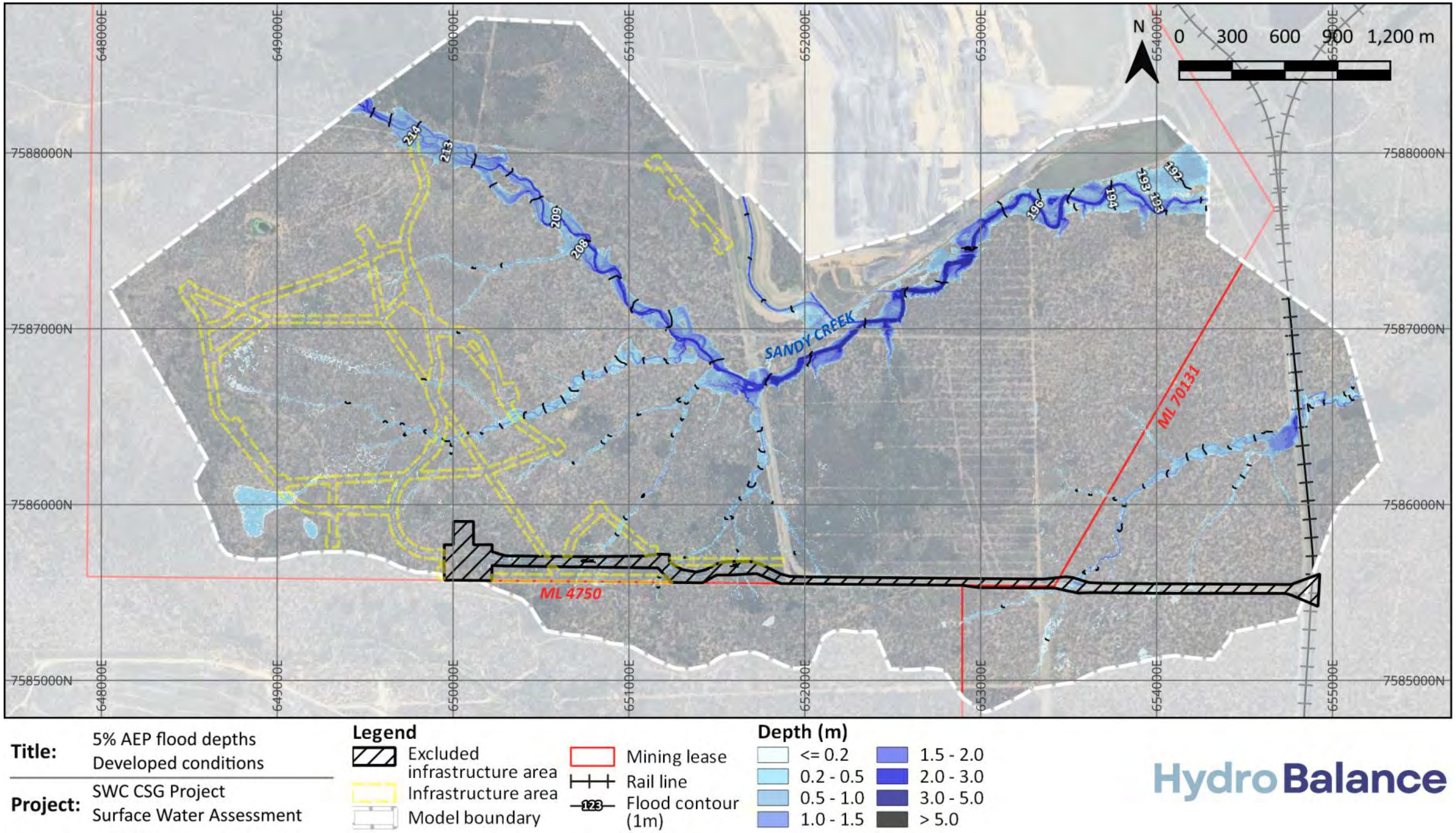


Figure B.5 – Developed conditions 5% AEP flood depths and heights

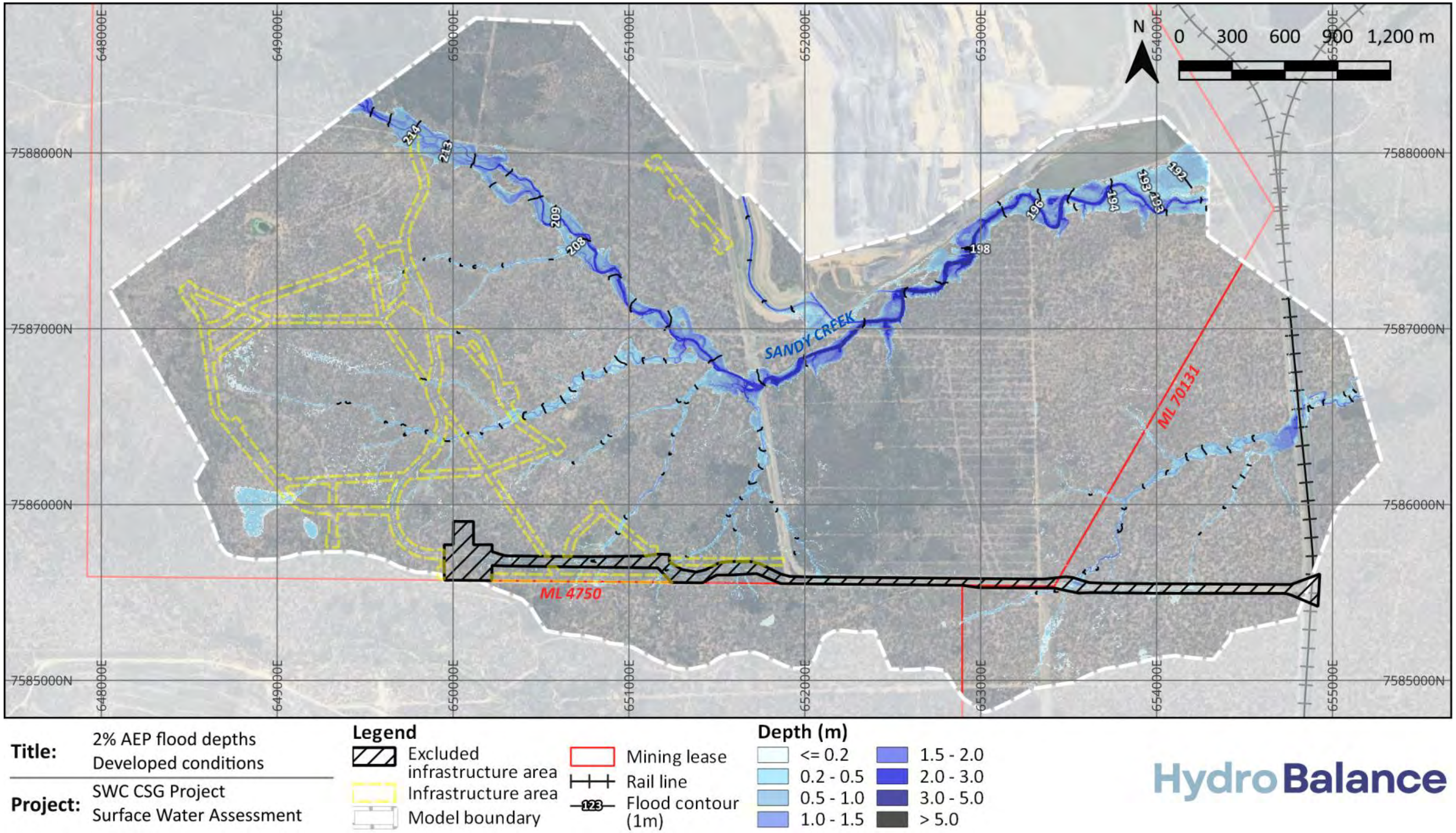


Figure B.6 – Developed conditions 2% AEP flood depths and heights

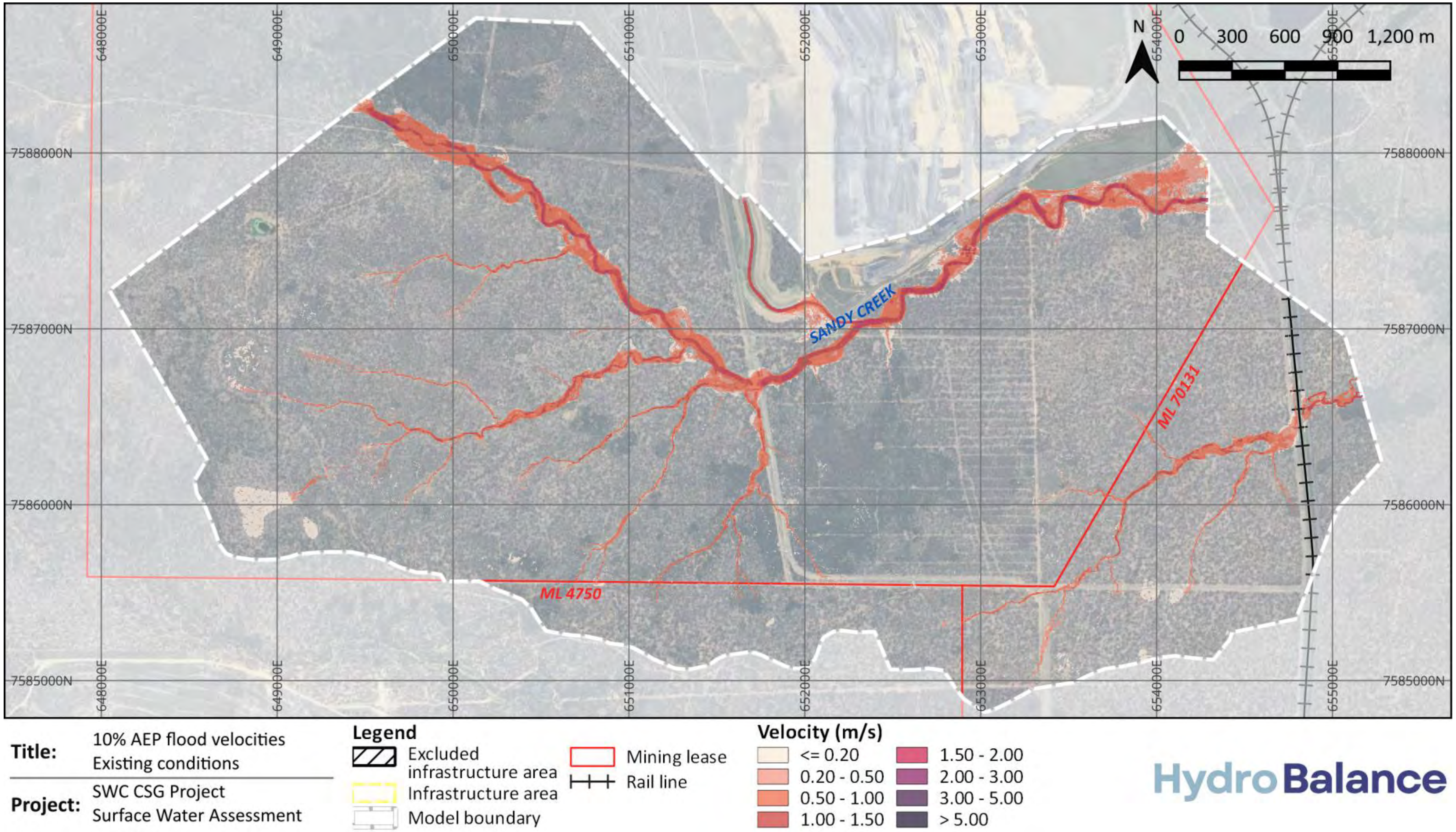


Figure B.7 – Existing conditions 10% AEP flood velocities

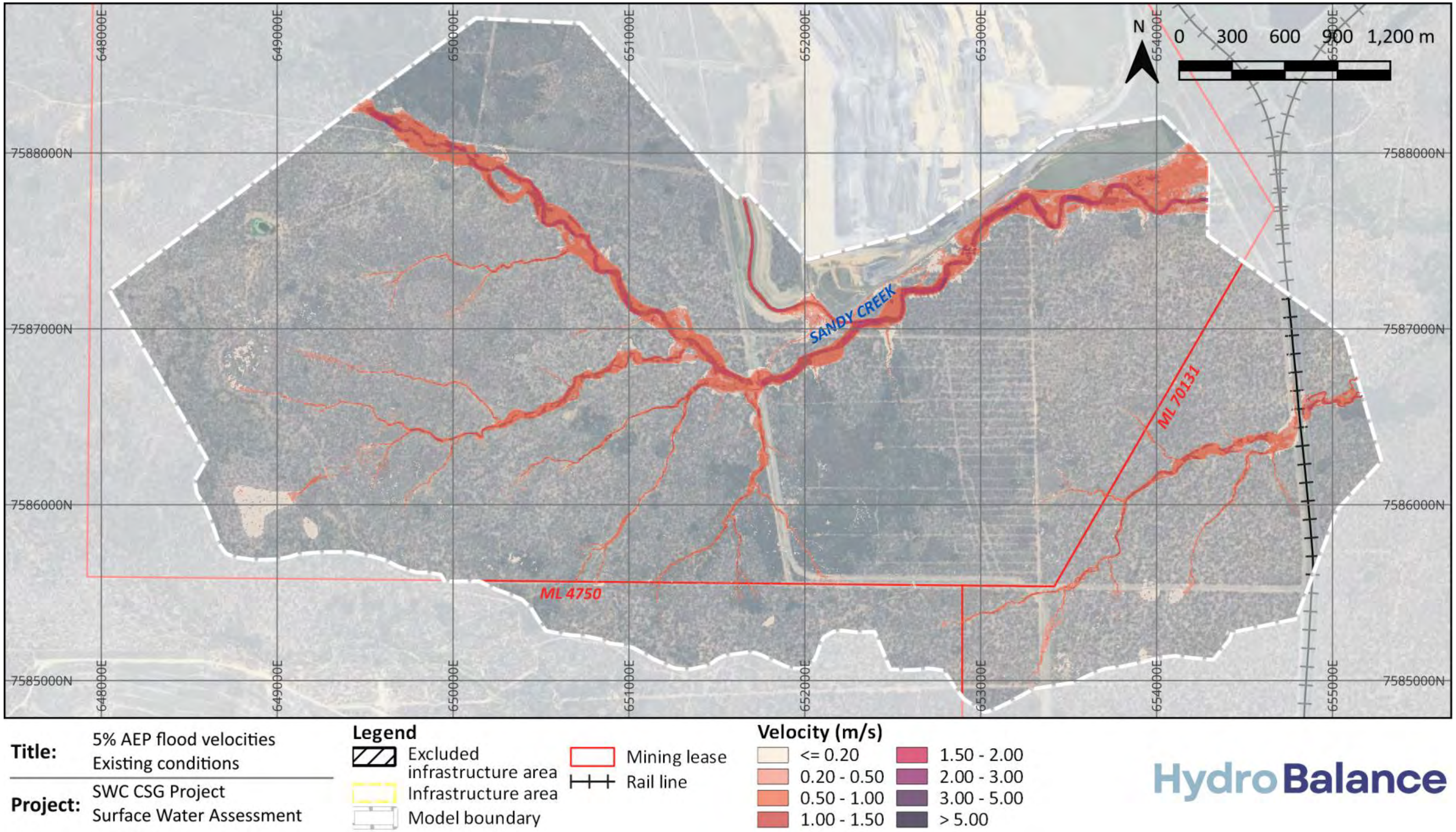


Figure B.8 – Existing conditions 5% AEP flood velocities

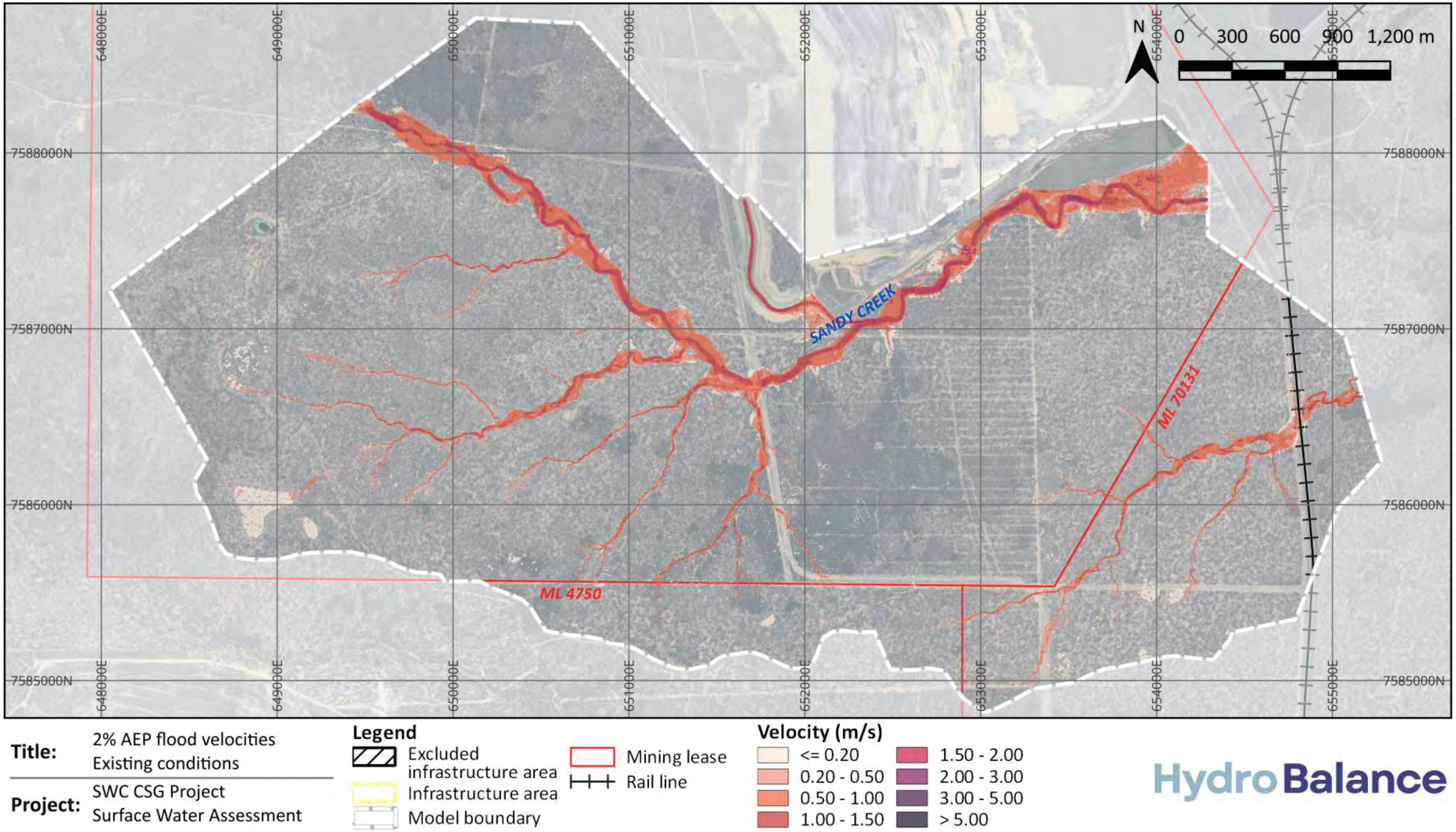


Figure B.9 – Existing conditions 2% AEP flood velocities

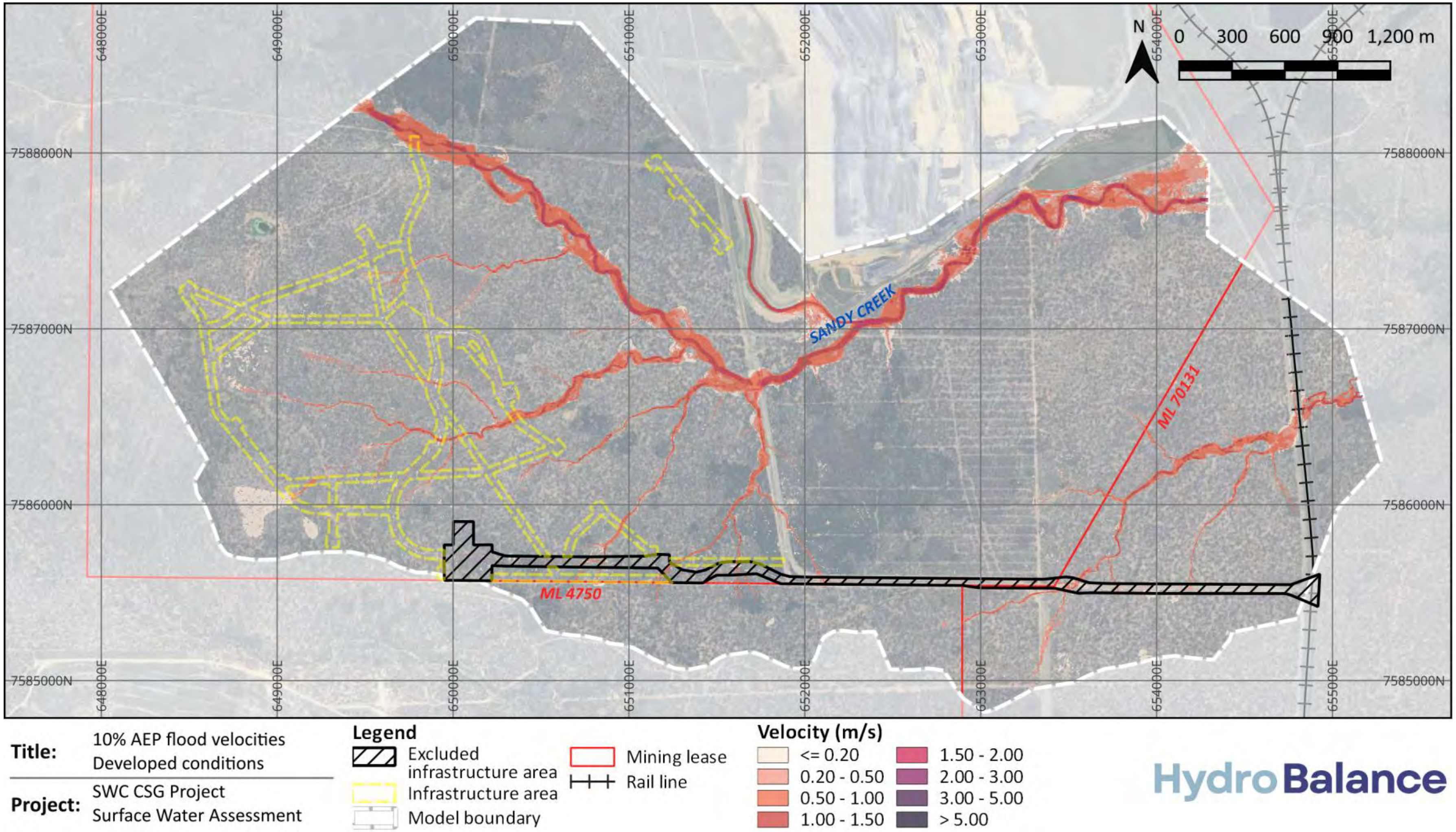


Figure B.10 – Developed conditions 10% AEP flood velocities

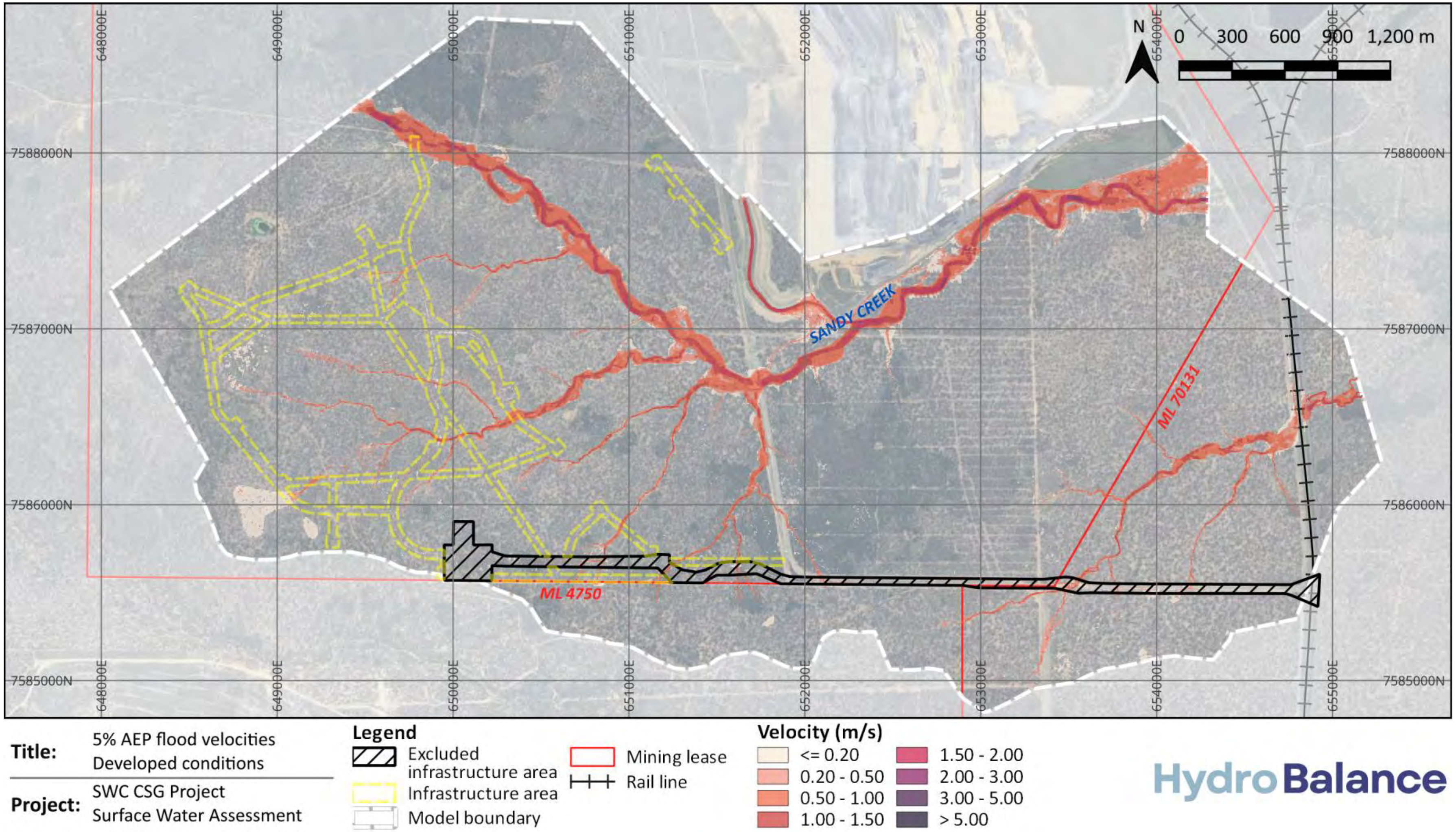


Figure B.11 – Developed conditions 5% AEP flood velocities

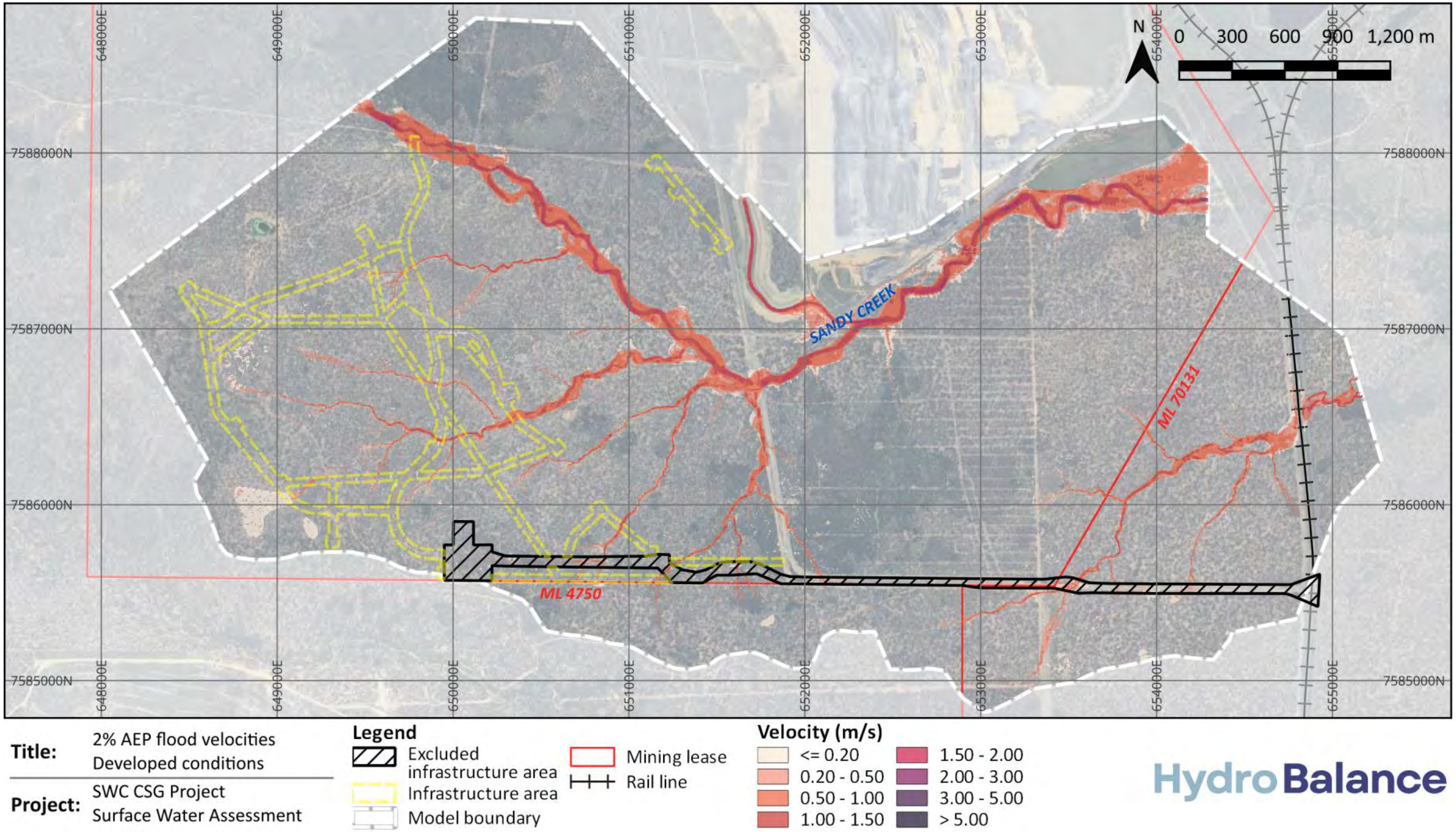


Figure B.12 – Developed conditions 2% AEP flood velocities

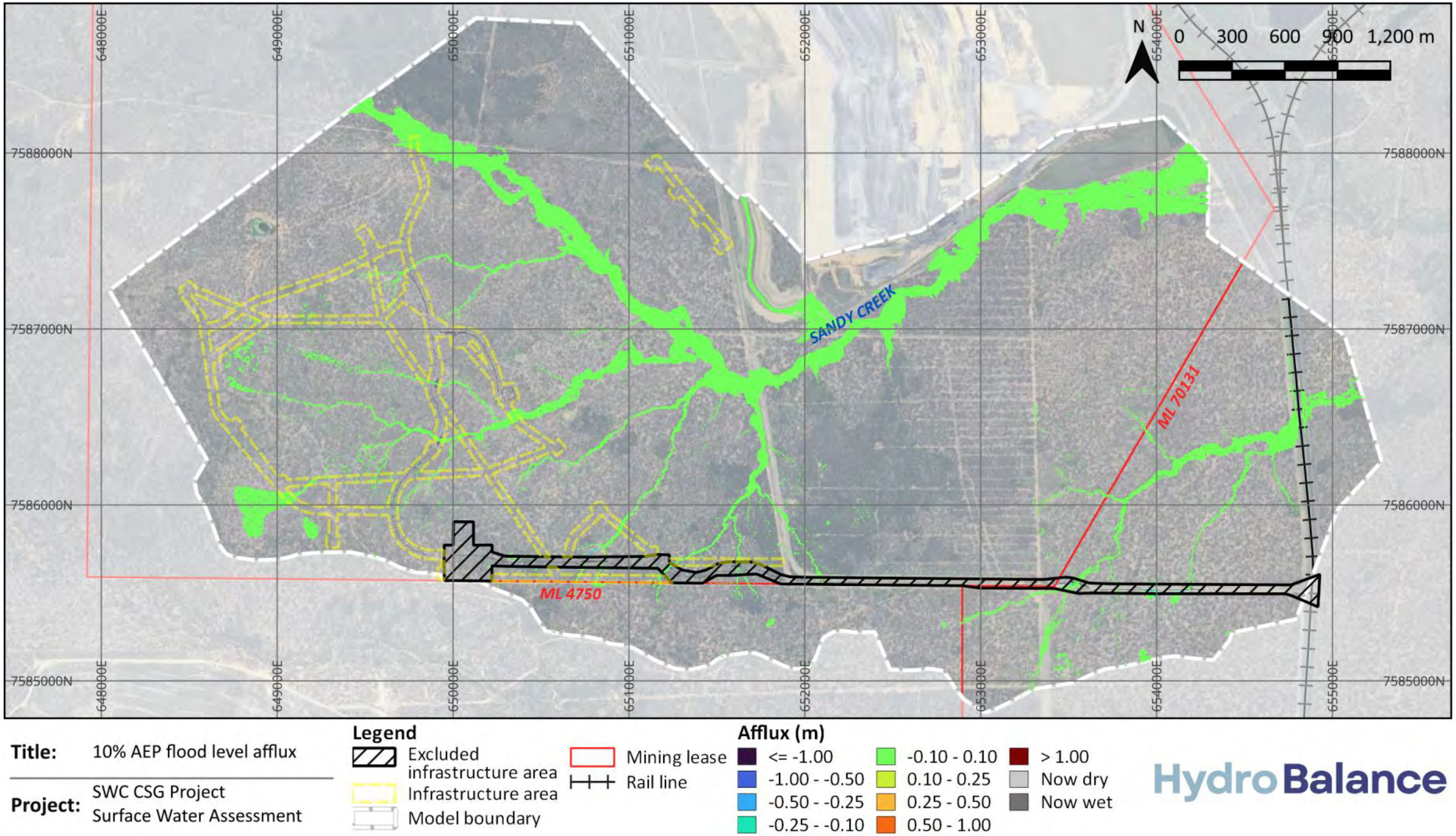


Figure B.13 – Afflux 10% AEP (developed minus existing conditions)

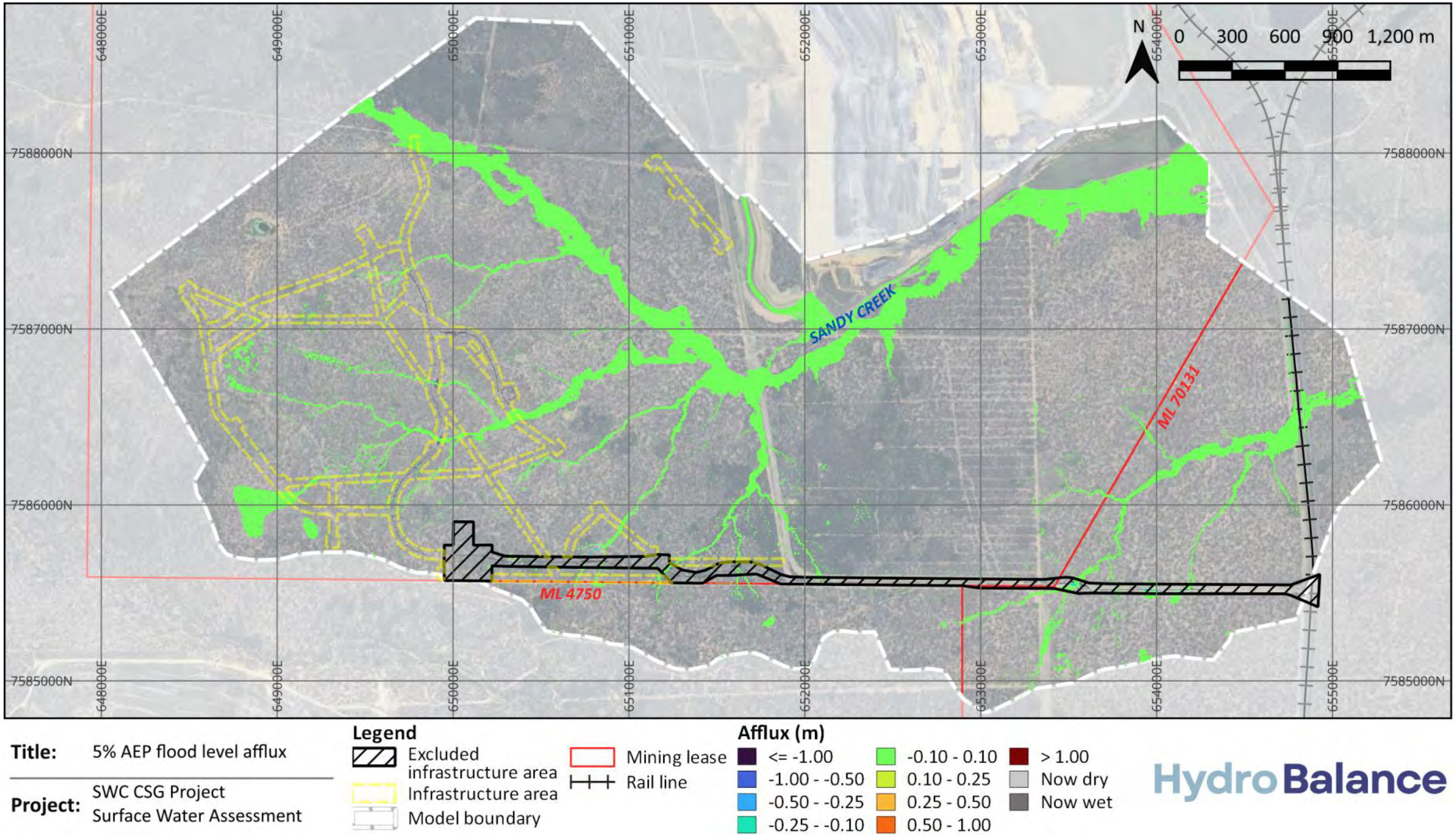
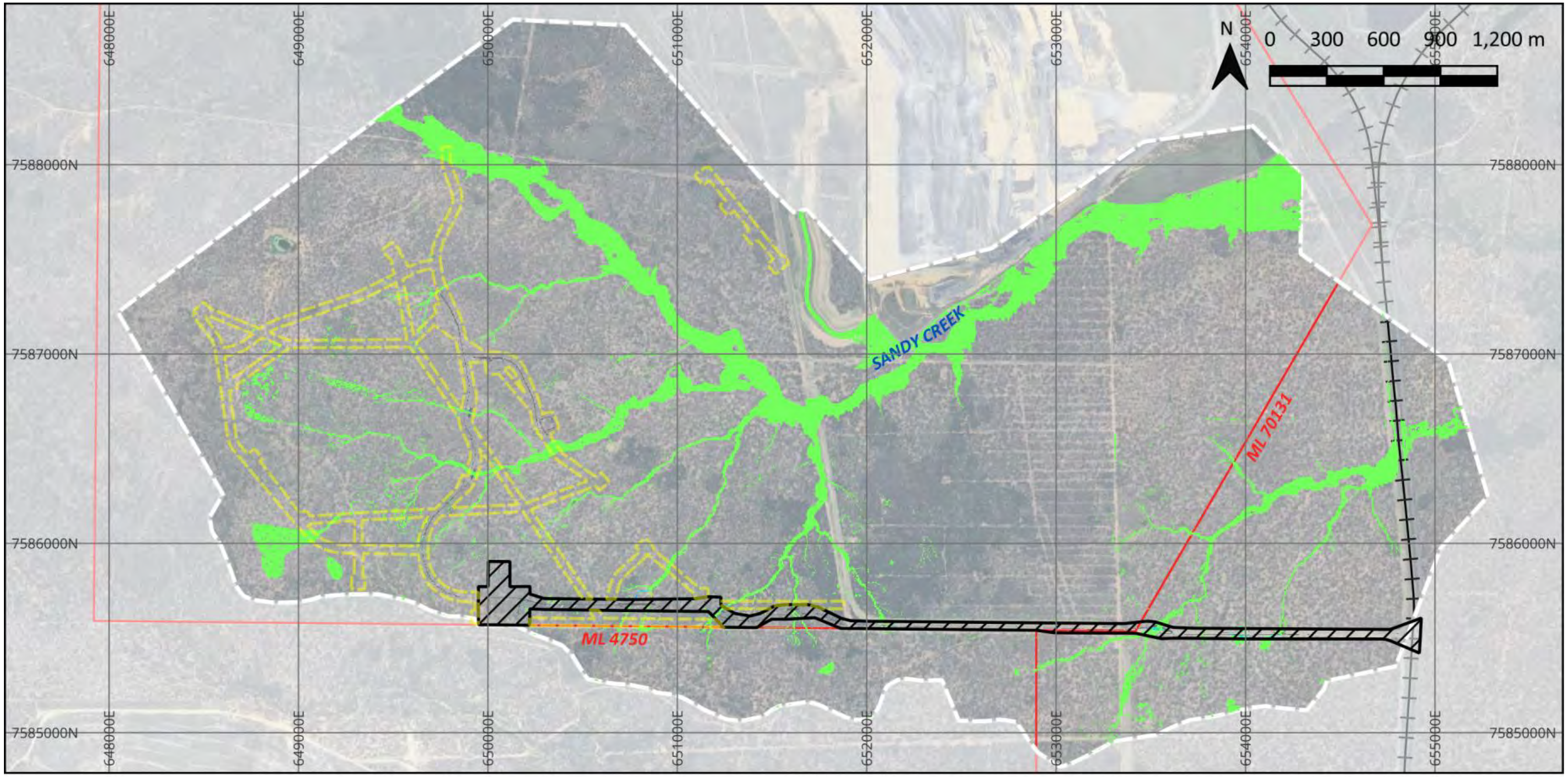


Figure B.14 – Afflux 5% AEP (developed minus existing conditions)



Title:	2% AEP flood level afflux
Project:	SWC CSG Project Surface Water Assessment

Legend

- Excluded infrastructure area
- Infrastructure area
- Model boundary
- Mining lease
- Rail line

Afflux (m)

- <= -1.00
- -1.00 - -0.50
- -0.50 - -0.25
- -0.25 - -0.10
- -0.10 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- > 1.00
- Now dry
- Now wet

HydroBalance

Figure B.15 – Afflux 2% AEP (developed minus existing conditions)

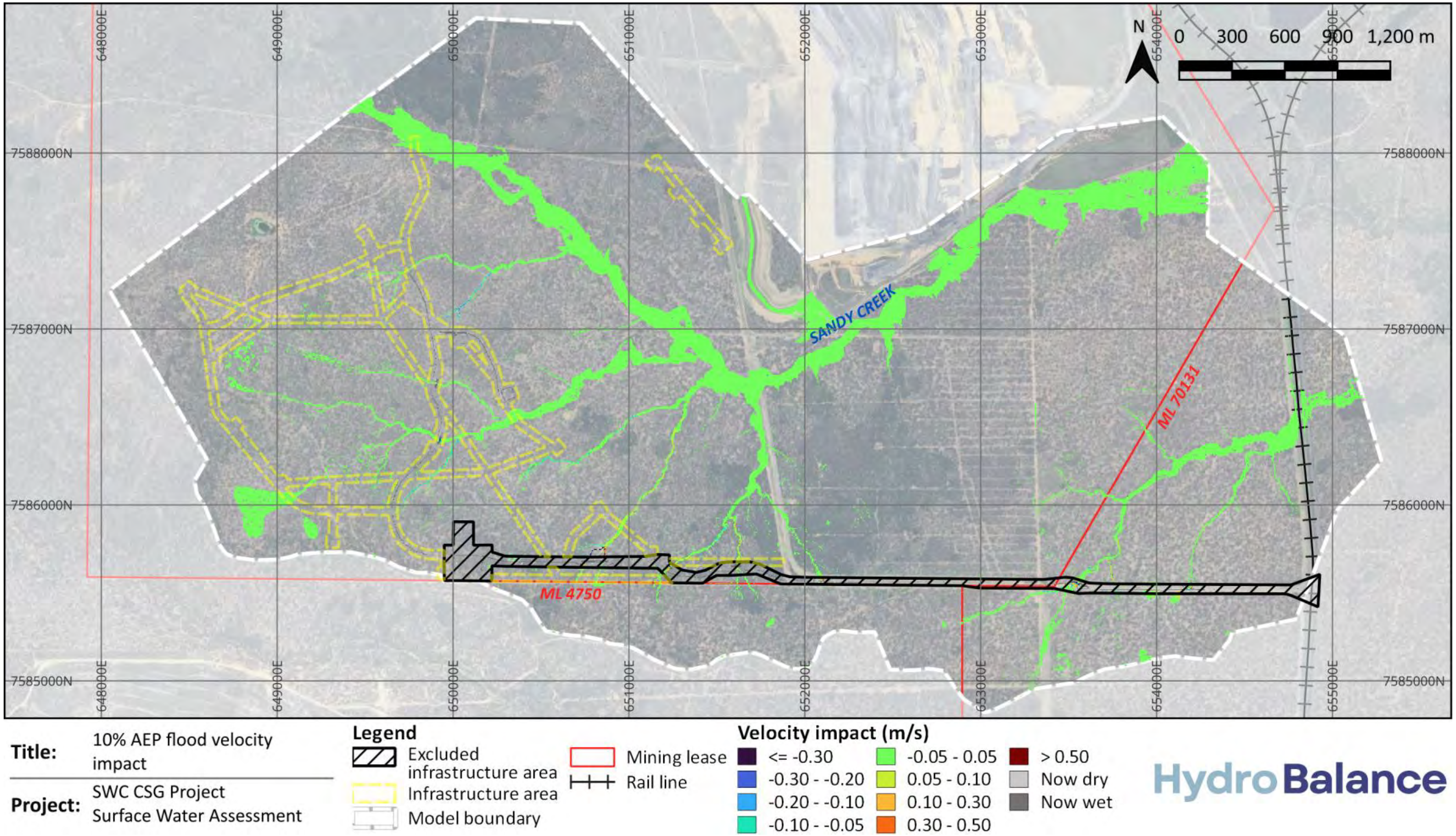
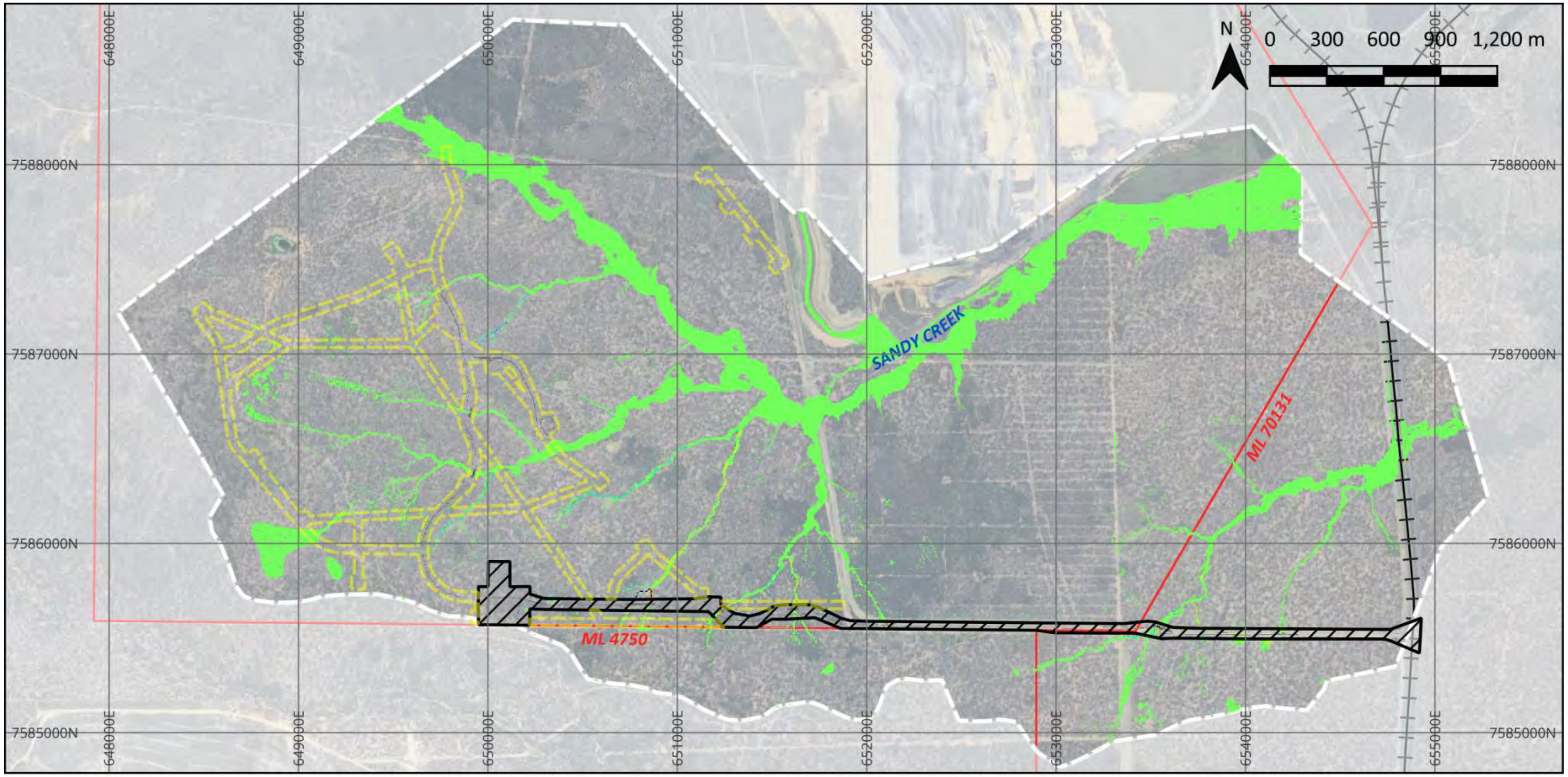


Figure B.16 – Velocity impact 10% AEP (developed minus existing conditions)



Title:	5% AEP flood velocity impact
Project:	SWC CSG Project Surface Water Assessment

Legend

- Excluded infrastructure area
- Infrastructure area
- Model boundary
- Mining lease
- Rail line

Velocity impact (m/s)

- <= -0.30
- -0.30 - -0.20
- -0.20 - -0.10
- -0.10 - -0.05
- -0.05 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- > 0.50
- Now dry
- Now wet

HydroBalance

Figure B.17 – Velocity impact 5% AEP (developed minus existing conditions)

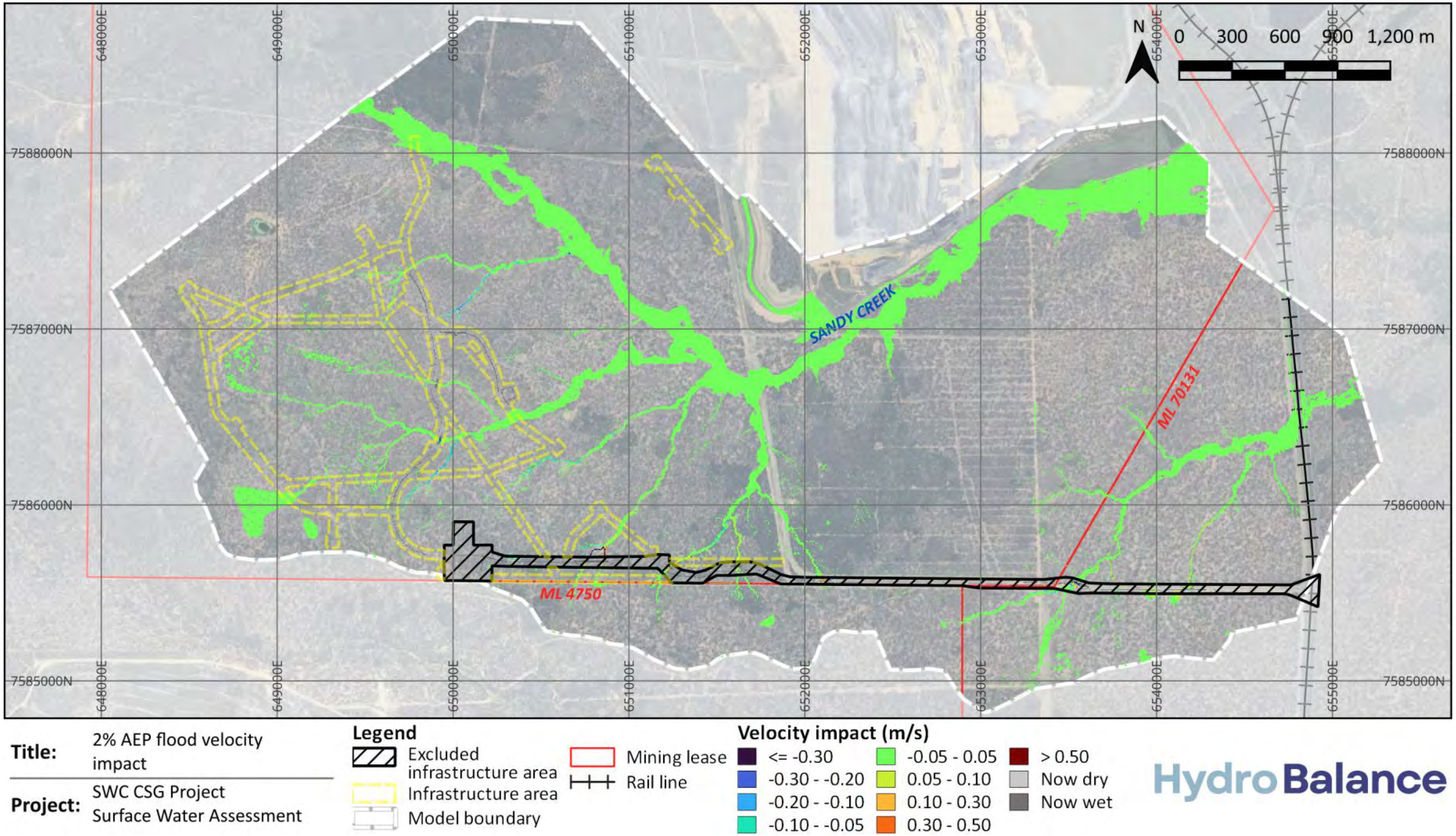


Figure B.18 – Velocity impact 2% AEP (developed minus existing conditions)

APPENDIX E
AQUATIC ECOLOGY ASSESSMENT

South Walker Creek Mine

Aquatic Ecological Values Assessment

Prepared for:

Stanmore

frc environmental part of SLR

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

frc reference: 240211

freshwater estuarine marine

Document Control Summary

Report Title: South Walker Creek Mine: Aquatic Ecological Values Assessment
Project No.: 240211
Project Director: Ben Cook
Project Manager: Andrew Mather
Project Team: Tom Richards, Beaudee Newberry, Andrew Mather and Ben Cook
Client: Stanmore Coal
Client Contact: Sam Blanco and Richard Oldham

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Ii	30/09/2024	B Cook	B Brooks	Stanmore Coal	.docx	final

Contents

Tables

Figures

Maps

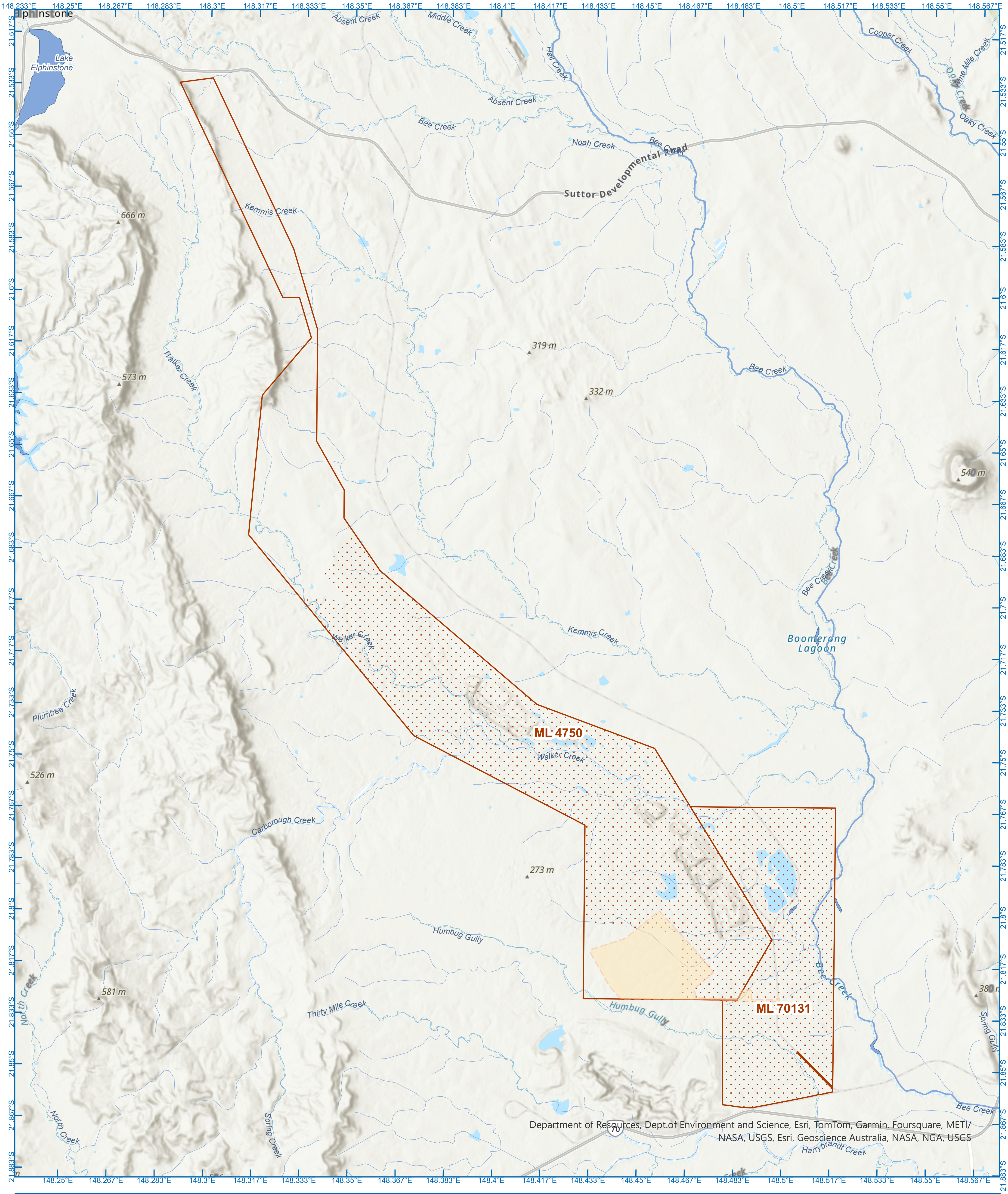
1 Introduction

frc environmental part of SLR Consulting was commissioned by Stanmore to implement an assessment of aquatic ecological values of waterways and wetlands across the South Walker Creek Mine (SWC) Area (SWC Area), with Sandy Creek and surrounds being focal area for the assessment (Map 1.1). The objective of the study was to synthesise existing data from past aquatic ecological survey work across the SWC Area and collect new site-specific survey data from the Sandy Creek locale, to provide a basis for a range of future impact assessments for proposed works at SWC.

The scope of this report is to present:

- a desktop assessment, including synthesis of historical survey data, to describe:
  - aquatic Matters of National Environmental Significance (MNES)
  - aquatic Matters of State Environmental Significance (MSES)
  - other aquatic matters:
    - water quality measured in situ
    - flow regime
    - aquatic habitat
    - groundwater dependent ecosystems
    - aquatic biota (turtles, fish, macroinvertebrates and aquatic plants)
- the methods and results of the 2024 aquatic ecology survey in the Sandy Creek locale
- an assessment of the aquatic ecological values of waterways and wetlands of the SWC Area, and the Sandy Creek locale.

In this report 'SWC Area' refers to groundwaters underlying the SWC mining lease area [i.e. mining lease 4750 (ML4750) and mining lease 70131 (ML70131)]. The Sandy Creek locale includes Sandy Creek proper, its minor tributaries and Bee Creek immediately downstream of the Sandy Creek confluence.

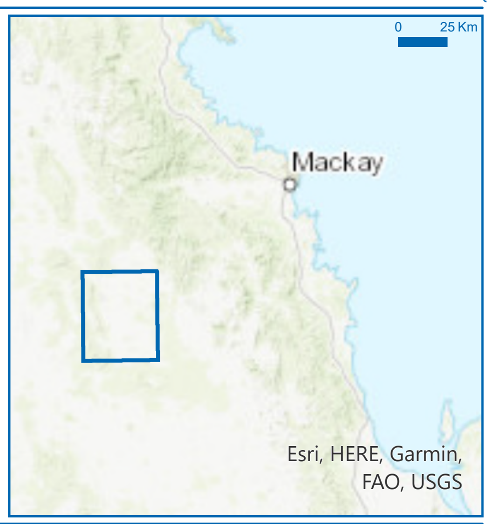


240211: South Walker Creek Mine: Stygofauna Values Assessment

Map 1.1: SWC Area and Sandy Creek Locale.

LEGEND

- Mine lease surface area granted
- SWC Mine lease boundary
- Sandy Creek Locale
- Lake/Reservoir
- Major Watercourse
- Minor Watercourse



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2 Aquatic Matters of National Environmental Significance

2.1 Legislative Context

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (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 (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- 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 EPBC Act provides protection for threatened flora, fauna and ecological communities by:

- identifying and listing species and ecological communities as threatened
- developing conservation advice and recovery plans for listed species and ecological communities
- developing a register of critical habitat
- recognising key threatening processes
- where appropriate, reducing the impacts of these processes through threat abatement plans and non-statutory threat abatement advices, and
- requiring approval for certain actions or activities that will, or are likely to, have a significant impact on an MNES or other protected matter.

Under the EPBC Act, if an action has, will have, or is likely to have, a significant impact on a MNES, approval is required from the Australian Government Environment Minister (the Minister). The MNES Significant Impact Guidelines (DotE 2013) outline a ‘self-assessment’ process to assist in determining whether an action is likely to have a significant impact on a MNES. If this process determines there may be a significant impact to a MNES, a referral should be submitted to the Minister for a decision on whether assessment and approval is required under the EPBC Act.

The Minister can make one of three decisions regarding a proposal:

- Not a controlled action: if the proposed action is not likely to be significant, approval is not required if the action is taken in accordance with the referral. Consequently, the action can proceed subject to any state, territory or local government requirements
- Not a controlled action – ‘particular manner’: if the proposed action is not likely to be significant if done in a particular manner
- Controlled action: if the proposed action is likely to be significant, it is called a 'controlled action'. The matters which the proposed action may have a significant impact on (e.g. Ramsar wetlands or threatened species) are known as the controlling provisions. Controlled actions require approval and are subject to further assessment processes.

Once a controlled action is assessed, it can be approved, approved subject to constraints, or refused.

2.2 Assessment Method

Protected Matters Searches were completed on 8 March 2024 for the SWC Area, and the Sandy Creek locale, separately (Appendix A). The MNES identified by the searches were reviewed, with only those matters relating to aquatic ecology (e.g. protected wetlands, aquatic species) considered in this study, and terrestrial MNES assumed to be assessed in the terrestrial ecology study.

For the identified aquatic MNES, the likelihood of occurrence was assessed using consideration of habitat suitability and distribution. For aquatic species that are listed as vulnerable under the EPBC Act it was also determined if an ‘important population, as defined in the Significant Impact Guidelines (DotE 2013), occurs in areas relevant to the Project.

2.3 Results

The Protected Matter Search results (Appendix A) the following aquatic MNES may occur in the SWC Area or the Sandy Creek locale (Appendix A):

- white-throated snapping turtle (*Elseya albagula*) (critically endangered), and
- Fitzroy River turtle (*Rheodytes leukops*) (vulnerable).

The white-throated snapping turtle is listed as critically endangered under the EPBC Act and endangered under the *Nature Conservation Act 1992* (NC Act). This species is restricted to the Fitzroy, Burnett and Mary Basins, and adjacent coastal basins (e.g. Kolan and Gregory-Burrum systems) (Todd et al. 2013). Within the Fitzroy River Basin, white-throated snapping turtle occurs from the lower Fitzroy River from the tidal barrage to the Upper Dawson River, Callide Dam, lower Nogoa River, upper Connors River, and lower Isaac River in the Tartrus Weir impoundment (GHD 2016). This species is a habitat specialist, preferring permanent, flowing, clear and well oxygenated water with moderate to high cover of aquatic habitat (i.e. large woody debris and undercut banks) (Hamann et al. 2007; Limpus et al. 2011b; Limpus et al. 2007; Todd et al. 2013). White-throated snapping turtle generally inhabits deep (i.e. approximately 6 m) pools during the day and shallow riffles at night (Gordos et al. 2007; Hamann et al. 2007), with both of these habitat types absent from waterways of the SWC Area, including Sandy Creek.

The Fitzroy River turtle is listed as vulnerable under the EPBC Act and vulnerable under the NC Act. This species is endemic to the Fitzroy River basin, with records of the species showing the centre of this species' distribution is the Fitzroy River (main stem) from the tidal barrage to Emerald, the Dawson River and the Connors River (ALA 2024). Published records of this species indicate that the species occurs from the Fitzroy Barrage to the upper Dawson River, the Mackenzie River and lower reaches of the Nogoa River, and to the Upper Connors River (Cann 1998; GHD 2016; Legler & Cann 1980; Limpus et al. 2011a). Fitzroy River turtle prefers permanent freshwater reaches where there are large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles (Limpus et al. 2011b), but has also been found in isolated permanent waterholes (frc environmental 2010; Limpus 2007). However, the species is not known to inhabit farm dams or ephemeral waterways (Limpus 2007). Nesting by Fitzroy River turtle occurs in spring (September to November), with hatching occurring in summer (November to March). The upper reaches of the Fitzroy Barrage on the lower Fitzroy River supports the largest known breeding aggregation of Fitzroy River turtles, with the reach of the Mackenzie River downstream of Tartrus Weir and the lower Isaac River in the upper reaches of the Tartrus Weir impoundment also supporting important nesting aggregations (GHD 2016; Limpus et al. 2011a), although isolated nesting sites occur throughout the range of the species. Predation of nests and hatchlings by mainly feral animals (e.g. pigs, foxes, wild dogs, cats; and trampling of nests by cattle), but also predation by some native species (e.g. goannas, water rats), is the key threatening process, with the population of Fitzroy River turtle now strongly dominated by adults due to long-term lack of recruitment. Water resource development adversely impacts turtles by inundating pool:riffle sequences, changing downstream flow regimes and causing injury and mortality of turtles on spillways; and broad water quality impacts, primarily from agricultural and mining land uses, are thought to adversely impact turtle health (GHD 2016; Limpus et al. 2011a).

The nearest confirmed records of these two species of turtle to the SWC Area are from the Connors River north of Lotus Creek (ALA 2024) over 95 km (stream distance) from the SWC Area. The nearest records of these species downstream of these areas are from the upper reaches of Tartrus Weir impoundment (Limpus et al. 2011a), which is over 120 km (stream distance) downstream from the SWC Area. There are no records of these species from Sandy Creek, Bee Creek or in close proximity to the SWC Area (ALA 2024).

Flow regime has a strong influence on the distribution of these two species in the Fitzroy River basin, given the degree of their specialisation for flow-dominated habitats (Cogger 2000; Todd et al. 2013). Comparison of flow durations at monitoring location BCUS on Bee Creek and at Department of Regional Development, Manufacturing and Water (DRDMW) gauging stations on the Fitzroy River, Dawson River, Connors River and Isaac River (Table 2.1), indicate that Bee Creek has significantly shorter duration of flows compared to flow durations recorded in the Fitzroy River, Dawson River and Connors River from where these two species of turtle are known. Thus, the distribution records that indicate these species do not occur in Sandy Creek, Bee Creek or near the SWC Area align with the reported habitat (i.e. hydrological) preferences of the species (i.e. near-permanent, flow-dominated river reaches).

All waterways within the SWC Area and Sandy Creek locale do not provide suitable habitat (i.e. unsuitable flow regime) for white-throated snapping turtle and Fitzroy River turtle; thus, there is low probability of occurrence (i.e. unlikely to occur) of these species in or near the SWC Area or the Sandy Creek locale. It is likely that the Connors River at the Funnel Creek confluence is the nearest location that has potentially suitable hydrological characteristics for white-throated snapping turtle and Fitzroy River turtle, with this location being over 70km downstream of the SWC Area and the Sandy Creek locale.

Table 2.1 Comparison of flow durations (i.e. percentage of time flows are recorded) in the Fitzroy River (main stem), Dawson River, Isaac River and Connors River.

Gauging Station	**Location**	**% time flows are recorded**
State Government gauging stations		
130003B	Fitzroy River at Riverslea	89
130005A	Fitzroy River at The Gap	84
130302A	Dawson River at Taroom	96
130317B	Dawson River at Woodleigh	92
130322A	Dawson River at Beckers	69
130324A	Dawson River at Utopia Downs	100
130374A	Dawson River at Bindaree	72
130403A	Connors River at Mount Bridget	75
130404A	Connors River at Pink Lagoon	81
130401A	Isaac River at Yatton	85
130410A	Isaac River at Deverill	26
130414A	Isaac River at Goonyella	21
Stanmore gauging station		
BCUS	Bee Creek	24
WCUS	Waker Creek	2

Source of data DNRME (2024).

Blue shading indicates reaches within the Fitzroy River Basin from which white-throated snapping turtle and Fitzroy River turtle have been recorded, with flows recorded 69 – 100% of the time at these locations.

Grey shading indicates reaches of the Isaac River from which white-throated snapping turtle and Fitzroy River turtle have not been recorded, and where flow duration is significantly lower (i.e. 21 – 26% of the time) than reaches where these species have been recorded. Flow duration is even lower at Bee Creek (i.e. 18% of the time), indicating highly unsuitable habitat characteristics for white-throated snapping turtle and Fitzroy River turtle.

3 Matters of State Environmental Significance

3.1 Legislative Context

The *Environmental Offsets Act 2014* (the Offsets Act) outlines the framework for environmental offsets in Queensland. Environmental offsets compensate for unavoidable significant impacts on prescribed environmental matters and may be required as a condition of an authority or approval for a prescribed activity.

Prescribed activities and prescribed environmental matters are defined in Schedules 1 and 2, respectively, of the *Environmental Offsets Regulation 2014* (the Offsets Regulation). Prescribed Environmental Matters under Schedule 2 of the Offsets Regulation are referred to collectively as Matters of State Environmental Significance (MSES). All MSES are prescribed environmental matters, with the exception of some MSES in urban areas, including marine plants and waterways at risk of waterway barriers. This means that significant impacts to marine plants and waterways at risk of waterway barriers in urban areas cannot be offset.

MSES are also referred to in the State Planning Policy. One of the objectives of this policy is that MSES are valued and protected, and the health and resilience of biodiversity is maintained or enhanced to support ecological processes.

MSES relevant to aquatic ecology comprise:

- Regulated Vegetation: Regional Ecosystems under the *Vegetation Management Act 1999* that are also prescribed Regional Ecosystems under the *Vegetation Management Regulation 2012*, specifically:
  - Regional Ecosystems within a wetland on the vegetation management wetlands map under the *Vegetation Management Act 1999*
  - Regional Ecosystems located within a defined distance (as identified in the Environmental Offsets Policy) from the defining banks of a relevant watercourse (identified on the vegetation management watercourse and drainage feature map).
- Wetlands and Watercourses:
  - A wetland in a Wetland Protection Area as shown on the Map of Referable Wetlands under the *Environmental Protection Regulation 2019*
  - A High Ecological Significance (HES) wetland shown on the Map of Referable Wetlands under the *Environmental Protection Regulation 2019*

  - A wetland or watercourse in High Ecological Values waters as defined under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.
- Protected Wildlife Habitat:
  - A habitat for an animal that is endangered (aquatic) wildlife or vulnerable wildlife or a special least concern animal under the *Nature Conservation (Animals) Regulation 2020*
- Highly Protected Zones of State Marine Parks, meaning highly protected areas (i.e. conservation park zone, marine national park zone, preservation zone or other highly protected area) within relevant (i.e. Great Barrier Reef Coast Marine Park, Moreton Bay Marine Park, Great Sandy Marine Park) Queensland Marine Parks, under the *Marine Parks Act 2004*
- Fish Habitat Areas, as declared under the *Fisheries Act 1994*
- Waterway Providing for Fish Passage, meaning any part of a waterway providing for passage of fish only if the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway, with relevant definitions as per the *Fisheries Act 1994*.
- Marine Plants, as defined under the *Fisheries Act 1994*.
- Legally Secured Offset Areas, as defined under the *Environmental Offsets Act 2014*.

The regulatory framework established by the *Environmental Offsets Act 2014* therefore provides a mechanism for achievement of applicable objectives of the *Environmental Protection Act 1994*, *Nature Conservation Act 1992*, the *Vegetation Management Act 1999* and the *Fisheries Act 1992*, in so far as these acts relate to aquatic ecology in the context of development assessment at SWC. The role of the *Environmental Protection Act 1994* and the Environmental Protection (Water and Wetland Biodiversity) 2019 in defining and protecting Environmental Values for waters is discussed further in Section 4.

3.2 Assessment Methods

Searches of Queensland Globe and Queensland Government Environmental Reports were completed on 8 March 2024. Identified aquatic MSES were mapping using State Government mapping layers, with those that relate to aquatic matters were assessed further for likelihood of occurrence within the SWC Area and the Sandy Creek locale.

3.3 Results

3.3.1 Regional Ecosystems within a Wetland and within a Defined Distance of a Watercourse

Specific assessment of the Regional Ecosystem classification and conservation status is presented in the Terrestrial Ecology Report. However, riparian vegetation provides important functions for in-stream ecology, as summarised by Pusey & Arthington (2003), including buffering of inorganic material derived from catchment areas, stream bank stability, shading the stream (which regulates light environment and water temperature), and exchange of organic material (e.g. leaf litter and large woody debris that support food and provide habitat. The naturalness, longitudinal continuity and width of riparian vegetation determine the extent to which these functions are supported. The regulatory framework established by the *Environmental Offsets Act 2014* defines regulated riparian vegetation widths, and the extent of longitudinal continuity that can be disturbed without resulting in a Significant Residual Impact.

Within the Fitzroy River Basin, Regional Ecosystems are MSES relevant to aquatic ecology if they are within:

- 10 m of waterways of stream order 1 and 2
- 25 m of waterways of stream order 3 and 4, and
- 50 m of waterways of stream order 5 or greater.

Bee Creek is a stream order 6 system and Walker Creek is a stream order 5 system; thus, riparian vegetation with 50m of these waterways is a MSES relevant to aquatic ecology. Carborough Creek and Kemmis Creek are stream order 4 systems, and Sandy Creek is a stream order 3 system; thus, riparian vegetation with 25 m of these waterways is a MSES relevant to aquatic ecology. Riparian vegetation within 10m of smaller tributary systems is a MSES relevant to aquatic ecology.

Regulated vegetation within 100 m of a wetland occurs is isolated patches across the Project Area, with a concentration of these patches in the south-western portion of the Project Area (Map 3.1). Several patches of regulated vegetation within 100 m of a wetland occur in the Sandy Creek locale (Map 3.1). Several of these vegetation patches, including the patch in the upstream portion of the Sandy Creek locale coincide with farm dams rather than natural wetlands.

3.3.2 Wetlands in a Wetland Protection Area

Two patches of wetlands in a Wetland Protection Area occur in the south-western portion of the Project Area (Map 3.2).

There are no wetlands in a Wetland Protection Area within the Sandy Creek locale.

3.3.3 High Ecological Significance Wetlands

Two patches of High Ecological Significance (HES) wetland occur in the south-western portion of the Project Area (Map 3.3). The HES wetlands are mapped as having 'high' aquatic conservation values as assessed using AquaBAMM (Clayton et al. 2006a).

There are no HES wetlands within the Sandy Creek locale.

3.3.4 High Ecological Value Waters (Watercourses and Wetlands)

There are no High Ecological Values Waters (Watercourses or Wetlands) within or near the SWC Area or the Sandy Creek locale.

3.3.5 Protected Wildlife Habitat

As noted in Section 2, there is no suitable habitat for Fitzroy River turtle (*Rheodytes leukops*) or White-throated snapping turtle (*Elseya albagula*) within or near the SWC Area or the Sandy Creek locale. No other aquatic species listed under the *Nature Conservation (Animals) Regulation 2020* occur in or near the SWC Area or the Sandy Creek locale.

Therefore, there is no Protected Wildlife Habitat relevant to aquatic ecology in the SWC Area or the Sandy Creek locale.

3.3.6 State Marine Parks – Highly Protected Areas

Highly protected areas of State Marine Parks are not relevant for the current study.

3.3.7 Declared Fish Habitat Areas

Declared fish habitat areas are not relevant for the current study.

3.3.8 Waterways that Provide Fish Passage

The main stem of Bee Creek, Walker Creek, Kemmis Creek and Carborough Creek have high (red) to major (purple) risk of impact to fish passage by waterway barrier works, and Sandy Creek has moderate (amber) to high (red) risk of impact to fish passage by waterway barrier works (Map 3.4). Other moderately sized tributaries of Bee Creek, Walker Creek, Kemmis Creek and Carborough Creek also have moderate (amber) to high (red) risk of impact to fish passage by waterway barrier works, and small tributaries have low (green) risk of impact to fish passage by waterway barrier works.

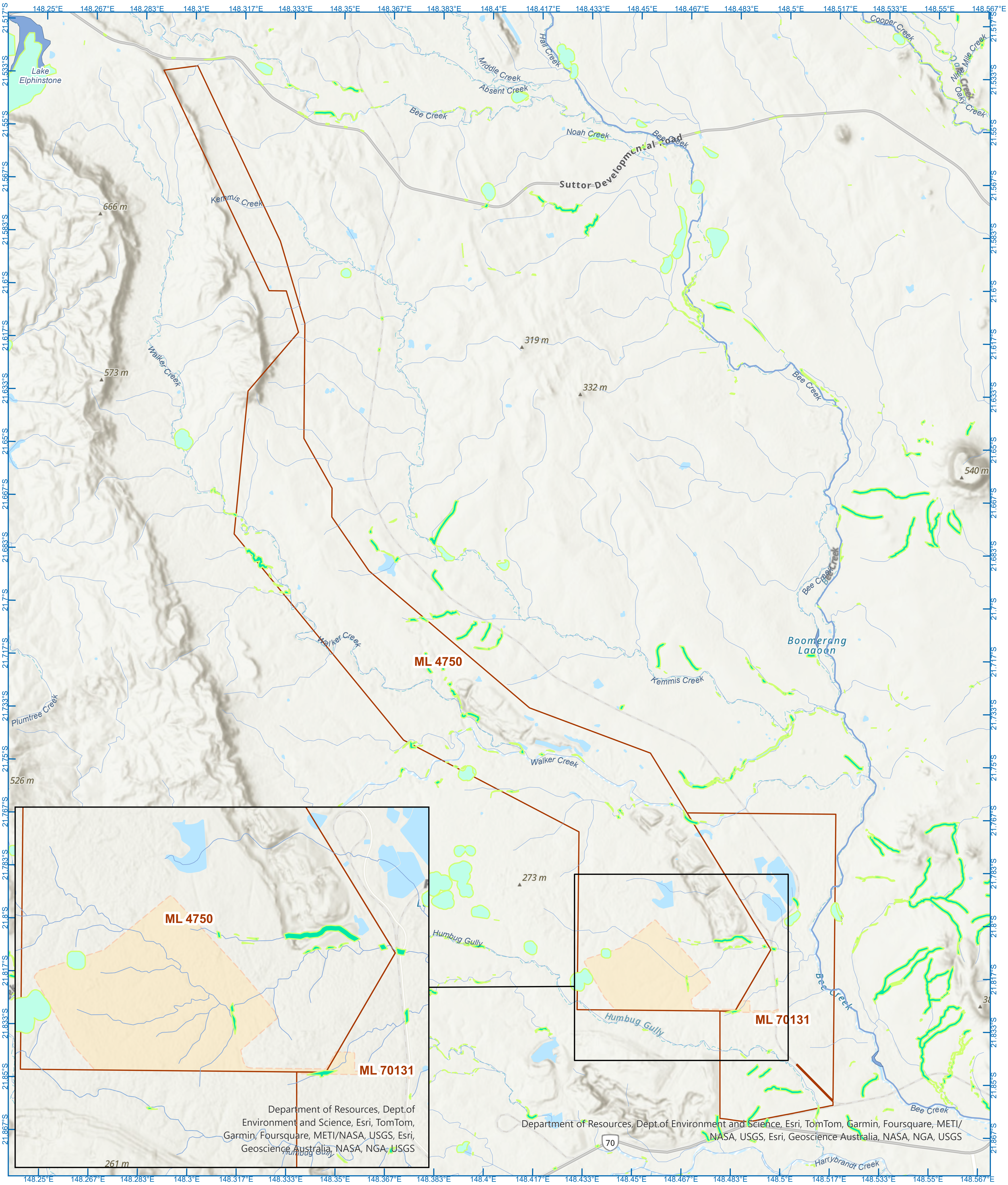
These waterways are dry for the majority of the time and survey data (see Section 4.3.1) indicates low abundance of a small number of common fish species have been recorded from these waterways. Therefore, these waterways are unlikely to provide migration pathways for large numbers of fish (in terms of both species and individuals), but rather provide temporary migration pathways for a moderate number of fish.

3.3.9 Marine Plants

Marine plants are not relevant for the current study.

3.3.10 Legally Secured Offset Areas

Legally secured offset areas that are relevant to aquatic ecology do not occur within or near the SWC Area or the Sandy Creek locale.

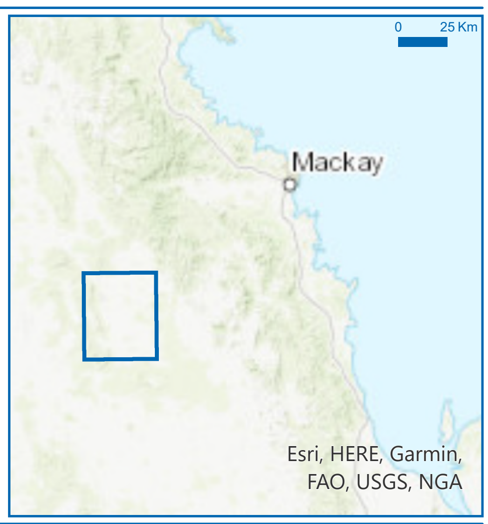


240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 3.1:
Regulated Vegetation within 100m of a Wetland.

LEGEND

- Mine lease boundary
- Sandy Creek Locale
- MSES regulated vegetation
- MSES regulated vegetation [category R- GBR riverine]
- MSES regulated vegetation [100m from wetland]
- Major Watercourse
- Minor Watercourse
- Lake/Reservoir



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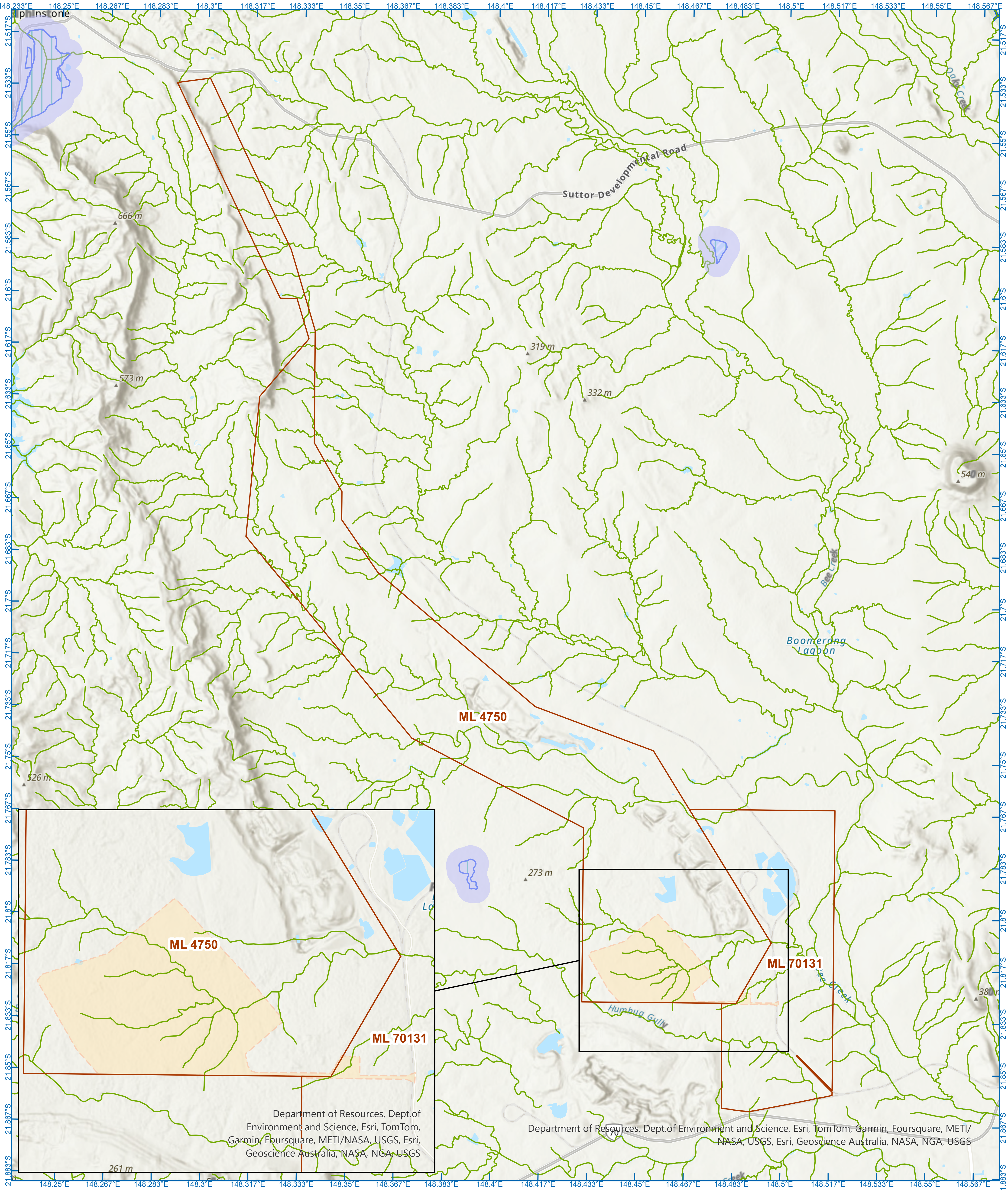


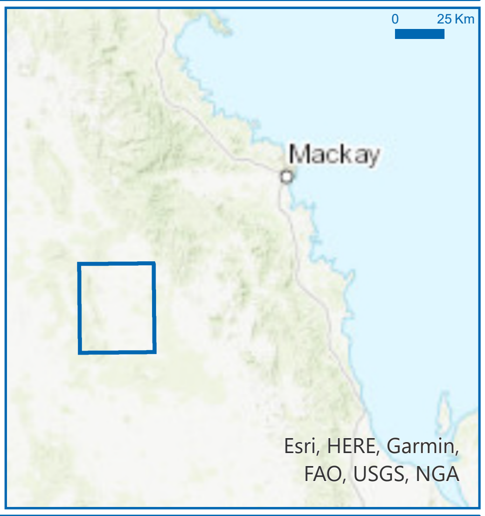
240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 3.2: Wetlands in a Wetland Protection Area and High Ecological Significance Wetlands.

LEGEND

GBR Wetland protection area
- GBR high ecological significance wetland
- GBR high ecological significance wetland trigger area

MSES wetland values
- MSES regulated vegetation [defined watercourse]
- MSES declared high ecological value waters [watercourse]
- MSES declared high ecological value waters [wetland]
- MSES high ecological significance wetlands
- MSES strategic environmental area [designated precinct]
- Mine lease boundary
- Sandy Creek Locale



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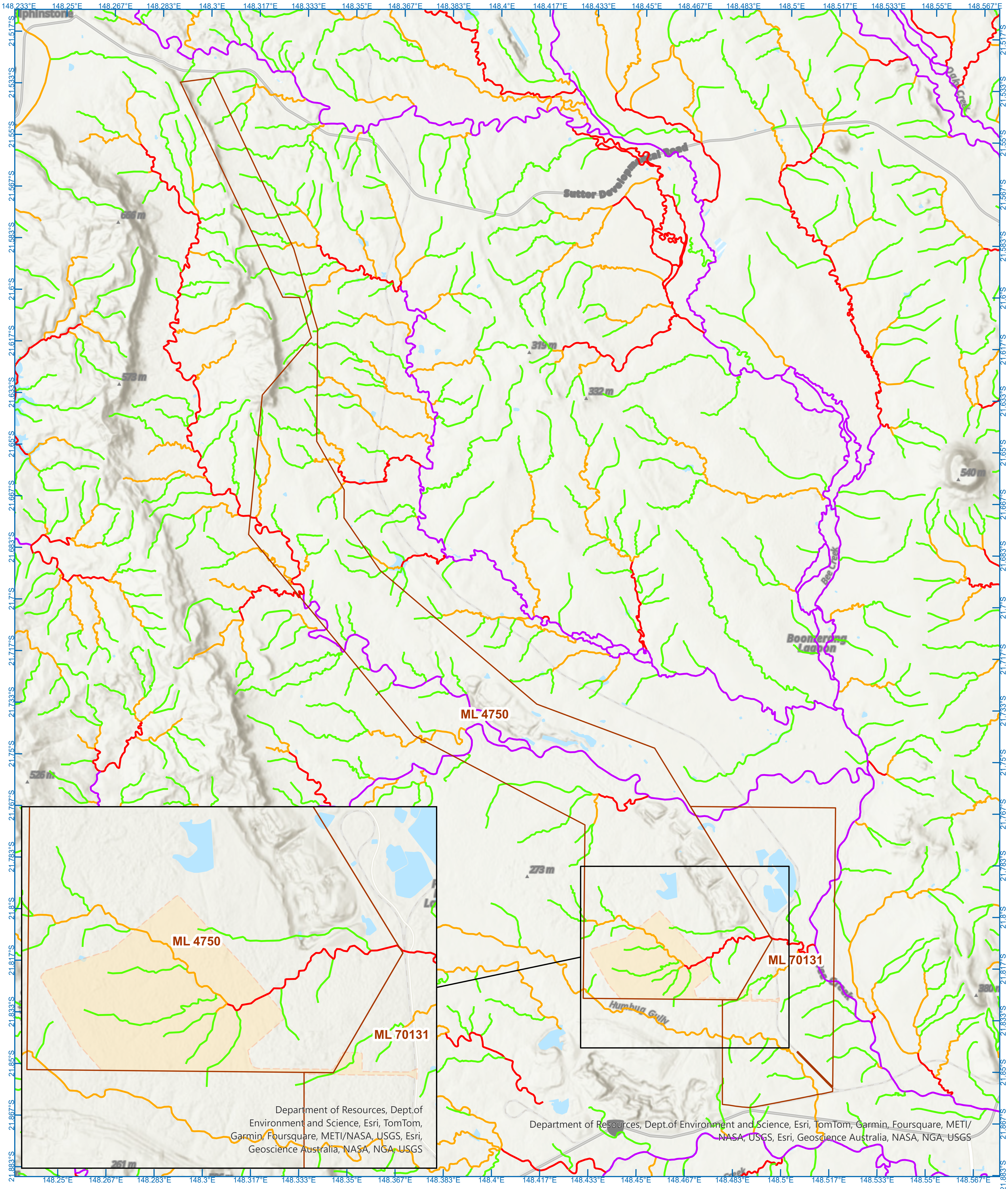


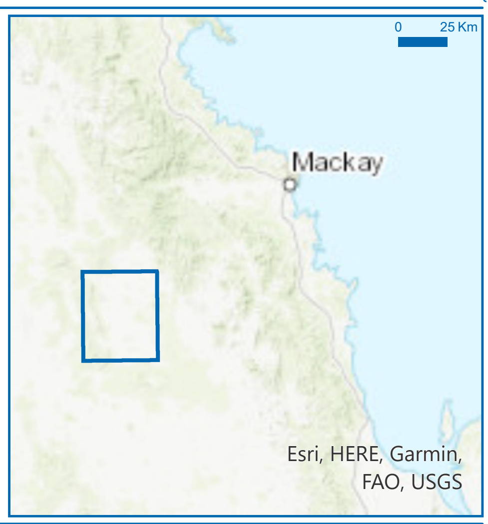
240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 3.4: Waterways that Provide Fish Passage.

LEGEND

- Mine lease boundary
- Sandy Creek Locale

Queensland waterways for waterway barrier works
- 1 Low
- 2 Moderate
- 3 High
- 4 Major
- 5 Major (Tidal)



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4 Other Aquatic Ecological Matters

4.1 Legislative Context

The *Environmental Protection Act 1994* provides for the protection of the Environmental Values (EVs) of waters (watercourses and wetlands), which is achieved via Environmental Protection (Water and Wetland Biodiversity) Policy 1999 (EPP). The EPP defines EVs and management goals for waters (including but not limited to High Ecological Value waters as discussed in Section 3), and indicators and Water Quality Objectives (WQO) for waters. EVs for waters include the protection of aquatic ecosystems.

The *Biosecurity Act 2014* (Biosecurity Act) seeks to manage risks associated with exotic pests (plants and animals, including noxious and invasive species) and diseases that impact plant and animal industries including aquaculture and wild capture fisheries, tourism, infrastructure including water supply, shipping, biodiversity, and the natural environment. The Biosecurity Act achieves its objective in a number of ways, including but not limited to:

- defining biosecurity matters (e.g. 'prohibited' biosecurity matters are species that are not yet known to be present in Queensland; 'restricted' biosecurity matters are known to be present in one or more regions of Queensland)
- establishing a general biosecurity obligation (GBO), which requires individuals and other entities to take all reasonable and practical measures to minimise the likelihood of causing a biosecurity risk.

4.2 Assessment Method

4.2.1 Desktop Assessment

Firstly, desktop assessment using available Government and Stanmore data was sourced to describe:

- aquatic habitat, using Stanmore data collected at REMP sites, and data from historical aquatic ecology surveys completed at SWC (Table 4.1 Table 4.2; Map 4.1)
- water quality, using Stanmore data recorded at gauging stations on Bee Creek and Sandy Creek and Receiving Environment Monitoring Program (REMP) sites, and data from historical aquatic ecology surveys completed at SWC (Table 4.1, Table 4.2; Map 4.1)

- flow regime, using Stanmore data recorded at gauging stations on Bee Creek (Table 4.1; Map 4.1)
- surface expression groundwater-dependent ecosystems (GDEs), using the GDE Atlas (BOM 2024) and verification using review of satellite imagery and aquatic habitat survey data
- aquatic biota (turtles, fish, macroinvertebrates and aquatic plants), using Atlas of Living Australia (ALA 2024), Environmental Reports Online (DES 2024a), Wetland Info (DES 2024b) and Stanmore data collected at REMP sites, and data from historical aquatic ecology surveys completed at SWC (Table 4.1, Table 4.2; Map 4.1).

Specifically, the historical REMP data that was synthesised was collected at 10 sites between 2015 and 2023 (Table 4.1; Map 4.1), and the historical aquatic ecology survey data was collected on February 2015, October 2020 and March 2021 (Table 4.2; Map 4.1).

Table 4.1 Sites sampled for the South Walker Creek Mine REMP.

Site	Description	Easting[a]	Northing[a]	Monitoring Data included in this Study
Reference Sites				
SCUS (MP2)	Sandy Creek upstream. Upstream of all South Walker Creek Mine activities.	651622	7586726	H, WQ, M
WCUS (MP1)	Walker Creek 4.28 km upstream of confluence with Carborough Creek. Upstream of all South Walker Creek Mine activities.	640907	7597509	H, WQ, M, F
CBCUS (MP6)	Carborough Creek upstream. Upstream of all South Walker Creek Mine activities.	644021	7595356	H, WQ, M, FL
BCUSS (MP4)	Bee Creek upstream, at Strathfield Road crossing. Upstream of all South Walker Creek Mine activities.	657796	7594896	H, WQ, M, F
KCUS	Kemmis Creek upstream at St Albans	644272	7601593	H, WQ, M
Receiving Environment Sites				
SCDS (MP5)	Sandy Creek downstream. Downstream of discharge location on Sandy Creek.	655723	7587584	H, WQ, M
WCDS (MP7)	Walker Creek downstream of Hail Creek Mine railway spur. Downstream of discharge location on Walker Creek.	653801	7592661	H, WQ, M, F
BCDSS (MP9)	Bee Creek immediately downstream of South Walker Creek Mine site.	657720	7584870	H, WQ, M

Site	Description	Easting[a]	Northing[a]	Monitoring Data included in this Study
BCDS (MP3)	Bee Creek downstream, at Peak Downs Highway. Downstream of all South Walker Creek Mine activities and discharge locations.	662632	7581570	H, WQ, M, F, FL
KCDS	Kemmis Creek downstream at Strathfield	653656	7596328	H, WQ, M

[a] Projection: GDA 94; Zone: 55k

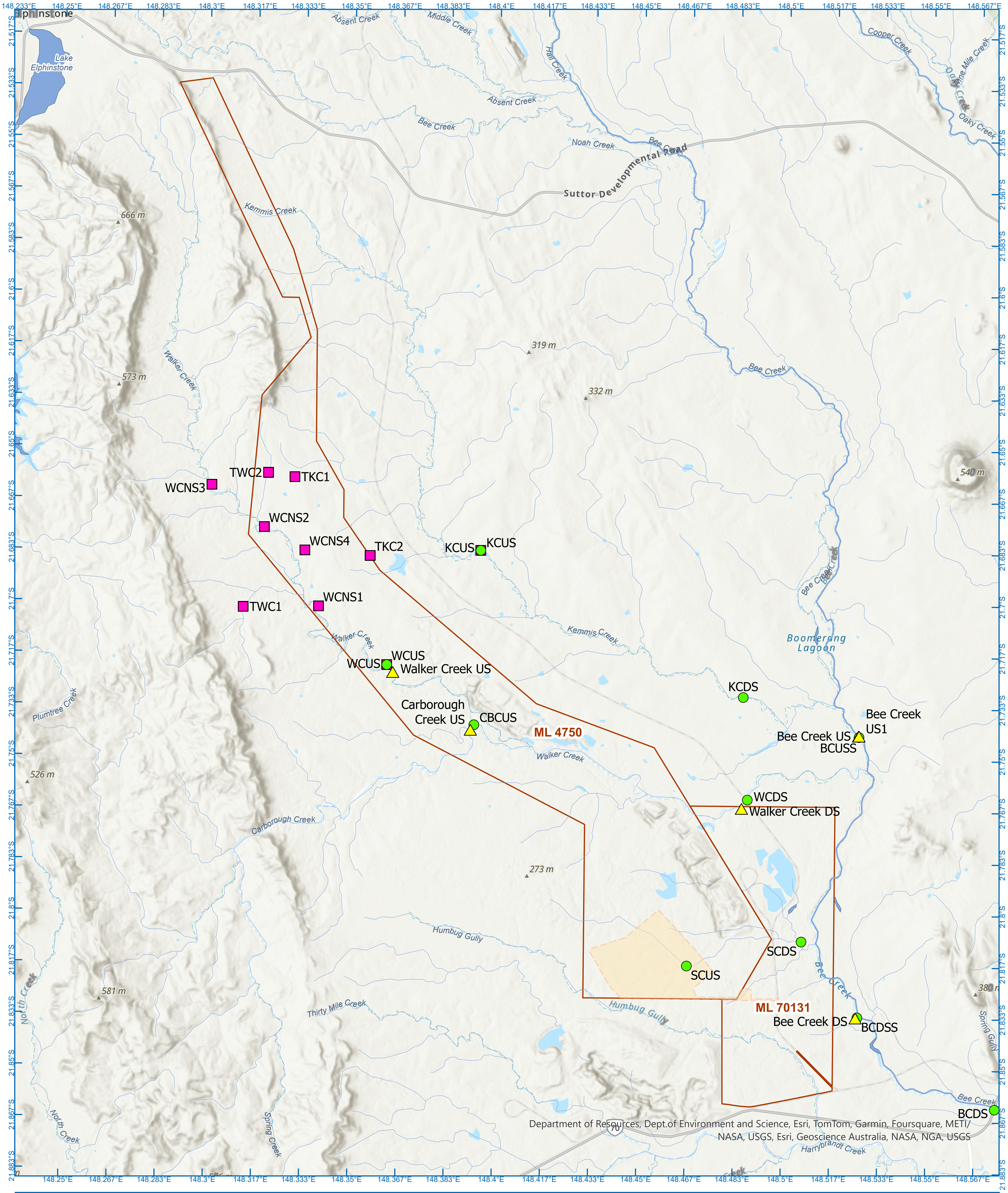
H – Habitat, WQ – Water Quality, M – Macroinvertebrates, F – Fish; FL - flow

Table 4.2 Sites surveyed for aquatic ecology in October 2020 and March 2021 for the Stage 1 ROM Uplift.

Site	Waterway	Easting[a]	Northing[a]	Components Monitored
WCNS1	Walker Creek new site 1	638466	7599607	H, P
WCUS	Walker Creek (REMP site)	640907	7597509	WQ, H, P, M, F, B
KCUS	Kemmis Creek (REMP site)	644272	7601593	WQ, H, P, M, F, B
WCNS4	Walker Creek new site 4	637978	7601611	H, P
TKC2	Tributary of Kemmis Creek 2	639741	7600871	H, P
WCNS2	Walker Creek new site 2	636528	7602443	H, P
TKC1	Tributary of Kemmis Creek 1	637623	7604230	H, P
TWC2	Tributary of Walker Creek 2	636677	7604384	H, P

[a] Projection: GDA 94; Zone: 55k

H – Habitat, WQ – Water Quality, M – Macroinvertebrates, F – Fish, P – Plants, B – Bioassessment



240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 4.1: Gauging Station, REMP Sites and Historical Survey Sites.

LEGEND

- Gauging stations
- SWC REMP sites
- Historical survey sites
- Sandy Creek Locale
- Mine lease boundary
- Major Watercourse
- Minor Watercourse
- Lake/Reservoir

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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

SCALE
0 0.5 1 2 3 4 5 6
Kilometres
Scale: 1:125,000 @ A3

Mackay

Esri, HERE, Garmin, FAO, USGS, NGA

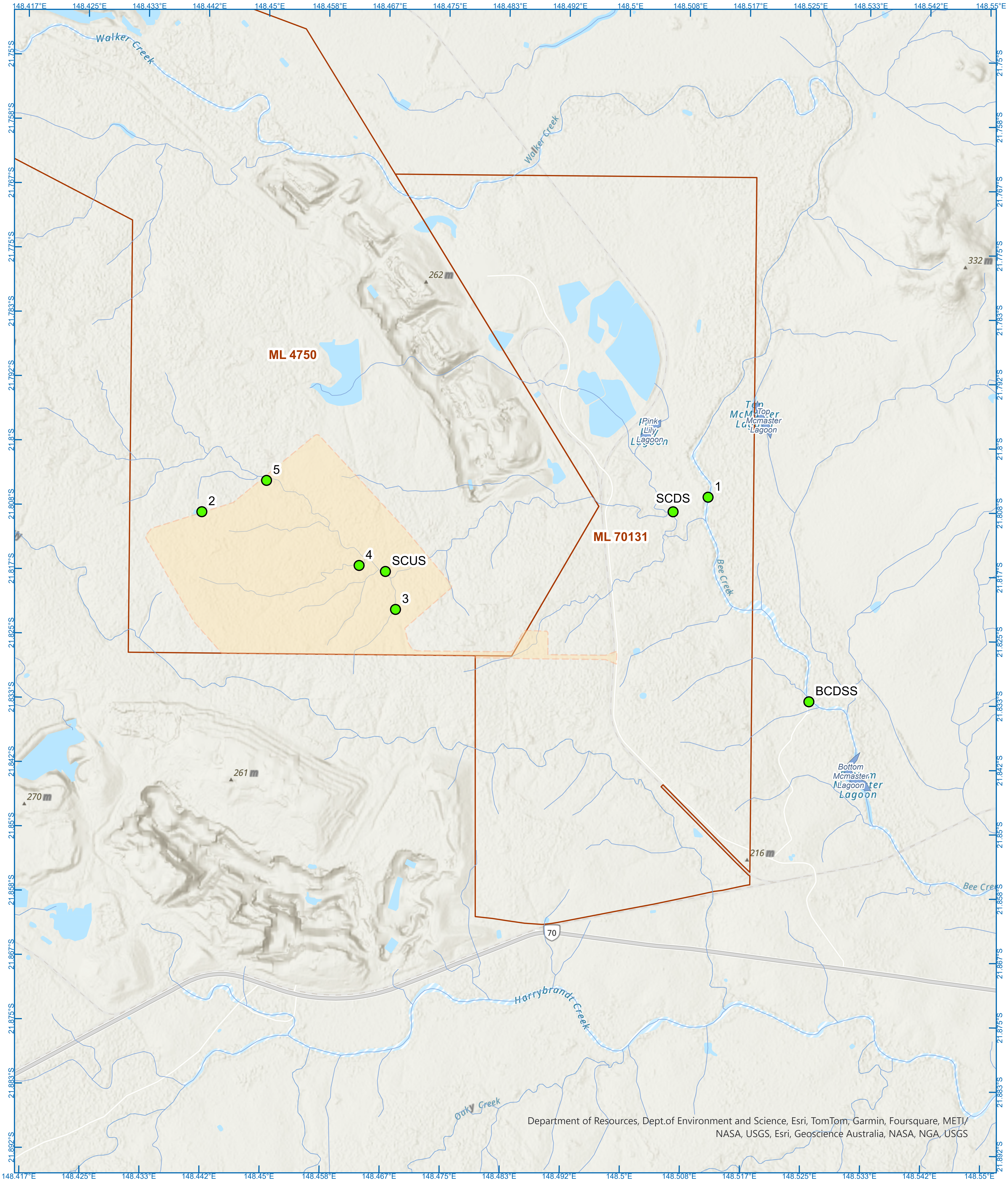
4.2.2 Field Survey of Sandy Creek Locale

Survey Design

Survey of aquatic ecology at eight sites within the Sandy Creek locale was conducted between 29 April – 3 May 2024 by suitably qualified persons (professional aquatic ecologists) (Table 4.3; Map 4.2). Field survey included water quality measurements, aquatic habitat, aquatic plant, macroinvertebrate, fish, and turtle assessments.

Table 4.3 Aquatic ecology sites surveyed in March 2024.

Site	Waterway	Latitude	Longitude
SCUS	Sandy Creek	-21.8166237	148.4667667
SCDS	Sandy Creek	-21.80853562	148.5065921
BCDSS	Bee Creek	-21.83297777	148.5256894
Site 1	Bee Creek	-21.80660132	148.5114246
Site 2	Tributary of Sandy Creek1	-21.80910502	148.4412231
Site 3	Tributary of Sandy Creek2	-21.82152991	148.4682169
Site 4	Tributary of Sandy Creek3	-21.81587667	148.4631081
Site 5	Sandy Creek	-21.80496954	148.4501584

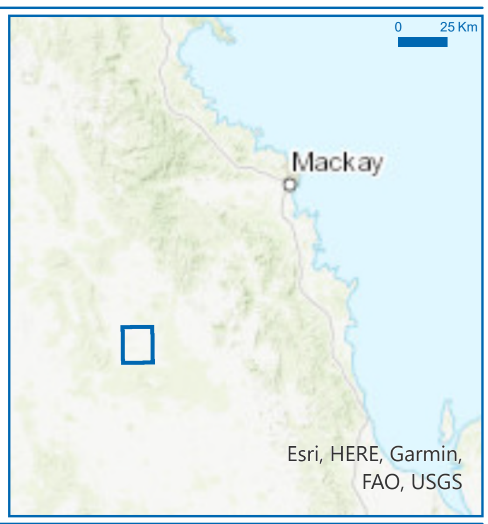


240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 4.2: Aquatic Ecology Sites Surveyed in April 2024.

LEGEND

- Survey sites
- Mine lease boundary
- Sandy Creek Locale
- Watercourse
- Lake/Reservoir



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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

N

SCALE

0 0.2 0.4 0.8 1.2 1.6 2 2.4

Kilometres

Scale: 1:50,000 @ A3

Environmental Conditions

Monthly rainfall data from the Bee Creek upstream gauging station [to be updated when recent rainfall data is available].

Flow Regime

Long-term hydrological data collected from gauging stations operated by Stanmore Coal in Bee Creek was collated and assessed. Flow regime was described from:

- flow duration curve, and
- historical daily flow data November 2016 and December 2021), which was graphed to assess antecedent patterns of flow, and the following flow statistics calculated from the raw data:
  - median daily flow
  - maximum daily flow, and
  - percentage of zero flow days.

Aquatic Habitat Survey

The in-stream habitat attributes and condition were assessed using a method based on the Australian River Assessment System (AUSRIVAS) protocol described in the Queensland Sampling and Processing Manual (DES 2018); see also DNRM (2001). The following parameters were assessed:

- channel shape and pattern
- bank slope, composition, stability, and vegetative cover
- bed substrate composition and stability
- in-stream habitat features, including submerged or emergent aquatic plants, large woody debris, undercut banks, boulders
- water velocity, depth and width, and continuity through the site, and
- riparian vegetation composition, extent, and condition.

A Riverine Bioassessment Score (DNRM 2001) was calculated for each site where macroinvertebrates were collected. This score is a numerical index of aquatic habitat condition that enables a direct comparison of habitat quality between sites. The method scores habitat quality for each of nine criteria (Table 2.3). The sum of the scores for each criterion gives the overall habitat score. This is used to allocate sites to one of four defined categories: excellent, good, moderate, and poor.

The Riverine Bioassessment method was designed for perennially flowing streams and rivers in southern Australia. Therefore, this method is not directly applicable to ephemeral systems in Queensland or non-flowing waterbodies, and even pristine ephemeral streams are rarely classed as being in excellent condition. Nonetheless, it is a useful system for comparison between sites where macroinvertebrates have been collected within a region.

Existing disturbances to riparian vegetation, bed and bank stability, flow and instream habitat were noted, including the presence of any existing barriers to fish passage. Photographs of aquatic habitat were taken to establish a record of current condition.

Table 4.4 Riverine Habitat Bioassessment Criteria and Scores, and Overall Aquatic Habitat Quality Categories.

Habitat Category	Category Score Range			
	Excellent	Good	Moderate	Poor
Bed substrate or available cover	16–20	11–15	6–10	0–5
Embeddedness	16–20	11–15	6–10	0–5
Water velocity and depth	16–20	11–15	6–10	0–5
Channel alteration	12–15	8–11	4–7	0–3
Bed scouring & deposition	12–15	8–11	4–7	0–3
Pool:riffle and run:bend ratio	12–15	8–11	4–7	0–3
Bank stability	9–10	6–8	3–5	0–2
Bank vegetative stability	9–10	6–8	3–5	0–2
Streamside vegetation cover	9–10	6–8	3–5	0–2
Total (Habitat Bioassessment Score for the Site)	**111–135**	**75–110**	**39–74**	**0–38**

Water Quality Survey

Water quality was measured in situ for temperature, pH, electrical conductivity and dissolved oxygen using a calibrated AquaTroll 400 meter. Turbidity was measured using a HACH 2100Q portable turbidity meter. Measurements were taken as close to the mid-channel as possible and 0.3 m below the surface.

Water quality results were tabulated and compared to Water Quality Objectives (WQOs) scheduled under the EPP (Water and Wetland Biodiversity) Policy 2019 for moderately disturbed waters for Central Tributaries of the Connors River Sub-basin (DEHP 2013) (Table 4.5). Water quality results were also interpreted with reference to the Commonwealth Government's Assessing and Managing Water Quality in Temporary Streams (ANZG 2020).

Table 4.5 Water Quality Objectives for Moderately Disturbed Waters in Connors River Catchment Waters.

Parameter	Unit	Water Quality Objective
Temperature	°C	-
Electrical conductivity	µS/cm	Baseflow: 430 High flow: 250
pH	unit	6.5-8.5
Dissolved oxygen	% saturation	85-110
Dissolved oxygen	mg/L	-
Turbidity	NTU	50

Turtle Survey

Turtles were surveyed using fyke nets and baited cathedral traps in accordance with the Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al. 2022) and the Commonwealth's Survey Guidelines for Australia's Threatened Reptiles (DSEWPC 2011b). Specimens were identified to species by experienced aquatic ecologists and native species released unharmed at the location of capture. Survey effort is presented in Table 4.6.

Raw turtle data was tabulated, and the conservation status of each species discussed.

Fish Survey

Fish were surveyed using back pack electrofishing, fyke nets and/or seine nets as appropriate for the site conditions in accordance with recommendations in the Commonwealth Government's Survey Guidelines for Australia's Threatened Fish (DSEWPC 2011a). Fishes were sampled under General Fisheries Permit and Animal Ethics Approval held by frc environmental. Fishing effort at each site (not including dry sites) is presented in Table 4.6.

Fish were identified to species and counted, with native species released unharmed to the place of capture and pest species euthanised using methods approved under our animal ethics approval.

For native species we noted migration pattern, conservation status and fisheries value, and for pest species we noted biosecurity classification.

Table 4.6 Fish and turtle survey effort.

Site	Method	Date In	Time In	Date Out	Time Out	Effort
BCDSS	fyke net	29/04/2024	14:00	30/04/2024	9:00	38 h
Site 1	fyke nets	30/04/2024	14:50	1/05/2024	16:30	51.33 h
	box traps	30/04/2024	14:50	1/05/2024	16:30	128.33 h
	cathedral traps	30/04/2024	14:50	1/05/2024	16:30	52.33 h
Site 2	seine net	2/05/2024	8:30	2/05/2024	8:45	1x 10m haul
	fyke nets	1/05/2024	11:30	2/05/2024	9:10	43.33 h
	box traps	1/05/2024	11:30	2/05/2024	9:10	108.33 h
	cathedral traps	1/05/2024	11:30	2/05/2024	9:10	43.33 h

Macroinvertebrate Survey

Macroinvertebrates were sampled from bed and edge habitat at each site holding water during the field survey using the AUSRIVAS sampling method as described in the Queensland AUSRIVAS manual (DNRM 2001) and the Monitoring and Sampling Manual (DES 2018). Samples were collected by disturbing a 10 m long section of bed or edge habitat with a standard triangular-framed dip net (250 µm mesh size), preserved using ethanol, and transported to frc environmental's biological laboratory.

In the laboratory, samples were sorted, identified to the lowest practical taxonomic level (in most instances family) and counted in accordance with Chessman (2003). For QA/QC procedures, macroinvertebrates in 10% of the samples were re-identified and re-counted and 10% of the data was re-entered by an ecologist other than the one who completed the original identifications and data entry. If any errors were found, then this process was repeated until no errors are found or they were within the accepted range (< 5% (DES 2018); noting that final error rates in our laboratory are consistently < 2%).

Standard freshwater macroinvertebrate indices were calculated for macroinvertebrate communities: taxonomic richness, PET (Plecoptera / Ephemeroptera / Trichoptera) richness, SIGNAL 2 (Stream Invertebrate Grade Number – Average Level) scores and percent tolerant taxa.

Raw macroinvertebrate data, and macroinvertebrate indices, were tabulated, and macroinvertebrate indices were compared to biological guidelines presented in scheduled under the EPP (Water and Wetland Biodiversity) Policy 2019 for moderately disturbed freshwaters in Central Tributaries of the Connors River Sub-basin (Table 4.7).

Table 4.7 Biological guidelines for macroinvertebrate indices for moderately disturbed freshwaters in the Connors River Sub-basin.

Index	Guideline		Description
	Bed/Composite Habitat	**Edge Habitat**	
Taxonomic richness	12 – 21	23 – 33	Taxa richness is the number of aquatic macroinvertebrate families collected in a sample
PET richness	2 – 5	2 – 5	Number of aquatic macroinvertebrate families collected in a sample from the Ephemeroptera (mayfly), Trichoptera (caddisfly) and Plecoptera (stonefly) order, which are sensitive to disturbance
SIGNAL-2 score	3.33 – 3.85	3.31 – 4.20	SIGNAL: stream invertebrate grade number average level; a measure of how sensitive the macroinvertebrate community is to disturbance (ranges 1 to 10, with numbers closer to 10 having high sensitivity to disturbance)
% tolerant taxa	25 – 50	44 – 56	The per cent tolerant taxa index is calculated from SIGNAL grade numbers. Taxa with SIGNAL grade numbers of 3 or less are designated as tolerant (Marshall et al. 2001), and the number of these tolerant taxa are compared to the overall taxa count and expressed as a percentage.

Aquatic Plant Survey

Aquatic plants were surveyed at each site using a timed meander survey (i.e. 15 – 20 minutes per site) across in-stream and riparian habitats, as recommended in the Queensland Government's *Flora Survey Guidelines – Protected Plants* (DES 2020). Plants were identified to species level if they were flowering, otherwise they were identified to genus. It was noted if plants are growing in the water, or in dry in-stream or riparian areas. The growth form of plants growing in water was also recorded (Table 4.8).

Raw aquatic plant data was tabulated, noting growth form and location with reference to water (i.e. in water, or on dry bed or bank). Any conservation significant aquatic plant species indicated by the survey species was noted, and the biosecurity classification of any aquatic weed was noted.

Table 4.8 Growth forms of aquatic plants growing in water.

Growth Form	Description
Submerged	Submerged aquatic plants are rooted in the bed of the stream or wetland, with leaves totally covered by water most of the time. Some species may have underwater flowers, whereas other species may require water levels to decrease to trigger flowering and have flowers above the water level.
Attached floating	Attached floating aquatic plants are rooted in the bed of the stream or wetland, with leaves typically floating on top of the water. Flowers are usually above the water.
Free floating	Free floating plants float on top of the water, or in the water column, with roots trailing into the water column. Flowers are typically above the water.
Emergent	Emergent plants are rooted in the bed of the stream or wetland, with leaves and flowers above the water.

4.3 Results

4.3.1 Aquatic Habitat

Desktop Assessment

Aerial imagery indicates that waterways of the SWC Area are generally dry comprising dry sandy channel for most of the time. Mine water dams within the SWC Area are mapped under the Queensland Wetland Mapping layer as lacustrine wetlands, and farm dams and natural wetlands that are concentrated in the south-western part of the SWC Area are mapped as palustrine wetlands (Map 4.3)., and there is little floodplain development surrounding waterways.

The existing survey data shows also that waterway sites of the SWC Area are on ephemeral waterways, with dry sandy beds and limited potential aquatic habitat present (Table 4.9):

- sites mostly consisted of well-defined channels, with mildly sinuous to irregularly meandering patterns. Banks ranged from low (0.5 m) to high (>6 m) and from flat to vertical, and sections of bank erosion were common throughout the SWC Area
- sites are often totally dry, or when water is present it is generally restricted to shallow isolated pools

- channel substrates are dominated by sand with small percentages of larger substrates (boulder, cobble, pebble and gravel), and some sites having small sections of bedrock exposed due to channel erosion
- habitat features are limited, with sandy beds generally providing little potential aquatic habitat. Exposed tree roots, large woody debris and undercut banks are present at some sites, and would provide some aquatic habitat at times the sites hold water. Aquatic plant species were of emergent growth form and at low densities at some sites, although aquatic plants are absent from many sites
- riparian vegetation was generally comprised of a native canopy (e.g. Eucalyptus and Casuarina) and an understory comprised of weeds and terrestrial grasses. Trees in riparian zones also tended to be moderately to extensively cleared for grazing (i.e. canopy layer sparse and / or discontinuous), and
- sites have moderate to high levels of disturbance, with clearing of riparian vegetation for grazing, and erosion of the surrounding landscape the most common disturbances.

Table 4.9 Habitat cards

<table>
<tr><td>Site: SCUS</td><td>Survey dates:</td><td>10 February 2015
30 April 2016
1 June 2017
12 June 2018
14 May 2019
1 June 2020
22 March 2021
15 June 2022
8 March 2023</td><td colspan="2">Site Photos</td></tr>
<tr><td>Waterway: Sandy Creek Upstream
Stream order: 2
Mapped ecological value: nil

Channel pattern: Mildly sinuous
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 – 2 m
Continuity of water: isolated pools/dry
Bed substrate: 10% gravel, 90% sand</td><td colspan="2">Basin: Isaac River
Waterway barrier risk: high (red)

Channel width: 5 m
Bank height, slope and stability:
LB: 2 m, moderate slope, stable
RB: 2 m, moderate slope, stable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: stable</td><td>
February 2015</td><td>
April 2016</td></tr>
<tr><td>In-stream habitat features: site dry
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grass/weeds dominate ground stratum
Riparian width: 5 m
Riparian vegetation canopy: Eucalypt, Casuarina and Melaleuca
Riparian vegetation ground stratum: terrestrial grasses, blue billygoat weed

Aquatic plants in water: nil
Adjacent land uses: cattle grazing, coal mine
Existing site disturbances: terrestrial weeds, clearing, cattle</td><td colspan="2">
June 2017</td><td>
June 2018</td><td>
May 2019</td></tr>
<tr><td>
June 2020</td><td colspan="2">
March 2021</td><td>
June 2022</td><td>
March 2023</td></tr>
</table>

Site: WCUS

Survey dates:
10 February 2015
1 May 2016
1 June 2017
11 June 2018
13 May 2019
2 June 2020
22 March 2021
16 June 2022
8 March 2023

Site Photos

Waterway: Walker Creek Upstream
Stream order: 4
Mapped ecological value: nil

Channel pattern: irregular / mildly sinuous
Channel cross-section shape: U-shape

Flow regime: ephemeral
Wetted width: 0 – 7 m
Continuity of water: isolated pool
Bed substrate: little boulder, little cobble, little gravel, extensive sand, some silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 12 m
Bank height, slope and stability:
LB: 5 m, moderate – steep slope, moderately stable
RB: 2 m, low – moderate slope, stable

Average and maximum water depth: 0.2 m; 0.5 m
Flow velocity: <0.01 m/s

Bed stability: moderate aggradation


February 2015


May 2016

In-stream habitat features: shallow, isolated pool, small woody debris, little in-stream plants, tree roots, some trailing bank vegetation, terrestrial leaves and twigs
Aquatic plants on dry bed or bank: *Cyperus* sp.

Riparian vegetation condition: heavily cleared; grass/weeds dominate ground stratum
Riparian width: 5 – 10 m
Riparian vegetation canopy: Casuarina and Eucalypt
Riparian vegetation ground stratum: terrestrial grasses, weeds, juvenile Casuarina and Eucalypt

Aquatic plants in water: *Cyperus* sp.
Adjacent land uses: Coal mine
Existing site disturbances: Raised bed crossing 0.5km US of site. Weeds, including *Parthenium*


June 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: CBCUS

Survey dates:
10 February 2015
1 May 2016
1 June 2017
11 June 2018
13 May 2019
2 June 2020
24 March 2021
15 June 2022
8 March 2023

Site Photos

Waterway: Carborough Creek Upstream
Stream order: 4
Mapped ecological value: nil

Channel pattern: Mildly sinuous
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 – 2 m
Continuity of water: small, isolated pools
Bed substrate: little gravel, extensive sand, some silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 15 m
Bank height, slope and stability:
LB: 5 m, low slope, stable
RB: 5 m, moderate slope, stable

Average and maximum water depth: 0.1 m; 0.8 m
Flow velocity: <0.01 m/s

Bed stability: moderate aggradation


February 2015


May 2016

In-stream habitat features: shallow isolated pools, large and small woody debris, leaves and twigs, tree roots, undercut banks
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: cleared; grass dominate ground stratum with some remnant large trees
Riparian width: 5 m
Riparian vegetation canopy: Eucalypt, Casuarina, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, weeds, cattle grazing


June 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: BCUSS

Survey dates: 11 February 2015; 30 April 2016; 1 June 2017; 12 June 2018; 14 May 2019; 2 June 2020; 23 March 2021; 16 June 2022; 9 March 2023

Site Photos

Waterway: Bee Creek Upstream
Stream order: 5
Mapped ecological value: nil

Channel pattern: Irregular
Channel cross-section shape: U-shape

Flow regime: ephemeral
Wetted width: 3 m
Continuity of water: isolated pool
Bed substrate: little boulder, some cobble, some pebble, some gravel, little sand, moderate silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 7 m
Bank height, slope and stability:
LB: 3 m, moderate slope, moderately stable
RB: 5 m, steep slope, unstable

Average and maximum water depth: 0.2 m; 0.6 m
Flow velocity: <0.01 m/s

Bed stability: stable


February 2015


April 2016

In-stream habitat features: shallow isolated pool, large and small woody debris, leaves and twigs, man-made debris
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: cleared; grass/weeds dominate ground stratum
Riparian width: 5 – 8 m
Riparian vegetation canopy: Eucalypt, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses, *Ruellia simplex*

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: raised bed crossing/culverts at site, clearing, weeds including *Ruellia simplex*


June 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: KCUS	**Survey dates:** 30 April 2016 1 June 2017 11 June 2018 14 May 2019 2 June 2020 23 March 2021 16 June 2022 9 March 2023	**Site Photos**	
Waterway: Kemmis Creek Upstream **Stream order:** 4 **Mapped ecological value**: nil **Channel pattern:** Irregular meanders **Channel cross-section shape**: U-shape **Flow regime**: ephemeral **Wetted width**: 0 – 6 m **Continuity of water**: Isolated pool **Bed substrate:** 20% boulder, 10% cobble, 10% pebble, 20% gravel, 30% sand, 10% silt/clay	**Basin:** Isaac River **Waterway barrier risk**: major (purple) **Channel width**: 8 m **Bank height, slope and stability**: LB: 5 m, steep slope, unstable RB: 5 m, moderate slope, moderately unstable **Average and maximum water depth**: 0.5 m; 0.7 m **Flow velocity**: <0.01 m/s **Bed stability**: stable	2015 - No photo	2016 - No photo
In-stream habitat features: shallow pool, large and small woody debris, undercut banks, some trailing bank vegetation, man-made structures, rock faces/boulders, tree roots **Aquatic plants on dry bed or bank**: nil **Riparian vegetation condition:** heavily cleared; grass/weeds dominate ground stratum **Riparian width**: 5 m **Riparian vegetation canopy**: Eucalypt and Casuarina **Riparian vegetation ground stratum:** terrestrial grasses and weeds **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing **Existing site disturbances:** pipe culvert/bridge at site, clearing, weeds including *Parthenium* and Mexican poppy	 June 2017	 June 2018	 May 2019
 June 2020	 March 2021	 June 2022	 March 2023

<table>
<tr><td>Site: SCDS</td><td>Survey dates:</td><td>11 February 2015
30 April 2016
31 May 2017
12 June 2018
14 May 2019
1 June 2020
22 March 2021
16 June 2022
9 March 2023</td><td colspan="2">Site Photos</td></tr>
<tr><td>Waterway: Sandy Creek Downstream
Stream order: 3
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: U-shape

Flow regime: ephemeral
Wetted width: 0 – 3 m
Continuity of water: isolated pools/dry
Bed substrate: some pebble, some gravel, extensive sand, some silt/clay</td><td colspan="2">Basin: Isaac River
Waterway barrier risk: high (red)

Channel width: 6 m
Bank height, slope and stability:
LB: 2 m, steep slope, moderately stable
RB: 2 m, moderate slope, moderately stable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: stable</td><td>
February 2015</td><td>
April 2016</td></tr>
<tr><td>In-stream habitat features: dry, large and small woody debrisman-made debris, leaves and twigs, tree roots
Aquatic plants on dry bed or bank: Cyperus sp.

Riparian vegetation condition: cleared; grass dominate ground stratum
Riparian width: 2 – 5 m
Riparian vegetation canopy: Eucalypt, Casuarina, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing, coal mine
Existing site disturbances: weeds including snake weed, cattle grazing</td><td colspan="2">
May 2017</td><td>
June 2018</td><td>
May 2019</td></tr>
<tr><td>
June 2020</td><td colspan="2">
March 2021</td><td>
June 2022</td><td>
March 2023</td></tr>
</table>

Site: WCDS

Survey dates: 11 February 2015; 30 April 2016; 31 May 2017; 12 June 2018; 14 May 2019; 1 June 2020; 23 March 2021; 16 June 2022; 9 March 2023

Waterway: Walker Creek Downstream
Stream order: 5
Mapped ecological value: nil

Channel pattern: Mildly sinuous
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 - 2.5 m
Continuity of water: isolated pool
Bed substrate: extensive sand, little silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 13 m
Bank height, slope and stability:
LB: 5 m, moderate slope, stable
RB: 5 m, moderate slope, stable

Average and maximum water depth: 0.2 m; 1 m
Flow velocity: <0.01 m/s

Bed stability: stable

In-stream habitat features: shallow isolated pool, large and small woody debris, leaves and twigs, man-made debris
Aquatic plants on dry bed or bank: *Lomandra longifolia*

Riparian vegetation condition: cleared; grass dominate ground stratum
Riparian width: 5 - 10 m
Riparian vegetation canopy: Eucalypt, Casuarina, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: bridge downstream, clearing, cattle grazing

Site Photos


February 2015


April 2016


May 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: BCDSS

Survey dates:
12 February 2015
30 April 2016
31 May 2017
12 June 2018
14 May 2019
3 June 2020
24 March 2021
16 June 2022
9 March 2023

Site Photos

Waterway: Bee Creek Downstream
Stream order: 6
Mapped ecological value: nil

Channel pattern: irregular
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 – 10 m
Continuity of water: isolated pools
Bed substrate: little pebble, little gravel, extensive sand

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 20 m
Bank height, slope and stability:
LB: 10 m, moderate slope, moderately unstable
RB: 10 m, moderate slope, moderately unstable

Average and maximum water depth: 0.1 m; 0.7 m
Flow velocity: <0.01 m/s

Bed stability: stable

February 2015

April 2016

In-stream habitat features: shallow pools, small and large woody debris, leaves and twigs, overhanging banks, trailing bank vegetation
Aquatic plants on dry bed or bank: *Cyperus exaltatus*

Riparian vegetation condition: cleared, grass dominate ground stratum
Riparian width: 5 – 12 m
Riparian vegetation canopy: Eucalypt, Casuarina, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: grazing
Existing site disturbances: grazing

May 2017

June 2018

May 2019

June 2020

March 2021

June 2022

March 2023

Site: BCDS

Survey dates:
9 February 2015
28 April 2016
31 May 2017
12 June 2018
14 May 2019
3 June 2020
23 March 2021
15 June 2022
9 March 2023

Site Photos

Waterway: Bee Creek Downstream
Stream order: 6
Mapped ecological value: nil

Channel pattern: straight
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 10 m
Continuity of water: connected pool in channel
Bed substrate: little cobble, little pebble, little gravel, extensive sand, some silt/clay

Basin: South Johnstone River
Waterway barrier risk: major (purple)

Channel width: 10 m
Bank height, slope and stability:
LB: 10 m, steep slope, moderately stable
RB: 1 m, steep slope, moderately stable

Average and maximum water depth: 0.5 m; 1 m
Flow velocity: <0.01 m/s

Bed stability: stable


February 2015


April 2016

In-stream habitat features: shallow and deep pool, large and small woody debris, undercut banks, leaves and twigs, tree roots, trailing roots
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: cleared; grass dominate ground stratum
Riparian width: 10 m
Riparian vegetation canopy: Eucalypt, Melaleuca, Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing, highway
Existing site disturbances: highway bridge at site, clearing


May 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: KCDS

Survey dates: 30 April 2016; 1 June 2017; 12 June 2018; 14 May 2019; 2 June 2020; 23 March 2021; 16 June 2022; 9 March 2023

Site Photos

Waterway: Kemmis Creek Downstream
Stream order: 4
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: U-shape

Flow regime: ephemeral
Wetted width: 2 - 4 m
Continuity of water: isolated pool
Bed substrate: little bedrock, little boulder, some cobble, some pebble, moderate gravel, little sand, little silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 15 m
Bank height, slope and stability:
LB: 7 m, steep slope, moderately unstable
RB: 7 m, steep slope, moderately unstable

Average and maximum water depth: 0.1 m; 0.2 m
Flow velocity: 0 m/s

Bed stability: stable

2015 – No photo

2016 – No photo

In-stream habitat features: shallow isolated pool, tree roots, small and large woody debris, undercut banks, leaves and twigs, rocks and boulders
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 5 m
Riparian vegetation canopy: Eucalypt, Melaleuca
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: raised bed level crossing at site, clearing, cattle grazing


June 2017


June 2018


May 2019


June 2020


March 2021


June 2022


March 2023

Site: WCNS1	**Survey dates:**	27 October 2020 26 March 2021	**Site Photos**	
			Downstream	**Upstream**
Waterway: Walker Creek New Site 1 **Stream order:** 4 **Mapped ecological value**: nil **Channel pattern:** Irregular meanders **Channel cross-section shape**: flattened U-shape **Flow regime**: ephemeral **Wetted width**: 0 m **Continuity of water**: dry **Bed substrate:** extensive sand, some silt/clay	**Basin:** Isaac River **Waterway barrier risk**: major (purple) **Channel width**: 10 m **Bank height, slope and stability**: LB: 5 m, steep slope, moderately unstable RB: 5 m, steep slope, moderately unstable **Average and maximum water depth**: 0 m; 0 m **Flow velocity**: 0 m/s **Bed stability**: moderate aggradation		 October 2020	 October 2020
In-stream habitat features: dry at time of survey, tree roots, branches, leaves and twigs **Aquatic plants on dry bed or bank**: nil **Riparian vegetation condition:** heavily cleared; grasses dominate ground stratum **Riparian width**: 7 – 12 m **Riparian vegetation canopy**: Eucalypt, Casuarina **Riparian vegetation ground stratum:** terrestrial grasses **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing **Existing site disturbances:** clearing, cattle grazing, weeds including *Parthenium* and Noogoora burr			 March 2021	 March 2021

<table>
<tr><td>Site: WCNS3</td><td>Survey dates:</td><td>28 March 2021</td><td colspan="2">Site Photos</td></tr>
<tr><td></td><td></td><td></td><td>Downstream</td><td>Upstream</td></tr>
<tr><td>Waterway: Walker Creek New Site 3
Stream order: 2
Mapped ecological value: nil

Channel pattern: mildly sinuous
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: little gravel, extensive sand, little silt/clay</td><td colspan="2">Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 8 m
Bank height, slope and stability:
LB: 7 m, moderate slope, moderately stable
RB: 7 m, moderate slope, moderately stable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: moderate aggradation</td><td>October 2020 - not surveyed</td><td>October 2020 - not surveyed</td></tr>
<tr><td>In-stream habitat features: dry at times of survey
Aquatic plants on dry bed or bank: Cyperus sp., Lomandra longifolia, Juncus usitatus

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 5 – 8 m
Riparian vegetation canopy: Eucalypt, Melaleuca, Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, weeds including Noogoora burr and Lantana</td><td colspan="2"></td><td>
March 2021</td><td>
March 2021</td></tr>
</table>

<table>
<tr><td>Site: WCNS4</td><td>Survey dates:</td><td>28 October 2020
28 March 2021</td><td colspan="2">Site Photos</td></tr>
<tr><td></td><td></td><td></td><td>Downstream</td><td>Upstream</td></tr>
<tr><td>Waterway: Walker Creek New Site 4
Stream order: 1
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: little cobble, some pebble, moderate gravel, extensive sand</td><td colspan="2">Basin: Isaac River
Waterway barrier risk: minor (green)

Channel width: 4 m
Bank height, slope and stability:
LB: 2 m, low slope, unstable
RB: 2 m, moderate slope, unstable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: stable</td><td>
October 2020</td><td>
October 2020</td></tr>
<tr><td>In-stream habitat features: dry at times of survey, tree roots, large woody debris, undercut banks, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt
Riparian vegetation ground stratum: terrestrial grasses

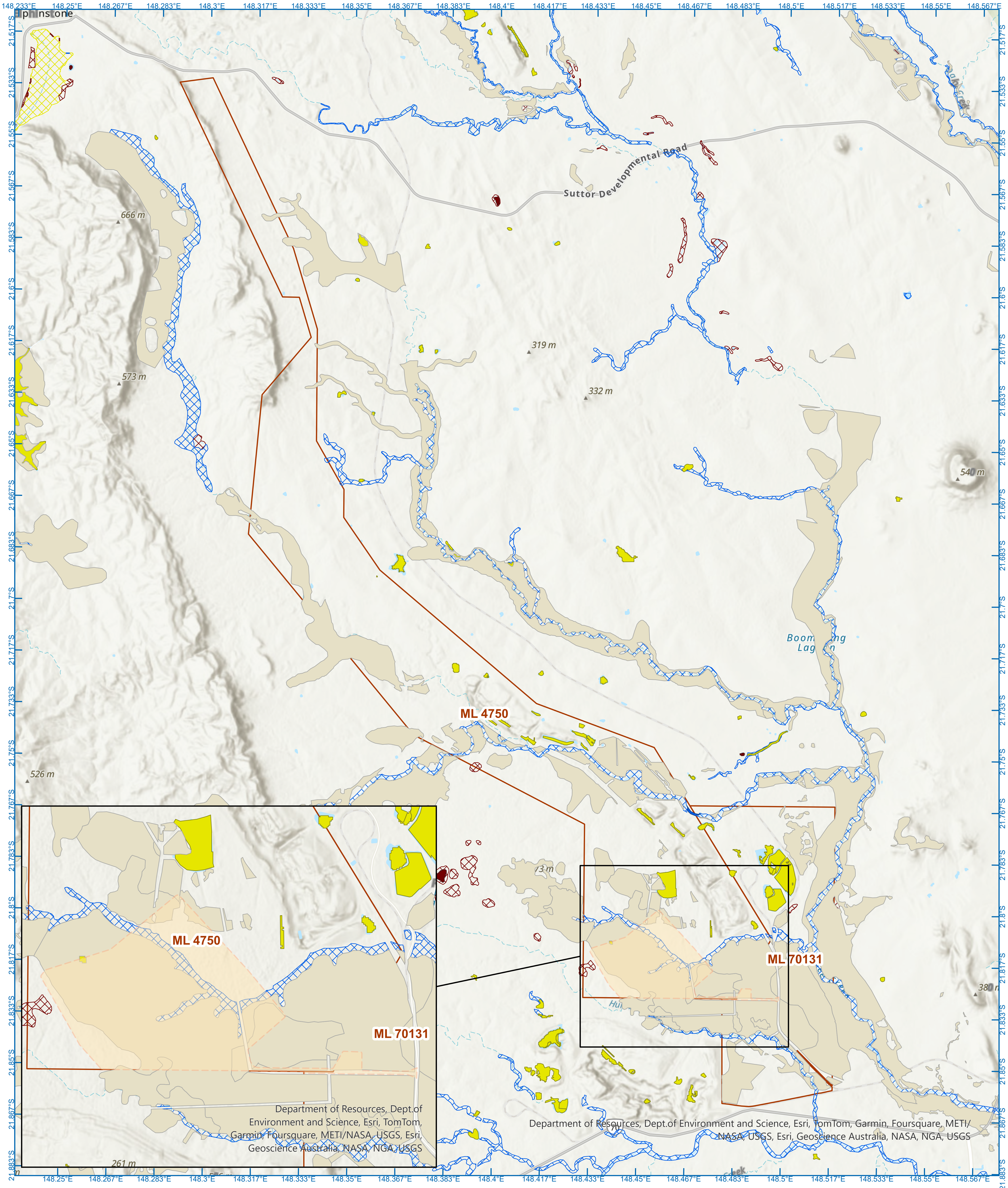
Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, weeds including Parthenium</td><td colspan="2"></td><td>
March 2021</td><td>
March 2021</td></tr>
</table>

Site: TKC2	**Survey dates:**	29 October 2020 26 March 2021	**Site Photos**	
			Downstream	**Upstream**
Waterway: Tributary of Kemmis Creek Downstream **Stream order:** 1 **Mapped ecological value**: nil **Channel pattern:** mildly sinuous/swampy **Channel cross-section shape**: flattened **Flow regime**: ephemeral **Wetted width**: 0 m **Continuity of water**: dry **Bed substrate:** extensive sand, moderate silt/clay	**Basin:** Isaac River **Waterway barrier risk**: minor (green) **Channel width**: 20 m **Bank height, slope and stability**: LB: 0 m, flat slope, stable RB: 0 m, flat slope, stable **Average and maximum water depth**: 0 m; 0 m **Flow velocity**: 0 m/s **Bed stability**: stable		 October 2020	 October 2020
In-stream habitat features: dry at time of survey, man-made debris, overgrown with grass/weeds **Aquatic plants on dry bed or bank**: nil **Riparian vegetation condition:** heavily cleared; grasses/weeds dominate ground stratum **Riparian width**: 20 m **Riparian vegetation canopy**: Eucalypt **Riparian vegetation ground stratum:** terrestrial grasses, weeds **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing, coal mine **Existing site disturbances:** culvert upstream of site, clearing, cattle grazing, weeds including dense *Parthenium*			 March 2021	 March 2021

Site: WCNS2	**Survey dates:** 28 October 2020 28 March 2021	**Site Photos**	
		Downstream	**Upstream**
Waterway: Walker Creek New Site 2 **Stream order:** 3 **Mapped ecological value**: nil **Channel pattern:** mildly sinuous **Channel cross-section shape**: flattenedU-shape **Flow regime**: ephemeral **Wetted width**: 0 m **Continuity of water**: dry **Bed substrate:** little boulder, extensive sand, little silt/clay	**Basin:** Isaac River **Waterway barrier risk**: moderate (orange) **Channel width**: 15 m **Bank height, slope and stability**: LB: 10 m, steep slope, moderately unstable RB: 10 m, moderate slope, moderately unstable **Average and maximum water depth**: 0 m; 0 m **Flow velocity**: 0 m/s **Bed stability**: stable	 October 2020	 October 2020
In-stream habitat features: dry at times of survey, tree roots, large woody debris, leaves and twigs **Aquatic plants on dry bed or bank**: *Cyperus* sp. *Lomandra longifolia* **Riparian vegetation condition:** cleared; grasses dominate ground stratum **Riparian width**: 5 – 10 m **Riparian vegetation canopy**: Eucalypt, Casuarina **Riparian vegetation ground stratum:** terrestrial grasses **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing **Existing site disturbances:** clearing, cattle grazing, weeds including Noogoora burr and lantana		 March 2021	 March 2021

Site: TWC1	**Survey dates:**	26 March 2021	**Site Photos**	
			Downstream	**Upstream**
Waterway: Tributary of Walker Creek Site 1 **Stream order: 2** **Mapped ecological value**: nil **Channel pattern:** Mildly sinuous **Channel cross-section shape**: flattened **Flow regime**: ephemeral **Wetted width**: 0 m **Continuity of water**: dry **Bed substrate:** little gravel, extensive sand, little silt/clay	**Basin:** Isaac River **Waterway barrier risk**: minor (green) **Channel width**: 5 m **Bank height, slope and stability**: LB: 2 m, moderate slope, moderately stable RB: 2 m, moderate slope, moderately stable **Average and maximum water depth**: 0 m; 0 m **Flow velocity**: 0 m/s **Bed stability**: moderate erosion		October 2020 - not surveyed	October 2020 - not surveyed
In-stream habitat features: dry at times of survey, tree roots, small woody debris, leaves and twigs **Aquatic plants on dry bed or bank**: *Cyperus* sp. **Riparian vegetation condition:** cleared; grasses dominate ground stratum **Riparian width**: 15 – 25 m **Riparian vegetation canopy**: Eucalypt, Melaleuca **Riparian vegetation ground stratum:** terrestrial grasses **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing **Existing site disturbances:** raised bed level crossing at site, clearing, cattle grazing			 March 2021	 March 2021

Site: TWC2	**Survey dates:**	29 October 2020 28 March 2021	**Site Photos**	
			Downstream	**Upstream**
Waterway: Tributary of Walker Creek Site 2 **Stream order:** 2 **Mapped ecological value**: nil **Channel pattern:** Irregular meanders **Channel cross-section shape**: flattened U-shape **Flow regime**: ephemeral **Wetted width**: 0 m **Continuity of water**: dry **Bed substrate:** little boulder, some cobble, some pebble, little gravel, extensive sand, little silt/clay	**Basin:** Isaac River **Waterway barrier risk**: minor (green) **Channel width**: 5 m **Bank height, slope and stability**: LB: 1 m, steep slope, moderately stable RB: 1 m, steep slope, moderately stable **Average and maximum water depth**: 0 m; 0 m **Flow velocity**: 0 m/s **Bed stability**: stable		 October 2020	 October 2020
In-stream habitat features: site dry at times of survey, tree roots, large woody debris, undercut banks, leaves and twigs **Aquatic plants on dry bed or bank**: nil **Riparian vegetation condition:** heavily cleared; grasses dominate ground stratum **Riparian width**: 1 m **Riparian vegetation canopy**: Eucalypt **Riparian vegetation ground stratum:** terrestrial grasses **Aquatic plants in water**: nil **Adjacent land uses**: cattle grazing **Existing site disturbances:** clearing, cattle grazing, weeds including *Parthenium*			 March 2021	 March 2021



240212: South Walker Creek Mine: Exploration Drilling and Gas Collection Project Impact Assessment Study

Map 4.3: Queensland Wetland Mapping Layer.

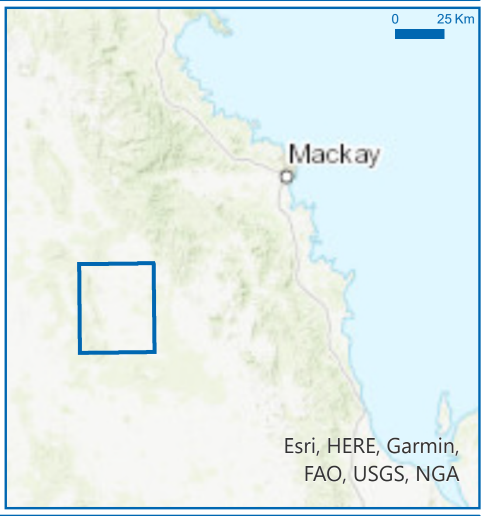
LEGEND

Wetland areas

Hydrologically natural
- Lacustrine wetlands
- Palustrine wetlands
- Riverine wetlands
- Intertidal wetlands
- Intertidal/subtidal wetlands

Hydrologically modified or artificial
- Lacustrine wetlands
- Palustrine wetlands
- Riverine wetlands
- Intertidal wetlands

Sub-dominant wetlands
- Sub-dominant wetlands (51 to 80%)
- Contains wetlands (1 to 50%)
- Mine lease boundary
- Sandy Creek Locale



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PART OF SLR

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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

N

SCALE

0 0.5 1 2 3 4 5 6

Kilometres

Scale: 1:125,000 @ A3

Field Survey Results for Sandy Creek Locale

The 2024 survey of aquatic habitat is presented in detail in Table 4.10, and summarised as follows:

- Sites on Sandy Creek (i.e. SCUS, SCDS, Site 3, Site 4 and Site 5) were dry at the time of survey in April and May 2024, and consisted of generally poor habitat, dominated by sandy substrate, with some woody debris, tree roots, and leaves and twigs that may provide very limited habitat at times when these sites hold water after significant rainfall events. Site disturbances include clearing for grazing, erosion and weeds (such as lantana and blue billygoat weed).
- Sites on Bee Creek (i.e. BCDSS and Site 1), consisted of wide, flat, sandy channels, with isolated pools and large woody debris providing aquatic habitat at the time of survey. Variability in habitat was low, with no aquatic plants, tree roots or undercut banks providing present in these ephemeral waterways. Site disturbances include clearing for grazing, erosion and weeds (such as blue billygoat weed).
- Site 2 was a farm dam upstream of tributaries of Sandy Creek, that was densely populated with aquatic pants and at the time of survey. Deep pool habitat with some woody debris and substrate made up of soft sediments (mainly silt/clay) provide limited diversity in aquatic habitat. Site disturbances include clearing for grazing, erosion and access for cattle to the water.

Table 4.10 Habitat Cards 2024 Aquatic Ecology Survey of Sandy Creek Locale

Site: BCDSS | **Survey date:** 30 April 2024 | **Site Photos**

Waterway: Bee Creek Downstream of confluence with Sandy Creek
Stream order: 6
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 3 m
Continuity of water: isolated pool
Bed substrate: extensive sand, little silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 15 m
Bank height, slope and stability:
LB: 6 m, steep/stepped slope, moderately stable
RB: 6 m, steep/stepped slope, moderately stable

Average and maximum water depth: 0.1 m; 0.7 m
Flow velocity: 0 m/s

Bed stability: severe aggradation

In-stream habitat features: shallow pool, some large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: moderate trees >10m in canopy, grasses dominate ground stratum
Riparian width: 10 m
Riparian vegetation canopy: Eucalypt and Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, raised bed culvert, moderate erosion

Downstream

Upstream

Site: SCUS	**Survey date:** 1 May 2024	**Site Photos**

Downstream

Waterway: Sandy Creek Upstream
Stream order: 3
Mapped ecological value: nil

Channel pattern: straight
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: extensive sand

Basin: Isaac River
Waterway barrier risk: moderate (orange)

Channel width: 5 m
Bank height, slope and stability:
LB: 1 m, steep slope, unstable
RB: 1 m, moderate slope, moderately unstable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: moderate aggradation

Upstream

In-stream habitat features: site dry at times of survey, tree roots, large woody debris, undercut banks, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; bare ground dominates stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt and Casuarina
Riparian vegetation ground stratum: terrestrial grasses and bare ground

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, weeds including blue billygoat weed

Site: SCDS	**Survey date:**	30 April 2024	**Site Photos**

Waterway: Sandy Creek Downstream
Stream order: 3
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: some pebble, some gravel, extensive sand

Basin: Isaac River
Waterway barrier risk: high (red)

Channel width: 10 m
Bank height, slope and stability:
LB: 3 m, moderate slope, moderately stable
RB: 3 m, moderate slope, moderately stable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: moderate aggradation

Downstream

In-stream habitat features: site dry at times of survey, tree roots, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt
Riparian vegetation ground stratum: terrestrial grasses, terrestriasl weeds

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, some bank erosion, weeds including *Lantana*

Upstream

Site: Site 1 | **Survey date:** 1 May 2024 | **Site Photos**

Waterway: Bee Creek Upstream of confluence with Sandy Creek
Stream order: 6
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 5 m
Continuity of water: isolated pool
Bed substrate: extensive sand, little silt/clay

Basin: Isaac River
Waterway barrier risk: major (purple)

Channel width: 15 m
Bank height, slope and stability:
LB: 6 m, steep/stepped slope, moderately unstable
RB: 6 m, steep/stepped slope, moderately unstable

Average and maximum water depth: 0.1 m; 0.5 m
Flow velocity: 0 m/s

Bed stability: moderate aggradation

Downstream

In-stream habitat features: shallow pool, tree roots, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt and Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing

Upstream

Site: Site 2	**Survey date:**	1 May 2024	**Site Photos**

Waterway: Tributary of Sandy Creek Site 1 – farm dam
Stream order: Farm dam
Mapped ecological value: nil

Channel pattern: Isolated pool
Channel cross-section shape: deepened U-shape

Flow regime: perennial
Wetted width: 60 m
Continuity of water: continuous
Bed substrate: little sand, extensive silt/clay

Basin: Isaac River
Waterway barrier risk: NA

Channel width: 60 m
Bank height, slope and stability:
LB: <1 m, flat slope, moderately stable
RB: <1 m, flat slope, moderately stable

Average and maximum water depth: >1 m; >1 m
Flow velocity: 0 m/s

Bed stability: stable

Downstream

In-stream habitat features: shallow and deep pool, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: *Cyperus esculentus, Ludwigia octovalvis, Persicaria attenuata*

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 5 m
Riparian vegetation canopy: Eucalypt
Riparian vegetation ground stratum: terrestrial grasses and bare ground

Aquatic plants in water: *Persicaria decipiens*, *P. attenuata*, *Nymphoides* sp., Lymnoideae sp. *Potamogeton* sp.
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, man-made farm dam

Upstream

Site: Site 3	**Survey date:** 1 May 2024	**Site Photos**

Waterway: Tributary of Sandy Creek Site 2
Stream order: 1
Mapped ecological value: nil

Channel pattern: Irregular
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: extensive sand

Basin: Isaac River
Waterway barrier risk: minor (green)

Channel width: 3 m
Bank height, slope and stability:
LB: 1 m, steep slope, moderately unstable
RB: 1 m, steep slope, moderately unstable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: severe aggradation

Downstream

In-stream habitat features: site dry at times of survey, tree roots, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses and bare ground dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt and Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: native forest
Existing site disturbances: clearing, cattle grazing, weeds including blue billygoat weed

Upstream

Site: Site 4	Survey date: 1 May 2024	Site Photos

Waterway: Tributary of Sandy Creek Site 3
Stream order: 1
Mapped ecological value: nil

Channel pattern: Irregular
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: extensive sand

Basin: Isaac River
Waterway barrier risk: minor (green)

Channel width: 5 m
Bank height, slope and stability:
LB: 1 m, moderate slope, moderately stable
RB: 3 m, vertical slope, very unstable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: severe aggradation

Downstream

In-stream habitat features: site dry at times of survey, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt and Casuarina
Riparian vegetation ground stratum: terrestrial grasses

Aquatic plants in water: nil
Adjacent land uses: cattle grazing
Existing site disturbances: clearing, cattle grazing, erosion, weeds including blue billygoat weed

Upstream

Site: Site 5	**Survey date:**	1 May 2024	**Site Photos**

Waterway: Sandy Creek Upstream Site 2
Stream order: 2
Mapped ecological value: nil

Channel pattern: Irregular meanders
Channel cross-section shape: flattened U-shape

Flow regime: ephemeral
Wetted width: 0 m
Continuity of water: dry
Bed substrate: extensive sand

Basin: Isaac River
Waterway barrier risk: moderate (orange)

Channel width: 3 m
Bank height, slope and stability:
LB: 1 m, vertical slope, moderately stable
RB: 1 m, vertical slope, moderately stable

Average and maximum water depth: 0 m; 0 m
Flow velocity: 0 m/s

Bed stability: moderate erosion

Downstream

In-stream habitat features: site dry at times of survey, tree roots, large woody debris, leaves and twigs
Aquatic plants on dry bed or bank: nil

Riparian vegetation condition: heavily cleared; grasses and bare ground dominate ground stratum
Riparian width: 1 m
Riparian vegetation canopy: Eucalypt
Riparian vegetation ground stratum: terrestrial grasses and bare ground

Aquatic plants in water: nil
Adjacent land uses: native forest
Existing site disturbances: clearing, cattle grazing, erosion

Upstream

4.3.2 Surface Expression Groundwater-dependent Ecosystems

Desktop Assessment

There are no surface expression groundwater-dependent ecosystems (GDEs) mapped in the SWC Area, and the predominantly dry waterway channels indicates that there are no areas of groundwater discharge to waterway.

Field Survey Results for Sand Creek Locale

The field survey indicated dry waterway channels, with few isolated shallow pools created by antecedent rainfall , which indicates that there are no areas of groundwater discharge to waterway.

4.3.3 Flow Regime

The flow regime of Bee Creek is ephemeral, with recorded flows being discrete short-duration events (Figure 4.2). Overall, flows are recorded approximately 18% of the time in Bee Creek (Figure 4.3), with no sustained low flows occurring but sustained periods with zero flow dominating the hydrological regime of these waterways. Median daily flow of zero ML/day and maximum daily flow of approximately 10,000 ML/day were recorded for Bee Creek. Approximately 76% of days have zero flow recorded.

Sandy Creek catchment is far smaller than the Bee Creek catchment, and while flow data for Sandy Creek is not available, flow events in Sandy Creek would be far less frequent and of lower magnitude and duration than flow events in Bee Creek.

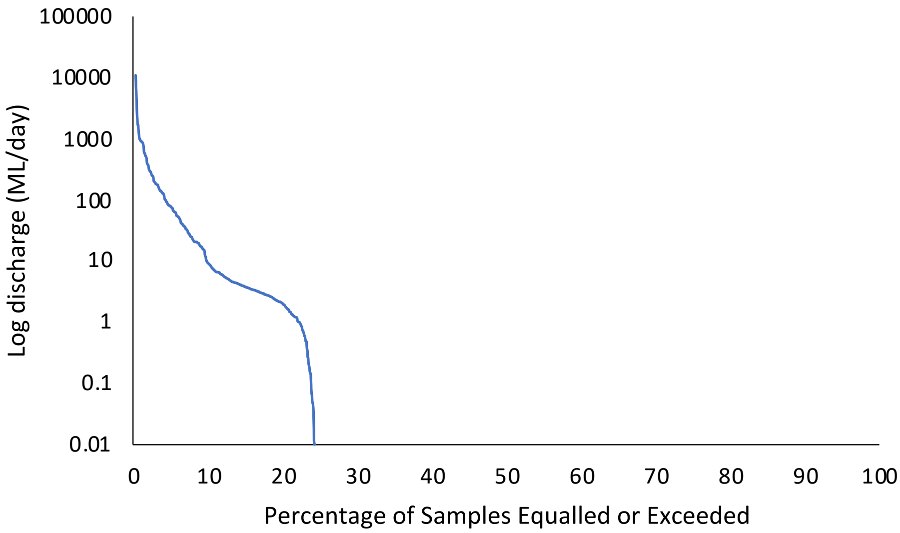


Figure 4.1 Daily flow (ML/day) recorded at upstream monitoring location on Bee Creek between November 2016 and December 2021.

4.3.4 Water Quality

Desktop Assessment

Water quality measured in situ for the SWC REMP between 2015 and 2023 was collated for relevant sites, and the minimum, median and maximum were calculated for each parameter (Table 4.11).

The median value was compared to the WQO, with results indicating:

- median electrical conductivity was higher than the WQO at three of the eight sites
- median pH was slightly higher than the WQO range at one site; with the minimum pH recorded at most sites within the WQO range, but the maximum pH at most sites higher than the WQO range
- there is no WQO for the concentration of dissolved oxygen, but the median dissolved oxygen concentrations recorded indicated suitable conditions for aquatic fauna
- the median per cent saturation of dissolved oxygen was slightly lower than the WQO at five sites, and
- the median turbidity was higher than the WQO at five of the eight sites.

Table 4.11 In situ water quality summary statistics at REMP sites compared to WQO from 2015 – 2023.

		Temperature	Electrical conductivity	pH	Dissolved Oxygen	Dissolved Oxygen	Turbidity
Units		ºC	µS/cm	units	mg/L	% saturation	NTU
WQO		–	<430 baseflow <250 high flow	6.5 – 8.5	–	85 – 110	<50
Upstream Sites							
WCUS	Count	10	19	19	10	10	19
	Minimum	16.2	97	6.1	0.3	3	3
	Median	21.8	230	8.2	6.8	70	290
	Maximum	28.4	590	8.8	88.0	107	2203
SCUS	Count	4	4	4	4	4	4
	Minimum	17.0	194	7.5	0.5	6	153
	Median	26.9	308	8.5	7.1	84	575
	Maximum	28.8	441	8.6	8.8	105	800
CBCUS	Count	5	5	5	4	4	5
	Minimum	21.3	129	6.6	4.1	53	3
	Median	25.3	423	8.1	5.0	60	48
	Maximum	33.1	658	8.4	8.8	103	124
BCUSS	Count	9	17	17	7	8	17
	Minimum	17.3	94	6.4	3.3	5	10
	Median	24.2	1050	8.6	7.7	62	51
	Maximum	29.4	1660	8.9	97.0	210	1000
KCUS	Count	4	4	4	4	4	4
	Minimum	16.2	202	6.5	4.2	8	3
	Median	22.2	394	8.0	7.1	63	30
	Maximum	34.1	681	9.4	96.8	97	42
Downstream Sites							
SCDS	Count	1	3	3	1	1	3
	Minimum	21.5	250	8.3	10.6	122	20
	Median	21.5	942	8.7	10.6	122	41
	Maximum	21.5	968	8.8	10.6	122	87
WCDS	Count	7	11	11	5	5	11
	Minimum	17.8	112	6.8	5.5	8	6
	Median	24.7	230	8.3	7.1	80	94
	Maximum	29.6	746	9.6	102.5	105	1146

		Temperature	Electrical conductivity	pH	Dissolved Oxygen	Dissolved Oxygen	Turbidity
Units		ºC	µS/cm	units	mg/L	% saturation	NTU
WQO		–	<430 baseflow <250 high flow	6.5 – 8.5	–	85 – 110	<50
BCDSS	Count	12	26	26	6	7	26
	Minimum	17.0	113	6.7	5.9	8	5
	Median	23.7	483	8.3	7.5	86	107
	Maximum	32.0	1076	8.7	90.3	107	4380
BCDS	Count	13	19	19	8	8	19
	Minimum	16.7	133	6.7	1.5	9	4
	Median	25.3	290	7.9	7.1	78	581
	Maximum	34.1	929	9.0	94.0	122	1957
KCDS	Count	5	5	5	5	5	5
	Minimum	15.9	136	6.5	3.2	9	66
	Median	22.3	194	9.3	14.8	78	80
	Maximum	31.4	267	10.2	111.4	250	824

Grey shading – median results above WQO
Blue shading – median results below WQO
The baseflow WQO for electrical conductivity was applied

Field Survey Results for Sandy Creek Locale

In situ water quality parameters for the April 2024 field survey generally complied with relevant WQOs, with the exception of (Table 4.12):

- dissolved oxygen, which was lower than the WQO at all sites holding water
- turbidity, which was higher than the WQO at BCDSS and Site 2.

Table 4.12 In situ water quality at all sites holding water during the April May 2024 survey, compared to the relevant WQOs.

	Temperature	Electrical Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen	Turbidity
Units	ºC	µS/cm	units	mg/L	% saturation	NTU
WQO	–	<430 baseflow <250 high flow	6.5 – 8.5	–	85 – 110	<50
Site						
BCDSS	20.9	430	6.8	4.2	47	156
Site 1	25.2	365	7.6	4.5	55	18
Site 2	22.9	320	8.1	5.3	63	134

Grey shading – median results above WQO
Blue shading – median results below WQO
The baseflow WQO for electrical conductivity was applied

4.3.5 Turtles

Desktop Assessment

It is possible that three common species of turtle (*Chelodina longicolis, C. expansa* and *Emydura macquarii krefftii*) occur periodically in the SWC Area.

None of the turtle species known or likely to occur in the SWC Area are listed threatened species under the EPBC Act or NC Act, as discussed in Sections 2 and 3.

Field Survey for Sandy Creek Locale

During the April 2024 field survey turtles were only recorded at one site, with 4 broad-shelled river turtle (*Chelodina expansa*) recorded at Site 2.

4.3.6 Fish

Desktop Assessment

Waterways of the SWC Area are temporary and only hold water after significant rain. Thus, fish would only be present in the waterways of the SWC Area after significant flow events that create hydrological connectivity with downstream refugia pools from which fish could migrate upstream and colonise the otherwise dry waterways. The fish species that would be present during wet conditions would have well-developed abilities for dispersal to capitalise on periodic flow events, and would be tolerant of water quality with often high electrical conductivity, high turbidity and low dissolved oxygen. While 53 native species of fish are known from freshwater reaches of the Fitzroy River Basin (DES 2024b), database searches (ALA 2024; DES 2024a) and previous surveys (frc environmental 2015) indicate that only eight native fish species have been recorded from the SWC Area and surrounds:

- Agassizi's glassfish (*Ambassis agassizii*)
- blue catfish (*Neoarius graeffei*)
- eastern rainbowfish (*Melanotaenia splendida splendida*)
- fly-specked hardyhead (*Craterocephalus stercusmuscarum*)
- spangled perch (*Leiopotherapon unicolor*)
- bony bream (*Nematalosa erebi*)
- southern purple spotted gudgeon (*Mogurnda adspersa*), and
- common gudgeons (*Hypseleotris* spp.).

It is likely that the following species would also occur periodically in or near the SWC area:

- Hyrtl's tandan (*Neosilurus hyrtlii*)
- sleepy cod (*Oxyeleotris lineolata*), and
- longfin eel (*Anguilla reinhardtii*).

These are all common species that are tolerant of harsh environmental conditions (e.g. variable flow, fluctuating water quality) that are typical of ephemeral watercourses of the region (Pusey et al. 2004). All species are potadromous (i.e. they migrate to various extents within freshwaters), with the exception of longfin eel which is diadromous (i.e. migrates between freshwaters and marine waters). None of these species have commercial or recreational fisheries value, except sleep cod which has limited interest by recreational fishers.

None of the fish species known or likely to occur in the SWC Area are listed threatened species under the EPBC Act or NC Act.

The three species of fish that are endemic to the Fitzroy River Basin (i.e. Leathery grunter (*Scortum hillii*), southern saratoga (*Scleropages leichardti*) and the genetic population of golden perch from the Fitzroy River (*Macquaria ambigua*)) are not known from the SWC Area or surrounds.

Tilapia (*Oreochromis mossambicus*) and eastern gambusia (*Gambusia holbrooki*), both of which are restricted biosecurity matters, are pest fish known from the wider region. The pest fish, platy (*Xiphophorus maculatus*) is also known from the region (frc environmental unpublished data), although this species is not a biosecurity matter. There are no records of pest fish from the SWC Area or surrounds.

Field Survey for Sandy Creek Locale

The 2024 field survey indicated 8 species of native freshwater fish were present in waterways of the Project study area (Table 4.13), with species diversity ranging from 3 to 7 species at sites holding water in April 2024. All native species that were identified are migratory within freshwater reaches of waterways (potadromous), and are species that are often early colonisers of ephemeral waterways after rainfall.

Agassiz's glassfish, eastern rainbowfish, spangled perch and bony bream were the most abundant taxa, while Agassiz's glassfish and spangled perch were also the most widespread (recorded at all sites holding water). All native fish species recorded are common in the Isaac River, and none of the species recorded are of conservation significance.

The restricted biosecurity matter Mozambique tilapia (*Oreochromis mossambicus*) was recorded at sites BCDSS and Site 2 in the farm dam, with large numbers of intermediate/juvenile fish recorded from Bee Creek site BCDSS, and 6 intermediate/juvenile fish recorded from farm dam Site 2.

Table 4.13 Fish species recorded at each site holding water during the April 2024 survey.

			Site		
Scientific Name	**Common Name**	**Migration pattern**	**BCDSS**	**Site 1**	**Site 2**
Native Fish Species					
Ambassis agassizii	Agassiz's glassfish	potadromous	95	840	44
Hypseleotris spp.	common gudgeon	potadromous	–	64	1
Leiopotherapon unicolor	spangled perch	potadromous	62	20	79
Melanotaenia splendida splendida	eastern rainbowfish	potadromous	58	–	17
Mogurnda adspersa	southern purple spotted gudgeon	potadromous	1	–	–
Nematalosa erebi	bony bream	potadromous	31	–	24
Neosilurus hyrtlii	Hyrtl's catfish	potadromous	–	–	4
Oxyeleotris lineolata	sleepy cod	potadromous	9	–	3
Native Native Fish Total Abundance			**256**	**924**	**172**
Native Native Fish Species Diversity			**6**	**3**	**7**
Pest Fish Species					
Oreochromis mossambicus	Mozambique tilapia		142	–	6

4.3.7 Macroinvertebrates

Desktop Assessment

Previous surveys for SWC REMP monitoring (frc environmental 2015 – 2023) and the SWC Kemmis Pit Extension Project indicate that aquatic insects dominate macroinvertebrate communities (Table 4.14).

Other macroinvertebrate taxa that have commonly been recorded from the SWC area and surrounds include: arachnids, molluscs, decapod crustaceans (prawns and freshwater crabs), microcrustaceans and segmented worms.

The available data for macroinvertebrate taxonomic richness, PET (Plecoptera / Ephemeroptera / Trichoptera) richness, Stream Invertebrate Grade Number Average Level version 2 (SIGNAL-2) Score and percent tolerant taxa indicated that the macroinvertebrate communities of waterways of the SWC Area are more impoverished than expected by the default biological objectives (Table 4.15). In some cases, these results may reflect the short period of time over which sites were holding water prior to sampling, thus there was insufficient time to allow colonisation of isolated pools by a greater number of taxa and thus attain a 'mature' macroinvertebrate community. However, the overall quality of aquatic habitat for macroinvertebrates in waterways of the SWC Area was low and water quality was often characterised by high electrical conductivity, high turbidity and low dissolved oxygen; thus, even 'mature' communities would likely have low diversity and few sensitive macroinvertebrate taxa. Compositionally, macroinvertebrate communities were dominated by insects (family diversity was highest in Coleoptera, Diptera, Hemiptera and Odonata), although other notable taxa included gastropods and decapod crustaceans.

None of the macroinvertebrate taxa known or likely to occur in the SWC Area are listed threatened species under the EPBC Act or NC Act.

Table 4.14 Aquatic insects reported from the SWC Area and surrounds.

Order	Families
Coleoptera (beetles)	Curculionidae, Dytiscidae, Gyrinidae, Haliplidae, Heteroceridae, Hydraenidae, Hydrochidae, Hydrophilidae, Nanophyidae, Noteridae, Scirtidae, Spercheidae, Staphylinidae
Diptera (flies)	Ceratopogonidae, Chaoboridae, s-f Chironominae, Culicidae, Dolichopodidae, Empididae, Ephydridae, Muscidae, s-f Orthocladiinae, Simuliidae, Stratiomyidae, Tabanidae, s-f Tanypodinae, Tipulidae
Ephemeroptera (mayflies)	Baetidae, Caenidae, Leptophlebiidae
Hemiptera (true bugs)	Corixidae, Gelastocoridae, Gerridae, Hydrometridae, Mesoveliidae, Micronectidae, Nepidae, Notonectidae, Ochteridae, Pleidae, Veliidae
Odonata (dragonflies and damselflies)	Aeshnidae, Coenagrionidae, Corduliidae, Gomphidae, Isostictidae, Libellulidae, Lindeniidae, S.O. Epiproctiphora, S.O. Zygoptera
Trichoptera (caddisflies)	Ecnomidae, Hydroptilidae, Leptoceridae
Lepidoptera (butterflies)	Crambidae

Table 4.15 Macroinvertebrate Indices from the SWC Area.

Habitat		Bed					Edge				
		Abundance	**Taxonomic Richness**	**PET Richness**	**SIGNAL-2**	**% Tolerant Taxa**	**Abundance**	**Taxonomic Richness**	**PET Richness**	**SIGNAL-2**	**% Tolerant Taxa**
Median WQO		**–**	**12 - 21**	**2 - 5**	**3.33 – 3.85**	**25 - 50**	**–**	**23 - 33**	**2 - 5**	**3.31 – 4.20**	**44 - 56**
SCUS	Minimum	8	3	0	1.83	83%	53	8	1	2.32	33%
	Median	12	6	0	2.17	83%	153	10	2	3.26	43%
	Maximum	13	6	0	2.50	100%	528	14	3	4.06	70%
WCUS	Minimum	40	3	0	2.32	33%	88	6	0	2.97	31%
	Median	83	5	0	3.50	40%	245	17	2	3.24	52%
	Maximum	149	10	1	3.57	80%	560	26	4	3.78	67%
CBCUS	Minimum	–	–	–	–	–	109	17	2	3.48	44%
	Median	–	–	–	–	–	294	18	2	3.50	47%
	Maximum	–	–	–	–	–	379	19	4	3.73	53%
BCUSS	Minimum	28	5	1	3.56	29%	37	7	0	2.93	14%
	Median	51	7	1.5	3.64	31%	199	17	3	3.49	45%
	Maximum	93	9	3	3.71	40%	529	23	4	3.88	88%
KCUS	Minimum	19	8	1	3.00	63%	12	5	0	2.38	40%
	Median	19	8	1	3.00	63%	110.5	11.5	1	3.17	55%
	Maximum	19	8	1	3.00	63%	373	33	5	3.72	64%
SCDS	Minimum	–	–	–	–	–	207	14	0	3.29	36%
	Median	–	–	–	–	–	371	18	1	3.31	55%
	Maximum	–	–	–	–	–	410	22	2	3.54	61%

Habitat		Bed					Edge				
		Abundance	Taxonomic Richness	PET Richness	SIGNAL-2	% Tolerant Taxa	Abundance	Taxonomic Richness	PET Richness	SIGNAL-2	% Tolerant Taxa
Median WQO		**–**	**12 - 21**	**2 - 5**	**3.33 – 3.85**	**25 - 50**	**–**	**23 - 33**	**2 - 5**	**3.31 – 4.20**	**44 - 56**
WCDS	Minimum	53	4	0	3.56	20%	90	9	1	3.16	30%
	Median	115.5	6	1	3.69	25%	176	15	3	3.66	45%
	Maximum	133	8	1	3.81	43%	614	22	4	4.00	56%
BCDSS	Minimum	99	6	0	3.04	50%	51	9	0	2.82	18%
	Median	116.5	10.5	1	3.20	55%	161.5	15.5	2.5	3.31	46%
	Maximum	194	11	2	3.23	67%	400	23	4	4.14	71%
BCDS	Minimum	6	5	0	3.09	25%	44	7	0	2.65	20%
	Median	43	6.5	1	3.63	39%	170	16	3	3.46	45%
	Maximum	102	8	3	4.11	60%	761	25	4	4.16	80%
KCDS	Minimum	–	–	–	–	–	24	8	1	2.79	43%
	Median	–	–	–	–	–	127	15	2	3.29	53%
	Maximum	–	–	–	–	–	332	22	3	3.62	69%

Grey shading indicates where the macroinvertebrate community is more impoverished than expected by the biological objective.

– indicates no data, either because only a single sample was available (bed habitat at site KCUS) or because no samples had been taken (bed habitat at site KCDS)

Note that sites WCNS1, WCNS4, TCK2, WCNS2, WCNS3, TKC1, TWC1 and TWC2 were dry.

Field Survey Results for Sandy Creek Locale

Results for the 2024 survey indicate that aquatic insects dominated macroinvertebrate communities, with high abundance of non-biting midges (subfamilies, Chironominae and Tanypodinae) recorded at all sites holding water, as well as other fly families (Diptera, including Ceratopogonidae, Chaoboridae, Culicidae, Tabanidae and Tipulidae), bug larvae (Hemiptera, including families Belostomatidae, Corixidae, Gerridae, Mesoveliidae, Micronectidae, Nepidae, Notonectidae, Pleidae and Veliidae), and beetle larvae (Coleoptera, including families Dytiscidae, Gyrinidae, Hydraenidae, Hydrochidae, Hydrophilidae and Staphylinidae). Also present were mayflies (Ephemeroptera in the families Baetidae and Caenidae), caddisflies (Trichoptera in the family Leptoceridae), dragonflies (Odonata in the families Coenagrionidae, Gomphidae and Libellulidae), crustaceans (Decapods in the families Atyidae and Palaemonidae), arachnids (mites; Acarina and spiders; Araeneae), butterfly larvae (Lepidoptera in the family Crambidae), and worms (Oligochaeta).

Overall, macroinvertebrate communities were dominated by taxa that are tolerant of variable water quality and variable aquatic habitat condition, however several PET taxa were recorded (Ephemeroptera and Trichoptera) from bed and edge habitat. No aquatic macroinvertebrate taxa that are listed threatened species were recorded in or near the Project study area.

Macroinvertebrate indices from the 2024 survey indicated (Table 4.16):

- taxonomic richness was lower than the WQO at all sites for bed habitat, and at sites BCDSS and Site 1 for edge habitat
- PET richness was lower than the WQO at all sites for bed habitat, and at Site 1 for edge habitat
- SIGNAL-2 score was lower than the WQO at Site 1 and Site 2 for edge habitat
- % tolerant taxa was higher than the WQO at Site 1 and Site 2 for edge habitat, and
- all other parameters complied with the relevant WQO.

Table 4.16 Macroinvertebrate indices for sites holding water during the 2024 survey.

Habitat	Bed				
	Abundance	Taxonomic Richness	PET Richness	SIGNAL-2	% Tolerant Taxa
WQO	**–**	**12 – 21**	**2 – 5**	**3.33 – 3.85**	**25 – 50**
BCDSS	47	7	0	3.56	43
Site 1	38	6	1	3.64	33
Site 2	381	4	0	3.81	25
Habitat	**Edge**				
Abundance	**Abundance**	**Taxonomic Richness**	**PET Richness**	**SIGNAL-2**	**% Tolerant Taxa**
WQO	**–**	**23 – 33**	**2 – 5**	**3.31 – 4.20**	**44 – 56**
BCDSS	225	20	3	3.57	47
Site 1	62	11	1	3.04	64
Site 2	320	24	2	3.30	61

Grey shading indicates that a parameter was poorer than the relevant WQO

4.3.8 Aquatic Plants

Desktop Assessment

Aquatic plant communities of the region are typically species-poor and have low per cent cover, which is likely due to the short duration of flows in ephemeral watercourses resulting in unsuitable habitat for many aquatic plant species (Van Manen 2005). Furthermore, at those sites in the wider region where more perennial water was present, submerged aquatic plants were uncommon due to high turbidity (Van Manen 2005), with emergent taxa dominating aquatic plant communities at these sites, including smartweeds (*Persicaria* spp.), rushes (*Eleocharis* spp.) and sedges (*Cyperus* spp.). Swamp lily (*Ottelia ovalifolia*), a floating attached species, was the most common aquatic plant not of an emergent growth form in the region.

Database searches (ALA 2024; DES 2024a; b) and previous surveys for SWC REMP monitoring (frc environmental 2015 – 2023), indicate that aquatic plants that have been recorded in and near the SWC Area are dominated by species with an emergent growth form that often grow on dry bed or banks (Table 4.17).

None of the recorded aquatic plant species are listed as threatened species under Queensland's NC Act.

There are no records of aquatic weeds, including those species that are biosecurity matters, from the SWC Area and surrounds (ALA 2024; DES 2024a; b).

At the scale of the Fitzroy River Basin, 316 wetland indicator plant species are known, of which 144 are rare or threatened (DES 2024b). Thus, compared to the wider Fitzroy River Basin, the approximately 35 common aquatic plant species recorded from SWC Area and surrounds indicates a low diversity of aquatic plants, with none of the rare or threatened species that occur elsewhere in the basin occurring in or near the SWC Area.

Table 4.17 Aquatic plants recorded from the SWC Area.

Common name	Species	Growth Form
sedges	*Cyperus esculentus, C. exaltatus, C. cristulatus, C. alopecuroides, C. polystachyos, C. difformis, C. squarrosus, C. scariosus; Fimbristylis nutans, F. microcarya, F. nuda*	emergent
common rush	*Juncus usitatus*	emergent
toad rush	*Juncus bufonius*	emergent
–	*Caldesia oligococca*	emergent
false daisy	*Eclipta prostrata*	emergent
sundew	*Drosera* spp.	emergent
water wort	*Elatine gratioloides*	emergent
–	*Lythrum paradoxum*	emergent
mat rush	*Lomandra* sp.	emergent
willow primrose	*Ludwigia octovalvis*	emergent
water primrose	*Ludwigia peploides*	emergent
hydrophilic grasses	*Walwhalleya subxerophila, Diplachne fusca var. fusca, Echinochloa colona, Panicum larcomianum*	emergent
knotweeds	*Persicaria orientalis, P. attenuata*	emergent
water milfoil	*Myriophyllum verrucosum*	submerged
water nymph	*Najas tenuifolia*	submerged
swamp lily	*Ottelia ovalifolia*	floating attached
blue water lily	*Nymphaea violacea*	floating attached
river she-oak	*Casuarina cunninghamiana subsp. Cunninghamiana*	riparian tree
river red gum	*Eucalyptus camaldulensis subsp. acuta*	riparian tree
paperbarks / tea-trees / bottlebrush	*Melaleuca bracteata, M. viminalis, M. fluviatilis. M. leucadendra, M. linariifolia*	riparian tree

Survey Results for Sandy Creek Locale

During the April 2024 survey of the Sandy Creek locale aquatic plants were only recorded at one site (Site 2 farm dam), with aquatic plants absent at all other sites.

Aquatic plants at Site 2 consisted of emergent, floating attached, floating and dry growth forms, with sedge (*Cyperus*) the most abundant taxa on the banks, and knotweeds (*Persicaria*) the most abundant taxa in the bed.

None of the recorded aquatic plant species are listed as threatened species under Queensland's NC Act, and no aquatic weed plant species were recorded.

Table 4.18 Per cent cover of aquatic plants on banks and in bed at each site during the April 2024 survey.

		Site							
Scientific Name	**Common Name**	**BCDSS**	**SCUS**	**SCDS**	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
On banks									
Cyperus esculentus	yellow nutsedge	–	–	–	–	50	–	–	–
Ludwigia octovalvis	willow primrose	–	–	–	–	5	–	–	–
Persicaria attenuata	attenuated smartweed	–	–	–	–	20	–	–	–
In water									
Lemnoideae	duckweed	–	–	–	–	5	–	–	–
Nymphoides sp.	–	–	–	–	–	10	–	–	–
Persicaria attenuata	attenuated smartweed	–	–	–	–	20	–	–	–
Persicaria decipiens	slender knotweed	–	–	–	–	5	–	–	–
Potamogeton sp.	pondweed	–	–	–	–	5	–	–	–

5 Aquatic Ecological Values Assessment

5.1 Assessment Method

The Aquatic Environmental Values assessment used the Australian Government's *Aquatic Ecosystems Task Group* (AETG) *High Ecological Value Aquatic Ecosystem* (HCVAE) *toolkit* (DAWE 2012). Specifically, five criteria, with a range of sub-criteria, that describe 'high aquatic ecological value' are presented (Table 5.1), along with a range of methodologies for scoring aquatic ecosystems against each criterion.

One of the scoring methodologies presented is a ranked 'quartile' approach, where an aquatic ecosystem is ranked from 1 to 4 for each criterion; in this case:

- 1 – criteria not achieved
- 2 – criteria achieved to a limited extent
- 3 – criteria partly to mostly achieved
- 4 – criteria achieved.

The maximum value across all the 17 sub-criteria is then taken as the overall score for the aquatic ecosystem, as follows:

- 1 = very low
- 2 = low
- 3 = moderate
- 4 = high.

The high conservation value aquatic ecosystem criteria and associated quartile scoring approach is similar to the aquatic ecosystem values assessment method used in the *Aquatic Biodiversity Assessment Mapping Method* (AquaBAMM) (Clayton et al. 2006b), as referenced in the *Aquatic Ecology EIS Preparation Guideline* (DES 2022).

Table 5.1 Criteria for Defining High Ecological Value Aquatic Ecosystems in Australia.

Criteria	Sub-criteria
Diversity	exceptional diversity of native and migratory species
	exceptional diversity of aquatic habitats
	exceptional diversity of geomorphological features and processes
Distinctiveness	threatened aquatic ecosystem types
	threatened aquatic species (national or state level)
	threatened aquatic communities (national or state level)
	endemic aquatic species
	rare (but not threatened) aquatic species
	rare or unusual geomorphic features likely to support unusual assemblages of aquatic species adapted to these conditions
	rare or unusual geomorphic features that demonstrate key features of the evolution of Australia's landscape
Vital habitat	supports unusually large numbers of a particular native or migratory aquatic species
	maintenance of populations of specific aquatic species at critical life history stages
	provides important movement corridor for migration by aquatic fauna, linking breeding and feeding habitats
	key significant refugia for aquatic species that are dependent on the habitat, especially at times of stress
	key habitat that supports fisheries resources
Naturalness	the ecological character of the aquatic ecosystem is not adversely affected by modern human activity
Representativeness	the aquatic ecosystem is an outstanding example of an aquatic ecosystem class to which it has been assigned, within a drainage division.

Results

Using the HCVAE criteria, the assessment indicated that (Table 5.2):

- Major waterways of the SWC Area (e.g. Bee Creek, Kemmis Creek, Walker Creek and Carborough Creek) have moderate aquatic ecological values, because they periodically support migration of a modest number of common and widespread fish species, but unusual, threatened or rare features or species do not occur.

- Sandy Creek has low aquatic ecological values, because Sandy Creek provides periodic habitat for common aquatic macroinvertebrate species, but unusual, threatened or rare features or species do not occur.
- Minor waterways of the SWC Area and minor tributaries of Sandy Creek have very low aquatic ecological values because aquatic biota do not occur and unusual, threatened or rare features or species do not occur.

The aquatic ecological receptors of the SWC Area, and the Sandy Creek locale, are not considered to be sensitive receptors because:

- waterways are ephemeral and predominantly in dry condition, during which time they do not support aquatic species,
- natural water quality is highly variable, which is typical for ephemeral systems (ANZG 2020),
- threatened aquatic species do not occur in or near the Project area, and
- aquatic species known from and likely to occur in the Project area are tolerant of, and resilient to, a range of water quality and aquatic habitat conditions (e.g. many fish species are early colonisers of aquatic habitat following flow events after long periods of no flow; macroinvertebrate communities are dominated by tolerant taxa; aquatic plants are uncommon and dominated by low cover of ubiquitous emergent taxa).

Table 5.2 Assessment of Aquatic Ecological Values

Criteria	Sub-criteria	Major Waterways of SWC Area	Minor Waterways of SWC Area	Sandy Creek	Minor Tributaries of Sandy Creek
Diversity	exceptional diversity of native and migratory species	2	1	2	1
	exceptional diversity of aquatic habitats	2	1	2	1
	exceptional diversity of geomorphological features and processes	2	1	2	1
Distinctiveness	threatened aquatic ecosystem types	1	1	1	1
	threatened aquatic species (national or state level)	1	1	1	1
	threatened aquatic communities (national or state level)	1	1	1	1
	endemic aquatic species	1	1	1	1
	rare (but not threatened) aquatic species	1	1	1	1
	rare or unusual geomorphic features likely to support unusual assemblages of aquatic species adapted to these conditions	1	1	1	1
	rare or unusual geomorphic features that demonstrate key features of the evolution of Australia's landscape	2	1	1	1
Vital habitat	supports unusually large numbers of a particular native or migratory aquatic species	3	1	2	1
	maintenance of populations of specific aquatic species at critical life history stages	2	1	2	1
	provides important movement corridor for migration by aquatic fauna, linking breeding and feeding habitats	3	1	2	1

Criteria	Sub-criteria	Major Waterways of SWC Area	Minor Waterways of SWC Area	Sandy Creek	Minor Tributaries of Sandy Creek
	key significant refugia for aquatic species that are dependent on the habitat, especially at times of stress	1	1	1	1
	key habitat that supports fisheries resources	1	1	1	1
Naturalness	the ecological character of the aquatic ecosystem is not adversely affected by modern human activity	1	1	1	1
Representativeness	the aquatic ecosystem is an outstanding example of an aquatic ecosystem class to which it has been assigned, within a drainage division.	2	1	1	1
Maximum Score		3	1	2	1
Aquatic Ecological Value		Moderate	Very low	Low	Very Low

6 Aquatic Ecological Values Impact Assessment and Mitigation

6.1 Aquatic Ecological Risk Assessment Method

Sources of potential impact were identified from the review of the Project Descriptions and assessed aquatic ecological values, and sensitivity of aquatic ecological receptors, of the SWC Area and the Sandy Creek locale.

The assessment of potential Project impacts of the Multi-Year Exploration Program and Gas Drainage projects on the EVs of surface water ecosystems comprised:

- a risk-based assessment, with the level of risk being an outcome of the consequence and likelihood of the potential impact (Table 5.3, Table 5.4 and Table 5.5)
- assessment of potential impacts to aquatic MNES using the *Significant Impact Guidelines 1.1* (DoTE 2013), and
- assessment of potential impacts to aquatic MSES using the *Significant Residual Impact Criteria* (DEHP 2014).

Table 5.3 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
Very low	Unlikely or not expected to occur

Table 5.4 Ratings used to assess the consequence of potential impacts.

Rating	Consequence of potential impacts
Very High	Long-term harm to protected components of the environment.
High	Short-term but reversible harm to protected components of the environment; long-term harm to sensitive (i.e. rare, threatened, narrow range endemic) components of the environment
Moderate	Long-term harm to non-protected components of the environment; no environmental harm to protected or sensitive (i.e. rare, threatened, narrow range endemic) components of the environment
Low	Short-term but reversible harm to non-protected components of the environment; no environmental harm to protected or sensitive (i.e. rare, threatened, narrow range endemic) components of the environment.
Very Low	Negligible or minimal impact with no material harm to any component of the environment.

Table 5.5 Environmental risk matrix.

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

6.2 Project Descriptions

6.2.1 Multi-Year Exploration Program

Exploration drilling is a critical component in informing mine planning, particularly for large and complex mining operations like the SWC Mine. Stanmore is therefore seeking to carry out exploration drilling to inform mine planning for the SWC Mine. Stanmore proposes a Multi-Year Exploration Program to complete exploration drilling in an extended single campaign, rather than incremental and sporadic exploration activities. This allows for appropriate environmental impact assessment and consideration by regulators, environmental authorisation under the *Environmental Protection Act 1994* (the EP Act), and planned environmental management of exploration activities.

The Multi-Year Exploration Program footprint comprises access tracks, drill pads and seismic transects. These are small and isolated disturbance areas located at intervals across the exploration area, as shown in Map 5.1.

The exploration activities will include:

- Development of 4.5 m wide access tracks, with existing tracks used where possible.
- Development of drill pads of approximately 1,400 m^2 area each.
- Gas exploration and resource definition drilling.
- Core, Reverse Circulation (RC) (chip) and gas drilling via the same form of drill rig with support vehicles and equipment (small truck and two to three light vehicles).
- Seismic investigations with approximately 3 m wide seismic investigation lines. The seismic investigation is yet to be planned in detail.

Surface preparations for the Multi-Year Exploration Program will include:

- In instances where the area remains undisturbed, comprehensive assessments for cultural heritage and ecological significance will precede any further actions. The SWC site clearance protocols will be followed.
- Prioritisation of drainage diversion and erosion and sediment installation controls, and their permanence contingent upon site-specific conditions. These structures will primarily aim to redirect uncontaminated stormwater away from the construction zone while managing and/or containing any potentially polluted stormwater. During initiation of site preparation amidst wet seasons, installation of drainage diversion and erosion and sediment controls will coincide with or precede vegetation clearance whenever feasible.
- Vegetation clearance will be conducted, with the extent of clearance dependent on drill pad and access specifics. The Project incorporates flexibility to realign access tracks or drill pads (micro-siting) if environmental constraints necessitate adjustments during implementation, therefore ensuring recognition of environmental risks.
- Topsoil removal and on-site storage for rehabilitation.
- Implementation and maintenance of erosion and sediment controls.

- Handling and disposal of major hazardous materials on-site will adhere strictly to the *Work Health and Safety Regulation 2011*, and *Hazardous Substances Code of Practice 2003*.

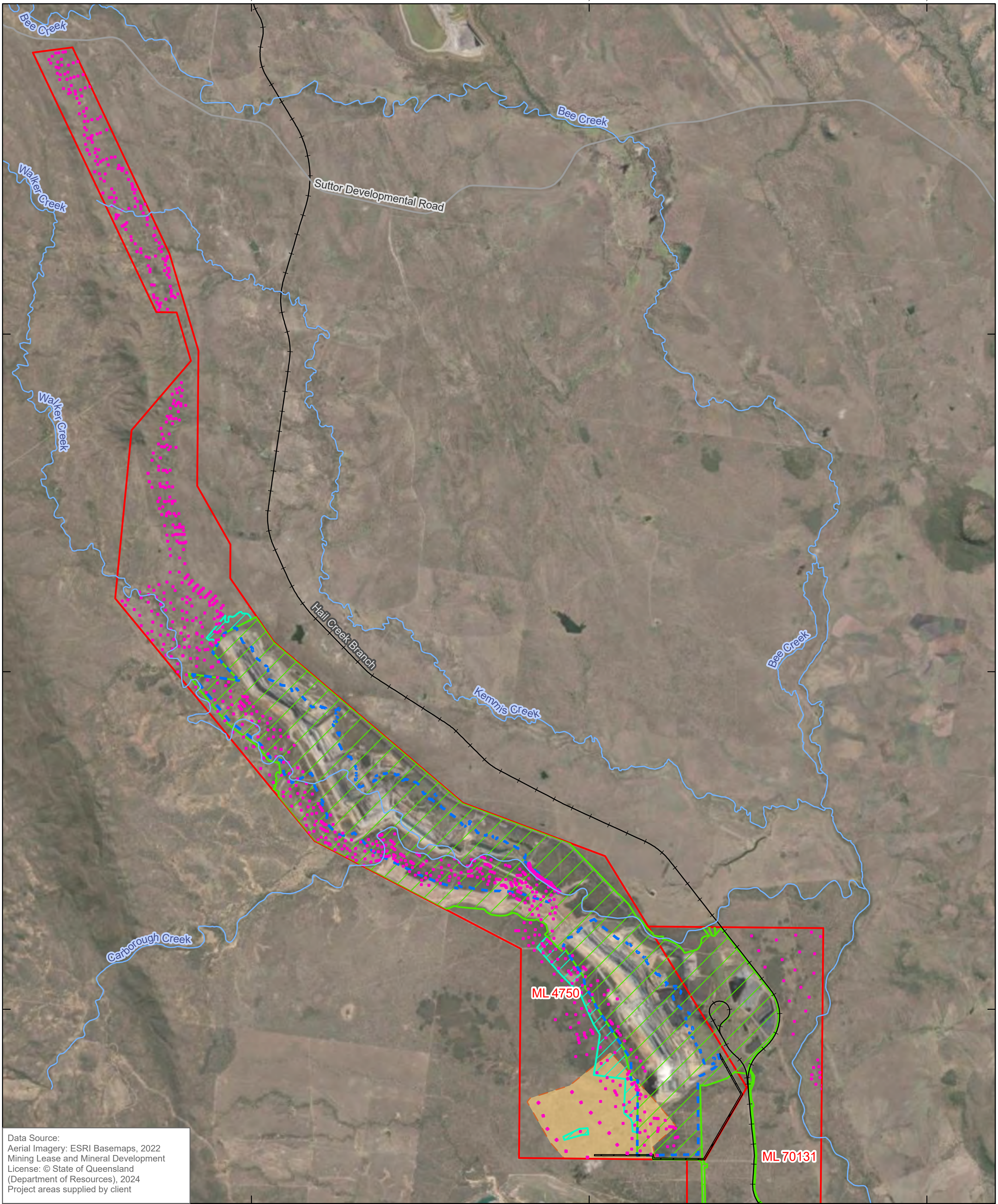
Exploration drill pads will be closed and rehabilitated in accordance with the SWC Rehabilitation Management Plan and will address the requirements and conditions of the existing EA. There may be some instances where exploration drill holes are retained and converted into groundwater monitoring bores.

Access tracks will also generally be closed and rehabilitated in accordance with the SWC Rehabilitation Management Plan and will address the requirements and conditions of the existing EA. There may be instances where access tracks are retained, in agreement with land title holders, to provide for ongoing access.

In general, the closure and rehabilitation process will typically be as follows:

- Demobilisation of drill rig and support equipment.
- Backfill RC chip drill hole with excess chips.
- Backfill mud sumps (once sufficiently dry) back to natural ground level with subsoil and topsoil to match natural soil profile.
- Install drill hole casing beyond depth of bedrock / competent rock, to prevent groundwater ingress to boreholes (from alluvial aquifers, upper level aquifers).
- Capping the drill hole, for example, seal (with concrete) the top of the drill hole at approximately two metres depth below natural ground level, and backfill with subsoil and topsoil to match natural soil profiles.
- Retain erosion and sediment controls. Remove all remaining materials and wastes from site.
- Restore stored subsoil and topsoil to original profile.
- Allow natural regeneration via seedbank in topsoil.
- Monitor and manage any weed infestation, monitor for revegetation success.
- Remove erosion and sediment controls following stabilisation of soils and revegetation of the drill pad / tracks.

It is noted that upgraded or new access tracks may cross waterways, but drill pads will be micro-sited to ensure that they are located outside of waterways and wetlands.



Data Source:
Aerial Imagery: ESRI Basemaps, 2022
Mining Lease and Mineral Development License: © State of Queensland (Department of Resources), 2024
Project areas supplied by client

0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

stanmore

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Gas Project Study Buffer
- Proposed Drill Pad
- Proposed Powerline Corridor from Power Station to Mine

SOUTH WALKER CREEK EA AMENDMENT PROJECT

EXPLORATION PROGRAM AND GAS DRAINAGE

Map 5.1

6.2.2 Gas Drainage Project

Proactive measures such as pre-draining and collection of gas from sections of the SWC Mine in advance of resource extraction is a useful method of managing gas hazards and the release of fugitive greenhouse gas emissions, such as methane. Stanmore proposes to extract this gas as part of future operations. The drainage of gas and use for electricity generation also results in an overall reduction in greenhouse gas emissions, compared to uncontrolled releases using electricity generated through the combustion of thermal coal. Stanmore intends to extract gas via development and operation of drainage field, which will supply the resource to a gas fired power station that will supply the mine site's electricity requirements. The Gas Drainage Project will be developed in the south of ML4750 (Map 5.2) and will include:

- Development of 13 dual lateral gas wells (i.e. surface to in-seam wells), with a well head that separates water from gas.
- Gas drainage pipelines, from each well head to a central gas drainage pipeline.
- Water collection pipelines to allow water to be pumped from the gas wells to dams within existing operations and incorporated into SWC mine as part the mine water management system.
- Augmentation and expansion of existing access tracks (i.e. all-weather light vehicle tracks with road drainage directed to sediment basins).

The gas well design and drilling methodology will be implemented through a two-step procedure. Initially, a vertical well will be drilled to access and extract gas and water from the targeted coal seam. This vertical well serves as the primary conduit for gas resource extraction, penetrating down to the depth of the coal seam. Subsequently, a lateral in-seam borehole or multiple boreholes are drilled along the trajectory of the coal seam, intersecting with the previously drilled vertical well (Figure 5.1). These in-seam boreholes are strategically positioned to provide unimpeded pathways for both gas and water to migrate towards the vertical well. Once intersected, the gas is allowed to flow freely to the surface, while the water is pumped out through the vertical well.

An average of 13 ML/year of coal seam water will be produced and transferred to the existing SWC Water Management System. This small additional volume of water will have a negligible influence on the overall Water Management System (Hydro Balance 2014).

The Gas Drainage Project is estimated to have an initial 15 year Project life, supplying 4 terajoules of methane gas per day (TJ/day). If more than 9 wells are required to achieve a supply of 4 TJ/d then additional wells will be drilled as required.

The decommissioning of gas drainage infrastructure will be systematically undertaken to align with the rehabilitation conditions outlined in the EA. This process involves the phased removal of installed wells and surface infrastructure. There will be no use of grouting or removal of gravel hardstand during this decommissioning phase. Decommissioned areas will undergo a series of rehabilitation measures to restore environmental standards. This includes restoring near-natural surface profiles and reinstating subsoils and topsoils to approximate natural soil profiles, promoting good conditions for vegetation establishment. Further steps may involve grading, ripping, and seeding in accordance with the SWC rehabilitation management plan. These activities are adapted to the characteristics of the terrain, aiming to promote soil stability, and foster the reestablishment of vegetation cover.

A gas fired power station is planned (under a separate project) to be situated within the existing mining leases and adjacent to the SWC mine operations. It will use gas extracted by the proposed Gas Drainage project to generate electricity for use at the SWC mine. The power station is not the subject of this amendment application and is not considered in this assessment.

The drainage field will include the capability for gas flaring in close proximity to the proposed power station (separate project).

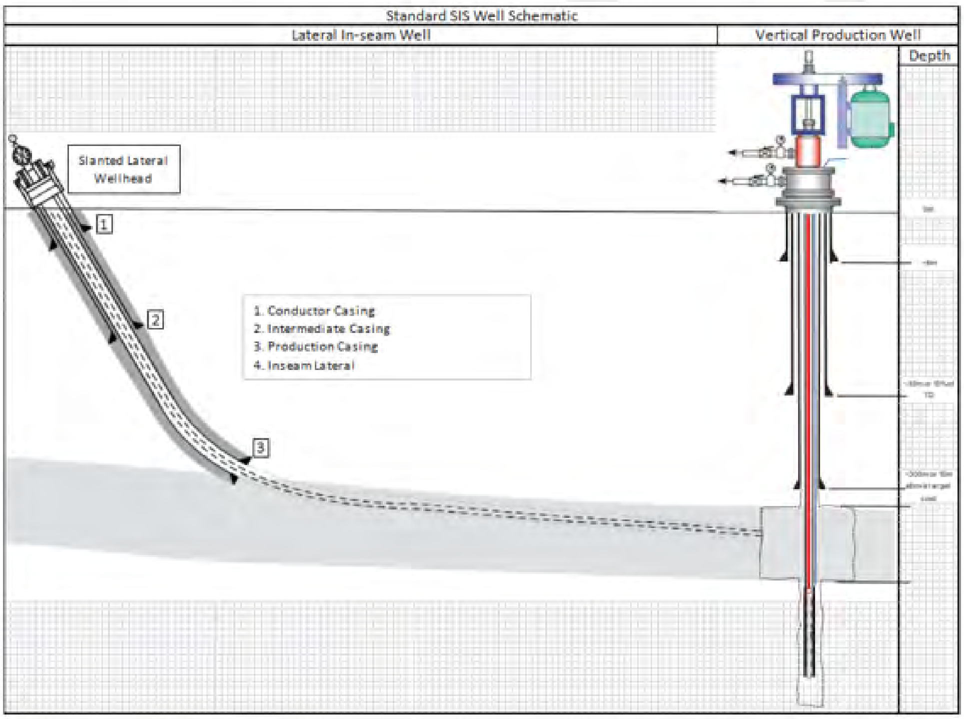
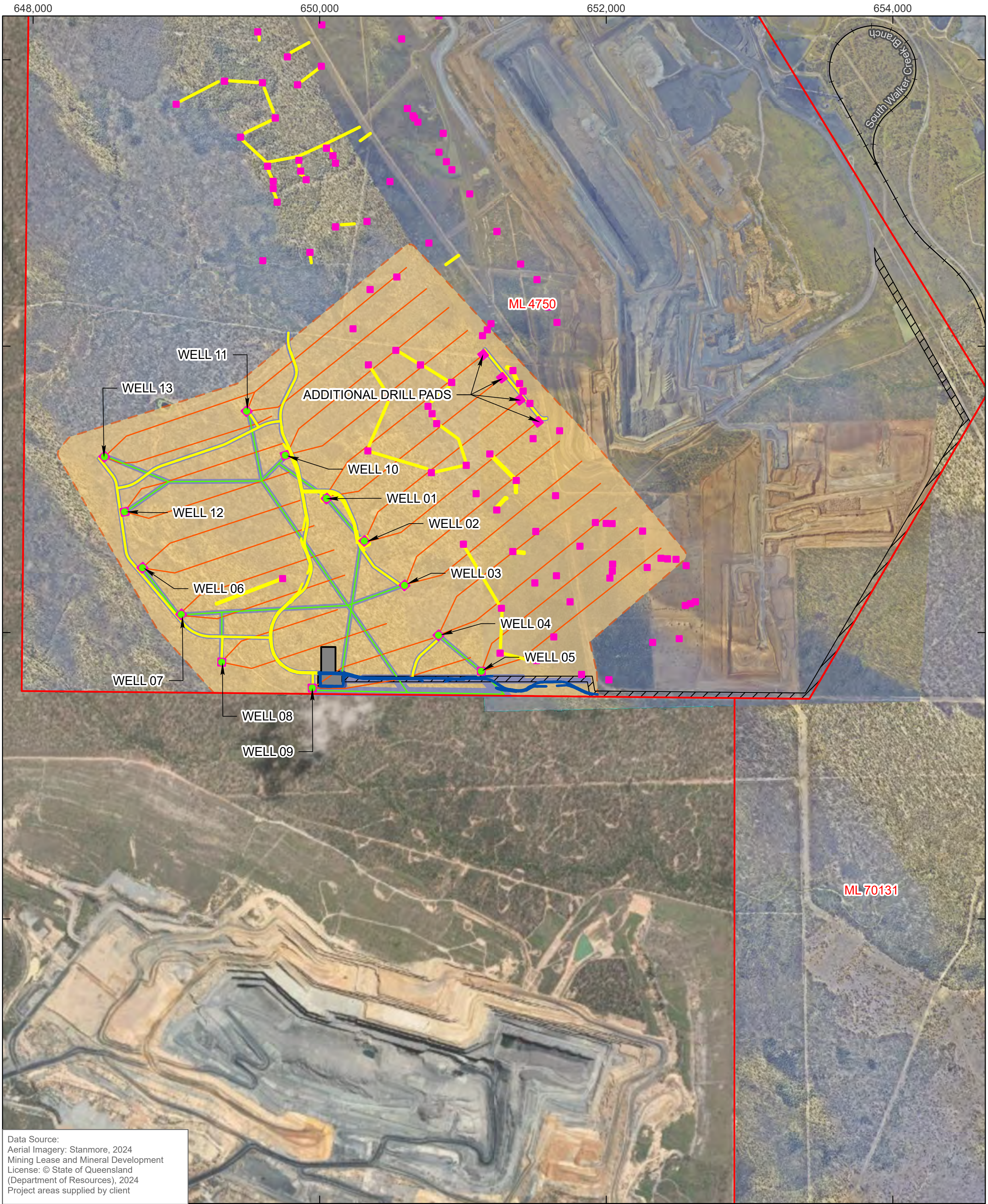


Figure 5.1 Standard Surface to In-seam well and Vertical Well Diagram.



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:35,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

stanmore

LEGEND

- Railway
- South Walker Creek Mine
- Well Head
- Proposed Access Road/ Track
- Proposed Access Road from Power Station to Mine – Separate Project
- Proposed Gas/Water Gathering Lines
- Proposed Dual Lateral Holes
- Gas Project Study Buffer
- Power Station Infrastructure – Separate Project
- Drill Pad
- Proposed Powerline Corridor from Power Station to Mine
- Surface Disturbance Buffer

SOUTH WALKER CREEK EA AMENDMENT PROJECT

GENERAL GAS DRAINAGE LAYOUT

Map 5.2

6.3 Sources of Potential Impact to Aquatic Ecology

6.3.1 Multi-Year Exploration Program

The Multi-Year Exploration Program may cause adverse impact to aquatic ecological receptors via:

- Increased turbidity and sedimentation associated with stormwater runoff from disturbed areas, earthworks and stockpiled soils, causing indirect impacts on water quality and aquatic biota in receiving waters.
- Contamination of waterways from fuel or chemical spills, causing direct impacts to water quality and aquatic biota in receiving waters.
- Contamination from introduction and spread of weeds within waterways and wetlands, which causes an indirect impact to aquatic ecology.
- Instream works and temporary waterway barriers required for waterway crossings, which causes direct impact to aquatic habitat.
- Permanent waterway barriers, including bed-level crossings.

The Multi-Year Exploration Program will likely require clearing of Regional Ecosystems within a Defined Distance of a Watercourse, noting that this impact pathway is assessed in the Terrestrial Ecology Report.

6.3.2 Gas Drainage Project

The Surface Water Study (Hydro Balance 2024) found that the Gas Drainage Project will have no impact on patterns of stream flow or water quality in receiving waters, and that there will be negligible influence of the produced water on the SWC Water Management System. Therefore, the identified sources of potential impact of the Gas Drainage Project on aquatic ecological receptors were:

- Increased turbidity and sedimentation associated with stormwater runoff from disturbed areas, earthworks and stockpiled soils, causing indirect impacts on water quality and aquatic biota in receiving waters.
- Contamination of waterways from fuel or chemical spills, causing direct impacts to water quality and aquatic biota in receiving waters.
- Contamination from introduction and spread of weeds within waterways and wetlands, which causes an indirect impact to aquatic ecology.
- Instream works and temporary waterway barriers required for waterway crossings, which causes direct impact to aquatic habitat.

- Permanent waterway barriers, including bed-level crossings.

The Gas Drainage Project will likely require clearing of Regional Ecosystems within a Defined Distance of a Watercourse, noting that this impact pathway is assessed in the Terrestrial Ecology Report.

6.4 Risk-based Impact Assessment

6.4.1 Contamination From Increased Turbidity and Sedimentation

Disturbance of soil from earth works, and stockpiles of soils, can cause stormwater runoff to have high turbidity and entrained sediments. When delivered to downstream aquatic environments, such stormwater can cause water quality impacts (increased turbidity), aquatic habitat impacts (e.g. smothering of benthic habitats with sediment), and flow-on effects to aquatic biota.

Preparation and implementation of an Erosion and Sediment Control Plan will mitigate impacts of turbidity and sedimentation. Furthermore, works in proximity to waterways will preferentially be undertaken at times of no rainfall. Routine monitoring (e.g. current REMP monitoring) for the Multi-Year Exploration Program, and Construction Phase Water Quality Monitoring Program for the Gas Drainage Project, will be implemented, and if water quality is adversely impacted then remedial actions will be undertaken to correct water quality issues.

The consequence of impact from increased turbidity and sedimentation to aquatic ecology receptors is low, because the impact would comprise a short-term but reversible harm to non-sensitive aquatic ecological receptors.

The likelihood of impact from increased turbidity and sedimentation to aquatic ecology receptors is low, because sediment and erosion controls are well established mitigations, with water quality monitoring further contributing to the ability to control this source of impact to aquatic ecology. The impact would have a remote possibility of occurring.

The mitigated risk of impact from increased turbidity and sedimentation to aquatic ecology receptors is low.

6.4.2 Contamination Due to Fuel and Chemical Spills

The spill of fuels, oils and other chemicals from vehicles and drilling machinery can cause impacted water quality, and sub-lethal (e.g. poor health) and lethal (i.e. mortality) effects on aquatic biota.

Mitigations to avoid and control this impact pathway include:

- refuelling in designated areas located away from waterways (e.g. >50 m)
- storing fuels and chemicals in bunded designated areas designed, constructed and maintained in accordance with relevant Australian standards
- storage fuels and chemicals away from waterways, farm dams and drainage features
- deploying suitable spill kits for containment of any spill.

Routine monitoring (e.g. current REMP monitoring) for the Multi-Year Exploration Program, and Construction Phase Water Quality Monitoring Program for the Gas Drainage Project, will be implemented, and if water quality is adversely impacted then remedial actions will be undertaken to correct water quality issues.

The consequence of impact from fuel and chemical spills to aquatic ecology receptors is moderate, because the impact would comprise potentially long-term harm to non-sensitive aquatic ecological receptors.

The likelihood of impact from fuel and chemical spills to aquatic ecology receptors is low because bunded, designated refuelling and storage areas are well established mitigations, with water quality monitoring further contributing to the ability to control this source of impact to aquatic ecology by enabling investigations of potential exceedances and implementation of suitable remedial actions as needed. The impact is not expected to occur.

The mitigated risk of impact from fuel and chemical spills to aquatic ecology receptors is low.

6.4.3 Introduction and Spread of Weeds

Weeds, especially those species that are biosecurity matters, can greatly reduce habitat quality for native aquatic fauna, can outcompete native aquatic plants, and can lead to water quality issues (e.g. low dissolved oxygen caused by decomposition of excessive organic matter derived from weeds).

Biosecurity Plans, likely incorporated within the Construction Environmental Management Plan for the Gas Drainage Project, incorporating vehicle and machinery hygiene protocols and other applicable weed hygiene protocols (e.g. protocols relating to seeds that attach to clothing), will effectively mitigate the potential impacts associated with contamination of waterways by weeds. Furthermore, the Biosecurity Plans will require regular inspection of the Project sites and workspaces for weeds (including aquatic weeds), which will be promptly controlled if detected.

The consequence of impact from spread of aquatic weeds to aquatic ecology receptors is moderate, because the impact could comprise a long-term harm of the environment if weeds were introduced and were to become established.

The likelihood of impact from spread of aquatic weeds to aquatic ecology receptors is low, because vehicle and machinery hygiene protocols, and weed inspection and control programs, are well established mitigations; thus, impact would have a remote possibility of occurring.

The mitigated risk of impact from spread of aquatic weeds to aquatic ecology receptors is low.

6.4.4 Instream Works and Temporary Waterway Barriers

Upgrading of existing access tracks, and development of new access tracks, required for both the Multi-Year Exploration Program and Gas Drainage Projects, may require temporary crossings of waterways to create workspaces.

Blockages to fish passage and stream flows (including temporary blockages) may prevent migration by aquatic fauna, and this may impact their ability to access different habitats along a waterway, including habitats that me be important in their life cycle. Stranding of fish at temporary waterway barriers may also lead to fish mortality, especially in ephemeral waterways if the barriers prevent access to dry season refugial habitat.

Other temporary instream works may also adversely impact fish habitat quality and fish passage, such as trenching for construction of gas drainage pipe infrastructure. Therefore, all works within waterways:

- will be conducted in the following order of preference:
- conducting works when no water is present in waterways;

conducting works in times of no flow;

conducting works in times of flow but in a way that does not negatively impact the flow of water within the waterway.

- adopt applicable guidelines, including the Accepted Development Requirements (ADR) for Waterway Barrier Works (DAF 2018) and the *Australian Pipelines and Gas Association Codes of Practice*
- remediated to ensure:

  bed and banks will be profiled to align with pre-construction condition

  there will be no changes to bed level on either the upstream or downstream side of the constructed infrastructure no ongoing erosion or instability of banks or bed.

Instream works and construction of temporary barriers may also cause an increase in turbidity and sediment delivery to waterways. The impact of this impact pathway will be mitigated using erosion and sediment control, as described above.

The consequence of impact from temporary waterway barriers to aquatic ecology receptors is low, because the impact would comprise a short-term but reversible harm of the environment.

The likelihood of impact from temporary waterway barriers to aquatic ecology receptors is low, because compliance with the ADR is an established mitigation, temporary disturbances (e.g. trenching for pipe installation) will be remediated, and construction will preferentially occur during the dry season reducing risks further. The impact would be unlikely or not expected.

The mitigated risk of impact of temporary waterway barriers to aquatic ecology receptors is low.

6.4.5 Permanent Waterway Barrier Works

Augmentation of existing bed level crossings of waterways, and construction of new bed level crossings of waterways, will be required for both the Multi-Year Exploration Program and Gas Drainage Projects.

Poorly designed and constructed waterway crossings may create waterway barriers that prevent or impede movements of aquatic fauna, especially fishes, during flow events, especially low flow events. Many of the fish native to ephemeral systems migrate up and downstream and between different habitats at particular stages of their lifecycle, especially at the start of the wet season or on initiation of flow events. Blockages to fish passage and stream flows may prevent ephemeral wet season aquatic habitat being available to aquatic biota, or mean that aquatic biota cannot move to dry season refugial habitat at the end of the wet season, and thus perish. Waterways over which bed level crossings are planned have low risk of adverse impact from waterway barriers.

The below mitigations will ensure that potential impacts to aquatic fauna passage and bank stability are low:

- works will be conducted in the following order of preference:
- conducting works when no water is present
- conducting works in times of no flow

- conducting works in times of flow but in a way that does not negatively impact the flow of water within the watercourse
- adopt applicable guidelines, such as the Accepted Development Guidelines for Waterway Barrier Works (DAF 2018)
- remediation works needed will ensure:
- bed and banks will be profiled to align with pre-construction condition
- there will be no changes to bed level on either the upstream or downstream side of the constructed infrastructure
- no ongoing erosion or instability of banks or bed.

The consequence of impact from permanent waterway barriers to aquatic ecology receptors is moderate, because the impact would comprise a long-term harm to non-sensitive aquatic ecological receptors.

The likelihood of impact from permanent waterway barriers to aquatic ecology receptors is low, because compliance with the ADR is an established mitigation. The impact would be unlikely or not expected.

The mitigated risk of impact of permanent waterway barriers to aquatic ecology receptors is low.

6.5 MNES Significant Impact Guideline Assessment

There are no aquatic MNES relevant to the Project. The Project will have no significant impact on aquatic MNES.

6.6 MSES Significant Residual Impact Assessment

There are no HES wetlands or HEV wetlands or waterways relevant to the Multi-Year Exploration Program or Gas Drainage Project; thus, the projects will have no impact on these aquatic MNES. It is noted that both the Multi-Year Exploration Program and Gas Drainage Projects will likely require clearing of Regional Ecosystems within a Defined Distance of a Watercourse, noting that this impact pathway is assessed in the Terrestrial Ecology Report.

The Project will not cause a significant residual impact on waterways that provide fish passage because all access road crossings of waterways will use temporary barriers during construction, and permanent operational phase barriers (i.e. bed level crossings), that comply with the ADR, and any buried services (e.g. water pipelines) will be below bed level of rehabilitated waterways (Table 5.6).

Table 5.6 Significant Residual Impact Assessment for waterways that provide fish passage.

Significant Residual Impact Criteria	Significant Residual Impact?
Result in the mortality or injury of fish	No
Result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage, such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish	No
Reduce the extent, frequency or duration of fish passage previously found at a site	No
Substantially modify, destroy, or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish	No
Result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows	No
Lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species	No

7 Summary

Thorough assessment of aquatic ecological values indicated that:

- Major waterways of the SWC Area (e.g. Bee Creek, Kemmis Creek, Walker Creek and Carborough Creek) have moderate aquatic ecological values, because they periodically support migration of a modest number of common and widespread fish species, but unusual, threatened or rare features or species do not occur.
- Sandy Creek has low aquatic ecological values, because Sandy Creek provide periodic habitat for common aquatic macroinvertebrate species, but unusual, threatened or rare features or species do not occur.
- Minor waterways of the SWC Area and minor tributaries of Sandy Creek have very low aquatic ecological values because aquatic biota do not occur and unusual, threatened or rare features or species do not occur.

The aquatic ecological receptors of the SWC Area, and the Sandy Creek locale, are not considered to be sensitive receptors because:

- Waterways are ephemeral and predominantly in dry condition, during which time they do not support aquatic species.
- Natural water quality is highly variable, which is typical for ephemeral systems.
- Threatened aquatic species do not occur in or near the Project area.
- Aquatic species known from and likely to occur in the Project area are tolerant of, and resilient to, a range of water quality and aquatic habitat conditions (e.g. many fish species are early colonisers of aquatic habitat following flow events after long periods of no flow; macroinvertebrate communities are dominated by tolerant taxa; aquatic plants are uncommon and dominant by low cover of ubiquitous emergent taxa).

The identified sources of potential impact on aquatic ecological values from the Multi-Year Exploration Program and the Gas Drainage Project were:

- Increased turbidity and sedimentation associated with stormwater runoff from disturbed areas, earthworks and stockpiled soils, causing indirect impacts on water quality and aquatic biota in receiving waters.
- Contamination of waterways from fuel or chemical spills, causing direct impacts to water quality and aquatic biota in receiving waters.

- Contamination from introduction and spread of weeds within waterways and wetlands, which causes an indirect impact to aquatic ecology.
- Instream works and temporary waterway barriers required for waterway crossings, which causes direct impact to aquatic habitat.
- Permanent waterway barriers, including bed-level crossings.

Risk-based assessment of these sources of potential impact indicated low risk to aquatic ecological receptors where the identified mitigations were applied for both the Multi-Year Exploration Program and Gas Drainage Projects (Table 5.7).

The Multi-Year Exploration Program and Gas Drainage Projects will not have a significant impact on an aquatic MNES or a significant residual impact on an aquatic MSES.

Table 5.7 Summary of Risk Assessment and Impact Mitigation

Potential Source of Impact	Mitigations	Mitigated Consequence of Impact	Mitigated Likelihood of Impact	Mitigated Risk of Impact
Contamination from increased turbidity and sedimentation	Preparation and implementation of an Erosion and Sediment Control Plan Preferentially undertake works at times of no rainfall and no flow. Routine REMP monitoring for the Multi-Year Exploration Program, and reparation and implementation of a Construction Phase Water Quality Monitoring Program for the Gas Drainage Project, to assess if water quality is adversely impacted and remedial actions are needed to correct water quality issues.	low	low	low
Contamination due to fuel and chemical spills	Mitigations to avoid and control this impact pathway include: • refuelling in designated areas located away from waterways (e.g. >50 m) • storing fuels and chemicals in bunded designated areas designed, constructed and maintained in accordance with relevant Australian standards • storage fuels and chemicals away from waterways and drainage features • deploying suitable spill kits for containment of any spill. Routine REMP monitoring for the Multi-Year Exploration Program, and reparation and implementation of a Construction Phase Water Quality Monitoring Program for the Gas Drainage Project, to assess if water quality is adversely impacted and remedial actions are needed to correct water quality issues.	moderate	low	low

Potential Source of Impact	Mitigations	Mitigated Consequence of Impact	Mitigated Likelihood of Impact	Mitigated Risk of Impact
Introduction and spread of aquatic weeds	Biosecurity Plans, likely incorporated within the Construction Environmental Management Plan for the Gas Drainage Project, incorporating vehicle and machinery hygiene protocols and other applicable weed hygiene protocols (e.g. protocols relating to seeds that attach to clothing), will effectively mitigate the potential impacts associated with contamination of waterways by weeds.	moderate	low	low
Instream works and temporary barriers	Temporary barriers will comply with the requirements of the Accepted Development Requirements Additionally, all works within waterways will be conducted in the following order of preference: 1. conducting works when no water is present in waterways; 2. conducting works in times of no flow; 3. conducting works in times of flow but in a way that does not negatively impact the flow of water within the waterway. Preparation and implementation of an Erosion and Sediment Control Plan	low	low	low
Permanent waterway barriers	Permanent barriers will comply with the requirements of the Accepted Development Requirements	moderate	low	low

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Appendix A Protected Matters Search Results

Australian Government
Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 11-Mar-2024

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	25
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	14
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	8
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area	In feature area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area	In feature area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Calidris acuminata			
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Erythrotriorchis radiatus			
Red Goshawk [942]	Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos			
Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area	In feature area
Geophaps scripta scripta			
Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area	In feature area
Neochmia ruficauda ruficauda			
Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area	In feature area
Poephila cincta cincta			
Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Stagonopleura guttata			
Diamond Firetail [59398]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
Dasyurus hallucatus			
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area	In feature area
Macroderma gigas			
Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Nyctophilus corbeni			
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Petauroides volans			
Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
PLANT			
Dichanthium queenslandicum			
King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area	In feature area
Dichanthium setosum			
bluegrass [14159]	Vulnerable	Species or species habitat known to occur within area	In feature area
Eucalyptus raveretiana			
Black Ironbox [16344]	Vulnerable	Species or species habitat known to occur within area	In feature area
Polianthion minutiflorum			
[82772]	Vulnerable	Species or species habitat may occur within area	In feature area
Samadera bidwillii			
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area	In feature area
REPTILE			
Denisonia maculata			
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area	In feature area
Egernia rugosa			
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area	In feature area
Elseya albagula			
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat may occur within area	In feature area
Lerista allanae			
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area	In feature area
Rheodytes leukops			
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area	In feature area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			

Scientific Name	Threatened Category	Presence Text	Buffer Status
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Cuculus optatus			
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Urannah Dam and Pipelines Project	2020/8708		Completed	In buffer area only
Controlled action				
Arrow Bowen Pipeline (CSG), QLD	2012/6459	Controlled Action	Post-Approval	In feature area
Bowen Gas Project	2012/6377	Controlled Action	Post-Approval	In feature area
Goonyella Riverside Mine to South Walker Creek Mine Dragline Move	2016/7788	Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Kemmis 2 open cut coal mine South Walker Creek, 25 km WSW of Nebo Bowen Basin, QLD	2013/7025	Controlled Action	Post-Approval	In feature area
MRA2C Project, South Walker Creek Operations	2017/7957	Controlled Action	Post-Approval	In feature area
South Walker Creek Mulgrave Pit mine extension, Nebo, QLD	2014/7272	Controlled Action	Post-Approval	In feature area
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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APPENDIX F
STYGOFAUNA IMPACT ASSESSMENT

South Walker Creek Mine

Stygofauna Values Assessment

Prepared for:

Stanmore

frc environmental part of SLR

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

frc reference: 240211

freshwater estuarine marine

Document Control Summary

Report Title: South Walker Creek Mine: Stygofauna Values Assessment
Project No.: 240211
Project Director: Ben Cook
Project Manager: Andrew Mather
Project Team: Tom Richards, Beaudee Newberry, Andrew Mather and Ben Cook
Client: Stanmore Coal
Client Contact: Richard Oldham

Distribution Record

Edition	Date	Reviewed By	Issued By	Issued To	File Type	Description
i	29/05/2024	B. Cook	B. Cook	Stanmore Coal	.docx	draft
Ii	30/09/2024	B. Cook	B. Brooks	Stanmore Coal	.docx	final

Contents

Tables

Figures

Maps

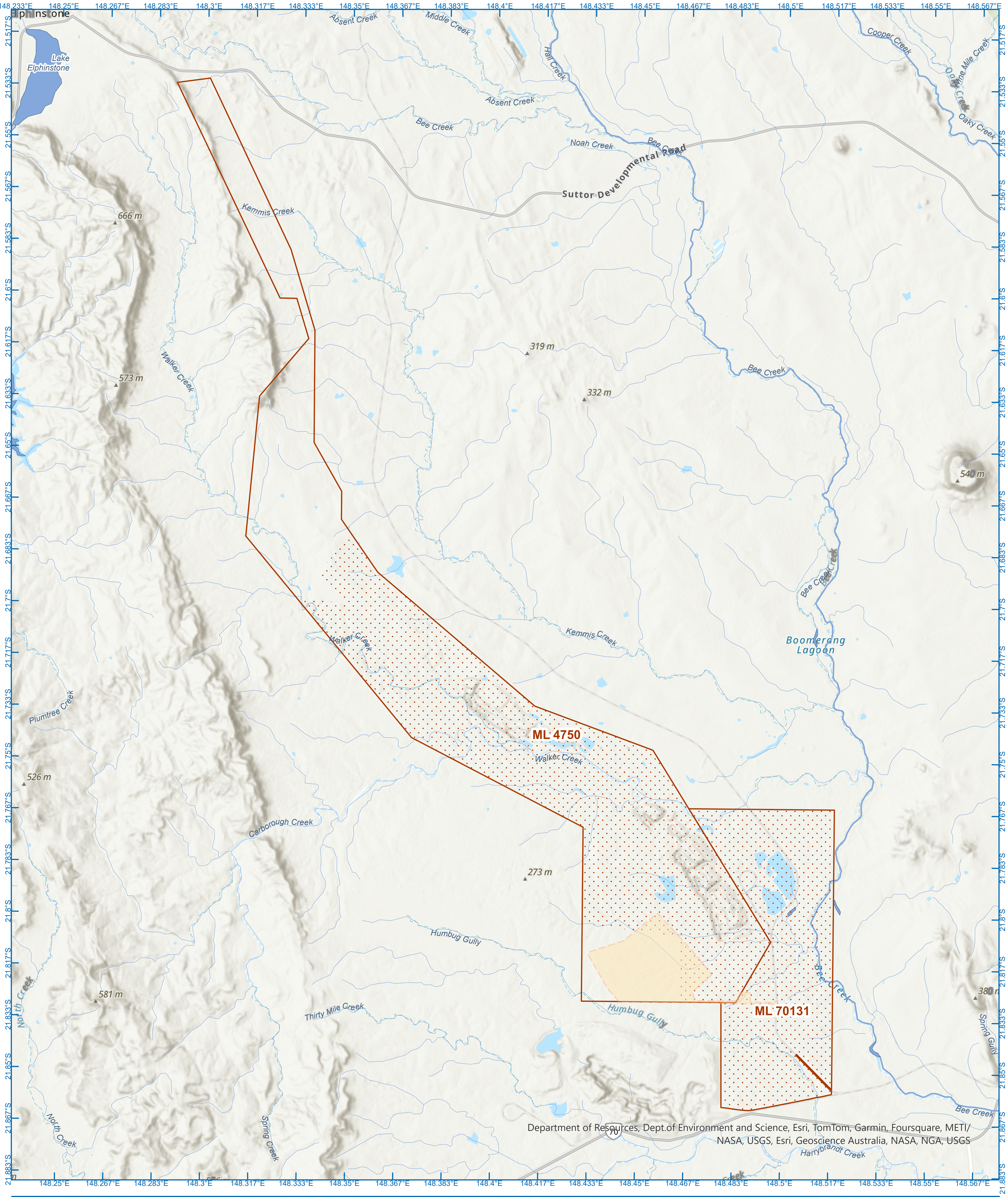
1 Introduction

frc environmental part of SLR Consulting was commissioned by Stanmore to implement an assessment and stygofauna values of groundwaters underlying the South Walker Creek Mine Area (SWC Area), including current exploration areas, with Sandy Creek and surrounds being focal area for the assessment (Map 1.1). The objective of the study was to synthesise existing data from past stygofauna survey work across the SWC Area, and collect new site-specific survey data from the Sandy Creek locale, to provide a basis for a range of future impact assessments for proposed works at SWC mine.

The scope of this report is to present:

- a desktop assessment, including synthesis of historical survey data, to describe stygofauna values of the SWC Area.
- the methods and results of the 2024 stygofauna survey in the Sandy Creek locale.
- an assessment of the stygofauna values of groundwaters of the SWC Area, and the Sandy Creek locale.

In this report 'SWC Area' refers to groundwaters underlying the SWC mining lease area [i.e. mining lease 4750 (ML4750) and mining lease 70131 (ML70131)], and the Sandy Creek locale relates to groundwaters underlying Sandy Creek and surrounds (Map 1.1).

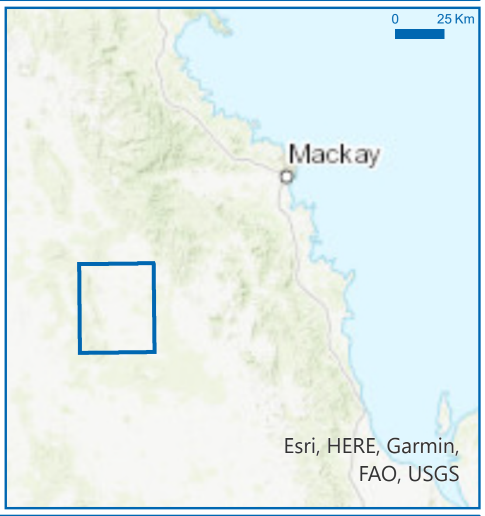


240211: South Walker Creek Mine: Stygofauna Values Assessment

Map 1.1: SWC Area and Sandy Creek Locale.

LEGEND

- Mine lease surface area granted
- SWC Mine lease boundary
- Sandy Creek Locale
- Lake/Reservoir
- Major Watercourse
- Minor Watercourse



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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

N

SCALE

0 0.5 1 2 3 4 5 6
Kilometres

Scale: 1:125,000 @ A3

2 Legislative Context

2.1 Commonwealth Environment Protection and Biodiversity Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (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 (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- 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 EPBC Act provides protection for threatened flora, fauna and ecological communities by:

- identifying and listing species and ecological communities as threatened
- developing conservation advice and recovery plans for listed species and ecological communities
- developing a register of critical habitat
- recognising key threatening processes
- where appropriate, reducing the impacts of these processes through threat abatement plans and non-statutory threat abatement advices, and
- requiring approval for certain actions or activities that will, or are likely to, have a significant impact on an MNES or other protected matter.

Under the EPBC Act, if an action has, will have, or is likely to have, a significant impact on a MNES, approval is required from the Australian Government Environment Minister (the Minister). The MNES Significant Impact Guidelines (DotE 2013) outline a 'self-assessment' process to assist in determining whether an action is likely to have a significant impact on a MNES. If this process determines there may be a significant impact to a MNES, a referral should be submitted to the Minister for a decision on whether assessment and approval is required under the EPBC Act.

The Minister can make one of three decisions regarding a proposal:

- Not a controlled action: if the proposed action is not likely to be significant, approval is not required if the action is taken in accordance with the referral. Consequently, the action can proceed subject to any state, territory or local government requirements
- Not a controlled action – 'particular manner': if the proposed action is not likely to be significant if done in a particular manner
- Controlled action: if the proposed action is likely to be significant, it is called a 'controlled action'. The matters which the proposed action may have a significant impact on (e.g. Ramsar wetlands or threatened species) are known as the controlling provisions. Controlled actions require approval and are subject to further assessment processes.

Once a controlled action is assessed, it can be approved, approved subject to constraints, or refused.

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.

2.2 Queensland Environmental Protection Act 1994

The Queensland *Environmental Protection Act 1994* (EP Act) provides for the protection of EVs of Queensland's natural environment, with the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity); pursuant to the EP Act) providing for the protection of EVs of Queensland's surface, marine and groundwaters. EVs of water to be protected under the EPP (Water and Wetland Biodiversity) include protection of water for drinking, stock watering, irrigation, human consumers of aquatic food resources, aquaculture, farm water supply and aquatic ecosystems. Of relevance to this assessment is the aquatic ecosystems Environmental Value, which in the context of groundwater relates to stygofauna, as indicated in the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DoSITI 2015); see also DES (2018). Therefore, the presence of stygofauna, and especially stygobitic taxa, indicate groundwater ecosystems where protection of the aquatic ecosystem's EV, as defined in the EPP (Water and Wetland Biodiversity), is required by the legislative framework set out under the EP Act.

2.3 Queensland Nature Conservation Act 1992

There are no stygofauna species listed as threatened under the Queensland *Nature Conservation (Animals) Regulation 2020* pursuant to the *Nature Conservation Act 1992*.

3 Desktop Assessment of Stygofauna Underlying the SWC Area

3.1 Methods

Firstly, review of stygofauna of the region was undertaken using published and otherwise available information (e.g. Glanville et al. 2016; Hancock & Boulton 2008; Hose et al. 2015; Saccò et al. 2022), and previous stygofauna studies completed at SWC (frc environmental 2019; 2022b), were reviewed and synthesised to:

- characterise the groundwater ecosystem of the SWC Area
- describe the specific stygofauna of the SWC Area and the characteristics of bores at which stygofauna have previously been recorded.

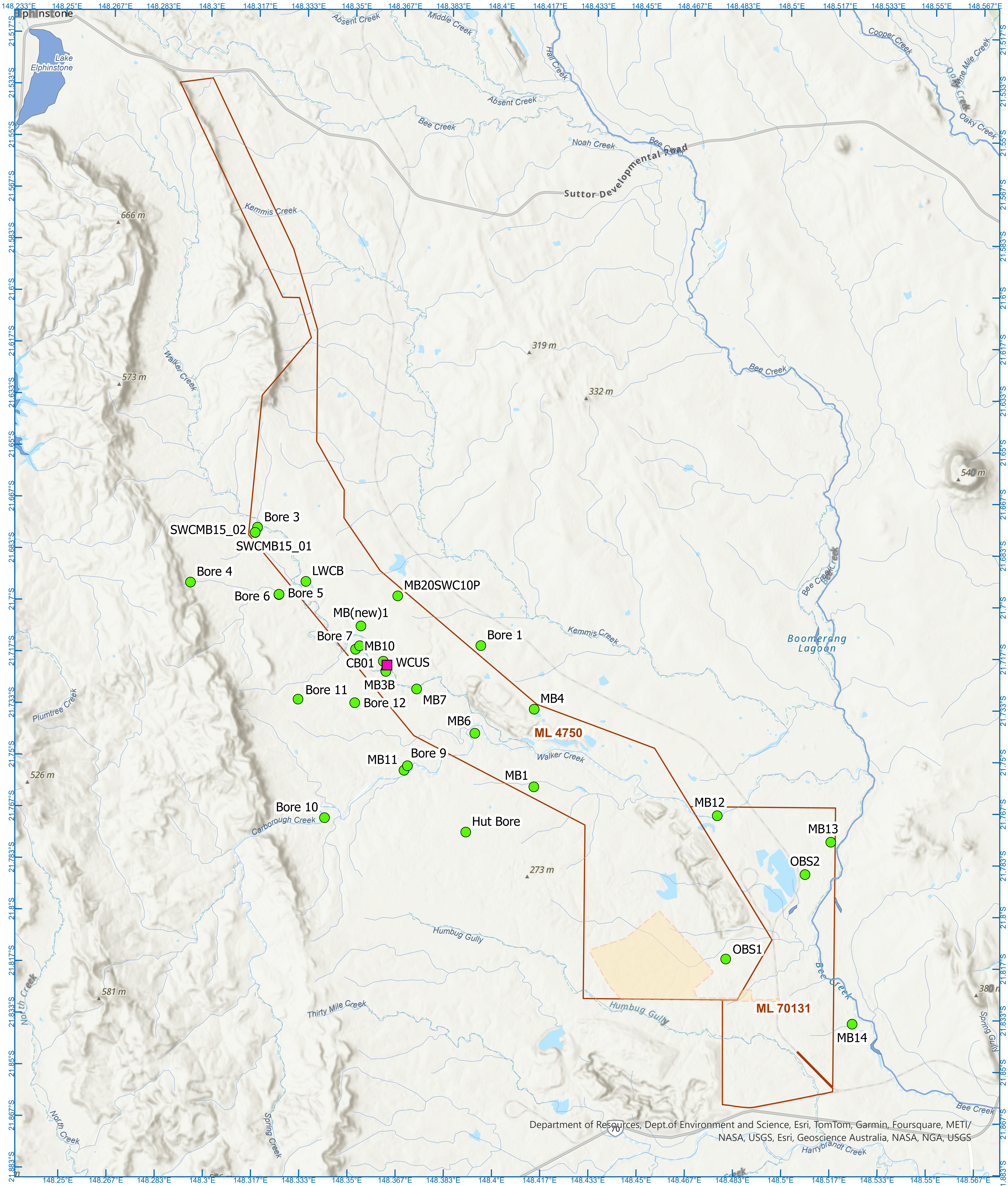
The bores sampled for stygofauna in the SWC Area to date, and relevant characteristics of each bore, are listed in Table 3.1, with bore locations shown on Map 3.1.

Table 3.1 Bores previously surveyed for stygofauna in the SWC Area and their environmental characteristics.

Bore	Drilled depth (m)	Depth to water (mbgl)	Geology	Electrical conductivity (µS/cm)	TDS (mg/L)	pH
MB1	18	>18 (dry)	Regolith	NDA	NDA	NDA
MB10	11.8	5.08 – 5.68	Alluvium	1580 – 2420	822 – 1330	7.4 – 8.1
MB11	14.3	4.15 – 4.92	Alluvium	576 – 4420	352 – 3010	6.7 – 7.6
MB13	25.3	14.76 – 15.33	Alluvium	1450 – 1650	839 – 1180	7.1 – 8.2
MB14	26.38	14.65 – 15.66	Alluvium	891 – 993	524 – 662	7.2 – 7.9
MB6	15	10.83 – 13.12	Regolith	840	464	NDA
MB7	30	8 – 9.23	Regolith	1210	701	NDA
MB12	15.1	10.98 – 11.51	Regolith	4770 – 6070	2740 – 4600	7.2 – 7.9
OBS1	39	26.5 – 28.63	Regolith	13,500 – 21,500	11,700 – 13,600	7.32 – 7.63
OBS2	34	10.7 – 13.5	Regolith	17,600 – 33,300	16,800	6.8
MB4	82	23.59 – 32.24	Coal Seam	8400	2740	NDA
CB01	135	12 – 18.1	Coal Seam	6670	2800	NDA
Bore 1	39.5	NDA	Alluvium	NDA	NDA	NDA
Bore 3	NDA	NDA	Alluvium	NDA	NDA	NDA
Bore 4	NDA	Surface	Spring	2458	NDA	7.0
Bore 5	NDA	NDA	Alluvium	NDA	NDA	NDA
Bore 6	NDA	NDA	Alluvium	2152	NDA	7.7
Bore 7	9.85	NDA	Alluvium	860	NDA	8.1
Bore 9	7.57	NDA	Alluvium	553	NDA	7.9
Bore 10	NDA	NDA	Alluvium	NDA	NDA	NDA
Bore 11	NDA	NDA	Alluvium	NDA	NDA	NDA

Bore	Drilled depth (m)	Depth to water (mbgl)	Geology	Electrical conductivity (µS/cm)	TDS (mg/L)	pH
Bore 12	90.5	23.9	Alluvium	18080	NDA	6.5
LWCB	NDA	NDA	Alluvium	NDA	NDA	NDA
Hut Bore	NDA	Dry	Alluvium	NDA	3030	NDA
MB(new1)	NDA	NDA	NDA	NDA	NDA	NDA
MB3A	16	2.85 – 3.88	Regolith	1390 – 2860	824 – 1670	7.8 – 8.5
MB3B	9.5	2.8 – 3.58	Regolith	803 – 2360	455 – 613	6.6 – 8.1
SWCMB15_01	10.6	8.77 – 9.27	Sandy gravel	1,130 – 1,760	670 – 1,070	7.96 – 8.21
SWCMB15_02	28.6	7.89 – 8.61	Sandstone	2,870 – 3,050	1,700 – 1,770	7.94 – 8.18
MB20SWC10P	48.6	13.79 – 13.85	Siltstone / coal	3,360 – 3,770	2,140 – 2,230	7.92 – 8.25

Source of all data: Golder Associates (2018) BHP (2020) and client supplied raw data for monitoring rounds in 2019 and 2020; NDA = no data available

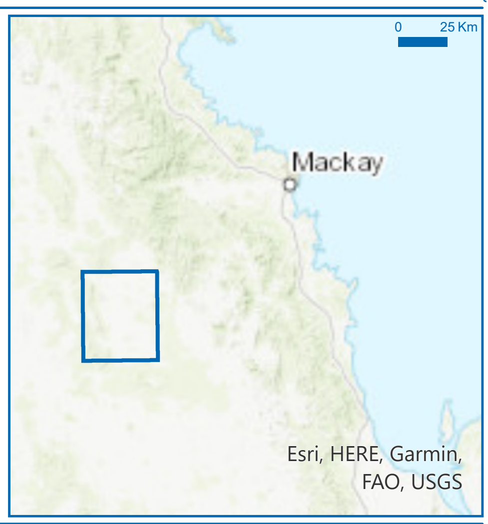


240211: South Walker Creek Mine: Stygofauna Values Assessment

Map 3.1:
Bores previously surveyed for stygofauna in the SWC Area.

LEGEND

- Bores
- WCUS
- Mine lease boundary
- Sandy Creek Locale
- Major Watercourse
- Minor Watercourse
- Lake/Reservoir



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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

SCALE
0 0.5 1 2 3 4 5 6
Kilometres
Scale: 1:125,000 @ A3

3.2 Results

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 SWC Area is located at the boundary of the Isaac-Comet Downs and Northern Bowen Basin sub-bioregions, with five described families from eight samples reported from the Isaac-Comet Downs subregion, and five families from six samples reported from the Northern Bowen Basin subregion. Saccò et al. (2022) reported 12 higher taxa of stygofauna (stygoxenes and stygobites collectively) from coastal river basins in eastern Australia from alluvial and karst geological units.
- 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.

3.2.2 Characterisation of the Groundwater Ecosystem Underlying the SWC Area

The geology of the SWC Area, from shallowest to deepest, comprises surface layers of unconsolidated regolith and alluvium adjacent to watercourses, overlaying the Rewan Formation (mudstone, siltstone and sandstone), which overlays the Blackwater Group (i.e. Rangal Coal Measures, Fort Cooper Coal Measures and the Moranbah Coal Measures, which collectively comprise coal deposits with seams of sandstone, siltstone and mudstone) (Golder Associates 2022). Groundwater is typically less than 15 m below ground level, and groundwater quality across the SWC Area is summarised in Table 3.2.

Table 3.2 SWC Groundwater Quality Summary Statistics.

Statistic	Electrical Conductivity	Total Dissolved Solids	pH
unit	µS/cm	mg/L	unit
Minimum	553	352	6.5
Median	2,420	1,330	7.9
Average	5,282	2,896	7.6
Maximum	33,300	16,800	8.3

3.2.3 Stygofauna Recorded from the Groundwater Ecosystem Underlying the SWC Area

The GDE Atlas indicated that there are no subterranean GDEs within or near the broader SWC area, including the Sandy Creek locale.

However, field-based assessment of stygofauna (i.e. subterranean aquatic fauna that live in groundwater ecosystems) across the broader SWC area indicated (frc environmental 2022a):

- a stygobite (i.e. obligate groundwater inhabitants, groundwater-dependent) taxon, Parabathynellidae (syncarid shrimp; Figure 3.1), was found consistently at bore MB10 in April 2019, November 2019, October 2020 and March 2021 (but not at any other bore), and
- several stygoxene (i.e. facultative groundwater inhabitants, not groundwater-dependent) taxa (e.g. a mite, a worm, a nematode, a seed shrimp and a copepod) were recorded at bores MB12 (regolith), OSB12 (regolith), bore 6 (alluvium), bore 7

(alluvium), bore 8 (alluvium), bore 10 (alluvium), bore 11 (alluvium), bore 12 (alluvium) and MB(new1), with most of these taxa recorded at more than one bore, and the mite being widespread across the SWC area.

None of the stygofauna taxa known from, or likely to occur in, the SWC area are listed species under the EPBC.

The stygobitic parabathynellidae was consistently found at bore MB10. The geological unit of bore MB10 is alluvium, which is a geological unit from which stygofauna are commonly recorded (Glanville et al. 2016; Hancock & Boulton 2008; Hose et al. 2015). The concentrations of EC and TDS of groundwater at bore MB10 were within the reported preferred range of stygofauna, and depth to water at bore MB10 was low (i.e. <6 m), indicating that the parabathynellidae recorded at this bore were in groundwater ecosystems that likely intersected the root zone of terrestrial vegetation (Eamus et al. 2006), suggesting terrestrial tree roots potentially comprise a habitat element for this stygobitic taxon. Review of macroinvertebrate data collected at surface water site WCUS on Walker Creek in 2021 (27 – 28 March 2021) (Map 3.1), in close proximity to bore MB10 indicated the presence of parabathynellidae, likely from within disturbed sediments at a point of localised groundwater influences in the waterway. This result suggests the distribution of this taxon extends from bore MB10 to the main stem of Walker Creek within the shallow alluvial groundwater system.

The characteristics of groundwater where the stygoxene taxa were recorded were:

- predominantly alluvium geology but also regolith geology
- low to high EC and TDS, and
- shallow to deep depth to water table, often below the likely root zone of terrestrial vegetation.

Two troglofaunal (i.e. subterranean terrestrial fauna) taxa, both without pigment or eyes, were recorded on previous surveys: Chilopoda (Figure 3.3) and Diplopoda (Figure 3.4). Assessment of troglofauna was not within the scope of this stygofauna study.

Table 3.3 Stygofauna previously recorded from the SWC Area.

Bore ID	April 2019				November 2019				October 2020				March 2021			
	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]
MB1	Not surveyed				Chilopoda Diplopoda	centipede millipede	troglofauna troglofauna	15 28	Not surveyed				Not surveyed			
MB10	Parabathynellidae 1	syncarid shrimp 1	stygobite	30	Parabathynellidae 1 Diplopoda	syncarid shrimp 1 millipede	stygobite troglofauna	5 5	Parabathynellidae 1	syncarid shrimp 1	stygobite	4	Parabathynellidae 1 Diplopoda	syncarid shrimp 1 millipede	stygobite troglofauna	7 2
MB11	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
MB13	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
MB14	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
MB6	–	–	–	–	Not surveyed				Not surveyed				Not surveyed			
MB7	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
MB12	–	–	–	–	Oligochaete 1	Segmented worm 1	stygoxene	1	Not surveyed				Not surveyed			
OBS1	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
OBS2	Acarina 1	Mite 1	stygoxene	2	–	–	–	–	Not surveyed				Not surveyed			
MB4	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
CB01	–	–	–	–	–	–	–	–	–	–	–	–	Not surveyed			
Bore 1	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
Bore 3	–	–	–	–	Not surveyed				Not surveyed				–	–	–	–
Bore 4	–	–	–	–	–	–	–	–	Not surveyed				–	–	–	–
Bore 5	–	–	–	–	Not surveyed				Not surveyed				–	–	–	–
Bore 6	Acarina 1 Nematoda 1	Mite 1 Nematode	stygoxene stygoxene	1 1	–	–	–	–	Not surveyed				–	–	–	–
Bore 7	–	–	–	–	Dugesiidae	planarian	stygoxene	2	Not surveyed				Calanoida 1 Nematoda	Copepod Nematode	stygoxene stygoxene	1 1
Bore 9	Oligochaete 1	Segmented worm 1	stygoxene	1	–	–	–	–	Not surveyed				Not surveyed			
Bore 10	Ostracod 1	Seed shrimp 1	stygoxene	1	–	–	–	–	Not surveyed				Oligochaete 1 Ostracod 1	segmented worm 1 seed shrimp	stygoxene stygoxene	1 1
Bore 11	–	–	–	–	Chilopoda	centipede	troglofauna	1	Not surveyed				Acarina 1 Nematoda	Mite 1 Nematode	stygoxene stygoxene	2 2
Bore 12	Acarina 1	Mite 1	stygoxene	23	–	–	–	–	Not surveyed				Not surveyed			
LWCB	–	–	–	–	Not surveyed				Not surveyed				Not surveyed			
Hut Bore	–	–	–	–	Not surveyed				Not surveyed				Not surveyed			
MB(new1)	–	–	–	–	Diplopoda	millipede	troglofauna	1	Acarina 1	Mite 1	stygoxene	1	Not surveyed			
MB3A	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			

Bore ID	April 2019				November 2019				October 2020				March 2021			
	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]	Stygofaunal taxon	Common name	Class	Abundance [a]
MB3B	–	–	–	–	–	–	–	–	Not surveyed				Not surveyed			
SWCMB15_01	Not surveyed				Not surveyed				Not surveyed				–	–	–	–
SWCMB15_02	Not surveyed				Not surveyed				Not surveyed				–	–	–	–
MB20SWC10P	Not surveyed				Not surveyed				Not surveyed				–	–	–	–

– no stygofauna recorded.

Figure 3.1 Photograph of Parabathynellidae caught at bore MB10 in April 2019.

Figure 3.2 Photograph of Parabathynellidae caught at bore MB10 in September 2019.

Figure 3.3 Photograph of Chilopoda.

Figure 3.4 Photograph of Diplopoda

4 Stygofauna Pilot Study for the Sandy Creek Locale

4.1 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* (DoSITI 2015), see also the Department of Environment and Science's (DES) Water Monitoring and Sampling Manual (DES 2018).

A desktop review was used to determine the suitability of groundwater ecosystems of the Sandy Creek locale 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 and distribution of stygofauna in the Sandy Creek locale.
- review of hydrogeological data for the Sandy Creek locale.
- review of groundwater pH, electrical conductivity (EC) and total dissolved solids (TDS) data within and surrounding the Sandy Creek locale.

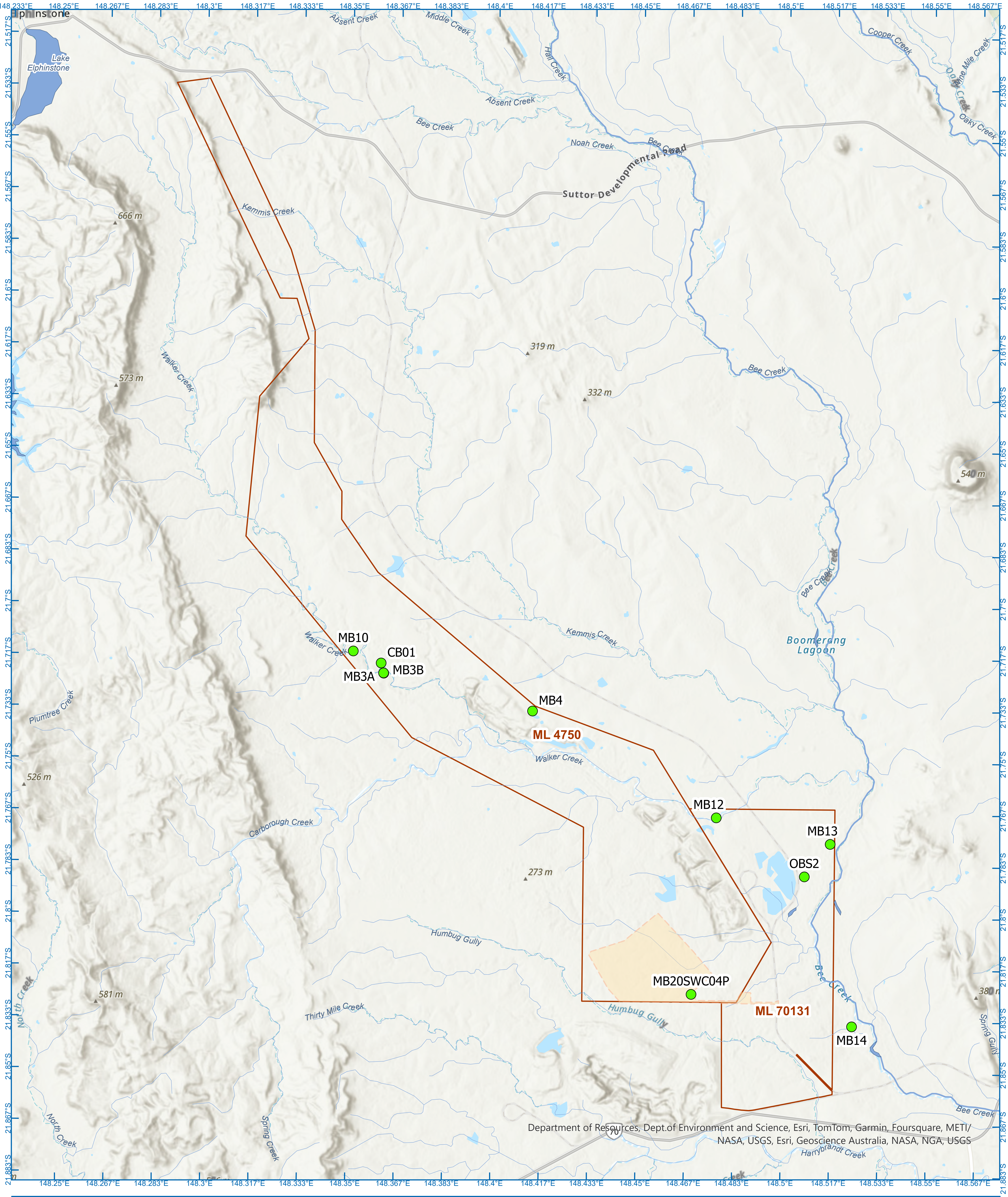
Stygofauna survey at ten bores was completed in April 2024 (Table 4.1; Map 4.1). The full water column in each bore was sampled using six hauls of a weighted phreatobiological net (similar to a plankton net). Three of the hauls with a very fine net (mesh size 50 µm), and three hauls with a fine net (mesh size 150 µm) were used. 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.

The study design included bores within the Sandy Creek locale (i.e. bores MB14, OBS2, MB13, MB12, MB20SWC04P), and background bores elsewhere in the SWC area, including bore MB10 from which stygobitic fauna have been recorded previously.

Table 4.1 Bores sampled for stygofauna in the Sandy Creek locale in April 2024.

Bore	Easting	Northing	Drilled depth (m)	Lithology	Electrical conductivity (µS/cm)	TDS (mg/L)	pH
MB13	656766	7591177	25.3	Alluvium	1,450 - 1,650	839 - 1,180	7.1 - 8.2
MB14	657528	7584673	26.38	Alluvium	891 - 993	524 - 662	7.2 – 8.2
OBS2	655845	7590019	34	Regolith	17,600 – 33,300	16,800	6.8
MB20SWC04P	651811	7585831	80.6	Coal Seam	NDA	NDA	NDA
MB4	646166	7595932	82	Coal Seam	NDA	NDA	NDA
CB01	640774	7597645	135	Coal Seam	6,670	2,800	NDA
MB10	639782	7598073	11.8	Alluvium	1,580 – 2,420	822 – 1,330	7.4 – 8.1
MB3B	640866	7597282	9.5	Regolith	803 – 2,360	455 - 613	6.6 – 8.1
MB3A	640860	7597291	16	Regolith	1,350 – 2,860	824 – 1,670	7.8 – 8.5
MB12	652709	7592123	15.1	Regolith	4,770 – 6,070	2,740 – 4,600	7.2 – 7.9

Source of all data: Golder Associates (2018; 2022), BHP (2020) and client supplied raw data for monitoring rounds in 2019 and 2021; ; NDA = no data available
Projection: AGD84 AMG Zone 55



240211: South Walker Creek Mine: Stygofauna Values Assessment

Map 4.1:
Bores surveyed for stygofauna in the Sandy Creek locale in April 2024.

LEGEND

- Bores
- Mine lease boundary
- Sandy Creek Locale
- Major Watercourse
- Minor Watercourse
- Lake/Reservoir

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SOURCES

DATE	DRAWN BY	VERSION	PROJECTION
2024-06-06	AB	i	Coordinate System: GDA 1994 MGA Zone 55 Projection: Transverse Mercator Datum: GDA 1994

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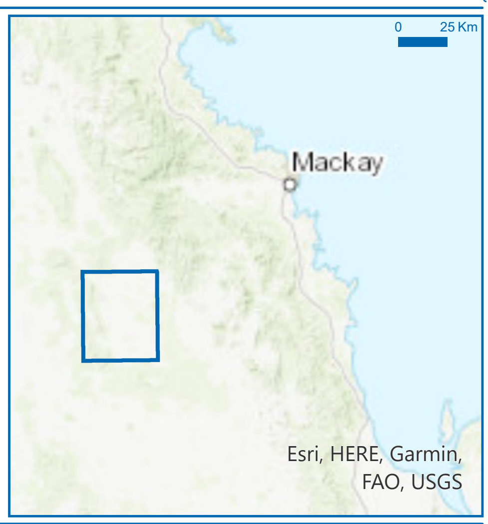


4.2 Results

4.2.1 Habitat Suitability

Lithology

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 the highest stygofaunal diversity in Queensland.

The geology of the Sandy Creek locale comprises alluvium and regolith, and underlying coal seam, and is therefore has geological units that are suitable for supporting stygofauna.

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 recorded at bores in shallow alluvium within the Sandy Creek locale was approximately 12 to 27 meters below ground level, with shallow groundwater (i.e. <10 meters below ground level) regolith also present. The depth to water of shallow groundwaters in the Sandy Creek locale are suitable for supporting stygofauna.

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 underlying the Sandy Creek locale is generally within the range known to support diverse stygofauna, with the exception of only a single bore (i.e. bore OBS2).

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 underlying the Sandy Creek locale ranged from 6.6 to 8.2, and therefore generally aligned with the pH range known to support stygofauna.

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 Sandy Creek locale overlapped with the range of TDS know to support stygofauna, although the maximum TDS at a number of the bores was higher than the TDS of groundwater from which stygofauna have been recorded. Therefore, the TDS fo groundwater of the Sandy Creek locale was assessed as partly suitably for supporting stygofauna.

4.2.2 Stygofauna

Previous stygofauna surveys of bores in the Sandy Creek locale indicated Acarina sp. and Oligochaeta sp. (both stygoxenes) from regolith (i.e. bores OBS2 and MB12, respectively), noting bore OBS2 has the highest electrical conductivity of the bores surveyed. However, no stygobitic taxa have been recorded from bores in the vicinity of Sandy Creek, with stygobites (Parabathynellidae) previously recorded only from bore MB10, and from surface water site WCUS on Walker Creek.

The April 2024 survey indicated four stygofauna taxa were recorded from three bores (Table 4.2), including:

- Parabathynellidae (a stygobite) from bores CB01 and MB10.

- Bathynellidae (a stygobite) from bore MB10.
- Acarina sp. (a styxene) from bore MB12, and
- Oligochaeta sp. (a stygoxene) from bore MB12.

The Parabathynellidae recorded in bore CB01 is the first stygobite recorded in the SWC area at a bore other than bore MB10, and indicates that stygobitic taxa are more widespread in the area than previously recorded. The Bathynellidae stygobite recorded at bore MB10 is also the first record of this taxa from SWC, indicating that the stygofauna of the Project area are more diverse than previously recorded.

The troglofaunal taxa Collembola sp. 1 (at bore MB14) and Diplopoda sp. (at bore MB10) were also recorded; however, troglofaunal taxa are not aquatic and are listed here for record keeping purposes only.

Table 4.2 Results of April 2024 Stygofauna survey.

Bore	Stygofaunal Taxon	Count	Class
MB13	–	–	–
MB14	Collembola sp. 1	1	Troglofauna
OBS2	–	–	–
MB20SWC04P	–	–	–
MB04	–	–	–
CB01	Parabathynellidae	1	Stygobite
MB10	Bathynellidae Parabethynellidae Diplopoda sp. (Myriapoda)	2 3 3	Stygobite Stygobite Troglofauna
MB3B	–	–	–
MB3A	–	–	–
MB12	Acarina sp. (Mesostigmata) Oligochaeta sp.	1 8	Stygoxene Stygoxene

– no stygofauna recorded

5 Stygofauna Values Assessment

5.1 Method

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 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.

The EVs of stygofauna of the SWC Area 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.

5.2 Results

The know occurrence of two stygobitic taxa at bore MB10, and the known presence of at least one of these taxa also at bore CB01 and in sediments of Waker Creek at site WCUS, indicate that the locality near these bores within the wider SWC has moderate stygofauna values. Stygobitic stygofauna is considered a sensitive groundwater ecological receptor.

Non-listed stygoxenes are known from several bores within the Sandy Creek locale, and the characteristics of most bores in the Sandy Creek locale indicate suitable or potentially suitable habitat for stygofauna. Therefore, the stygofauna value of the Sandy Creek locale is low to moderate.

6 Stygofauna Impact Assessment and Mitigation

6.1 Stygofauna Risk Assessment Method

Sources of potential impact were identified from the review of the Project Descriptions and assessed aquatic ecological values (EVs) of stygofauna of the SWC mine area and the Sandy Creek locale.

The assessment of potential Project impacts of the Multi-Year Exploration Project and Gas Drainage Project on the EVs of surface water ecosystems comprised a risk-based assessment, with the level of risk being an outcome of the consequence and likelihood of the potential impact (Table 6.1, Table 6.2 and Table 6.3.).

Table 6.1 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
Very low	Unlikely or not expected to occur

Table 6.2 Ratings used to assess the consequence of potential impacts.

Rating	Consequence of potential impacts
Very High	Long-term harm to protected components of the environment.
High	Short-term but reversible harm to protected components of the environment; long-term harm to sensitive (i.e. rare, threatened, narrow range endemic) components of the environment
Moderate	Long-term harm to non-protected components of the environment; no environmental harm to protected or sensitive (i.e. rare, threatened, narrow range endemic) components of the environment
Low	Short-term but reversible harm to non-protected components of the environment; no environmental harm to protected or sensitive (i.e. rare, threatened, narrow range endemic) components of the environment.
Very Low	Negligible or minimal impact with no material harm to any component of the environment.

Table 6.3 Environmental risk matrix.

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

6.2 Project Descriptions

6.2.1 Multi-Year Exploration Program

Exploration drilling is a critical component in informing mine planning, particularly for large and complex mining operations like the SWC Mine. Stanmore is therefore seeking to carry out exploration drilling to inform mine planning for the SWC Mine. Stanmore proposes a Multi-Year Exploration Program to complete exploration drilling in an extended single campaign, rather than incremental and sporadic exploration activities. This allows for appropriate environmental impact assessment and consideration by regulators, environmental authorisation under the *Environmental Protection Act 1994* (the EP Act), and planned environmental management of exploration activities.

The Multi-Year Exploration Program footprint comprises access tracks, drill pads and seismic transects. These are small and isolated disturbance areas located at intervals across the exploration area, as shown in Map 6.1.

The exploration activities will include:

- Development of 4.5 m wide access tracks, with existing tracks used where possible.
- Development of drill pads of approximately 1,400 m^2 area each.
- Gas exploration and resource definition drilling.
- Core, Reverse Circulation (RC) (chip) and gas drilling via the same form of drill rig with support vehicles and equipment (small truck and two to three light vehicles).

- Seismic investigations with approximately 3 m wide seismic investigation lines. The seismic investigations is yet to be planned in detail.

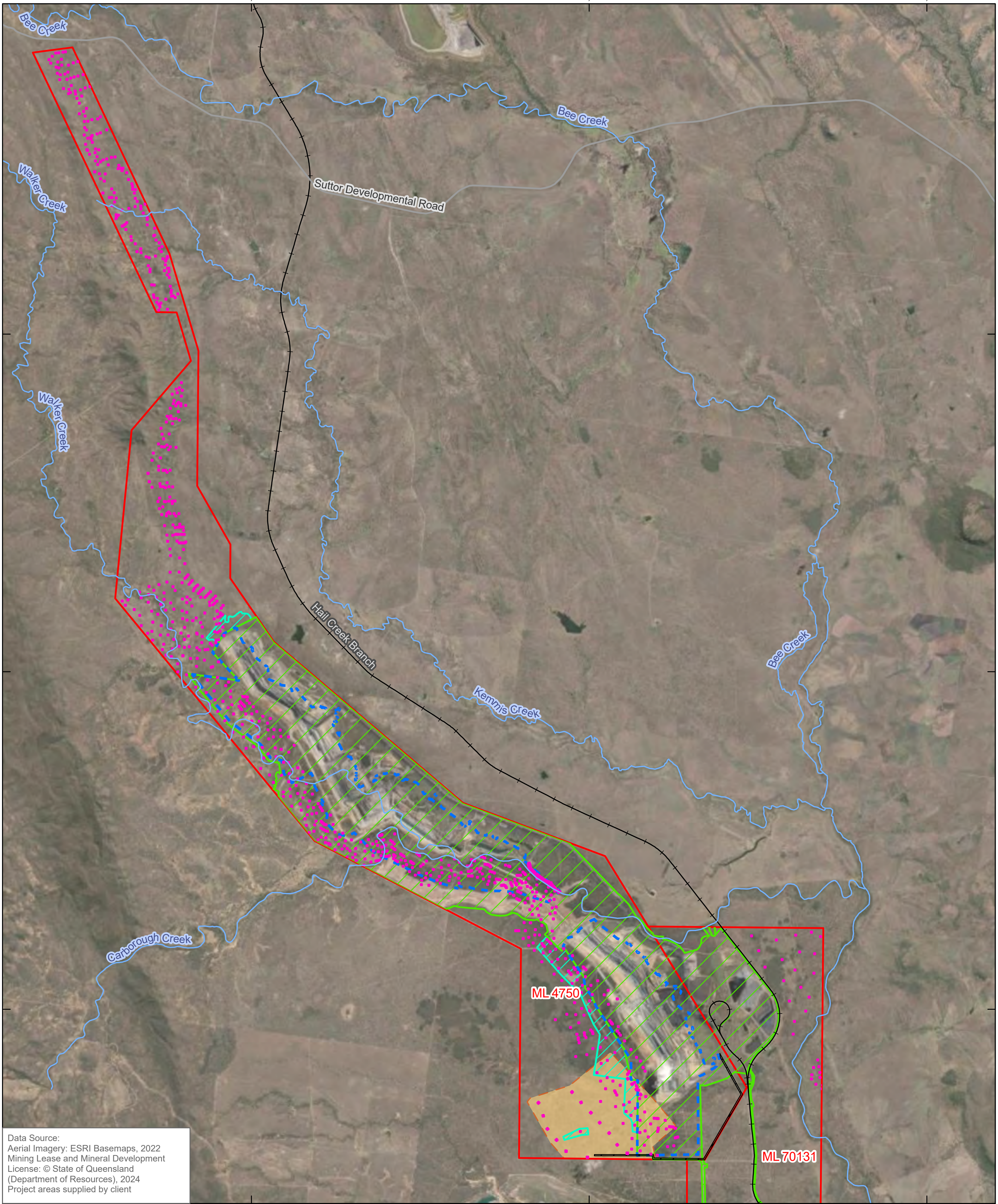
Surface preparations for the Multi-Year Exploration Project will include:

- In instances where the area remains undisturbed, comprehensive assessments for cultural heritage and ecological significance will precede any further actions. The SWC site clearance protocols will be followed.
- Prioritisation of drainage diversion and erosion and sediment installation controls, and their permanence contingent upon site-specific conditions. These structures will primarily aim to redirect uncontaminated stormwater away from the construction zone while managing and/or containing any potentially polluted stormwater. During initiation of site preparation amidst wet seasons, installation of drainage diversion and erosion and sediment controls will coincide with or precede vegetation clearance whenever feasible.
- Vegetation clearance will be conducted, with the extent of clearance dependent on drill pad and access specifics. The Project incorporates flexibility to realign access tracks or drill pads (micro-siting) if environmental constraints necessitate adjustments during implementation, therefore ensuring recognition of environmental risks.
- Topsoil removal and on-site storage for rehabilitation.
- Implementation and maintenance of erosion and sediment controls.
- Handling and disposal of major hazardous materials on-site will adhere strictly to the *Work Health and Safety Regulation 2011*, and *Hazardous Substances Code of Practice 2003*.

Exploration drill pads will be closed and rehabilitated in accordance with the SWC Rehabilitation Management Plan and will address the requirements and conditions of the existing EA. There may be some instances where exploration drill holes are retained and converted into groundwater monitoring bores.

Access tracks will also generally be closed and rehabilitated in accordance with the SWC Rehabilitation Management Plan (Stanmore SMC Pty Ltd, September 2021) and will address the requirements and conditions of the existing EA. There may be instances where access tracks are retained, in agreement with land title holders, to provide for ongoing access.

It is noted that upgraded or new access tracks may cross waterways, but drill pads will be micro-sited to ensure that they are located outside of waterways and wetlands.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Gas Project Study Buffer
- Proposed Drill Pad
- Proposed Powerline Corridor from Power Station to Mine

SOUTH WALKER CREEK EA AMENDMENT PROJECT

EXPLORATION PROGRAM AND GAS DRAINAGE

stanmore

Map 6.1

Path: \\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.040822.00001 Stanmore SWC EA Major Amendment\07 SLR Data\01 CADGIS\GIS\ArcPro\Stanmore SWC EA Major Amendment\Stanmore SWC EA Major Amendment.aprx\620040822_PD_F03-02_Exploration Program and Gas Drainage

6.2.2 Gas Drainage Project

Proactive measures, such as pre-draining and drainage of gas from sections of the SWC Mine in advance of resource extraction, are a useful method of managing gas hazards and the release of fugitive greenhouse gas emissions, such as methane. Stanmore proposes to extract this gas as part of future operations. The drainage of gas and use for electricity generation also results in an overall reduction in greenhouse gas emissions, compared to uncontrolled releases using electricity generated through the combustion of thermal coal. Stanmore intends to extract gas via development and operation of drainage field, which will supply the resource to a gas fired power station that will supply the mine site's electricity requirements.

The Gas Drainage Project will be developed in the south of ML4750 (Map 6.2) and will include:

- Development of 13 dual lateral gas wells (i.e. surface to in-seam wells), with a well head that separates water from gas.
- Gas drainage pipelines, from each well head to a central gas drainage pipeline.
- Water collection pipelines to allow water to be pumped from the gas wells to dams within existing operations and incorporated into SWC mine as part the mine water management system.
- Augmentation and expansion of existing access tracks.

The gas well design and drilling methodology will be implemented through a two-step procedure. Initially, a vertical well will be drilled to access and extract gas and water from the targeted coal seam. This vertical well serves as the primary conduit for gas resource extraction, penetrating down to the depth of the coal seam. Subsequently, a lateral in-seam borehole or multiple boreholes are drilled along the trajectory of the coal seam, intersecting with the previously drilled vertical well (Figure 6.1). These inseam boreholes are strategically positioned to provide unimpeded pathways for both gas and water to migrate towards the vertical well. Once intersected, the gas is allowed to flow freely to the surface, while the water is pumped out through the vertical well.

An average of 13 ML/year of coal seam water will be produced and transferred to the existing SWC Water Management System. This small additional volume of water will have a negligible influence on the overall Water Management System (Hydro Balance 2014).

The Gas Drainage Project is estimated to have an initial 15 year Project life, supplying 4 terajoules of methane gas per day (TJ/day). If more than 9 wells are required to achieve a supply of 4 TJ/d then additional wells will be drilled as required.

The decommissioning of gas drainage infrastructure will be systematically undertaken to align with the rehabilitation conditions outlined in the EA. This process involves the phased removal of installed wells and surface infrastructure. There will be no use of grouting or removal of gravel hardstand during this decommissioning phase. Decommissioned areas will undergo a series of rehabilitation measures to restore environmental standards. This includes restoring near-natural surface profiles and reinstating subsoils and topsoils to approximate natural soil profiles, promoting good conditions for vegetation establishment. Further steps may involve grading, ripping, and seeding in accordance with the SWC Rehabilitation Management Plan (Stanmore SMC Pty Ltd, September 2021). These activities are adapted to the characteristics of the terrain, aiming to promote soil stability, and foster the reestablishment of vegetation cover.

A gas fired power station is planned (under a separate project) to be situated within the existing mining leases and adjacent to the SWC mine operations. It will use gas extracted by the proposed Gas Drainage Project to generate electricity for use at the SWC mine. The power station is not the subject of this amendment application and is not considered in this assessment.

The drainage field will include the capability for gas flaring in close proximity to the proposed power station (separate project).

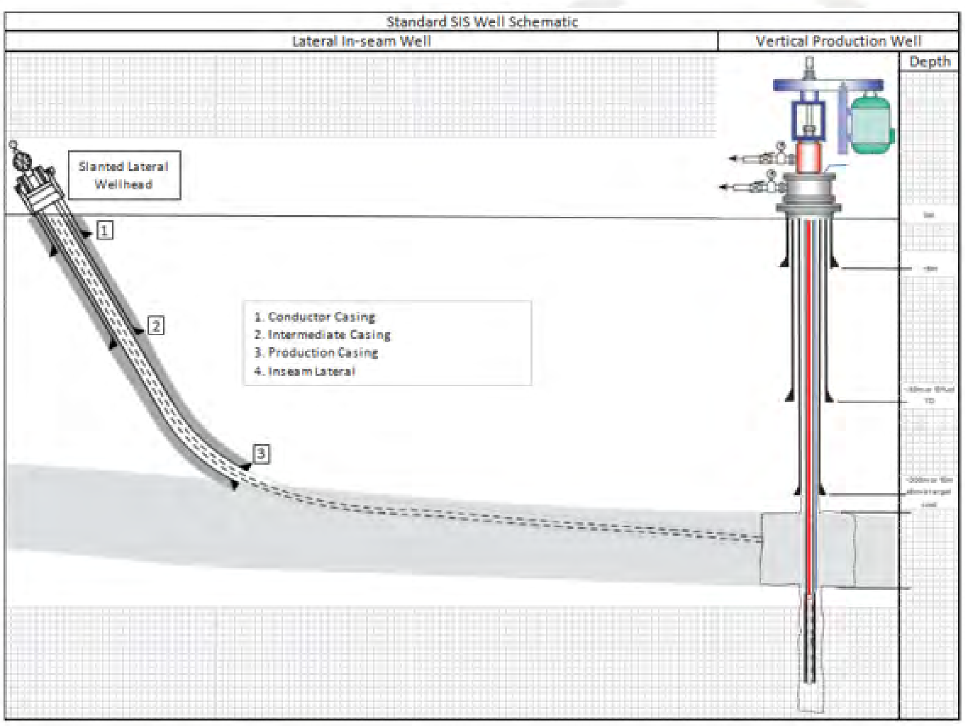
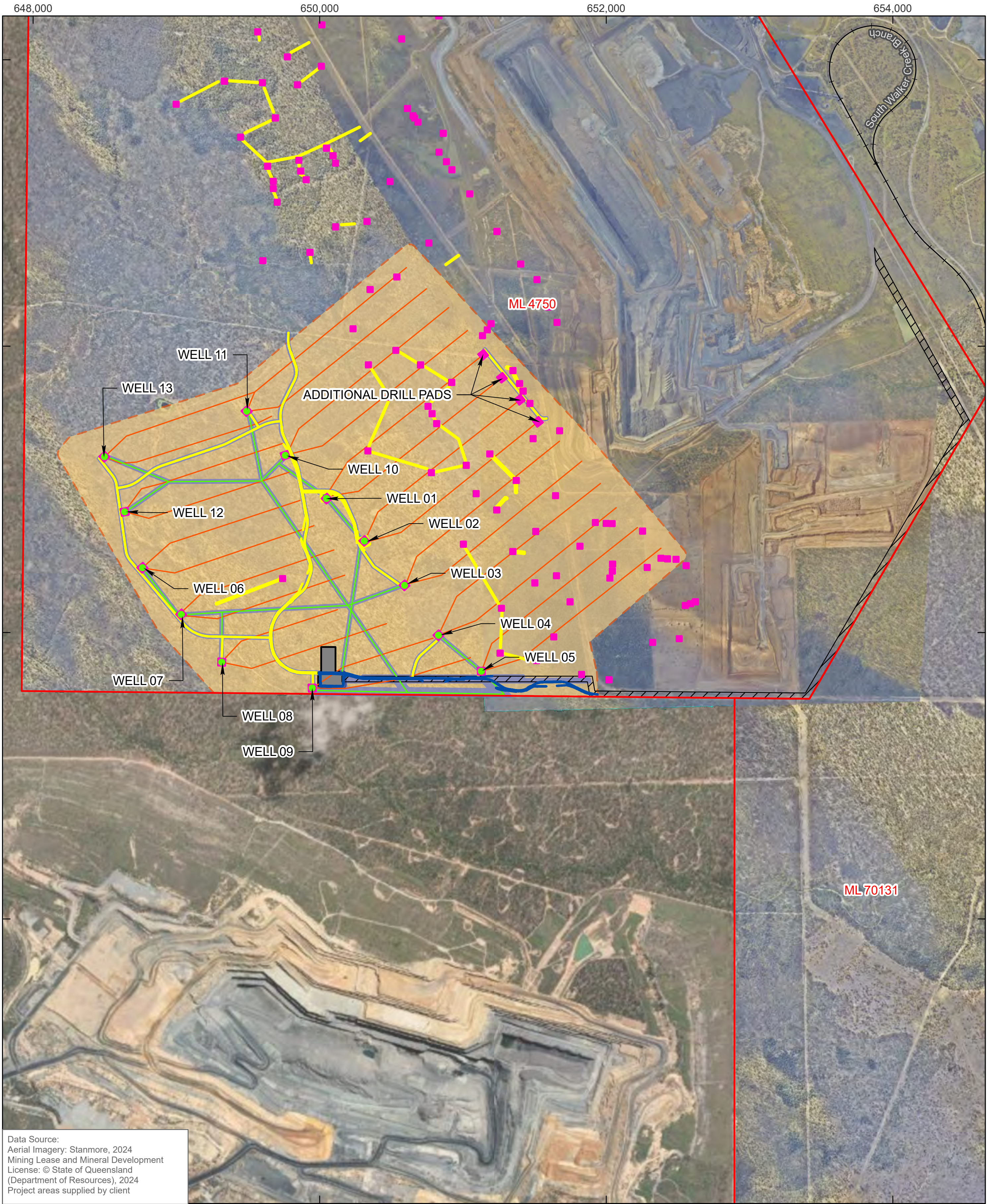


Figure 6.1 Standard Surface to In-seam well and Vertical Well Diagram.



Data Source:
Aerial Imagery: Stanmore, 2024
Mining Lease and Mineral Development License: © State of Queensland (Department of Resources), 2024
Project areas supplied by client

0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:35,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- South Walker Creek Mine
- Well Head
- Proposed Access Road/ Track
- Proposed Access Road from Power Station to Mine – Separate Project
- Proposed Gas/Water Gathering Lines
- Proposed Dual Lateral Holes
- Gas Project Study Buffer
- Power Station Infrastructure – Separate Project
- Drill Pad
- Proposed Powerline Corridor from Power Station to Mine
- Surface Disturbance Buffer

SOUTH WALKER CREEK EA AMENDMENT PROJECT

GENERAL GAS DRAINAGE LAYOUT

stanmore

Map 6.2

6.3 Sources of Potential Impact to Stygofauna

6.3.1 Multi-Year Exploration Program

The Multi-Year Exploration Program may cause adverse impact to stygofauna receptors via:

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

6.3.2 Gas Drainage Project

The Gas Drainage Project may cause adverse impact to stygofauna receptors via:

- 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) impacts, and
- physical disturbance of groundwater ecosystems by groundwater drawdown, which may cause direct impact to stygofauna habitat.

6.4 Risk-based Impact Assessment

6.4.1 Vegetation Clearing

Terrestrial vegetation overlying shallow groundwater ecosystems of suitable lithology and water quality, 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 these types of shallow groundwater ecosystems for stygofauna. Potential impacts would be localised to the immediate area of clearing.

The consequence of impact of terrestrial vegetation clearing on stygofauna is moderate because this impact pathway may cause long-term harm to stygofauna habitat (non-protected component of the environment), although stygofauna have also been recorded in areas that are heavily cleared and areas that are cultivated.

The likelihood of impact of terrestrial vegetation clearing on stygofauna is low because vegetation across the Project area and Sandy Creek locale is already heavily cleared and the proportion of addition vegetation clearing required for the Project is limited.

The risk of impact of terrestrial vegetation clearing on stygofauna is low.

6.4.2 Contamination of Groundwater

Contamination of groundwater includes seepage and spillage of fuels, oils and other lubricants required for the operation of vehicles and machinery, used in both construction and operation phases of the Project. Toxicants in mine affected water (MAW) and fuel and oil are potentially toxic to aquatic fauna (including stygofauna) 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 and type of any chemical, fuel or oil spill, but a small chemical, fuel or oil spill would likely cause impact on a relatively local scale.

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
- Stanmore’s Spill Prevention and Response Procedure will be in place for these projects, and
- only existing refuelling facilities that are bunded will be used.

The consequence of impact to stygofauna by groundwater contamination is moderate because this impact pathway may cause long-term harm to stygofauna habitat (a non-protected component of the environment).

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.

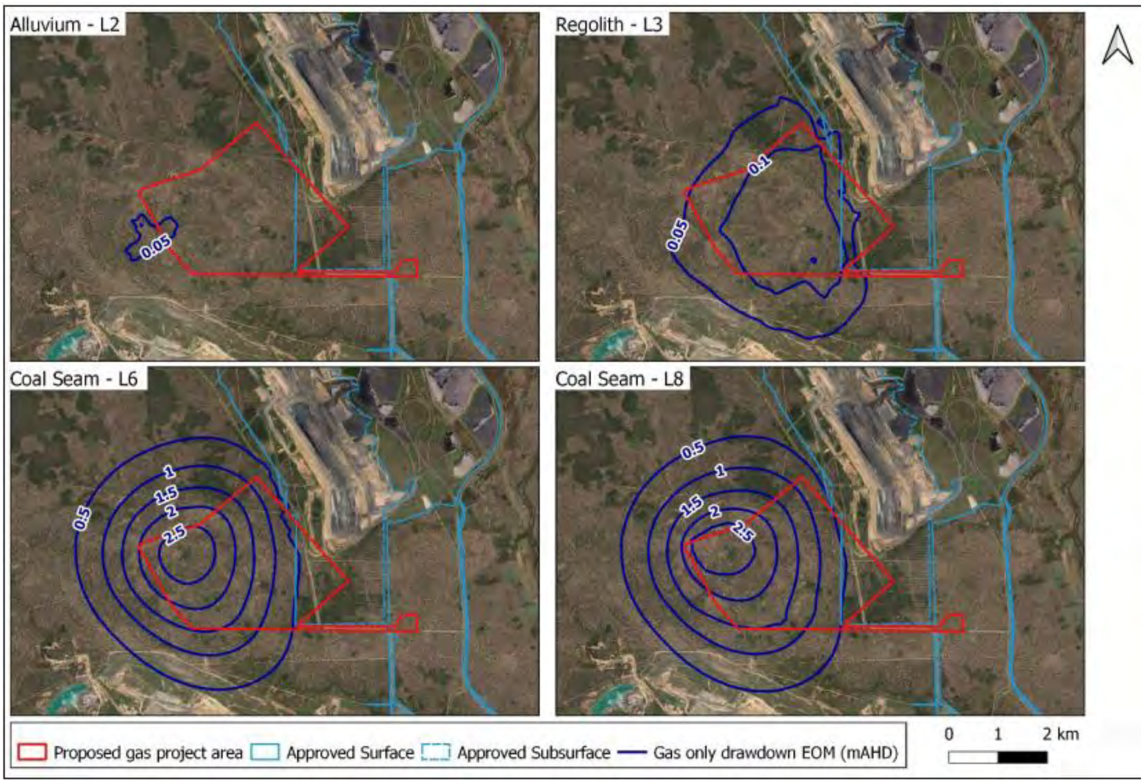
6.4.3 Groundwater Drawdown

Drawdown of groundwater associated with gas drainage may reduce the area of available stygofauna habitat. The groundwater study (WSP 2024) indicated that saturated thickness of groundwater ecosystems in the SWC Area was 10 to 40m in alluvium, 30m in regolith, up to 50m in overburden, and >50m in coal seams. The predicted levels of drawdown associated with gas drainage were minimal; e.g. 0.05m in alluvium, 0.1m in regolith and 2.5m in coal seams (Source: WSP, 2024, Figure 6.2).

The consequence of impact to stygofauna by groundwater drawdown is moderate because this impact pathway may cause long-term harm to stygofauna habitat (a non-protected component of the environment).

The likelihood of impact to stygofauna by groundwater drawdown is low because the predicted magnitude and extent of groundwater drawdown is limited, and outside the area of known stygofauna occurrence (i.e. bore MB10 and CB01).

The risk of impact to stygofauna from groundwater drawdown is low



Source: WSP (2024)

Figure 6.2 EOM drawdown at September 2043 considering existing operations and the proposed gas drainage project.

7 Summary

The known occurrence of two stygobitic taxa at bore MB10, and the known presence of at least one of these taxa also at bore CB01 and in sediments of Waker Creek at site WCUS, indicate that the locality near these bores within the wider SWC mine has moderate stygofauna values. Stygobitic stygofauna is considered a sensitive groundwater ecological receptor.

Non-listed stygoxenes are known from several bores within the Sandy Creek locale, and the characteristics of most bores in the Sandy Creek locale indicate suitable or potentially suitable habitat for stygofauna. Therefore, the stygofauna value of the Sandy Creek locale is low to moderate.

The identified sources of potential impact on aquatic ecological values from the Multi-Year Exploration Program and the Gas Drainage Project were:

- 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 by groundwater drawdown, which may cause direct impact to stygofauna habitat.

Risk-based assessment of these sources of potential impact indicated low risk to stygofauna receptors where the identified mitigations were applied for both the Multi-Year Exploration and Gas Drainage Projects (Table 7.1).

Table 7.1 Summary of Risk Assessment and Impact Mitigation

Potential Source of Impact	Mitigations	Mitigated Consequence of Impact	Mitigated Likelihood of Impact	Mitigated Risk of Impact
Vegetation clearing	NA.	moderate	low	low
Contamination due to fuel and chemical spills	Mitigations to avoid and control this impact pathway include: · storing and handling of all applicable materials will be in accordance with the relevant legislative requirements and Australian Standards · Stanmore's Spill Prevention and Response Procedure will be in place for these projects, and · only existing refuelling facilities that are bunded will be used.	moderate	low	low
Groundwater drawdown	NA.	moderate	low	low

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APPENDIX G
GREENHOUSE GAS ASSESSMENT

South Walker Creek Mine Multi-Year Exploration Program and Gas Drainage Project

Greenhouse Gas Assessment

Stanmore SMC Pty Ltd

Level 32, 12 Creek Street
Brisbane QLD 4001

Prepared by:

SLR Consulting Australia

SLR Project No.: 620.040822.00003

19 September 2024

Revision: 02

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
02 – Client Review	13 September 2024	K Lawrence	G Starke	B Brooks
02 – Finalised	20 September 2024	K Lawrence	G Starke	B Brooks

Basis of Report

This report has been prepared by SLR Consulting Australia (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Stanmore SMC Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed Scope of the work.

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Tables in Text

Figures in Text

Acronyms and Abbreviations

ASRS	Australian Sustainability Reporting Standards
CH_4	methane
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
DA	Development Application
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DESI	Department of Environment, Science and Innovation
EA	Environmental Authority
EP Act	Environmental Protection Act 1994
GHG	greenhouse gas
GJ	gigajoule
GWP	Global Warming Potential
ha	hectare
ICE	Inventory of Carbon and Energy
ISO	International Organisation for Standardisation
kg	kilogram
kL	kilolitre
km	kilometres
L	litre
ML	Mining Lease
Mt	megatonne
N_2O	nitrous oxide
NGA	National Greenhouse Accounts
NGER	National Greenhouse and Energy Reporting
NGO	non-governmental organisations
PFCs	perfluorocarbons
SF_6	sulfur hexafluoride
Stanmore	Stanmore SMC Pty Ltd
Stanmore Resources	Stanmore Resources Ltd
SWC Mine	South Walker Creek Mine
tCO_2-e	tonnes of carbon dioxide equivalent
the Guideline	Guideline Greenhouse Gas Emissions (Qld)
TJ	terajoules
WBCSD	World Business Council for Sustainable Development
WRI	World Resource Institute

1.0 Introduction

The South Walker Creek Coal Mine (SWC Mine) is an open-cut coal mining operation owned by Stanmore SMC Pty Ltd (Stanmore), a subsidiary of Stanmore Resources Ltd (Stanmore Resources). The SWC Mine is situated in the Bowen Basin geological formation, approximately 135 kilometres (km) south-west of Mackay in Queensland. The SWC Mine operates under environmental authority (EA) EPML00712313 for activities on mining lease (ML) ML4750 and ML70131.

SLR Consulting Australia Pty Ltd (SLR) was engaged by Stanmore to prepare this Greenhouse Gas (GHG) to support an EA Amendment Application for the exploration drilling and gas drainage field activities (the Project). For clarity and ease of reference, these are referred to as the Gas Drainage Project and the Multi-Year Exploration Program. Collectively, these are 'the Project'.

Exploration drilling is a critical component in informing mine planning, particularly for large and complex mining operations like the SWC Mine. Stanmore is therefore seeking to carry out exploration drilling to inform mine planning for the SWC Mine. Stanmore proposes a Multi-Year Exploration Program to complete exploration drilling in an extended single campaign, rather than incremental and sporadic exploration activities. This allows for appropriate environmental impact assessment and consideration by regulators, environmental authorisation under the *Environmental Protection Act 1994* (Qld) (EP Act) and planned environmental management of exploration activities.

Proactively pre-draining and collecting natural gas from sections of the SWC Mine in advance of resource extraction is a potential option to manage the release of fugitive GHG emissions such as methane. This is one of the key business drivers for developing the gas drainage field, in anticipation of the need for future emission reductions under the Safeguard Mechanism.

The drainage of natural gas and use for electricity generation also results in an overall reduction in GHG emissions, compared to using electricity from the grid, typically generated through the combustion of thermal coal. Stanmore intends to extract natural gas via development and operation of a gas drainage field, which will supply a gas fired power station. The power generated will be enough to meet SWC's electricity demand and allow export of the remaining power to the grid.

SLR Consulting Australia Pty Ltd (SLR) was engaged by Stanmore to prepare a GHG Assessment to support an EA Amendment Application for the exploration drilling and gas drainage field activities (the Project). For clarity and ease of reference, these are referred to as the Gas Drainage Project and the Multi-Year Exploration Program. Collectively, these are 'the Project'.

The objective of this GHG assessment is to identify and quantify key Scope 1, 2 and 3 GHG emissions associated with the construction and operational phases of the Project in accordance with relevant State and Australian regulatory guidelines. This GHG Assessment has been prepared to address the requirements of the *Guideline Greenhouse Gas Emissions* (DESI 2024) ('the Guideline'), which sets out application requirements under the EP Act and provides information about how to meet these requirements in relation to GHG emissions (see **Section 4.2.2**).

The key tasks undertaken as part of the GHG Assessment were:

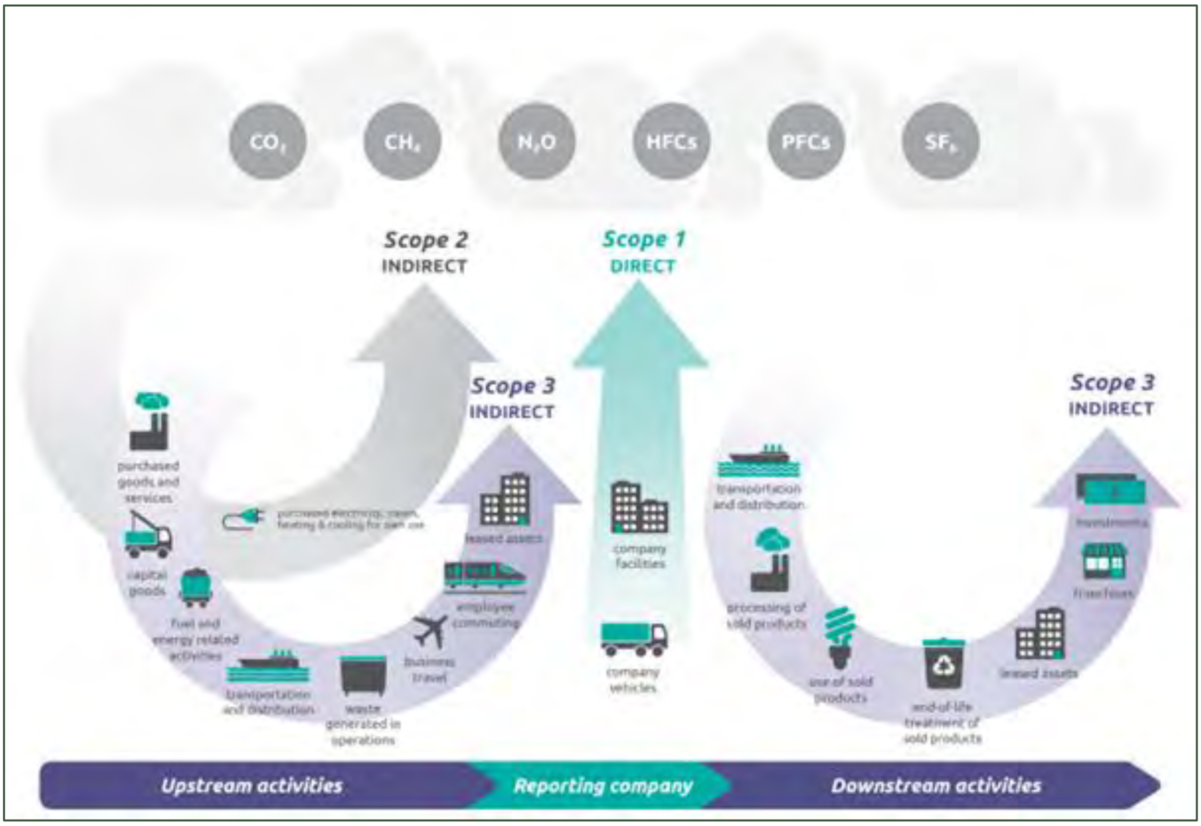
- Identification of potential GHG emission sources associated with the construction and operational phases of the Project.
- Calculation of the likely energy consumption and Scope 1, 2 and 3 GHG emissions (in tonnes of carbon dioxide equivalent (tCO_2-e) per annum) resulting from the Project construction and operations.
- Assessment of the potential significance of the GHG emissions from the Project in the context of current and predicted State and National GHG emission levels.
- Identification of mitigation measures to minimise and manage GHG emissions and ensure energy use efficiency.

2.0 Background

2.1 Scope 1, 2 and 3 Emissions

The internationally accepted method of reporting GHG emissions is to separate the emission sources into three categories, referred to as 'Scopes'. The three Scopes of GHG emissions as per the *National Greenhouse and Energy Reporting (NGER) (Measurement) Determination 2008*, are described below and summarised in **Figure 1**.

Figure 1 Overview of GHG Protocol Scopes and Emissions



SOURCE: (WRI 2011)

Scope 1 emissions

Direct emissions where the point of emission release is owned/controlled by the organisation or project owner, such as:

- Emissions resulting from fuel combustion, e.g. from petrol or diesel fuelled vehicles, gas-fired boilers or diesel generators.
- Fugitive emissions during the extraction, production, processing and distribution of fossil fuels (e.g. methane emissions from coal mines, leakage from gas or natural gas extraction and processing).
- Industrial process emissions, e.g. the use of fuels as feedstocks, leakage of insulating or refrigerant GHGs from switchgear and cooling systems.
- Waste emissions, which result from the decomposition of organic material in an on-site landfill or on-site wastewater treatment plant.

Scope 2 emissions

Indirect GHG emissions that occur inside the project footprint or within the control of the reporting organisation. The main Scope 2 emission relates to electricity usage, where the emissions arise principally at an electricity generator, or through the loss of electricity from the electricity transmission network or distribution network.

Scope 3 emissions

Other indirect GHG emissions that occur outside the project footprint or control of the reporting organisation. For example:

- Emissions associated with the extraction, production, processing and distribution of fuels used by the project/organisation.
- Embodied CO_2-e emissions associated with construction materials and raw materials used by the project/organisation.
- Emissions associated with the transport, distribution and end use of sold products.

The purpose of differentiating between the Scopes of emissions is to avoid the potential for 'double counting', which is where two or more organisations assume responsibility for the same emissions.

Reporting under the NGER Act requires that organisations report Scope 1 and Scope 2 emissions, but not Scope 3 emissions. Scope 3 emissions may be reported voluntarily by companies outside of their NGER report.

2.2 Global Warming Potentials

GHG emissions are generally reported in terms of carbon dioxide equivalent (CO_2-e). This is to provide a standardised unit for reporting due to different gases having varying effects of global warming impacts or global warming potential (GWP). The GWP refers to the GHG potential to trap heat in the atmosphere for a certain period (generally 100 years), relative to carbon dioxide (with a GWP of one).

At the time of writing, the most recent available *National Greenhouse Accounts Factors* published by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) equates methane (as an example) with a GWP of 28, which means for every tonne of methane emitted, it has the same global warming effect of 28 tonnes of carbon dioxide (DCCEEW 2024). As such, gases such as methane or nitrous oxide are relatively potent GHGs.

Table 1 presents the GWPs of the key GHGs that are associated with the Project and have been used in calculating the Project emissions.

Table 1 GHG Global Warming Potentials

Gas	Chemical Formula	Global Warming Potential (GWP)
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
Sulfur hexafluoride	SF_6	23,500
Source: (DCCEEW 2024)		

3.0 Project Overview

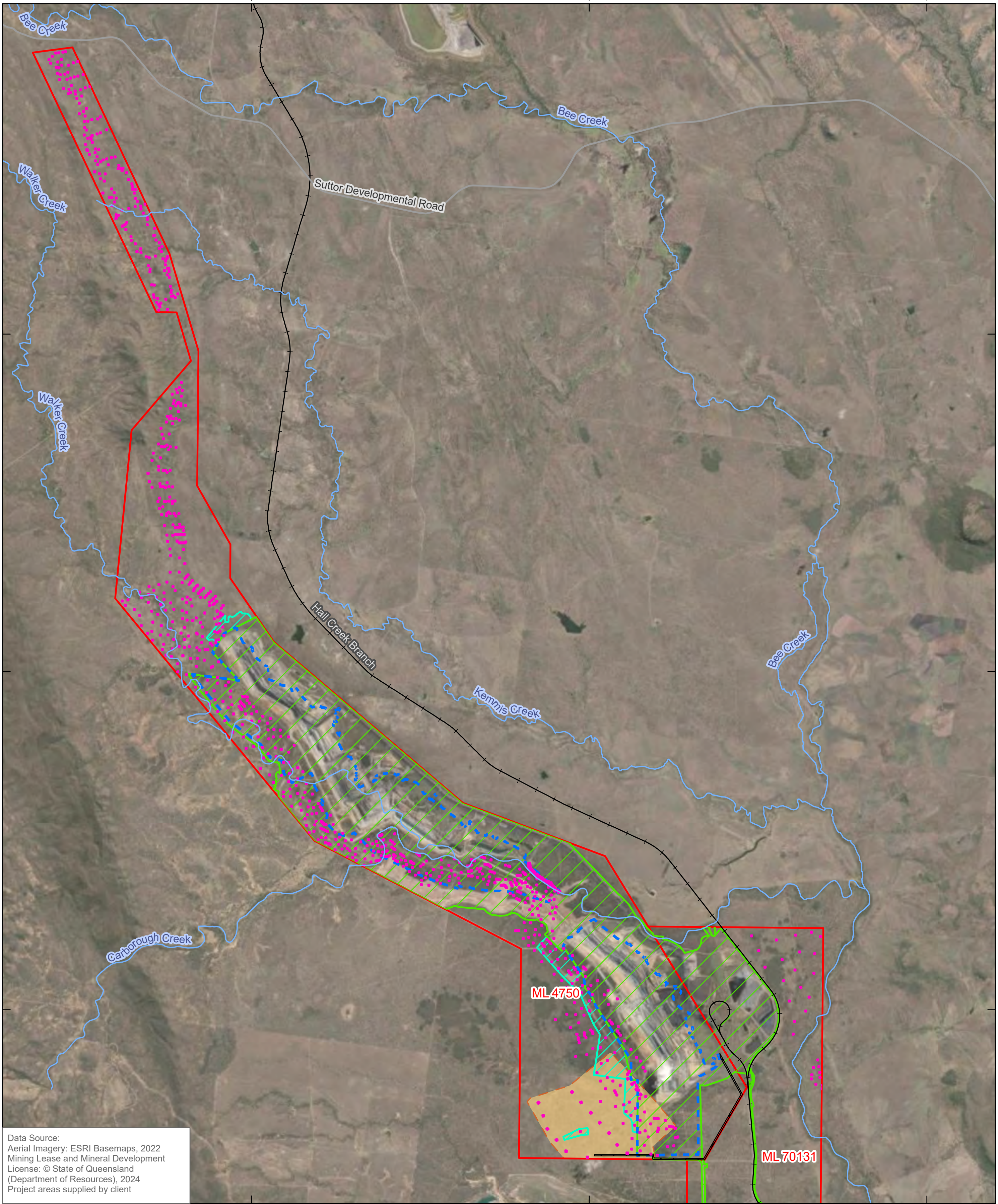
3.1 General

The Project comprises two main components, shown in **Figure 2**:

- The Multi-Year Exploration Program generally planned for completion over Calendar Years (CY) 2025 to 2029 (and beyond, if required) on ML4750 and ML70131 in areas beyond those authorised by the current EA, involving:
  - Exploration access tracks.
  - Exploration drill pads.
  - Seismic transects.

  The Multi-Year Exploration Program footprint comprising access tracks, drill pads and seismic transects is shown in **Figure 3** (northern extent of the Project footprint) and **Figure 4** (southern extent of the Project footprint).
- The Gas Drainage Project involving the development of a gas drainage field on ML4750 involving:
  - Underground gas gathering lateral lines.
  - Gas wells.
  - Gas drainage pipelines located at ground level or buried where necessary, linking each well head to a central gas drainage pipeline.
  - Water collection pipelines to allow water to be pumped from the gas wells to dams within existing operations and incorporated into the SWC Mine as part the existing mine water management system.

  The Gas Drainage Project footprint comprises a number of gas drainage wells, water pumps, pipelines, and gas drainage lines that connect to the boundary of a gas fired power station located in ML4750. Approval for the gas fired power station is underway via a separate development application and is not part of the Project considered in this assessment.



0 2.5 5 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Gas Project Study Buffer
- Proposed Drill Pad
- Proposed Powerline Corridor from Power Station to Mine

SOUTH WALKER CREEK EA AMENDMENT PROJECT

EXPLORATION PROGRAM AND GAS DRAINAGE

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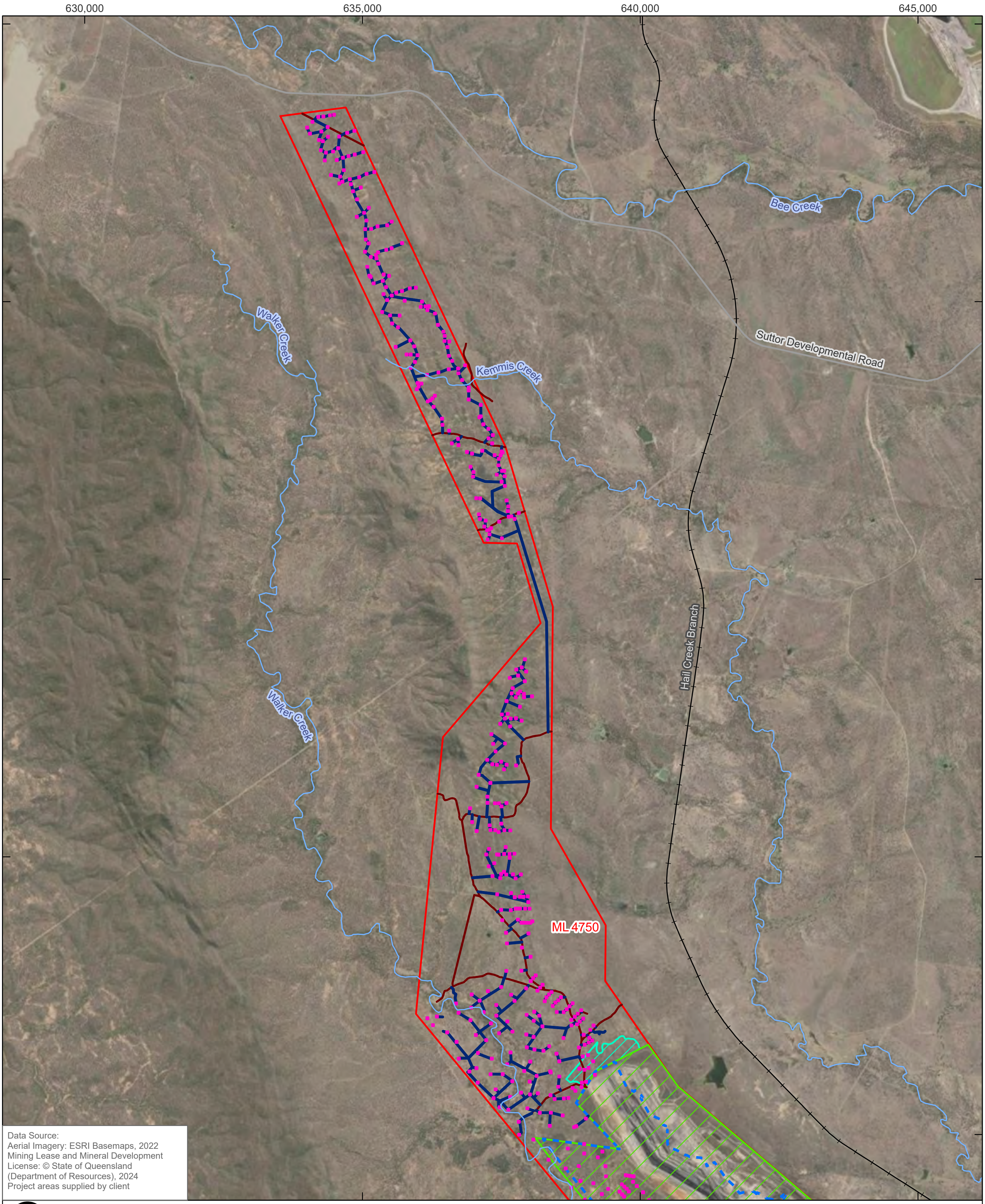
FIGURE 2



Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:90,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Existing Track Area
- Proposed Track Area
- Proposed Drill Pad

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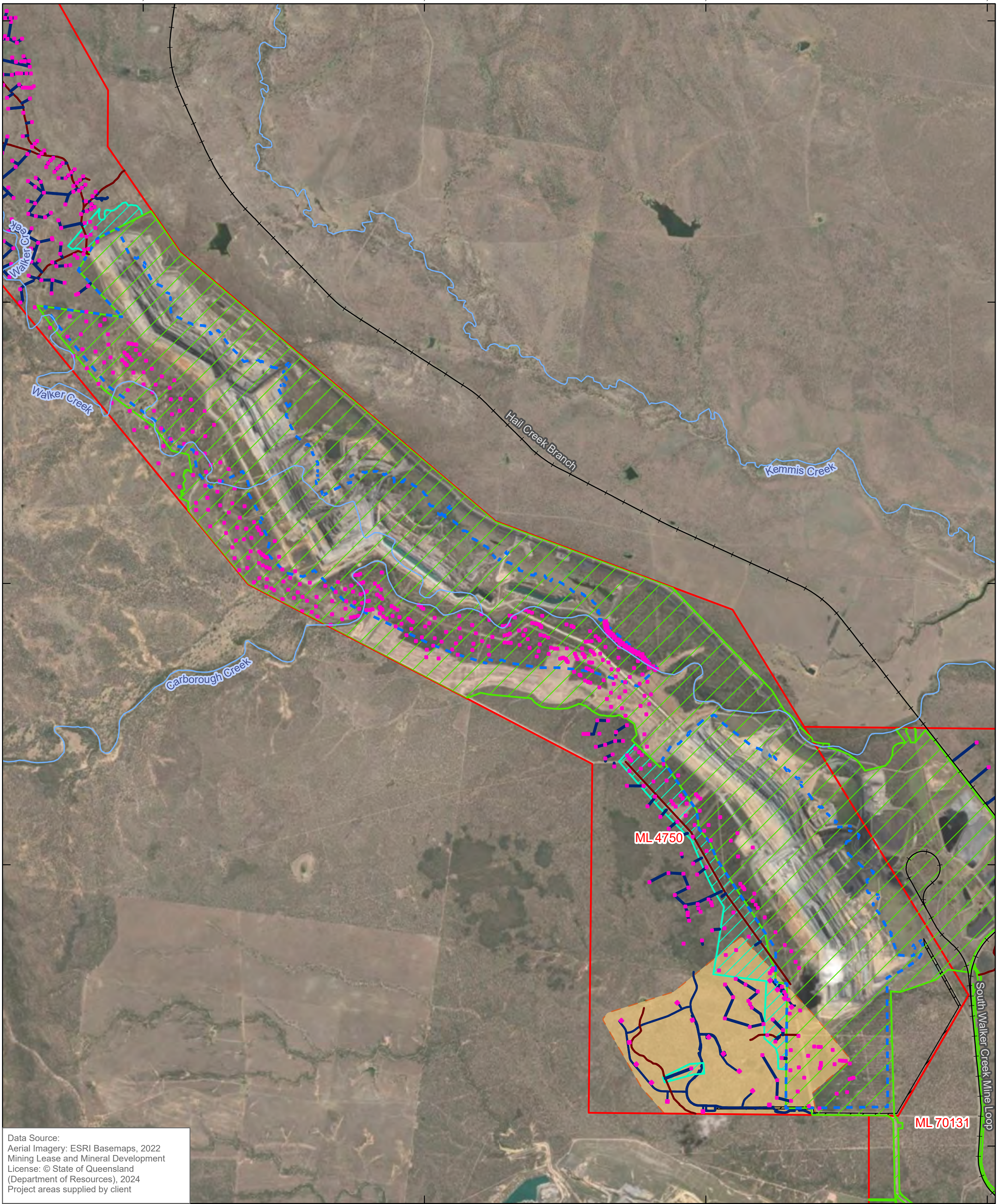
SOUTH WALKER CREEK EA AMENDMENT PROJECT

NORTHERN EXTENT OF PROJECT AREA

DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.

FIGURE 3

Path: \\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.040822.00001 Stanmore SWC EA Major Amendmen\07 SLR Data\01 CADGIS\GIS\ArcPro\Stanmore SWC EA Major Amendment\Stanmore SWC EA Major Amendment.aprx\620040822_PD_F03-03_Northern Extent of Project Area



Data Source:
Aerial Imagery: ESRI Basemaps, 2022
Mining Lease and Mineral Development
License: © State of Queensland
(Department of Resources), 2024
Project areas supplied by client

0 1 2 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:90,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- Road
- Watercourse
- South Walker Creek Mine
- Approved Surface Disturbance Area (30/7/2024)
- Approved Subsurface Disturbance Area (30/7/2024)
- Approved Additional Exploration Area (30/7/2024)
- Gas Project Study Buffer
- Existing Track Area
- Proposed Track Area
- Proposed Drill Pad
- Proposed Powerline Corridor from Power Station to Mine

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SOUTH WALKER CREEK EA AMENDMENT PROJECT

SOUTHERN EXTENT OF PROJECT AREA

FIGURE 4

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3.2 Multi-Year Exploration Program

3.2.1 Exploration Drilling Activities

The exploration activities required to inform the design and development of the Gas Drainage Project and further define the coal resources at SWC Mine will include:

- Development of 4.5 m wide access tracks, with existing tracks used where possible.
- Development of drill pads of approximately 1,400 m^2 area each.
- Gas exploration and resource definition drilling.
- Core, Reverse Circulation (RC) (chip) and gas drilling via the same form of drill rig with support vehicles and equipment (small truck and two to three Light Vehicles).
- Seismic exploration with approximately 3 m wide seismic exploration lines. The seismic exploration program is yet to be planned in detail.

The exploration activities will be completed progressively and involve operation of the following equipment:

- Grader for new and existing track management and drill pad development.
- Dozer for pushing vegetation for new tracks and drill pads if needed.
- Core and RC drill rigs used to complete drilling.
- Flatbed 3 tonne trucks will support drill rigs (transportation of equipment including rods, compressors, materials).
- Small excavator or backhoe to dig sumps for management of water and drilling muds.
- Vegetation trimmers, slashers and mulchers to support vegetation trimming and removal, with the objective of minimising associated disturbance corresponding with accessing relevant exploration sites.
- Light vehicles to carry personnel and equipment used for relevant analytical processes.
- Compact seismic exploration rigs (agricultural all-terrain vehicles mounted with seismic energy sources).

The location and construction of drill pads and holes are typically dictated by site conditions (vehicle accessibility / track conditions, land-owner permission, proximity to existing access points or previous drill pads), environmental conditions (including compliance with EA conditions), mine planning priority / gaps in coal resource data and safety considerations.

3.2.2 Seismic Investigations

Seismic exploration activities will also be required to complement resource evaluation work provided through the exploration drilling campaigns.

As the location and extent of seismic exploration is dependent upon the outcomes of the coal exploration drilling, it is not yet possible to define the exact locations where this form of exploration will take place. However, as applied at other Stanmore sites, seismic exploration activities will be planned to minimise land and vegetation disturbance, and usually result in negligible or minimal impacts to environmental values. Typically, each seismic area will be set up in a 50 m by 40 m spaced grid formation comprised of 3 m wide seismic lines. Hence, the preparation method for seismic survey lines will involve the slashing of grasses and non-wooded herbage along 3 m wide seismic lines.

Seismic surveying will be undertaken along the abovementioned seismic lines utilising a compact vehicle which is capable of traversing uneven terrain and narrow tracks (i.e. 3 m wide). The seismic vehicle will be selected to limit the extent of disturbance associated with the seismic survey and to allow for better mobility through wooded and vegetated terrain.

3.3 Gas Drainage Project

Drainage of coal seam methane requires the implementation of a network of gas extraction wells, extending from the ground surface down to the target seams. These wells will be interconnected with gathering lines and supported by surface infrastructure for gas processing, monitoring, and control.

The gas drainage field will be developed in the south-western area of ML4750 (**Figure 2**). The gas drainage system may comprise single or dual lateral collection lines or a combination of both.

The preferred method for gas extraction typically involves Surface to In-Seam wells utilising directional drilling techniques to penetrate from the surface and extend laterally along the seams targeted for gas pre-drainage. Vertical wells are also drilled from the surface. The lateral wells are drilled to intersect the vertical wells. The vertical wells are used for collecting and conveying the natural gas and associated water to the surface for further processing.

The gas drainage field is estimated to have an initial 15 year Project life. The details of volumes and gas processing facilities is being developed by Stanmore. The drainage field will include the capability for flaring excess gas at the power station (being approved as a separate project) or a nearby location.

Access to the gas drainage field will be via the site access centre and then via existing light vehicle access roads and tracks, including a new track to the SWC power station. New access tracks will be established to provide ongoing access to the gas wells. The access tracks will be constructed via earthworks (dozing / grading and compaction) of the existing subsoil / underlying rock material. Suitable waste rock from these processes, other sources from within SWC or imported materials may be used to provide a sub-base and all weather road surface.

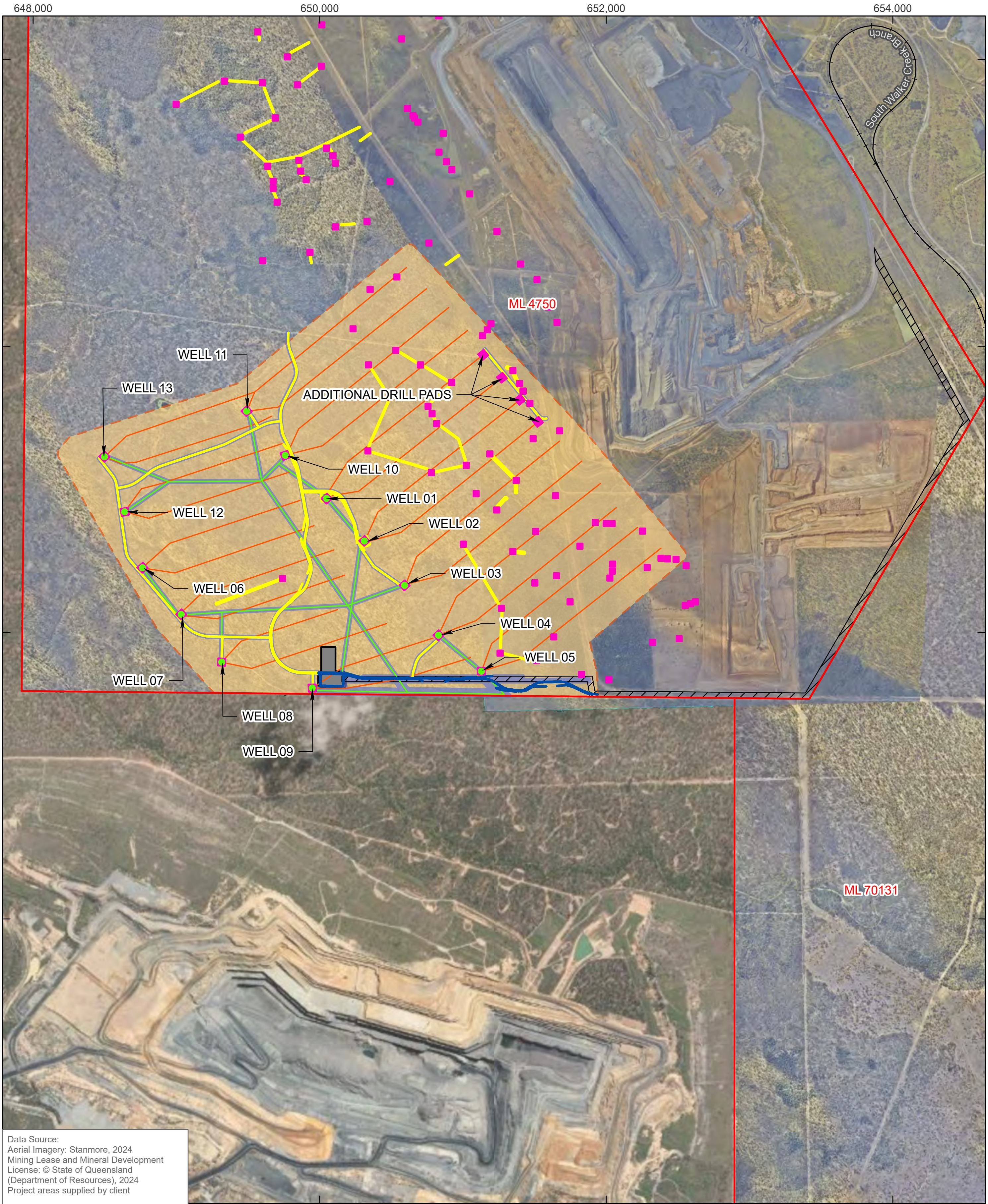
The gas well pads will be installed to be approximately 150 mm above natural ground level and approximately 50 m wide by 50 m long. The construction of the gas well pads will be completed through the removal of vegetation by blade clearing using a dozer or pneumatic shovel / backhoe.

3.4 Construction Schedule and Workforce Requirements

Over the Multi-Year Exploration Program and Gas Drainage Project’s initial construction phase, an estimated workforce of 25 to 35 individuals will be required.

Following commencement of gas drainage operations, a permanent onsite team of approximately two to three individuals will be retained to ensure ongoing Gas Drainage Project support.

The current construction schedule indicates that the main earthworks and construction activities will occur over an approximate five month period (currently anticipated to run from July to December 2025, inclusive). This includes construction of access tracks and drilling and completion of the initial wells.



0 0.5 1 km

Coordinate System:	GDA2020 MGA Zone 55
Scale:	1:35,000 at A4
Project Number:	620.040822.00001
Date Drawn:	27-Sep-2024
Drawn by:	RB

LEGEND

- Railway
- South Walker Creek Mine
- Well Head
- Proposed Access Road/ Track
- Proposed Access Road from Power Station to Mine – Separate Project
- Proposed Gas/Water Gathering Lines
- Proposed Dual Lateral Holes
- Gas Project Study Buffer
- Power Station Infrastructure – Separate Project
- Drill Pad
- Proposed Powerline Corridor from Power Station to Mine
- Surface Disturbance Buffer

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SOUTH WALKER CREEK EA AMENDMENT PROJECT

GENERAL GAS DRAINAGE LAYOUT

FIGURE 5

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4.0 Policy and Legislation

4.1 Commonwealth Policy and Legislation

Australia ratified the Paris Agreement in 2016, aiming to reduce GHG emissions by 26-28% below 2005 levels by 2030. In 2022, Australia updated its target to a 43% reduction by 2030 and pledged to achieve net zero emissions by 2050. Other federal actions are briefly outlined below.

4.1.1 National Greenhouse and Energy Reporting Act (NGER Act)

The NGER Act introduces a single national framework for reporting and disseminating company information about GHG emissions, energy production, and energy consumption. Under the NGER Act, companies that meet threshold levels for GHG emissions, energy consumption or energy production are required to report their GHG emissions annually. The six GHGs that are reported under the NGER Act include the following compounds and groups of compounds:

- Carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous oxide (N_2O).
- Specified hydrofluorocarbons (HFCs).
- Specified perfluorocarbons (PFCs).
- Sulfur hexafluoride (SF_6).

The current GHG reporting thresholds for individual facilities are as follows:

- Emission of more than 25,000 tonnes of carbon dioxide equivalent (t CO_2-e)
- Production of 100 terajoules (TJ) or more of energy, or
- Consumption of more than 100 TJ of energy per year.

SWC Mine currently reports its energy consumption and GHG emissions annually under the NGER Scheme.

4.1.2 Safeguard Mechanism

The Safeguard Mechanism commenced in 2016. It was reformed in 2023 to ensure that covered facilities contribute to meeting Australia's reduction targets, while strengthening their competitiveness as the world moves to net zero. The reforms apply a decline rate to facilities' baselines so that they are reduced predictably and gradually over time on a trajectory consistent with achieving Australia's emission reduction targets of 43% below 2005 levels by 2030 and net zero by 2050 (see below).

The Safeguard Mechanism applies to industrial facilities emitting Scope 1 covered emissions (including direct emissions from fugitive emissions and emissions from fuel combustion, waste disposal and industrial process such as cement and steel making) of more than 100,000 t CO_2-e per year, including:

- Mining.
- Oil and gas production.
- Manufacturing.
- Transport.
- Waste facilities.

It applies to the electricity sector in a different way, by applying a single ‘sectoral’ baseline across all electricity generators connected to one of Australia’s main electricity grids. Individual grid-connected electricity generators are not covered as long as total emissions from grid-connected electricity generators do not exceed the sectoral baseline.

SWC Mine reports its GHG emissions annually under the NGER Scheme and is covered by the Safeguard Mechanism. This Project is part of a key measure for SWC mine to enable it to reduce its Scope 1 fugitive methane emissions under SWC’s decarbonisation strategy.

4.1.3 Australian Sustainability Reporting Standards

In October 2023, the Australian Accounting Standards Board released the draft Australian Sustainability Reporting Standards (ASRS) - *Disclosure of climate-related financial information*. One key aspect of this legislation is the requirement of all reporting entities under the NGERs Act to disclose their overall emissions inventory, along with their relevant value chain (Scope 3) emissions from the 2025 financial year. Furthermore, the mandates will also require entities to report both their location- and market-based emissions from the third year of disclosure.

4.2 State Policy and Legislation

4.2.1 Queensland Climate Change Response

The Queensland Climate Change Response sets out the Queensland Government’s strategy to transition to a low carbon economy and address the impacts of climate change. The Queensland Climate Change response includes the following key strategies:

- **Queensland Energy and Jobs Plan:** Queensland’s transition to a more renewables-focussed power grid includes renewable energy targets of 50% by 2030, 70% by 2032, and 80% by 2035 (Queensland Government 2023).
- **Queensland Resources Industry Development Plan**: The Queensland Government has set a state target to reach zero net emissions by 2050, along with an interim target of reducing emissions 75% by 2035, based on 2005 levels (Queensland Government 2022).
- **Queensland New Industry Development Strategy**: The Queensland New-Industry development strategy sets out the Queensland Government’s approach to proactively developing the industries that will be in demand in a decarbonising world.

4.2.2 Guideline - Greenhouse Gas Emissions

In May 2024, the Queensland Department of Environment, Science and Innovation (DESI), released the *Guideline Greenhouse Gas Emissions* (DESI 2024) (hereafter ‘the Guideline’), which clarifies existing application requirements under the *Environmental Protection Act 1994* (EP Act) and provides information about how to meet these requirements in relation to GHG emissions.

The Guideline sets out the minimum expectations for GHG emissions information to be provided with applications for new environmental authorities (EAs) and applications to amend existing EAs. The requirements for development applications, and where they are addressed in this report, are summarised in **Table 2**.

Table 2 DESI Guideline GHG Emissions – EA Application Requirements

Requirement	Where Addressed in this Report
Details of GHG emissions likely to be generated by the activities of the project over its life.	**Section 5.3**
An emissions inventory identifying the GHGs to be emitted and the stage of the project at which the emissions will occur, with a breakdown of GHG emissions by source, that: • Estimates the projected annual Scope 1 and Scope 2 CO_2-e emissions over the life of the project, including both unabated emissions and emissions after all avoidance and abatement measures have been accounted for. • Provides an estimate of annual Scope 3 emissions and total Scope 3 emissions over the life of the project.	**Section 6.0**
A determination as to whether the application meets the threshold for medium to high GHG emission category emitting applications, where: • Applications with expected GHG emissions (Scope 1 and Scope 2) of 25,000 tonnes CO_2-e or more per year (at any time during the life of the project) are considered **medium to high emitters** • Applications with expected GHG emissions (Scope 1 and Scope 2) of less than 25,000 tonnes CO_2-e per year are considered **low emitters**.	**Section 6.3**
Details of the management practices proposed to be implemented to prevent or minimise adverse impacts in line with the GHG abatement hierarchy.	**Section 7.0**
A risk assessment that outlines the scale of expected GHG emissions from the activity and how they are expected to contribute to climate change impacts on Queensland's environmental values.	**Section 6.3**
Applications that exceed the threshold for medium to high emitters must also submit a GHG Abatement Plan.	Not required

4.3 GHG Emission Estimation Guidelines

As required by the Guideline, a GHG emission inventory has been compiled for the Project based on emission factors and reporting guidelines available in the documents and references described in the following sections.

4.3.1 The Greenhouse Gas Protocol

The GHG Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organisations (NGOs), governments and others convened by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The objective of the GHG Protocol Initiative is to develop internationally accepted GHG accounting and reporting standards for business.

The GHG Protocol comprises two separate but linked standards:

- *GHG Protocol Corporate Accounting and Reporting Standard* (WRI/WBCSD 2004a) - This document provides a step-by-step guide for companies to use in quantifying and reporting their GHG emissions.
- *GHG Protocol for Project Accounting* (WRI/WBCSD 2004b) - A guide for quantifying reductions from GHG mitigation projects.

The first edition of the GHG Protocol *Corporate Accounting and Reporting Standard* was published in September 2001. It covers accounting and reporting of the six GHGs covered by the Kyoto Protocol and has been widely adopted by industry, NGOs and government organisations as a basis for GHG accounting and reporting systems.

The latest edition of the *GHG Protocol Corporate Accounting and Reporting Standard* (WRI/WBCSD 2004a), has been referred to in preparing this assessment.

4.3.2 GHG Accounting and Reporting Principles

GHG accounting and reporting principles are intended to underpin all aspects of GHG accounting and reporting. The five principles outlined below are consistent with the GHG Protocol (see **Section 4.3.1**), and ISO 14064-1, 2, and 3 GHG guidelines (internationally accepted best practice). These principles[1] (of relevance, completeness, consistency, transparency and accuracy) are based on financial accounting and reporting standards and are outlined below.

The following outlines the basic requirements of any GHG assessment, as defined by WRI/WBCSD.

Relevance

The relevance of a company's GHG report relates to the information which it contains. The information should allow stakeholders, both internal and external to the organisation, to make informed decisions about GHG management. An important aspect of relevance is the selection of appropriate boundary conditions which reflect the reality of the company's operations. The operation of the company, the purpose of the information and the needs of users will all inform the choice of the inventory boundary. In choosing the inventory boundary, a number of factors should be considered:

- Organisational structure (control, ownership etc.).
- Operational boundaries (on and off-site activities, services, impacts).
- Business context (geographical locations, nature of activities, industry sector, purpose and users of information).

Completeness

All relevant emission sources within the chosen inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled. WRI (2004) states that no materiality threshold (or minimum emissions accounting threshold) should be defined as this is not in line with the principle of completeness. However, if emissions are not able to be estimated or estimated at a sufficient level of quality, then these should be transparently documented and justified.

[1] Text on GHG Principles taken from the GHG Protocol documentation (WRI/WBCSD 2004a)

Consistency

Consistency in an emissions inventory allows stakeholders to compare GHG emissions performance from year to year. This consistency also allows trends to be identified and performance against objectives and targets to be tracked. Any changes in the inventory (accounting approaches, boundaries, calculation methods) need to be transparently documented and justified.

Transparency

All processes, procedures, assumptions and limitations of an inventory should be presented clearly and accurately. Information needs to be recorded, compiled and analysed in a way that enables internal reviewers and external auditors to verify the credibility of the inventory. Specific exclusions and inclusions are to be documented and justified, assumptions disclosed, and appropriate references provided for the calculation methods applied and the data sources used. Transparency is essential in the production of a credible GHG inventory.

Accuracy

Accuracy describes how close the estimates of GHG emissions are to the 'true' value. The accuracy of a GHG inventory should be sufficient for stakeholders to make decisions with reasonable assurance of the integrity of the reported information. Quality management measures should be implemented to maximise inventory accuracy.

This GHG assessment has been prepared to meet the above requirements of the GHG Protocol.

4.3.3 National Greenhouse Accounts Factors

The National Greenhouse Accounts (NGA) Factors are published annually by DCCEEW and provide methods to help companies and individuals estimate GHG emissions. The NGA Factors draw on the *National Greenhouse and Energy Reporting (Measurement) Determination* 2008. However, they are not published for the purposes of reporting under the NGER Act; instead they have a more general application to the estimation of a broader range of GHG emissions inventories.

The default emission factors listed in the NGA Factors are estimated by DCCEEW using the Australian Greenhouse Emissions Information System and are determined simultaneously with the production of Australia's National Greenhouse Accounts. This promotes consistency between inventories at company or facility level and the emission estimates presented in the National Greenhouse Accounts.

The 2024 NGA Factors (DCCEEW 2024) have been referred to in this assessment.

5.0 GHG Inventory Methodology

5.1 Overview of Approach

This assessment was performed as a desktop study. The calculation of GHG emissions from the construction and operation of the Project has been performed in a five-stage process:

1. Definition of the Project boundary (i.e. the Project footprint).
2. Identification of GHG emission sources within the Project footprint during construction and operation.
3. Identification of GHG emission calculation methods and GHG emission factors for each source.
4. Identification of the activity data for each GHG emission source required for the calculations.
5. Calculation of estimated GHG emissions.

A number of assumptions have been relied upon in compiling the GHG emission inventory for the Project. GHG emissions from the key sources identified for the construction and operation of the Project have been estimated based on the most current available emission factors published for use in reporting GHG emissions, which rely on estimates of the level of intensity of each activity (referred to as activity data). The activity data used in the calculations has been compiled based on the current available Project design information and in consultation with the design team.

5.2 Boundary Definition

This section defines the boundaries adopted for the GHG emission inventory compiled for the Project as part of this GHG assessment.

The assessment has considered Scope 1, Scope 2 and Scope 3 emissions associated with the construction and operation of the Project.

Consistent with the Guideline (DESI 2024), the geographical boundary set for the emissions considered in the GHG assessment covers the Project footprint (including the access track), shown in **Figure 3** and **Figure 4**. Scope 1 and Scope 2 GHG emissions associated with the construction and operation of the Project are considered to be within the geographical boundary of this assessment. GHG emissions associated with current and future mining operations and coal handling and processing activities at SWC Mine (such as diesel consumption in mobile plant etc) that will not be directly impacted by the Project, were deemed to be outside the boundary of the assessment.

GHG emissions associated with the operation of the power station have been addressed under a separate assessment and approval application and have therefore not been addressed here. Changes in GHG emissions associated with SWC mine operations (e.g. due to the elimination of Scope 2 emissions associated with the consumption of electricity from the grid, and the potential reduction in fugitive methane emissions), have also been considered within the GHG assessment prepared for the power station and are outside the boundary of this study.

It is noted that the GHG Assessment prepared for the power station development application identified a potential reduction of 647,000 t CO_2-e/annum in South Walker Creek mine's reported Scope 1 and 2 emissions (SLR 2024). This EA Amendment is a key enabler to deliver the power station project, which will in turn enable these emission reductions.

GHG emissions will also occur during decommissioning of Project infrastructure at the end of its design life. Options for the Project infrastructure will vary between life extension, upgrading or decommissioning at the end of the 15 year project life. Due to these options, the GHG emissions beyond 15 years and associated with the end-of-life phase of the Project have not been estimated as part of this study. These emissions will be evaluated as part of any future life extension studies and will be factored into the decisions regarding the ongoing operation or decommissioning of the facilities.

5.3 Identification of GHG Emission Sources

Construction and operational GHG emission sources were identified through a review of the Project description. As discussed in **Section 5.2**, emissions associated with decommissioning the Project infrastructure at the end of its design life have not been quantified due to uncertainties regarding the fate of the plant at that time. These emissions are also expected to be a minor contributor to the total life of Project emissions.

GHG emissions associated with the construction and operation of the Project that were considered in preparing this assessment are summarised in **Table 3**. In relation to Scope 3 emissions during construction, the assessed emission sources are limited, as the information required to complete a detailed Scope 3 analysis is not yet available. Once detailed design has been completed and suppliers of goods and services are identified, a more comprehensive assessment can be performed to identify the overall value chain impacts.

Table 3 GHG Emission Sources Included in the Inventory for the Project

Project Activity	Scope 1	Scope 3
Construction		
Vegetation clearing	• Carbon lost in vegetation cleared for access roads and wellpads	-
Diesel combustion in earthworks and construction equipment	• Emissions from diesel combustion in mobile and fixed equipment, including dozers, excavators, haul trucks etc.	• Emissions associated with production and supply of diesel consumed
Diesel combustion for transport purposes	• Emissions from diesel combustion in heavy load trucks, light vehicles, etc transporting staff and equipment within the Project boundary	• Emissions associated with extraction and production of diesel consumed
Use of oils and greases	• Consumption of oils and greases	• Emissions associated with extraction and production of oils and greases consumed
Materials used for construction	-	• Emissions associated with production and supply of steel and road base used in construction
Employee travel	-	• Emissions from fuel combustion in vehicles used by workers travelling to site
Operation		
Fuel combustion for energy purposes	• Emissions from gas combustion in well head pump engines	-
Fugitive emissions	• Emissions of methane from leaks	-

GHG emissions associated with the following activities/sources were excluded from the emission inventory.

- Fuel consumption in vehicles and other mobile and fixed plant during operations will be very minor and the associated Scope 1 and Scope 3 emissions have been excluded from the emission inventory.
- The electricity needed for the Project's construction will be generated by onsite mobile generators. Thus, Scope 2 emissions are not relevant.
- Scope 3 emissions from diesel/gasoline combustion in private vehicles during employee travel to and from SWC will be very minor during operations, with a projected workforce of only 2-3 full time equivalent personnel.
- The construction and operational GHG emissions associated with the combustion of the pre-drainage gas in the power station is being assessed under a separate assessment and approval application and have therefore not been addressed here.

5.4 Calculation Methods and Emission Factors Used

5.4.1 Scope 1 Emissions

Vegetation Clearing

The estimation of GHG emissions associated with the clearing of vegetation utilised the Department of Industry Science Environment and Resources (DISER) FullCAM model. The data inputs used to derive an emission factor in 'tonnes CO_2-e per hectare cleared' are outlined below, while the clearance areas assumed for the Project are detailed in **Section 5.5**.

The FullCAM model settings are summarised in **Table 4**. The simulation was set to run from 1/1000 to 1/3000 with monthly simulations, with model output recorded annually. FullCAM models land use change over 1,000 years to reduce variability in carbon sequestration before land use changes take place. A sensitivity analysis was performed by running the model with the original vegetation assumed to be (a) Eucalyptus open woodland, and then (b) Native species regeneration, <500 mm rainfall.

The results of the FullCAM Model simulation are summarised in **Table 5**. The tonnes of carbon per hectare output by FullCAM immediately post the clearing event was converted to tonnes CO_2-e using a factor of 44/12 (ratio of the molecular weights of CO_2 and carbon).

As shown in **Table 5**, the estimated tonnes CO_2-e/hectare is slightly higher for eucalyptus open woodland compared to native regeneration. To provide a conservative assessment of potential GHG emissions associated with land clearing during the Project, an emission factor of 162.60 t CO_2-e/ha/annum cleared was used.

Table 4 FullCAM Inputs

Parameter	Value/Setting
Location	-21.80207 Lat, 148.43813 Long
Configuration	Point source model, output per hectare
Start and End of Simulation	Jan 1000 - Jan 3000
Simulation steps	Monthly, output every 12 steps (annual)
Output	Average over 1 ha
Spatial/temporal data	Apply downloaded spatial data Water, temperature and productivity cycle table data across all time
Initial conditions	Forest System Run 1: Eucalyptus open woodland Run 2: Native species regeneration, <500 mm rainfall
Max above ground biomass	20.7044 t dry mass / hectare
% soil that is clay by weight	28.1%
Event	Forest thinning, 100% of Site Theoretical date of 1 January 2025 No product recovery, no biofuel

Table 5 FullCAM Outputs

Output	Scenario	Carbon (t C/ha)	CO_2-e Equivalent (t CO_2-e/ha)
Carbon in debris after clearing	Eucalyptus open woodland	26.83	98.37
	Native species regeneration <500 mm rainfall	20.11	73.72
Total carbon, including soil carbon	Eucalyptus open woodland	44.35	162.60
	Native species regeneration <500 mm rainfall	38.45	140.98

Diesel Combustion

Estimates of GHG emissions from the combustion of diesel during construction were calculated by multiplying the estimated quantities of diesel to be combusted by a fuel-specific energy content factor and fuel-specific CO_2-e Scope 1 emission factors. The emission factors used in the calculations are summarised in **Table 6**.

The emission factors used for the combustion of diesel fuel in the heavy construction equipment are those given for stationary energy use, as the NGA Factors Workbook (DCCEEW 2024) states "*No transport factors are provided for vehicles not registered for road use. Stationary energy factors for individual fuel types should be used in these cases*".

Oils and Greases

Estimates of annual GHG emissions from the use of petroleum-based oils and greases during construction were made by multiplying the quantities estimated to be used by the relevant energy content factor and CO_2-e Scope 1 emission factor. The emission factors used in the calculations are summarised in **Table 6**.

Gas Combustion

The well head pump engines will be fuelled with gas produced by the Project. Estimates of GHG emissions from the combustion of gas during operation were calculated by multiplying the estimated quantities of gas to be combusted by the fuel-specific energy content factor and CO_2-e Scope 1 emission factors shown in **Table 6**.

Fugitive Emissions

Fugitive emissions were estimated using Method 1 from the NGER Measurement Determination (Subdivision 3.3.6C - *Natural gas gathering and boosting (other than emissions that are vented or flared*)). This method uses a default emission factor (**Table 6**) based on the length of pipeline.

Table 6 Scope 1 Emission Factors Used

Emission Source	Energy Content Factor	Scope 1 Emission Factors				
		CO_2	CH_4	N_2O	Total	Units
Fuel Use – Stationary (power generation and off-road equipment) [1]						
Coal seam methane that is captured for combustion	0.0377 GJ/m^3	51.4	0.2	0.03	51.63	kg CO_2-e/GJ
Diesel	38.6 GJ/kL	69.9	0.1	0.2	70.2	kg CO_2-e/GJ
Fuel Use - Transport [2]						
Diesel – Heavy duty vehicles	38.6 GJ/kL	69.9	0.1	0.4	70.4	kg CO_2-e/GJ
Diesel – Cars and light commercial vehicles	38.6 GJ/kL	69.9	0.01	0.5	70.41	kg CO_2-e/GJ
Oils and Greases [1]						
Petroleum based oils	38.8 GJ/kL	13.9	0	0	13.9	kg CO_2-e/GJ
Petroleum based greases	38.8 GJ/kL	3.5	0	0	3.5	kg CO_2-e/GJ
Fugitive Emissions						
Onshore gas gathering and boosting pipelines	-	0.0265	6.52	0	6.5465	t CO_2-e/km pipeline

Note:
[1] NGA Factors Workbook 2024, Table 5 and Table 8 (DCCEEW 2024)
[2] NGA Factors Workbook 2024, Table 9 (DCCEEW 2024), assumed Euro III factors

5.4.2 Scope 3 Emissions

Production and Supply of Diesel, Oils and Greases

The Scope 3 emission factors used to estimate the CO_2-e emissions associated with the production and supply of diesel, oils and greases used by the Project are shown in **Table 7**.

Construction Materials - Embodied Energy

The main construction materials identified for the Project are steel and road base, the production and transport of which will result in the emission of GHGs.

To account for Scope 3 emissions associated with the use of steel, the emission factor listed in the *Inventory of Carbon and Energy* (ICE) database (Hammond and Jones 2019) shown in **Table 7** was adopted. The ICE database is an embodied carbon database for building materials, and contains data for over 200 materials, broken down into over 30 main material categories, including bricks, cement and concrete, glass, timber, plastics, metals, minerals and stone. The ICE database was created from a large review of the literature. The first version was released in 2005 and it has been updated at periodic intervals with the latest update occurring in November 2019.

The ICE Database provides a range of emission factors for aggregate and sand mixtures. However, to provide a more Australian-focussed and contemporary estimate of the embodied carbon in the road base that will be used for the access road construction, the Environmental Product Declaration published by Boral for their Victorian operations was referenced (in the absence of a similar EPD for a Queensland-based supplier). This is a 'cradle-to gate' factor and does not include delivery to site or installation.

Transport of Materials of Construction

Scope 3 CO_2-e emissions associated with the transport of these materials from the point of origin to SWC (assumed to be Moranbah) by road have also been estimated, based on the emission factor in t CO_2-e/t-km (t-km is a unit of measure of freight transport which represents the transport of one tonne of goods by a given transport mode [road, rail, air, sea, inland waterways, pipeline etc] over a distance of one kilometre) shown in **Table 7**.

Table 7 Scope 3 Emission Factors Used

Fuels, Oils and Greases [1]			
Fuel / Substance	**Energy Content Factor (GJ/kL)**	**Scope 3 Emission Factor**	**Unit**
Diesel	38.6	17.3	kg CO_2-e/GJ
Petroleum based oils	38.8	18.0	kg CO_2-e/GJ
Petroleum based greases	38.8	18.0	kg CO_2-e/GJ
Embodied Energy of Construction Materials			
Material	**Product Description**	**Embodied Carbon Factor**	**Unit**
Steel [2]	Steel, welded pipe, world average	2.78	t CO_2-e/tonne
Road base [3]	2% cement stabilised aggregates	0.0295	t CO_2-e/tonne
Transport of Materials	**Transport Mode Emissions Intensity**		**Unit**
Road [4]	Rigid truck – default factor	0.00022	t CO_2-e/t-km

1 NGA Factors Workbook 2023, Table 8 (DCCEEW 2024).
2 ICE Database (Hammond and Jones 2019).
3 *Environmental Product Declaration: Quarry and Recycling Products (including recycled road base, sand, aggregate and stabilized product)* (Boral 2024). Used embodied carbon reported for '2% stabilised products' produced by the Wollert Site, based on that being the highest value for that product from any site in Victoria. A density of 2.24 t/m^3 was assumed (WARRIP 2017).
4 *Embodied Carbon Measurement for Infrastructure: Technical Guidance* (NSW Government 2024).

Fuel Combustion Associated with Worker Commuting

Estimates of GHG emissions from the combustion of fuel by workers travelling from home to site during the construction phase were calculated by multiplying the estimated quantities of fuel to be combusted, by the fuel-specific energy content factor and fuel-specific CO_2-e Scope 1 emission factors shown in **Table 6**. In the absence of detailed information, and to be conservative, it was assumed all workers will travel in diesel-fuelled passenger vehicles.

5.5 Activity Data

The activity data used in the GHG emission calculations are outlined in **Table 8**.

Table 8 Project Construction and Operation Activity Data

Input Data	Units	Scope	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Life of Project
Construction																		
Vegetation clearance																		
- Exploration [1]	ha/annum	1	15.75	15.75	15.75	15.75	-	-	-	-	-	-	-	-	-	-	-	**63.0**
- CSG production [2]			0.84	-	-	0.42	-	-	0.42	-	-	0.42	-	-	-	-	-	**2.1**
- Access roads [3]			9.43	8.95	8.95	9.19	-	-	0.24	-	-	0.24	-	-	-	-	-	**37.0**
Diesel consumption [4]																		
- stationary/off-road	kL/annum	1 & 3	52	49	49	51	-	-	1.3	-	-	1.3	-	-	-	-	-	**204**
- transport			6.5	6.2	6.2	6.3	-	-	0.2	-	-	0.2	-	-	-	-	-	**26**
Use of petroleum based oils [4]	kg/annum	1 & 3	95	90	90	92	-	-	2.4	-	-	2.4	-	-	-	-	-	**371**
Use of petroleum based greases [4]	kg/annum	1 & 3	95	90	90	92	-	-	2.4	-	-	2.4	-	-	-	-	-	**371**
Steel used in construction [4]	t/annum	3	0.25	0.24	0.24	0.25	-	-	0.01	-	-	0.01	-	-	-	-	-	**1.0**
Road base used in construction [4]	m^3/annum	3	4,633	4,398	4,398	4,516	-	-	117	-	-	117	-	-	-	-	-	**18,180**
Diesel for worker travel [5]	kL/annum	3	52	10	10	10	-	-	10	-	-	10	-	-	-	-	-	**105**
Operation																		
Portion of year operating	months	1	4	12	12	12	12	12	12	12	12	12	12	12	12	12	12	-
Number of engines	units		2	2	2	3	3	3	4	4	4	5	5	5	5	5	5	-
Wellhead engine gas use [6]	GJ/annum		1,947	5,840	5,840	8,760	8,760	8,760	11,680	11,680	11,680	14,600	14,600	14,600	14,600	14,600	14,600	**162,547**
Length of pipeline [7]	kilometres	1	3.65	3.65	3.65	5.47	5.47	5.47	7.30	7.30	7.30	9.12	9.12	9.12	9.12	9.12	9.12	**9.12**

1 Estimated based on 450 wells @ 0.14 ha each over 4 years.
2 Estimated based on Y1: 6 wells @ 0.14 ha; then 3 new wells every 3 years until total of 15 wells.
3 Apportioned based on hectares/annum cleared for exploration and wellsite construction.
4 Apportioned across life of Project based on hectares/annum cleared.
5 Nominal estimate based on 30 return trips per day (25-35 workers during construction) between Moranbah and SWC (85 km each way), 6 days/week for 5 months, travelling in vehicles with a fuel efficiency of 7.9 L/km (https://realworld.org.au/results?type=ute-4wd&fuel=diesel). Assume 20% of Y1 usage for Y2-Y4, Y7 and Y10.
6 Based on 8 GJ/day/engine with one engine per 3 wells (based on 2 engines required for first 6 wells); and assuming Y1: 6 wells, then 3 new wells every 3 years until total of 15.
7 Based on total estimated pipeline length for Project, and assuming the length of pipeline increases in proportion to number of production wells assumed to be constructed each year.

6.0 Estimated GHG Emissions

A summary of the estimated Scope 1 and Scope 3 GHG emissions for the Project (as total CO_2-e/annum and covering both construction-related activities and operational emissions associated with the combustion of gas in the wellhead engines) is provided in **Table 9**. As discussed in **Section 5.3**, the electricity needed for the Project will be generated by onsite mobile generators during construction and combustion of extracted gas during operation, therefore Scope 2 emissions are not relevant.

Additional detail on the estimated emissions by gas type is provided in **Appendix A**.

6.1 Scope 1 Emissions

The estimated Scope 1 emissions for construction and operation are shown graphically in **Figure 6**. A review of the estimated Scope 1 emissions shows:

- During the initial four years of the Project, the main source of Scope 1 GHG emissions is estimated to be related to carbon loss from clearing of vegetation.
- From year 5 onwards, when it is assumed that the bulk of the land clearing and access road construction has been completed, the main source of Scope 1 emissions is the combustion of gas in the wellhead engines.
- The total estimated annual Scope 1 GHG emissions from the Project are well below 25,000 tonnes CO_2-e per year, and as such the Project will be categorised as a **low emitter**.

It is noted that the estimated emissions associated with land clearing are subject to a high level of uncertainty, and should be regarded as indicative only. Actual emissions will be highly dependent on the access road routes and wellhead locations and the nature of the vegetation cover in the areas cleared.

Figure 6 Estimated Scope 1 GHG Emissions for the Project

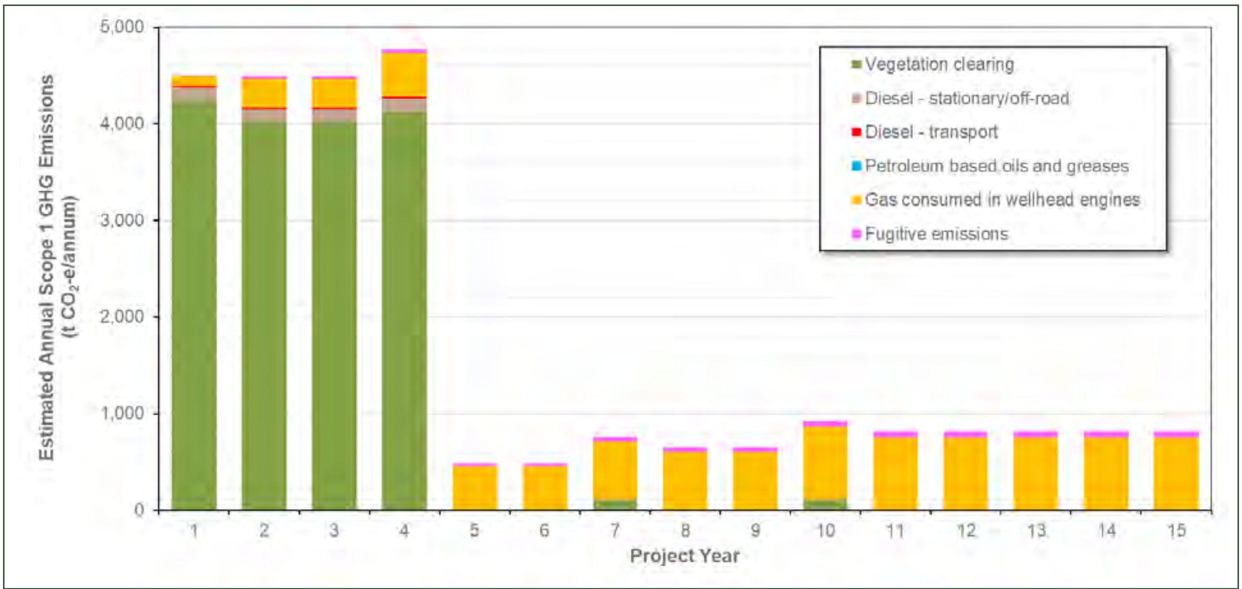


Table 9 Estimated Annual Scope 1 and Scope 3 GHG Emissions

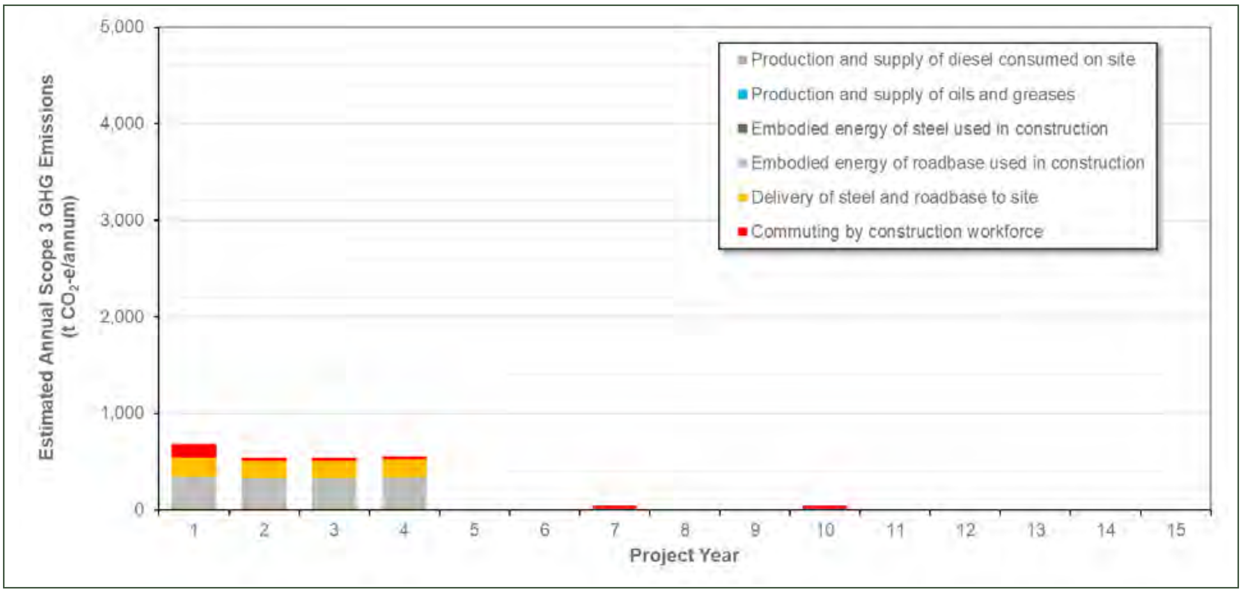
GHG Emissions Per Source	Scope	Estimated GHG Emissions (tonnes CO_2-e/annum)															
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
Construction Activities																	
Vegetation clearing	1	4,231	4,017	4,017	4,124	0	0	107	0	0	107	0	0	0	0	0	**16,602**
Diesel - stationary/off-road	1	141	134	134	137	0	0	4	0	0	4	0	0	0	0	0	**553**
Diesel - transport	1	17.7	16.8	16.8	17.2	0	0	0.4	0	0	0.4	0	0	0	0	0	**69**
Petroleum based oils/greases	1	0.07	0.07	0.07	0.07	0	0	0.00	0	0	0.00	0	0	0	0	0	**0.3**
Operational Activities																	
Gas consumed in well engines	1	101	302	302	452	452	452	603	603	603	754	754	754	754	754	754	**8,392**
Fugitive emissions	1	8	24	24	36	36	36	48	48	48	60	60	60	60	60	60	**665**
Total Scope 1		**4,498**	**4,493**	**4,493**	**4,767**	**488**	**488**	**762**	**651**	**651**	**925**	**814**	**814**	**814**	**814**	**814**	**26,282**
Construction Activities																	
Production and supply of diesel consumed on site	3	39	37	37	38	0	0	1	0	0	1	0	0	0	0	0	**153**
Production/supply of oils/greases	3	0.15	0.14	0.14	0.15	0	0	0.00	0	0	0.00	0	0	0	0	0	**0.6**
Embodied energy - steel	3	0.77	0.73	0.73	0.75	0	0	0.02	0	0	0.02	0	0	0	0	0	**3.0**
Embodied energy – road base	3	306	291	291	298	0	0	7.8	0	0	7.8	0	0	0	0	0	**1,201**
Delivery - steel and road base	3	194	184	184	189	0	0	4.9	0	0	4.9	0	0	0	0	0	**762**
Workforce commuting	3	142	28	28	28	0	0	28	0	0	28	0	0	0	0	0	**285**
Total Scope 3		**683**	**541**	**541**	**555**	**0**	**0**	**42**	**0**	**0**	**42**	**0**	**0**	**0**	**0**	**0**	**2,405**
Total Scope 1 and Scope 3		**5,181**	**5,034**	**5,034**	**5,322**	**488**	**488**	**804**	**651**	**651**	**967**	**814**	**814**	**814**	**814**	**814**	**28,687**

6.2 Scope 3 Emissions

The annual estimated Scope 3 GHG emissions for the Project are presented graphically in **Figure 7**. A review of the estimated emissions shows that Scope 3 GHG emissions associated with construction of the Project are relatively minor, representing approximately 9% of the Scope 1 emissions over the life of the Project.

The main source (50%) of the estimated Scope 3 emissions is related to the embodied energy of road base to be used for access road construction, based on the product specification assumed (see **Table 7**). The delivery of steel and road base to site via 3rd party road transport is estimated to contribute 32% (based on delivery from Moranbah), while worker commuting contributes 12%.

Figure 7 Estimated Scope 3 GHG Emissions for the Project - Construction



6.3 Risk Assessment

The *Guideline Greenhouse Gas Emissions* (DESI 2024) requires that a risk assessment be performed to outline the scale of expected GHG emissions from the activity and how they are expected to contribute to climate change impacts on Queensland's environmental values.

For the 2022 reporting year, which is the most recent available data available at time of writing this report, Australia's total GHG emissions were reported to be 432.621 Mt CO_2-e, with 124.097 Mt CO_2-e contributed by Queensland (DCCEEW 2024).

The maximum total annual Scope 1 GHG emissions from the Project (including construction activities) are estimated to be 4,767 t CO_2-e per annum (see **Table 9**). This represents approximately 0.001% of Australia's 2022 emissions, and 0.004% of Queensland's 2022 emissions. On this basis, construction and operation of the gas drainage network will be expected to be an insignificant contributor to climate change impacts on Queensland's environmental values.

Table 10 summarises the GHG emissions estimated for the SWC mine operations for the 2022/23 reporting year. In comparison to the whole of site emissions, the Project represents an increase of 1.3% on SWC mine's current Scope 1 emissions, and an increase of 1.1% on the combined Scope 1 and 2 emissions.

Table 10 SWC Mine 2022/23 GHG Emission Estimates

Source Category	Activity	SWC Mine Reported Emissions (t CO_2-e)
Scope 1		
Fuel combustion	Combustion of liquid fuels - Transport energy purposes	2,927
	Combustion of liquid fuels - Stationary energy purposes	176,037
	Combustion of petroleum oils or greases	107
Industrial processes	Gas insulated switchgear	13
Fugitive emissions	Fugitive emissions from extraction of coal (Method 1)	184,605
Energy	Energy consumed - not combusted (explosives)	4,854
Total Scope 1		**368,543**
Scope 2		
Purchase of electricity from main electricity grid		55,621
TOTAL		**424,164**

As discussed in **Section 5.2**, this EA Amendment is also a key enabler to deliver the power station project, which is proposed to reduce Scope 2 emissions from SWC Mine's operations, by replacing consumption of grid power. It also has the potential to reduce Scope 1 emissions from SWC Mine's operations, assuming all gas burnt in the power station will be otherwise (eventually) emitted as fugitive emissions during mining of the coal in the gas extraction area. Considering these potential benefits, the net change in emissions from SWC Mine's operations, once the reduction in fugitive methane emissions and avoided reliance on grid power is accounted for, is estimated to be a net reduction of approximately 647,000 Mt CO_2-e per annum[2]. This is further addressed in the GHG emissions assessment and approval application for the power station.

[2] It is noted that currently SWC Mine uses default fugitive emission factors to estimate fugitive emissions associated with its mining operations (i.e. Method 1 as per the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*). The reductions in fugitive methane emissions estimated as a result of the power plant will therefore not be addressed within the SWC Mine emissions inventory until the Method 2 approach is adopted by SWC Mine for reporting.

7.0 GHG Emissions Abatement

The Project is a key component of SWC Mine's decarbonisation strategy to reduce its Scope 1 emissions associated with fugitive methane emissions and Scope 2 emissions due to grid electricity consumption. To further leverage the GHG benefits of the Project, detailed design and construction plans for the exploration and drainage system will consider the measures outlined in **Table 11**.

As per the *Guideline Greenhouse Gas Emissions* (DESI 2024), projects classified as a low emitter are not required to submit a detailed GHG abatement plan as part of the application process.

Table 11 Project-Related Mitigation Measures

Measure	GHG Abatement Hierarchy (*see **Figure 7***)
Minimise clearing of vegetation through access road route selection and siting of wells	REDUCE
Maximise beneficial use of cleared vegetation	REDUCE
Minimise methane leakage from plant and equipment through routine maintenance	REDUCE
Specify and select appropriately sized and energy-efficient equipment for construction and operation	AVOID
Implement practices to minimise fuel consumption during construction	REDUCE
Regularly maintain construction plant and ensure compliance with relevant exhaust emission guidelines	REDUCE
Switch off plant and equipment when not in constant use, not left idling	AVOID
Plan construction works to ensure minimal movement of plant and equipment	REDUCE
Source materials and consumables from local suppliers, where possible, and minimise, where feasible, the embodied energy in materials of construction	REDUCE

Figure 8 GHG Abatement Hierarchy

SOURCE: (DESI 2024)

8.0 Conclusions

The key conclusions of the GHG Assessment performed for the Multi-Year Exploration Program and Gas Drainage Project are:

- During the initial four years of the Project, the main sources of Scope 1 GHG emissions is estimated to be related to carbon loss from clearing of vegetation. It is noted that the estimated emissions associated with land clearing are subject to a high level of uncertainty, and should be regarded as indicative only.
- From year 5 onwards, when it is assumed that the bulk of the land clearing and access road construction have been completed, the main source of Scope 1 emissions is the combustion of gas in the wellhead engines.
- The total estimated annual Scope 1 GHG emissions from the Project are well below 25,000 t CO_2-e per year, and as such the Project will be categorised as a **low emitter**.
- Scope 3 GHG emissions associated with construction of the Project are relatively minor, representing approximately 9% of the Scope 1 emissions over the life of the Project. The main sources are related to the embodied energy of road base (50%), and the delivery of steel and road base to site (32%). The emission estimates are highly dependent of the estimated activity data as detailed in this report.
- Compared to South Walker Creek Mine's current emissions profile, this project represents a minor addition to SWC's overall reported emissions (just over 1%). Furthermore, it potentially unlocks the capability to materially reduce fugitive emissions from the SWC through gas drainage and combustion in the power station or flare, which has been estimated to result in a net reduction of approximately 647 kt CO_2-e per annum.
- Considered in isolation, the Project will be expected to be a **minor contributor to climate change impacts** on Queensland's environmental values.
- A range of GHG mitigation measures have been identified for consideration during the detailed design and construction of the Project to further leverage the benefits of the Project.

9.0 References

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Appendix A GHG Emissions Inventory

South Walker Creek Mine Multi-Year Exploration Program and Gas Drainage Project

Greenhouse Gas Assessment

Stanmore SMC Pty Ltd

SLR Project No.: 620.040822.00003

19 September 2024

GHG Emissions Per Source	Scope	Units	Year 1				Year 2				Year 3				Year 4				Year 5			
			CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total
Construction Activities																						
Vegetation clearing	1	t CO_2-e	4,231			4,231	4,017			4,017	4,017			4,017	4,124			4,124	0			0
Diesel - stationary/off-road	1	t CO_2-e	140	0.2	0	141	133	0.2	0	134	133	0.2	0	134	137	0.2	0	137	0	0	0	0
Diesel - transport	1	t CO_2-e	17.6	0.02	0.1	17.7	16.7	0.02	0.1	16.8	16.7	0.02	0.1	16.8	17.1	0.02	0.1	17.2	0	0	0	0
Petroleum based oils and greases	1	t CO_2-e	0.07			0.07	0.07			0.07	0.07			0.07	0.07			0.07	0			0
Operational Activities																						
Gas consumed in wellhead engines	1	t CO_2-e	100	0.4	0.1	101	300	1.2	0.2	302	300	1.2	0.2	302	450	1.8	0.3	452	450	1.8	0.3	452
Fugitive emissions			0.03	7.9		8.0	0.10	23.8		24	0.10	23.8		24	0.15	35.7		36	0.15	35.7		36
Total Scope 1		**t CO_2-e**	**4,489**	**8.5**	**0.6**	**4,498**	**4,467**	**25.2**	**0.7**	**4,493**	**4,467**	**25.2**	**0.7**	**4,493**	**4,728**	**37.7**	**0.8**	**4,767**	**450**	**37.4**	**0.3**	**488**
Construction Activities																						
Production and supply of diesel consumed on site	3	t CO_2-e				39				37				37				38				0
Production and supply of oils and greases	3	t CO_2-e				0.15				0.14				0.14				0.15				0
Embodied energy of steel used in construction	3	t CO_2-e				0.77				0.73				0.73				0.75				0
Embodied energy of roadbase used in construction	3	t CO_2-e				306.1				290.6				290.6				298.4				0
Delivery of steel and roadbase to site	3	t CO_2-e				194.1				184.2				184.2				189.2				0
Commuting by construction workforce	3	t CO_2-e	141.3	0.02	1.01	142.4	28.3	0.004	0.20	28.5	28.3	0.004	0.20	28.5	28.3	0.004	0.20	28.5	0	0	0	0
Total Scope 3		**t CO_2-e**				**683**				**541**				**541**				**555**				**0**
Total Project		**t CO_2-e**	**4,630**	**8.6**	**1.6**	**5,181**	**4,495**	**25.2**	**0.9**	**5,034**	**4,495**	**25.2**	**0.9**	**5,034**	**4,756**	**37.7**	**1.0**	**5,322**	**450**	**37.4**	**0.3**	**488**

GHG Emissions Per Source	Scope	Units	Year 6				Year 7				Year 8				Year 9				Year 10			
			CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total
Construction Activities																						
Vegetation clearing	1	t CO_2-e	0			0	107			107	0			0	0			0	107			107
Diesel - stationary/off-road	1	t CO_2-e	0	0	0	0	4	0.01	0.01	4	0	0	0	0	0	0	0	0	4	0.01	0.01	4
Diesel - transport	1	t CO_2-e	0	0	0	0	0.4	0.0004	0.0025	0.4	0	0	0	0	0	0	0	0	0.4	0.0004	0.0025	0.4
Petroleum based oils and greases	1	t CO_2-e	0			0	0.00			0.00	0			0	0			0	0.00			0.00
Operational Activities																						
Gas consumed in wellhead engines	1	t CO_2-e	450	1.8	0.3	452	600	2.3	0.4	603	600	2.3	0.4	603	600	2.3	0.4	603	750	2.9	0.4	754
Fugitive emissions			0.15	35.7		36	0.19	47.6		48	0.19	47.6		48	0.19	47.6		48	0.24	59.5		60
Total Scope 1		**t CO_2-e**	**450**	**37.4**	**0.3**	**488**	**712**	**49.9**	**0.4**	**762**	**601**	**49.9**	**0.4**	**651**	**601**	**49.9**	**0.4**	**651**	**862**	**62.4**	**0.5**	**925**
Construction Activities																						
Production and supply of diesel consumed on site	3	t CO_2-e				0				1				0				0				1
Production and supply of oils and greases	3	t CO_2-e				0				0.00				0				0				0.00
Embodied energy of steel used in construction	3	t CO_2-e				0				0.02				0				0				0.02
Embodied energy of roadbase used in construction	3	t CO_2-e				0				7.8				0				0				7.8
Delivery of steel and roadbase to site	3	t CO_2-e				0				4.9				0				0				4.9
Commuting by construction workforce	3	t CO_2-e	0	0	0	0	28	0.004	0.20	28	0	0	0	0	0	0	0	0	28	0.004	0.20	28
Total Scope 3		**t CO_2-e**				**0**	**28**	**0.0**	**0.2**	**42**				**0**	**0**	**0.0**	**0.0**	**0**				**42**
Total Project		**t CO_2-e**	**450**	**37.4**	**0.3**	**488**	**740**	**49.9**	**0.6**	**804**	**601**	**49.9**	**0.4**	**651**	**601**	**49.9**	**0.4**	**651**	**890**	**62.4**	**0.7**	**967**

GHG Emissions Per Source	Scope	Units	Year 11				Year 12				Year 13				Year 14				Year 15			
			CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total	CO2	CH4	N2O	Total
Construction Activities																						
Vegetation clearing	1	t CO_2-e	0			0	0			0	0			0	0			0	0			0
Diesel - stationary/off-road	1	t CO_2-e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diesel - transport	1	t CO_2-e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum based oils and greases	1	t CO_2-e	0			0	0			0	0			0	0			0	0			0
Operational Activities																						
Gas consumed in wellhead engines	1	t CO_2-e	750	2.9	0.4	754	750	2.9	0.4	754	750	2.9	0.4	754	750	2.9	0.4	754	750	2.9	0.4	754
Fugitive emissions			0.24	59.5		60	0.24	59.5		60	0.24	59.5		60	0.24	59.5		60	0.24	59.5		60
Total Scope 1		**t CO_2-e**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**
Construction Activities																						
Production and supply of diesel consumed on site	3	t CO_2-e				0				0				0				0				0
Production and supply of oils and greases	3	t CO_2-e				0				0				0				0				0
Embodied energy of steel used in construction	3	t CO_2-e				0				0				0				0				0
Embodied energy of roadbase used in construction	3	t CO_2-e				0				0				0				0				0
Delivery of steel and roadbase to site	3	t CO_2-e				0				0				0				0				0
Commuting by construction workforce	3	t CO_2-e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Scope 3		**t CO_2-e**	**0**	**0.0**	**0.0**	**0**				**0**	**0**	**0.0**	**0.0**	**0**				**0**	**0**	**0.0**	**0.0**	**0**
Total Project		**t CO_2-e**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**	**751**	**62.4**	**0.4**	**814**

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