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Report on

Underground Water Impact Report Ironbark No. 1 Mine

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Table of contents

1	Introduction.....	1
1.1	Mine overview and setting	1
1.2	UWIR scope and structure	1
2	Regulatory requirements	3
3	Assessment methodology	6
3.1	Desktop study	6
3.1.1	Database and government mapping reviews for water bores	6
3.1.2	Database and government mapping reviews for sensitive environmental features	6
3.1.3	Previous groundwater studies.....	7
3.1.4	Review of groundwater monitoring data	8
3.1.5	Fitzroy groundwater monitoring network.....	8
3.2	Numerical modelling	9
4	Groundwater regime.....	11
4.1	Overview	11
4.2	Quaternary Alluvium	12
4.2.1	Distribution	12
4.2.2	Hydrogeological parameters	12
4.2.3	Recharge, flow, and discharge	12
4.2.4	Groundwater quality	12
4.2.5	Groundwater yields and use	12
4.3	Tertiary Sediments.....	12
4.3.1	Distribution	12
4.3.2	Hydrogeological parameters	13
4.3.3	Recharge, flow, and discharge	13
4.3.4	Groundwater quality	13
4.3.5	Groundwater yields and use	13
4.4	Triassic Rewan Group	13
4.4.1	Distribution	13
4.4.2	Hydrogeological parameters	13
4.4.3	Recharge, flow, and discharge	14
4.4.4	Groundwater quality	14
4.4.5	Groundwater yields and use	14
4.5	Permian Sediments.....	14
4.5.1	Distribution	14
4.5.2	Hydrogeological parameters	14
4.5.3	Recharge, flow, and discharge	14
4.5.4	Groundwater quality	15
4.5.5	Groundwater yields and use	15
5	Environmental values	16
6	Groundwater impact assessment.....	17
6.1	Introduction	17
6.2	Groundwater take.....	17

Table of contents

6.3	Groundwater drawdown during the UWIR period	18
6.4	Groundwater drawdown over the mine life	18
6.5	Environmental impacts.....	18
6.5.1	Impacts on groundwater resources.....	19
6.5.2	Impacts on groundwater users.....	19
6.5.3	Impacts on surface drainage.....	20
6.5.4	Impacts on springs	20
6.5.5	Impacts on groundwater dependent ecosystems	20
6.5.6	Impacts on groundwater quality	21
6.5.7	Impacts on formation integrity and environmental values	21
7	Groundwater monitoring program	22
7.1	Groundwater level and quality monitoring	22
7.2	Groundwater take monitoring.....	24
8	UWIR Review and updates	25
8.1	Roles and responsibilities	25
8.2	Review and revision	25
8.3	Reporting and record keeping.....	25
9	Conclusions	26
10	References	27

List of figures

Figure 1	Mine location and setting	28
Figure 2	Mine layout.....	29
Figure 3	Topography and drainage	30
Figure 4	DNRM Registered bores	31
Figure 5	Mine groundwater monitoring network.....	32
Figure 6	Piper diagram.....	33
Figure 7	Conceptual hydrogeological model.....	34
Figure 8	Interpreted depth to water table	35
Figure 9	Interpolated groundwater contours	36
Figure 10	Surface geology	37
Figure 11	Saturated alluvium extents.....	38
Figure 12	Drainage line photographs in Project area	39
Figure 13	Bowen Basin geology	40
Figure 14	Measured groundwater levels in monitoring bores	41
Figure 15	Predicted drawdown in water table at the end of UWIR Year 1	42
Figure 16	Predicted drawdown in water table at the end of UWIR Year 2	43
Figure 17	Predicted drawdown in water table at the end of UWIR Year 3 (IAA)	44
Figure 18	Predicted drawdown in water table at the end of mining (LTAA).....	45

Table of contents

Figure 19	Predicted Depressurisation in the Leichhardt Seam at the end of UWIR Year 1	46
Figure 20	Predicted Depressurisation in the Leichhardt Seam at the end of UWIR Year 2	47
Figure 21	Predicted Depressurisation in the Leichhardt Seam at the end of UWIR Year 3 (IAA)	48
Figure 22	Predicted Depressurisation in the Leichhardt Seam at the end of mining (LTAA)	49

List of tables

Table 1	UWIR Content Requirements	3
Table 2	UWIR Water Monitoring Strategy Content Requirements	5
Table 3	Groundwater bore details.....	8
Table 4	Salinity Classification Scale	9
Table 5	Summary of Environmental Values – Isaac Northern Tributaries and Isaac Groundwaters (DEHP 2011).....	16
Table 6	Predicted volume of groundwater take	17
Table 7	Summary of groundwater monitoring program	23

List of appendices

Appendix A	Laboratory analysis results
Appendix B	Numerical modelling

Underground Water Impact Report

Ironbark No.1 Mine

1 Introduction

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) was commissioned by Hansen Environmental Consulting (HEC) on behalf of Fitzroy (CQ) Pty Ltd (Fitzroy) to prepare an Underground Water Impact Report (UWIR) for the Ironbark No.1 Mine (the mine). This section provides an overview of the mine, explains the background to the UWIR and describes the scope and structure of the UWIR.

1.1 Mine overview and setting

The project involves the development of an underground coal mine approximately 35 km north-east of Moranbah Township (Figure 1). Fitzroy acquired the mine in November 2016 and obtained an Environmental Authority (EA0001299) for the mine on 13 July 2018.

Construction of the mine portal and decline commenced in December 2021. The mine life will be approximately 20 years. The mine will produce up to approximately 6 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal. Coal will be extracted from the Leichhardt coal seam using longwall and bord and pillar mining methods. ROM coal will be hauled by truck to the existing Carborough Downs Coal Mine (CDCM) coal handling and preparation plant (CHPP). Product coal will be loaded onto trains at the CDCM train loading facility for transport to port, and exported to overseas markets.

The project site is located adjacent to the Burton open cut coal mine to the north and west, and the Broadlea open cut coal mine to the south (Figure 1).

The topography of the mine site consists of low-lying gently undulating terrain generally of less than 2% gradient (Figure 3). Ephemeral drainage lines cross the site from east to west with the majority of the project site located within the catchments of Bullock Creek, Spade Creek and Alpha Creek (Figure 3).

The geology of the mine site comprises the Permian Rangal Coal Measures and overlying Triassic Rewan Group sediments. These sediments outcrop at the surface or are overlain by Tertiary sediments. Localised deposits of unconsolidated alluvium occur within the creek beds that traverse the mine site.

1.2 UWIR scope and structure

The UWIR is a requirement of the groundwater management framework legislated under Chapter 3 of the Water Act 2000 (Water Act). The main purpose of the UWIR is to describe the groundwater take due to mining (and any associated impacts) over a three-year period (the UWIR period).

This UWIR addresses the initial three years of the project from the commencement of box cut excavation in early 2022. The mining activities during this UWIR period include the construction of a single box cut portal and two drifts in the north-west corner of the mine site in the area where the coal seam is shallowest, drilling and construction of a shaft, and the extraction of coal from the longwall and bord and pillar mining areas shown in Figure 2.

The UWIR has been prepared in accordance with Section 376 of the Water Act and the DES guideline Underground water impact reports and final reports (the UWIR guideline), where relevant.

Consistent with the UWIR guideline, the information supplied in support of the EA approval processes under the EP Act has been used as the basis for the UWIR. Hence, the scope of work for the UWIR is generally limited to a minor update of the existing approved groundwater assessments to allow information specific to the UWIR period to be presented. The specific scope of the UWIR includes:

- a review of relevant groundwater, project development, geological and environmental reports from the mine site to develop an appreciation of the hydrogeological setting of the project;
- an updated review of hydrogeological data held on the Department of Regional Development Manufacturing and Water (DRDMW's) Groundwater Database to identify water supply bores;
- an updated census of water supply bores to confirm the extent of groundwater use in the area and collect relevant groundwater monitoring data;
- review of the conceptual model of the groundwater regime of the mine site and its surrounds, based on all available data;
- refinement of the existing numerical groundwater model to allow the mining effects on groundwater levels to be presented for the first three years of mining only;
- estimation of the groundwater impacts over the first three years of mining; and
- confirmation of the existing approved EA groundwater monitoring program and management measures.

The UWIR includes:

- an introduction to the UWIR (Section 1);
- a description of the relevant regulatory UWIR requirements (Section 2);
- a description of the assessment method (Section 3);
- a description of the groundwater regime and sensitive environmental features (Section 4);
- an assessment of the mine's groundwater impacts (Section 5);
- a description of the groundwater monitoring program (Section 7);
- a description of the process for reviewing and updating the UWIR (Section 8); and
- the key conclusions of the UWIR (Section 9).

2 Regulatory requirements

Section 376 of the Water Act specifies the UWIR content requirements. Table 1 lists the specific content requirements and provides an explanation of where each requirement is addressed in this UWIR.

Table 1 UWIR Content Requirements

Water Act Section No.	Water Act Section Content	UWIR Cross Reference
376(1)(a)	An underground water impact report must include each of the following— for the area to which the report relates— (i) the quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights; and (ii) an estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period starting on the consultation day for the report;	(i) Groundwater has been produced in the initial mine workings and underground water rights have been exercised. The estimated volume of water take is provided in Section 6.2. (ii) Section 6.2 describes the estimated groundwater take over the entire UWIR period.
376(1)(b)	For each aquifer affected, or likely to be affected, by the exercise of the relevant underground water rights— (i) a description of the aquifer; and (ii) an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers; and (iii) an analysis of the trends in water level change for the aquifer because of the exercise of the rights mentioned in paragraph (a)(i); and (iv) a map showing the area of the aquifer where the water level is predicted to decline, because of the taking of the quantities of water mentioned in paragraph (a), by more than the bore trigger threshold within 3 years after the consultation day for the report; and (v) a map showing the area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights, by more than the bore trigger threshold at any time;	(i) and (ii) Section 4.1 describes the groundwater regime in the relevant aquifers. (iii) Section 6.3 presents groundwater levels recorded within UWIR period and predicted future drawdown. (iv) Figure 15 to Figure 17 and Figure 19 to Figure 21 show the areas where depressurisation due to mining is predicted to exceed the bore trigger threshold during the UWIR period. (v) Figure 18 and Figure 22 shows the areas where depressurisation due to mining is predicted to exceed the bore trigger threshold during the life of the mine.
376(1)(c)	A description of the methods and techniques used to obtain the information and predictions under paragraph (b);	Section 3 describes the UWIR methodology.
376(1)(d)	A summary of information about all water bores in the area shown on a map mentioned in paragraph (b)(iv), including the number of bores, and the location and authorised use or purpose of each bore;	Sections 3.1.1 and 6.5.2 describes the water bore census undertaken for the UWIR and confirms that there are no water bores within the area of predicted depressurisation.
376(1)(da)	A description of the impacts on environmental values that have occurred, or are likely to occur, because of any previous exercise of underground water rights;	Section 6.5 presents an assessment of potential impacts on springs, groundwater dependent ecosystems and groundwater quality.
376(1)(db)	An assessment of the likely impacts on environmental values that will occur, or are likely to occur, because of the exercise of underground water rights— (i) during the period mentioned in paragraph (a)(ii); and (ii) over the projected life of the resource tenure;	Section 6.5 presents an assessment of potential groundwater impacts due to groundwater take.

Water Act Section No.	Water Act Section Content	UWIR Cross Reference
	A program for— (i) conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) and (v); and (ii) giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps;	Section 8.2 describes the UWIR review and reporting process for the affected aquifers.
376(1)(f)	A water monitoring strategy;	Section 7 describes the groundwater monitoring program.
376(1)(g)	A spring impact management strategy;	There are no springs within the mine site or its surrounds. Hence, a strategy for spring management is not justified.
376(1)(h)	If the responsible entity is the office— (i) a proposed responsible tenure holder for each report obligation mentioned in the report; and (ii) for each immediately affected area—the proposed responsible tenure holder or holders who must comply with any make good obligations for water bores within the immediately affected area;	Not applicable.
376(1)(i)	The information or matters prescribed under a regulation.	No other relevant information or matters have been prescribed under a regulation.
376(2)	However, if the underground water impact report does not show any predicted water level decline in any area of an affected aquifer by more than the bore trigger threshold during the period mentioned in subsection (1)(b)(iv) or at any time as mentioned in subsection (1)(b)(v), the report does not have to include the program mentioned in subsection (1)(e).	Section 8 describes the UWIR review and reporting process for the affected aquifers.

Section 378 of the Water Act lists the content requirements for the water monitoring strategy. Table 2 lists the specific content requirements and provides an explanation of where each requirement is addressed in this UWIR.

Table 2 UWIR Water Monitoring Strategy Content Requirements

Water Act Section No.	Water Act Section Content	UWIR Cross Reference
378(1)	<p>A responsible entity's water monitoring strategy must include the following for each immediately affected area and long-term affected area identified in its underground water impact report or final report—</p> <ul style="list-style-type: none"> (a) a strategy for monitoring— <ul style="list-style-type: none"> (i) the quantity of water produced or taken from the area because of the exercise of relevant underground water rights; and (ii) changes in the water level of, and the quality of water in, aquifers in the area because of the exercise of the rights; (b) the rationale for the strategy; (c) a timetable for implementing the strategy; (d) a program for reporting to the office about the implementation of the strategy. 	Section 7 describes the groundwater monitoring program.
378(2)	<p>The strategy for monitoring mentioned in subsection (1)(a) must include—</p> <ul style="list-style-type: none"> (a) the parameters to be measured; and (b) the locations for taking the measurements; and (c) the frequency of the measurements 	Section 7 describes the groundwater monitoring program.
378(3)	<p>If the strategy is prepared for an underground water impact report, the strategy must also include a program for the responsible tenure holder or holders under the report to undertake a baseline assessment for each water bore that is—</p> <ul style="list-style-type: none"> (a) outside the area of a resource tenure; but (b) within the area shown on the map prepared under section 376(b)(v). 	Not applicable. Sections 3.1.1 and 6.5.2 describes the water bore census undertaken for the UWIR and confirms that there are no water bores within the area of predicted depressurisation.
378(4)	<p>If the strategy is prepared for a final report, the strategy must also include a statement about any matters under a previous strategy that have not yet been complied with.</p>	Not applicable.

3 Assessment methodology

This section describes the methodology adopted for the collection of hydrogeological data to inform the UWIR.

3.1 Desktop study

3.1.1 Database and government mapping reviews for water bores

A search of relevant Queensland databases was undertaken to identify the presence of current water bores within and surrounding the mine. A water bore is a groundwater supply bore.

The following databases and mapping were searched:

- The DRDMW Groundwater Database of registered water bore data from private water bores and Queensland Government groundwater investigation and monitoring bores. Data accessed includes bore location, groundwater levels, construction details, stratigraphic logs, hydrogeological testing and groundwater quality.
- The Queensland Spatial Catalogue (QSpatial), via Queensland Globe. Records of petroleum and coal seam gas (CSG) exploration, production and monitoring wells are contained within this database.

These searches identified 46 registered groundwater bores within 5 km of the project mining area (Figure 4). Bore installation records available for these bores identify:

- 10 are the mine groundwater monitoring bores.
- One “water supply” bore (RN81908) located on the Burton Mine site which intersects “salty” water with bore casing into the Rewan Group. This bore was identified in the 2008 groundwater impact assessment (AGE, 2008) which concluded that there was no reliance on groundwater for stock watering.
- 35 are Broadlea North Mine bores and include monitoring bores and water supply bores. Fitzroy is the owner of Broadlea Mine.

There are 15 records of CSG exploration and appraisal wells installed around the mine area, all of which are not operational and identified as “suspended/capped/shut-in” or “plugged and abandoned”. The location of these CSG bores are shown in Figure 4.

3.1.2 Database and government mapping reviews for sensitive environmental features

The potential for groundwater dependent ecosystems (GDEs) to be present within the project site was reviewed, with the review consisting of:

- a search of the Queensland Springs Database;
- a search of the Bureau of Meteorology’s (BoM) GDE Atlas;
- groundwater field investigations; and
- a desktop review of groundwater monitoring data and modelling results.

The Queensland Springs Database indicated that no spring wetlands are located within the project site or its surrounds.

The BoM GDE mapping indicates several potential GDEs in the project site, namely:

- terrestrial vegetation along the northern and eastern extents of the mining lease which are mapped as low to moderate potential GDEs;
- terrestrial vegetation along Alpha Creek and to a lesser extent Bullock Creek which are mapped as low to moderate potential GDEs;
- aquatic wetland/riverine habitat within watercourses associated with Bullock, Spade and Alpha Creeks that are mapped as high potential GDEs; and
- aquatic wetland/riverine habitat within watercourses associated with Hat Creek that is mapped as moderate potential GDEs.

A desktop review of the spring inventories has been undertaken using the springs database within the GDE Atlas (Queensland Wetland Data – Springs). The nearest mapped spring is located approximately 130 km northeast of the project site. No springs have been identified within 10 km of the project site. This is consistent with field observations from the creeks which show that there are no perennial pools associated with creeks traversing the project site and its surrounds. On the basis, springs are extremely unlikely to be affected by the project mining activities. Hence, there is no technical justification for a spring management strategy.

3.1.3 Previous groundwater studies

The hydrogeology of the Ironbark site was first assessed by AGE as part of feasibility studies and approvals for the former owner of the project (Vale). This assessment included a field program to investigate the local hydrogeology and numerical modelling to assess the project impacts. Monitoring bores were installed adjacent to the ephemeral drainages that traverse the mining lease and indicated a permanent alluvial aquifer does not occur on the project site, with groundwater occurring within the weathered zone of the underlying Rewan Group. Laboratory analyses indicated the groundwater was brackish to saline limiting the beneficial use of the water. No usage of groundwater was identified.

In 2012, additional investigation of groundwater was undertaken by URS. This work included installing two bores and conducting pumping tests to measure yields and estimate hydraulic properties of the Leichhardt Seam. This work indicated the Leichhardt Seam forms a low yielding groundwater system confined by the overlying Permian overburden and Triassic Rewan Group. Further groundwater modelling provided refined estimates of groundwater take to the project during operations.

In 2018, additional groundwater investigations were undertaken in response to queries from the DES. This work included measuring groundwater levels, collecting water samples and further groundwater modelling. The fieldwork confirmed previous conclusions that groundwater occurred primarily within the weathered bedrock and was brackish to saline. As part of the 2018 work, the numerical model was recalibrated and updated to ensure it represented the influence of subsidence induced fracturing as accurately as possible.

This included utilising an empirical method (Ditton and Merrick 2014) to estimate the height of the fracture network above longwall mining areas. The method developed by Ditton and Merrick (2014) uses data on fracture height from operating mines in NSW and Queensland to develop an empirical method to estimate fracture height for greenfield sites. The method accounts for the depth of the mining, the width of the longwall panel, the thickness of coal extracted, and the ability of the rock mass to form 'spanning beams' above the panels.

The updated numerical model predicted a reduced seepage rate of groundwater into the mining areas. Updated maps indicating the zone of depressurisation within the coal seam and shallow overburden were developed as part of this work.

A routine groundwater monitoring program was implemented in 2018. The program included monitoring groundwater levels and water quality within the existing monitoring bore network. In October 2018 two monitoring bores were installed in areas upgradient of the approved mining to act as reference bores (IBGWR1 and IBGWR2).

Further updates were made to the numerical model in 2022 to improve the model calibration and provides an assessment of impacts associated with an amendment to the mine plan.

3.1.4 Review of groundwater monitoring data

All relevant data was collated and analysed to develop a conceptual understanding of the groundwater regime. Groundwater data collected from the mine monitoring bores has been used to inform this groundwater conceptualisation.

3.1.5 Fitzroy groundwater monitoring network

The groundwater monitoring network for the project site originally comprised eight narrow diameter bores at five sites (EFGW series) and two test pumping bores (PT series). Four bores are screened within the alluvium, four within the Triassic Rewan Group and one in the Leichhardt Seam. Fitzroy recently installed two reference bores (Ref Bore #1 and Ref Bore #2) in October 2018. Ref Bore #1 targets is in the shallow overburden and Ref Bore #2 targets the alluvium. Table 3 summarises the bore construction details with Figure 5 showing the location of the monitoring bores at the project site.

Table 3 Groundwater bore details

Bore ID	Screened stratigraphy	Ground Elevation (mAHD)	Screen interval (mbGL)	Bore depth (mbGL)
EFGW1S	Alluvium	282.76	8.7 - 11.7	11.7
EFGW2S*	Alluvium	308.25	1.9 - 4.9	4.9
EFGW2D	Rewan Formation	308.16	25.6 - 28.6	25.6
EFGW3S*	Alluvium	306.04	1.2 - 4.2	4.2
EFGW3D	Rewan Formation	306.14	27.4 - 30.4	30.4
EFGW4S	Alluvium	299.53	1.5 - 4.5	4.5
EFGW4D	Rewan Formation	299.80	37.5 - 40.5	40.5
EFGW5D	Rewan Formation	320.34	56 - 59	59.1
PT1	Leichhardt Seam	329.36	126 - 138	138
IBGWR1	Rewan Formation	325.85	41 – 47	50
IBGWR 2	Rewan Formation	303.69	18 - 24	30

Note: * These bores are dry and are not included in Table E1 of the EA.

The groundwater monitoring network described in Table E1 of the EA includes the groundwater bores listed in Table 3, with the exception of alluvial bores EFGW2S and EFGW3S. These bores were removed from the EA groundwater monitoring network as results indicate they are dry and therefore don't measure any groundwater.

Spatially distributed groundwater level data were used to characterise groundwater flow directions, gradients and velocities. In addition, time variant variations in groundwater level were used to interpret the rate and distribution of recharge/discharge, depressurisation influence from mining, and pre-development variability in groundwater level.

Groundwater quality data provides useful information on the hydrogeological regime, as it is influenced by interaction with the aquifer matrix, and groundwater recharge/discharge processes.

Salinity is a key constraint to the usability of groundwater resources for productive applications such as potable supply, irrigation, stock watering and industrial applications. If waters with elevated salinity levels are used for incompatible purposes or applications it may result in impacts to agricultural productivity, health and the environment.

A categorisation scheme for salinity proposed by FAO (2013) is presented in Table 4. Groundwater salinity in each project monitoring bore sampled during the field campaign has been categorised using these criteria. DNRME bores within 5 km of the project mining area with available groundwater quality data were also categorised.

There are no records indicating that 'fresh' groundwater has been encountered near the project site.

Table 4 Salinity Classification Scale

Salinity	Range (TDS mg/l)	# project bores with corresponding salinity	# registered bores within 5 km with corresponding salinity data
Fresh	<500	0	0
Brackish	500 – 1,500	1	20
Moderately saline	1,500 – 7,000	3	7
Saline	7,000 – 15,000	3	0
Highly saline	15,000 – 35,000	0	0
Brine	>35,000	0	0
Total		7	27

Major ion data for water quality data collected to date from the project monitoring bores are summarised on a Piper plot (Figure 6) which categorises water type based on the normalised, relative proportion of each major cation and anion. The data shows minimal variation the groundwater quality within the project area which can be classified as sodium-chloride type water. The piper diagram is based on the relative proportions of the major cations and anions. The results of the groundwater quality data collated for the project are summarised in Appendix A.

3.2 Numerical modelling

The mine has an existing 3D numerical groundwater model that was developed as part of the previous groundwater impact assessments described in Section 3.1.3. The groundwater model results have been used to support the EA application and subsequent EA amendments.

The groundwater model has also been used to inform the UWIR. The model has specifically been used to predict groundwater take and resulting groundwater depressurisation. These predictions have been used to identify Immediately Affected Areas (IAA) and Long Term Affected Areas (LTAA) and assess the impacts of the project on groundwater users and the surrounding environment.

To increase the accuracy of the UWIR, the model was updated to incorporate additional details of the mine layout over the first three years of mining (as shown in Figure 2). No other changes to the existing groundwater model have been made as part of the UWIR.

The key aspects of the model are detailed as follows:

- The numerical groundwater model was developed from the collated dataset (described in Sections 4.2 to 4.5) using MODFLOW software and represents the conceptual groundwater regime described in Section 4.1.
- The model represents the key geological units using 23 model layers and extends 35 km north-south and 27 km east west. The mining area is located in the west part of the model domain.
- Model development was supplemented by published geological maps, digital geology surfaces and information from mining operations near the project mining area and data from the DRDMW groundwater database.
- The Australian Groundwater Modelling Guidelines (Barnett et al., 2012) were used to frame the calibration process. A detailed description of the calibration method is provided in Appendix B. The groundwater model was initially calibrated to groundwater level records from 36 bores intersecting a variety of aquifers and aquitards; which included the monitoring bores installed during the project mining area investigation. The calibration was guided by water level measurements and site specific measurements of hydraulic conductivity from packer tests and pumping tests within the coal seam, as well as operational observations of groundwater inflow into the neighbouring Carborough Downs Coal Mine.

- A steady state calibration achieved a 8.1% scaled RMS error indicating the model can suitably replicate steady state water levels and is an acceptable calibration metric as recommended by the Australian Groundwater Modelling Guidelines (Barnett et al. 2012). Furthermore, the calibrated groundwater levels, and flow patterns generally replicate measured data and groundwater trends. The model calibration is therefore considered robust.
- The numerical model was used to predict the effects of the mining activities on the groundwater regime for the UWIR period. The modelling results were used to inform assessments of the impacts on groundwater users and the surrounding environment. Section 5 describes the predictions of the groundwater model.
- The sensitivity of the model predictions to the input parameters was tested, and involved varying key model parameters in isolation and assessing the influence the change made on predictions of drawdown and groundwater take. Key model parameters were selected based on their potential to most influence model predictions. Sensitivity analysis included testing the range of likely uncertainty in key hydraulic parameters for horizontal hydraulic conductivity, vertical hydraulic conductivity, specific yield and specific storage.
- The changes used to test the model sensitivity include extremes in the potential parameter ranges and encompass the full range of relevant measured values for these parameters.

Appendix B provides the model parameters.

4 Groundwater regime

4.1 Overview

The project site is located on the north-western flank of the Bowen Basin, a sedimentary basin comprising Permian to Triassic age geology (Figure 13). A veneer of more recent weathered sediments typically overlies the Bowen Basin strata (Figure 9). Localised basalt and alluvium deposits are also present within the mine site and its surrounds.

The relevant hydrogeological units of the mine site and its surrounds broadly comprise:

- thin localised Quaternary alluvium associated with Bullock Creek, Spade Creek, Alpha Creek and Hat Creek;
- a thin, highly weathered and heterogeneous veneer of semi-consolidated sandstone, mudstone and other minor sediments associated with the Tertiary Suttor Formation, duricrusted palaeosols at the top of deep weathering profiles, colluvium and regolith;
- low permeability sediments of the Rewan Group which also include a surface weathering profile; and
- permian sediments of the Rangal Coal Measures (including the target Leichhardt Seam) and the deeper Fort Cooper Coal Measures and Moranbah Coal Measures.

Figure 7 shows a conceptual cross-section of the geology and groundwater regime within the mine site and its surrounds. This illustrates the main hydrogeological processes and mechanisms relevant to the project groundwater regime, including recharge, flow directions, discharge, and anthropogenic activities (i.e. mining).

The main groundwater-bearing formations are the coal seams of the Permian sediments. The coal seams have been significantly depressurised and impacted by mining and gas production activities at nearby operations. The Rewan Group is a low permeability formation that is a regionally recognised aquitard.

The alluvium and Tertiary sediments do not form permanent, saturated aquifers, and persistent groundwater occurs only where these sediments extend below the regional water table.

The Tertiary sediments include the Tertiary Suttor Formation which is predominantly a quartzose sandstone/conglomerate unit with minor multicoloured claystone and mudstone and bands of ironstone and silcrete. The Suttor Formation unconformably overlies the Permian and Triassic strata and forms a capping on the hills and ridges (prominent ridge escarpments), rising up to 40 m above the surrounding land surface. These escarpments occur on the eastern boundary and part of the northern and southern boundaries, and as remnant knolls within the project area. They do not form permanent, saturated aquifers, as they occur above the regional groundwater table.

The Clematis Group and basalt are not a significant feature of the local groundwater regime due to their distance from the mining activities.

Recharge occurs predominantly via direct and diffuse rainfall to the Tertiary sediments, localised areas of alluvium, and weathered Triassic/Permian strata. A portion of the rainfall moves downwards to the groundwater table then moves through the system following the hydraulic gradient. This interaction will be enhanced during periods of creek flow (e.g. resulting from significant rain events). Recharge to the Tertiary sediments, Rewan Group and Permian sediments will occur where these units sub-crop below the alluvium.

The regional water table varies within 5 m to 13 m of the surface along the creeks where they are incised into the topography. In areas of higher topographic elevation, the water table deepens from 20 m to over 60 m below the ground surface. That is, the regional groundwater flow is a subdued reflection of the topography from northeast to the southwest (as shown on Figure 8), towards lower lying areas and the existing the Broadlea North Coal Mine to the south. A gentle hydraulic gradient of approximately 0.005 (1:200) has been calculated from local groundwater levels.

Groundwater quality within the project site and its surrounds ranges from moderately saline to highly saline. Regionally, groundwater generally is saline within the Triassic and Permian sediments. There are no known groundwater users in the project site or its surrounds.

Similarly, and as discussed in Section 3.1.1, there is no take of groundwater from the surrounding CSG wells which are all exploration and appraisal wells of which none are operational.

4.2 Quaternary Alluvium

4.2.1 Distribution

As discussed in Section 4.1, alluvium is mapped as occurring along parts of Bullock Creek, Spade Creek, Alpha Creek and Hat Creek. The distribution of mapped alluvium is shown on Figure 10. Monitoring bores drilled within the mapped alluvium extents did not intersect alluvial sediments except in EFGW2S, EFGW1S and IBGWR2. Similarly, alluvium was not encountered elsewhere within the project site. Its occurrence is confined to a narrow band along the creeks and tributary channels and is relatively thin between <1 m and 10 m, averaging a few metres in thickness. Where alluvium is present, saturated alluvium was only intersected in the lower reaches of Alpha Creek before it flows into Bullock Creek, where it was assessed to be 10 m deep with the lower half saturated. The saturated extents of alluvium are shown in Figure 10. Figure 11 shows the variable nature of the creek beds within the mine site, ranging from a sandy base to rock bars where there is no alluvium. The bed sands within the creek will be inundated during periods of rainfall and following ephemeral creek flow. However, the bed sands are thin and will dry rapidly following cessation of creek flows.

4.2.2 Hydrogeological parameters

The hydraulic conductivity of the alluvium is highly variable depending on whether the alluvium consists of clayey or silty sands or clean sands and gravels. Due to the thin saturated thickness and localised occurrence of groundwater in the alluvium, yields are very low. There are no farm bores that have been constructed in the alluvium which confirms that the saturated sections are localised and that the yield is unreliable.

4.2.3 Recharge, flow, and discharge

Recharge to the alluvium occurs via:

- direct rainfall infiltration to the alluvium; and
- seepage of perennial surface water flows into the river bed resulting in localised continuous recharge through the alluvium that will dissipate to the surrounding groundwater regime.

4.2.4 Groundwater quality

Groundwater monitoring data shows that the quality of groundwater in the alluvium reflects recharge by river flow and by direct infiltration of rainfall. Groundwater is variable from typically brackish to moderately saline with an acidic to slightly alkaline pH and low concentrations of metals.

4.2.5 Groundwater yields and use

There are no water supply bores targeting the alluvium within 5 km of the project site.

4.3 Tertiary Sediments

4.3.1 Distribution

As discussed in Section 4.1, the Tertiary sediments which include remnant Tertiary sandstone that outcrop east of the project site, are elevated well above the surrounding land surface and are expected to be unsaturated. Elsewhere, these sediments therefore comprise a shallow, highly weathered and heterogeneous veneer of low permeability Tertiary sediments that do not contain any significant volumes of groundwater and are often dry. The distribution of mapped Tertiary sediments are shown on Figure 9.

The Tertiary sediments are not a significant aquifer for the purposes of this assessment.

4.3.2 Hydrogeological parameters

The Tertiary sediments have a low hydraulic conductivity range due to a predominantly low bulk hydraulic conductivity that is dominated by clay (regionally it would be comparable to that for the underlying weathered Rewan Group).

4.3.3 Recharge, flow, and discharge

The Tertiary sediments are recharged by direct infiltration from rainfall where these sediments are present at the surface. Recharge also occurs via seepage from the alluvium, where present.

Recharge rates are low due to the predominately clayey nature of the formation. Within the mine, the Tertiary sediments were assessed to be dry with groundwater not intersected in any of the monitoring bores drilled on site.

4.3.4 Groundwater quality

Where present, regional groundwater quality within the Tertiary sediments is typically brackish to saline. The groundwater quality is therefore be broadly comparable to the underlying Rewan Group.

4.3.5 Groundwater yields and use

The Tertiary sediments are commonly regarded as an aquitard and typically exhibit very low yields (less than 0.1 L/s).

No groundwater supply bores are known to target the Tertiary sediments within 5 km of the project site.

4.4 Triassic Rewan Group

4.4.1 Distribution

As discussed in Section 4.1, the Rewan Group sub-crops within the project site. The mapped extents of the Rewan Group are shown on Figure 12.

The Rewan Group is uniformly saturated at depth (i.e. below the groundwater table) and may become unsaturated where it outcrops or sub-crops above the regional groundwater table. The Rewan Group typically host the regional groundwater table in the vicinity of the mine site and is therefore typically saturated within the mine site and its surrounds.

The Rewan Group is a recognised regional aquitard and acts as a confining unit overlying the Permian sediments.

4.4.2 Hydrogeological parameters

In-situ permeability testing at the mine site as part of the initial studies in 2008 indicated a low permeability for shallow sections of the Rewan Group, with hydraulic conductivity values between 0.03 and 0.08 m/d (AGE, 2008).

The Rewan Group is characterised by low primary porosity and as a result, groundwater movement is controlled by local fracture sets. Where fractures are intersected this unit shows slightly higher permeability, and conversely, where limited fractures are intersected this unit shows lower permeability associated with the primary porosity. Bulk permeability of this unit is therefore constrained by the degree of connection between any localised fractures.

4.4.3 Recharge, flow, and discharge

The Rewan Group is recharged via direct rainfall infiltration in outcropping areas and via seepage from overlying units including the Tertiary sediments and alluvium, where present. The rates of recharge are considered to be relatively low, compared to the alluvial aquifer. Regionally, the groundwater flow direction follows the regional topography toward the southwest where it slowly discharges to the underlying Permian sediments (Figure 8).

4.4.4 Groundwater quality

Groundwater monitoring data shows that groundwater quality at the project site and its surrounds is brackish to saline and neutral to slightly alkaline with low concentrations of metals. The groundwater quality is therefore broadly comparable to the Permian sediments. The low permeability of this formation and long groundwater residency times are reflected in the concentrations of dissolved minerals that are elevated in comparison to the alluvium.

4.4.5 Groundwater yields and use

The Rewan Group exhibits low yields within the project site and its surrounds (typically less than 1 L/s) that would commonly be regarded as characteristic of an aquitard.

No groundwater supply bores are known to target the Rewan Group within 5 km of the project site.

4.5 Permian Sediments

4.5.1 Distribution

As discussed in Section 4.1, the Permian sediments include the Rangal Coal Measures and the underlying Fort Cooper Coal Measures. The mapped extents of these Permian sediments are shown on Figure 10.

Groundwater storage and movement occurs within fractures and cleats that intersect the coal seams. Other sediments in the coal overburden and interburden sequence exhibit very low permeability and form discrete confining units between the coal seams. The Permian sediments may therefore be categorised into the following hydrogeological units:

- hydraulically "tight" and hence very low yielding to essentially dry sandstone and siltstone that comprise the majority of the inter-burden/overburden; and
- low to moderately permeable coal seams which are the primary water bearing strata within the Permian sediments.

The Permian sediments are uniformly saturated within the majority of the project site. Where the coal measures outcrop in the east of the project site and beyond, they may become unsaturated.

4.5.2 Hydrogeological parameters

The hydraulic conductivity within the Permian sediments is a function of fracturing and grain size within the various sedimentary units of the coal measures. The spacing and nature of cleating are the primary controls on hydraulic conductivity within the coal seams.

Regionally, the coal seams and the sediments between, above and below the coal seams have a hydraulic conductivity ranging from and 5.3×10^{-6} m/day to 0.01 m/day (AGE, 2008). The permeability data has been determined from permeability testing for the Burton Coal Mine, coal seam gas investigations at MCG Ellensfield No. 1 well and the nearby Carborough Downs Coal Mines.

4.5.3 Recharge, flow, and discharge

The Permian sediments are recharged slowly by direct rainfall on (predominantly where coal seams outcrop) and downward seepage from the overlying strata. The rate of recharge may be enhanced where the coal measures subcrop against the overlying strata. Overall, the rate of recharge remains low.

Regionally, groundwater flow is to the southwest and potentially to mining areas such as nearby Broadlea North Coal Mine (Figure 8). Groundwater discharge into overlying formations is negligible within the vicinity of the project site.

4.5.4 Groundwater quality

Groundwater quality at the project site and its surrounds is slightly alkaline to alkaline and moderately saline to saline with low concentrations of metals.

4.5.5 Groundwater yields and use

Regionally, groundwater yields from the coal seams are typically low, (i.e. less than 1 L/s). There are no known groundwater supply bores in the Permian sediments within 5 km of the project site.

5 Environmental values

Environmental Values and Water Quality Objectives for the Isaac River Sub-basin surface waters and groundwaters are described by DEHP (2011). DEHP (2011) divide the Isaac River basin into a series of surface water catchments, and groundwater zones. For surface water the site is located within the “Upper Isaac northern tributaries” catchment that includes Teviot Brook. For groundwater the site is within the “Isaac Groundwaters” Zone 34. Zone 34 is a zone of commonly saline groundwater with a Sodium-Chloride water type composition. Table 5 summarises the types of Environmental values identified for surface water and groundwater within the Northern Isaac River catchment zone.

Table 5 Summary of Environmental Values – Isaac Northern Tributaries and Isaac Groundwaters (DEHP 2011)

Environmental value	Isaac - Northern Tributaries Surface Waters	Isaac Groundwaters
Aquatic ecosystems	✓	✓
Irrigation	✓	✓
Farm supply/uses	✓	✓
Stock water	✓	✓
Aquaculture	✓	
Human consumer	✓	
Primary recreation	✓	✓
Secondary recreation	✓	
Visual recreation	✓	
Drinking water	✓	✓
Industrial use	✓	
Cultural and spiritual values	✓	✓

The Environmental Values identified as occurring elsewhere in the Northern Isaac catchment do not apply at the site as there are no permanent surface water bodies within the tributaries of Teviot Brook. The creeks are ephemeral and there are no permanent pools or wetlands. The water table at the mine site is deeper than the level of the creek beds, and does not flow into surface water bodies. The groundwater is brackish to saline meaning that the only potential Environmental Value for groundwater at the site is for stock water in areas where salinity permits this usage.

The site is only in the early stages of the project life, and therefore exercise of underground water rights is not expected to have created any historical impacts on Environmental Values. Section 6.5.7 discusses potential impacts on environmental values due to the exercise of underground water rights for the three UWIR year period, and over the life of the resource tenure.

6 Groundwater impact assessment

6.1 Introduction

The project involves the development of an underground mine that utilises bord and pillar and longwall mining methods.

Both bord and pillar mining and longwall mining will involve dewatering the underground workings which will result in depressurisation of the overlying and surrounding strata.

Longwall mining will also result in subsidence of the strata above the mined longwall panels due to physical removal of coal from the target seam. Subsidence is predicted to fracture the overlying strata, and this has the potential to enhance the depressurisation effects of mine dewatering.

The bord and pillar mine layout has been specifically designed with sufficient roadway and pillar strength to ensure that there will be no caving and the underground workings will be stable and safe. Consequently, the bord and pillar mining will not result in any significant subsidence above the underground bord and pillar workings.

The following sections provide a detailed assessment of the potential impacts of these activities, as follows:

- Section 6.2 presents the predicted groundwater take over the UWIR period.
- Section 6.3 presents the groundwater drawdown during the UWIR period.
- Section 6.4 presents the groundwater drawdown over the mine life.
- Section 6.5 describes potential impacts to groundwater users and the environment.

6.2 Groundwater take

Table 6 shows the predicted annual groundwater take for years 1, 2, and 3 of the UWIR period.

Table 6 Predicted volume of groundwater take

Year	Predicted Inflow (ML)
Year 1	37
Year 2	107
Year 3	85
Total	229

The gradual increase from 37 ML in year 1 to 85 ML in year 3 is a result of the mine development progressing through the unsaturated sediments and intersecting the groundwater table. The higher inflow in year 2 is a function of the mine plan switching from bord and pillar to longwall mining and increased drainage from overlying strata in the fracture zone.

The modelled groundwater take represents the theoretical volume of groundwater that could be removed from the groundwater regime. The actual volume of groundwater pumped from the underground mining area is commonly less than that predicted by the numerical model, as a component of the groundwater will be lost to wetting of surfaces, ventilation and retained moisture within the extracted coal. The groundwater take presented in Table 6 does not account for the abovementioned losses that will occur when converting groundwater take to mine dewatering rates.

6.3 Groundwater drawdown during the UWIR period

Groundwater levels measured in the monitoring bore network are shown in Figure 14. Groundwater levels are relatively stable with no significant drawdown attributable to mining evident. This is to be expected as mine development operations only intersected groundwater in July 2022.

Figure 15 to Figure 17 show the predicted depressurisation within the water table during the UWIR period. Figure 19 to Figure 21 show the predicted depressurisation within the target Leichhardt Seam. During the UWIR period, depressurisation of the water table and Leichhardt Seam is generally localised to the mining area in the northern part of the project site and its surrounds within approximately 1 km of the project site boundary. The extent of depressurisation is constrained by the physical limit of the coal seam to the west of the mining area.

The figures also show the extent of the IAA in the water table and Leichhardt Seam respectively. The IAA encompasses the area where drawdown is predicted to exceed the applicable bore trigger threshold of 5 m for consolidated aquifers over the three year UWIR period. There are no water supply bores within the IAA.

No depressurisation is predicted to occur in the Tertiary sediments or the alluvium as a result of mining in the project mining area.

6.4 Groundwater drawdown over the mine life

Figure 18 and Figure 22 shows the approved predicted maximum drawdown and depressurisation within the water table and Leichhardt Seam respectively at the end of mining.

Figure 18 shows the drawdown at the water table is most significant within the northern portion of the mining footprint where the coal seam and associated fracture network generated by mining is closer to the surface and the water table. In this area the model predicts approved drawdown to the base of the coal seam and therefore full dewatering of the Rewan Group overlying the mining areas. The model also indicates that drawdown will propagate from the mining area in the north along the strike of the coal seam towards the west in areas where the coal seam remains relatively shallow and relatively more permeable. Further to the south the magnitude of the drawdown from the approved mine plan within the mining footprint reduces as the mining and associated fracture network becomes deeper, and the coal seam hydraulic conductivity reduces due to pressure from the overlying strata.

The mine will locally depressurise the Leichhardt Seam within the mining area and its surrounds by up to approximately 400 m over the life of the mine (Figure 22). Depressurisation is greatest in the southern part of the mine site, where the depth of mining is greatest (approximately 450 m below ground level), and therefore the groundwater pressure is greatest.

Figure 18 and Figure 22 also show the extent of the LTAA in the water table and Leichhardt Seam. The LTAA encompasses the area where drawdown over the life of the mine is predicted to exceed the applicable bore trigger threshold of 5 m for consolidated aquifers. There are no water supply bores within the LTAA.

6.5 Environmental impacts

This section describes the operational impacts of the project for the UWIR reporting period on:

- groundwater resources;
- groundwater users;
- surface water features;
- springs;
- groundwater dependent ecosystems; and
- groundwater quality.

The groundwater assessment also investigated potential impacts on groundwater quality due to the use of hydrocarbons and chemicals.

6.5.1 Impacts on groundwater resources

Groundwater resources within the project site and its surrounds are located within the Isaac Connors Groundwater Management Area (GMA). The Isaac Connors GMA is managed under the Water Plan (Fitzroy Basin) and comprises two groundwater units. Groundwater Unit 1 includes the Isaac River alluvial aquifer and Groundwater Unit 2 comprises all other sub-artesian aquifers.

The Isaac River alluvium is located 15 km west of the project site at its closest point. There is no drawdown within the Isaac River alluvium as a result of the project, hence there will be no groundwater take from alluvium (i.e. Groundwater Unit 1). As a result, the project will not impact on this groundwater resource.

Groundwater depressurisation is limited to the coal seam and Permian and Triassic sediments which form part of Groundwater Unit 2. Table 5 shows the predicted groundwater take associated with the mine, and hence, Groundwater Unit 2. The project is predicted to result in a total groundwater take of up to approximately 229 ML from Groundwater Unit 2 over the UWIR period.

As discussed in Section 1.2, the project's groundwater take and associated groundwater impacts have been approved under the EP Act.

6.5.2 Impacts on groundwater users

A bore census was carried out to identify water supply bores within and surrounding the project site that could potentially be impacted by the project. The bore census drew upon information gathered through previous groundwater studies, consultation with landholders, advice from the proponent, and a search of the DNRME groundwater database.

The bore census was targeted towards bores and properties that could potentially be impacted by the project due to their proximity to proposed mining activities. The local hydrogeology was also taken into account in planning the bore census. The bore census included a conservative search radius of 5 km beyond the boundary of the project mining lease area.

The bore census indicated that groundwater use is uncommon in the area. Where used it is typically opportunistic and dispersed over a wide area due to the generally low yields and access to alternative supplies (i.e. surface water dams).

The bore census confirmed that there are no water supply bores within the mine site. There are also no water supply bores within the IAA or the LTAA. The bore census did confirm the presence of a single water supply bore (RN81908) approximately 1.3 km south of the project site southern mining lease boundary (Figure 3). As discussed in Section 3.1.1, this bore is located on the Burton Mine site, which is owned and operated by Peabody Energy Australia (Peabody). Peabody is also the owner of the land underlying the Ironbark No. 1 Mine. It is understood that the owner has access to an alternative water supply and therefore this bore is not used as a sole water supply to the property.

This bore is screened in the Rewan Group. As discussed in Section 6.3, the mine is not predicted to result in any depressurisation in the vicinity of Bore RN81908. As a result, this bore is unlikely to be affected by the project.

The Broadlea water supply borefield is located to the south-east of the project site and targets the Tertiary basalt aquifer. This borefield is owned by Fitzroy. As discussed in Section 6.3, the project is not predicted to result in any depressurisation of the Tertiary basalt in the vicinity of these bores and therefore the Broadlea water supply borefield is unlikely to be affected by the project.

As discussed in Section 1.2, the project's impacts on groundwater users has been approved under the EP Act.

6.5.3 Impacts on surface drainage

Figure 3 shows the drainage setting of the project.

The mine site is traversed by Spade Creek, Hat Creek, Alpha Creek and their tributaries. Bullock Creek is located on the western boundary of the project site and is a tributary of Teviot Brook. These creeks and their tributary drainage features are ephemeral and are characterised by short duration, surface water flows that are typically restricted to periods during and immediately after rainfall events. This is consistent with creek observations made during the 2008 and 2018 field investigations. This is also supported by surface water flow data collected from DNRME's surface water gauging stations sited downstream of the project mining area and groundwater modelling predictions, which both indicate no perennial flows in the vicinity of the project site.

Groundwater is currently located at depths of approximately 5 m to 13 m below ground level in the vicinity of the main channels of Spade Creek and the tributary of Bullock Creek, respectively. The depth to groundwater increases to approximately 30 m below ground level further to the northeast of the project site.

The separating depth between the bed of these creeks and the groundwater table means that there is no direct interconnection between the groundwater table and surface water flows in this area. Groundwater does not provide baseflow to surface waters in the vicinity of the project site.

As discussed in Sections 6.3 and 6.4, the mine is not predicted to lower the regional groundwater table. The project will therefore not result in impacts on surface waters or any reduction in stream baseflow.

As discussed in Section 1.2, the project's impacts on surface drainage have been approved under the EP Act.

6.5.4 Impacts on springs

As discussed in Section 3.1.2, there are no springs within the project site or its surrounds.

6.5.5 Impacts on groundwater dependent ecosystems

The Australian Groundwater Dependent Ecosystem Toolbox (GDE Toolbox), prepared by the National Water Commission (2011), defines GDEs as:

"Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain the communities of plants and animals, ecological processes they support, and ecosystem services they provide".

The potential for GDEs to be present within the project site was reviewed, with the review consisting of:

- a search of the Queensland Springs Database;
- a search of the Bureau of Meteorology's (BoM) GDE Atlas;
- groundwater field investigations; and
- a desktop review of groundwater monitoring data and modelling results.

The Queensland Springs Database indicated that no spring wetlands are located within the project site or its surrounds.

The BoM GDE mapping (described in Section 3.1.2) indicates several potential GDEs in the project site, namely Bullock, Spade and Alpha Creeks and associated drainage lines.

As discussed, in Section 4.1, the main groundwater-bearing formations are the (Leichhardt) coal seams of the Permian sediments. The regional groundwater table in the project site is at least 5 m below ground level, and more typically more than 10 m below ground level. The regional groundwater table is located in the Tertiary basalt, Tertiary sediments and deeper alluvium where these units extend below the regional groundwater surface. These geological formations overlie the coal measures, including the target Leichhardt Seam. The groundwater assessment predicted that the mine will locally depressurise the Leichhardt Seam around the project mining area, but will not affect the regional groundwater table located in the Tertiary and alluvial formations, nor will it change the depth of groundwater within these formations within the project site or surrounds.

As a result, the project is not anticipated to affect the availability of groundwater for any vegetation communities, including for any groundwater dependent communities which may be located in the project site. This conclusion is consistent with observations of vegetation communities at other local mining operations, where there has been no observed effect on riparian vegetation from mining activities. It is therefore concluded that the project will not impact GDEs.

As discussed in Section 1.2, the project's impacts on GDEs have been approved under the EP Act.

6.5.6 Impacts on groundwater quality

The mine will involve the limited use of chemicals and hydrocarbons as part of the mining activities.

The storage of hydrocarbon and chemicals will be managed in accordance with the EA which requires Fitzroy resources to implement and maintain a Waste Management Plan for the mine. This will include the use of bunding and immediate clean-up of spills which are standard practice and a legislated requirement at mine sites that will prevent the contamination of the groundwater regime.

Given the limited activities proposed, and the controls that will be adopted, the project has a very limited potential to give rise to groundwater contamination as a result of hydrocarbon and chemical contamination.

Water samples are collected from the groundwater monitoring network and analysed for the presence of hydrocarbons. No significant contamination is evident in the dataset.

As discussed in Section 1.2, the project's impacts on groundwater quality have been approved under the EP Act.

6.5.7 Impacts on formation integrity and environmental values

Over the 3-year UWIR period and the life of the project, the formations overlying the Leichardt Seam will experience fracturing associated with subsidence, with the height of the fracturing being related to the depth of the mining, the width of the longwall panels, the thickness of coal extracted, and the ability of the rock mass to form 'spanning beams' above the panels. As the mine progresses down dip to the east, the zone of fracturing will occur at an increasing depth below the surface. This is reflected in the zone of predicted drawdown that becomes less extensive towards the east due to the increasing depth of mining and reducing permeability of the coal seams. Surface subsidence will result in shallow tension cracks forming at the ground surface in the zone around the perimeter of each longwall panel. These cracks will be progressively rehabilitated over the life of the mine within 6 months of occurring. The shallow surface cracks do not result in any significant change in the permeability of the surface layer.

There are no geological formations within the stratigraphic sequence at the site that form productive aquifers, and also no stratigraphic units that form aquitards that need their integrity maintained to protect overlying aquifers from subsidence fracturing and depressurisation impacts. The entire Permian and Triassic sequence has a moderate to low permeability comprised of hydraulically "tight" and hence very low yielding to essentially dry sandstone and siltstone that comprise the majority of the inter-burden/overburden. The Environmental Values identified as occurring in the Northern Isaac catchment do not apply in the area of the site as there are no permanent surface water bodies in proximity to mining. The water table at the site is deeper than the level of the creek beds, and groundwater therefore does not provide baseflow to surface water bodies. The groundwater is brackish to saline meaning that the only potential Environmental Value for groundwater at the site is for stock water in areas where salinity permits this usage. There are no private water supply bores within the IAA or LTAA and therefore subsidence fracturing and associated drawdown during the three year UWIR period, and over the life of the resource tenure are of no consequence to Environmental Values. Therefore, the exercise of underground water rights, whilst effecting groundwater levels locally around the mining area will not have a significant environmental impact on the groundwater regime.

7 Groundwater monitoring program

7.1 Groundwater level and quality monitoring

The mine operates an extensive groundwater monitoring network in accordance with the Ironbark No.1 EA. In accordance with Table E1 of the EA and as described in Section 3.1.5, the EA groundwater monitoring network comprises nine monitoring bores located on the mine site (Figure 5) .

The purpose of the EA groundwater monitoring network is to monitor groundwater levels and water quality within the coal seams, shallow overburden and alluvium in response to mining.

The design of the existing EA groundwater monitoring network is based on the relatively low risk groundwater regime at the site, where no productive aquifers occur, and the only Environmental Value is for stock water. Whilst there is potential for use of groundwater as stock water, there are no private water supply bores installed for this purposes located within the IAA or LTAA.

The existing EA groundwater monitoring program targets key formations in the mining area and its surrounds and is therefore suitable for monitoring the effects of the mine on the groundwater regime and will continue to be utilised throughout the life of the project. Given the low risk groundwater regime at the site the existing EA monitoring program is considered fit for purpose, and there are no critical data gaps and would warrant supplementing the existing network with additional monitoring sites.

In accordance with the requirements of the Ironbark No.1 EA, the following monitoring will be undertaken at the EA groundwater monitoring bores:

- Groundwater levels will be recorded on a quarterly basis, which will enable natural groundwater level fluctuations (such as seasonal responses to rainfall) to be distinguished from potential water level impacts due to depressurisation resulting from mining activities. It is also designed to monitor changes in the IAA and the LTAA.
- Groundwater quality monitoring will be undertaken on a quarterly basis to enhance the existing baseline dataset available prior to commencement of the project. This will be used to detect any changes in groundwater quality during and post-mining. Water quality samples will be analysed for physico-chemical parameters including pH, electrical conductivity, alkalinity, hardness, major ions (Ca, Mg, Na, K, Cl and SO₄), metals and metalloids (As, Al, Pb, Fe, Zn and Mn) and total petroleum hydrocarbons.

The monitoring program and rationale is summarised in Table 7.

Table 7 Summary of groundwater monitoring program

Bore ID	Screened stratigraphy	Water level measurement	Water quality analysis ^	Frequency	Rationale
EFGW1S	Alluvium	✓	✓	quarterly	downstream monitoring of shallow water table
EFGW2S*	Alluvium	✓	✓	quarterly	detect any ephemeral perched water table
EFGW2D	Rewan Formation	✓	✓	quarterly	assess changes in water levels and water quality because of the exercise of relevant underground water rights
EFGW3S*	Alluvium	✓	✓	quarterly	detect any ephemeral perched water table
EFGW3D	Rewan Formation	✓	✓	quarterly	assess changes in water levels and water quality because of the exercise of relevant underground water rights
EFGW4S	Alluvium	✓	✓	quarterly	detect any ephemeral perched water table
EFGW4D	Rewan Formation	✓	✓	quarterly	assess changes in water levels and water quality because of the exercise of relevant underground water rights
EFGW5D	Rewan Formation	✓	✓	quarterly	assess changes in water levels and water quality because of the exercise of relevant underground water rights
PT1	Leichhardt Seam	✓	✓	quarterly	assess changes in water levels and water quality because of the exercise of relevant underground water rights
IBGWR1	Rewan Formation	✓	✓	quarterly	reference conditions
IBGWR2	Rewan Formation	✓	✓	quarterly	reference conditions

Notes: * These bores are dry and are not included in Table E1 of the EA.

^ pH, electrical conductivity, alkalinity, hardness, major ions (Ca, Mg, Na, K, Cl and SO₄), metals and metalloids (As, Al, Pb, Fe, Zn and Mn) and total petroleum hydrocarbons.

All samples for groundwater quality shall be collected after the bore is appropriately purged. Groundwater samples will be collected in accordance with the relevant guidelines and conventions specified in the “Monitoring and Sampling Manual” (DES, 2018), and in compliance with e.g. AS/NZS 5667:11 1998 (Australian/New Zealand Standards, 2016). The samples will be preserved and forwarded to a NATA accredited water laboratory for analysis.

The groundwater monitoring data will be reviewed annually, and the groundwater monitoring program revised, as necessary. The monitoring data and will be provided to OGIA on an annual basis.

In the event that the monitoring program identifies a significant departure from the prediction, an investigation will be undertaken to identify the cause and manage any unexpected impacts associated with the project.

No water bores are present on the project site, hence a Baseline Assessment Plan (BAP) and associated monitoring is not required.

7.2 Groundwater take monitoring

Fitzroy has an existing obligation to quantify its actual groundwater take under the Mineral Resources Act 1999 (MR Act). The DNRME Guideline for quantifying the volume of take of associated water under a mining lease or mineral development license (Groundwater Take Guideline) describes the acceptable methods for monitoring and quantifying actual groundwater take under the MR Act. The acceptable methods include direct measurement, water balance modelling, and numerical/analytical groundwater flow modelling.

In accordance with the requirements of the MR Act, Fitzroy will continue to assess actual groundwater take using the acceptable methods. The method used will be reviewed annually and revised, as necessary. The groundwater monitoring will provide data that can be used to validate the modelled estimates of water take, and identify any unexpected groundwater effects due to mining operations.

The actual groundwater take assessed under the MR Act requirements will be compared to the predicted groundwater take presented in this UWIR. This comparison will be undertaken annually. If the monitoring program shows groundwater take exceeds the predictions presented in this UWIR, an investigation will be undertaken to confirm whether the actual impacts on groundwater users or sensitive environmental features are likely to be significantly greater than expected. The investigation outcomes will be considered as part of the annual UWIR review described in Section 8.

8 UWIR Review and updates

8.1 Roles and responsibilities

Fitzroy is responsible for ensuring that the UWIR is implemented.

8.2 Review and revision

As discussed in Section 5, depressurisation of the water table Leichhardt Seam is expected to exceed the bore trigger threshold.

Hence, Fitzroy will undertake an annual review of the accuracy of the IAA and LTAA mapping, as required by Section 376(1)(e) of the Water Act.

The review process will comprise:

- An initial review of any new geology or groundwater data to identify potentially significant departures from the data used in the UWIR to develop the IAA and LTAA mapping.
- Where potentially significant departures are identified, the potential effect of these departures on the IAA and LTAA will be investigated.
- If the investigation concludes that the IAA or LTAA are likely to have been under-estimated and additional water bores are likely to be affected, the IAA and LTAA will be revised.

The UWIR has been designed to align with the current EA groundwater conditions. It is therefore necessary to review and update the UWIR in response to any material changes to the EA groundwater conditions.

8.3 Reporting and record keeping

The outcome of each annual review will be reported to the DES and the Office of Groundwater Impact Assessment following completion of each annual review. The reported outcomes will include a statement of whether there has been a material change in the information or predictions used to prepare the maps.

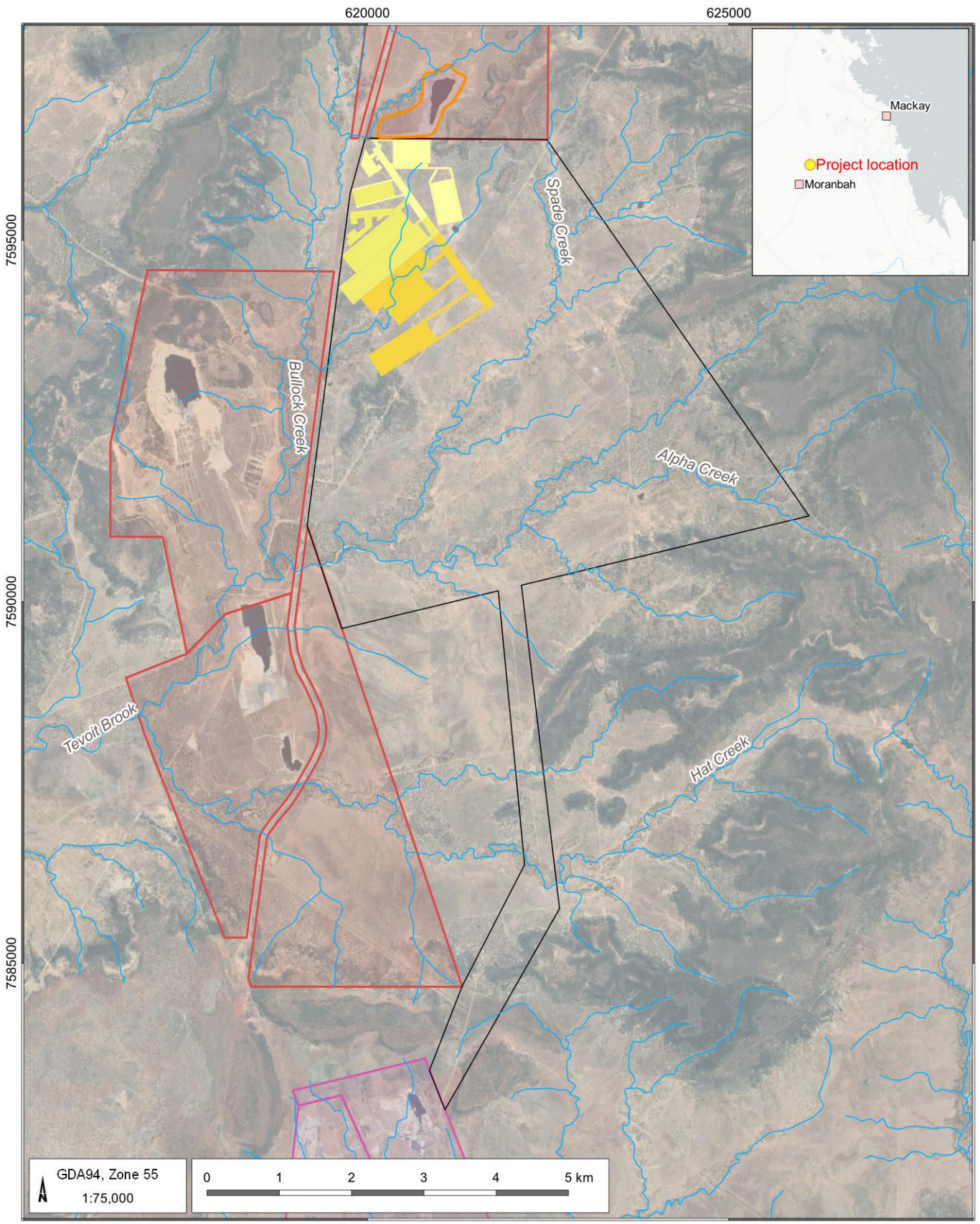
9 Conclusions

The key conclusions of this UWIR are as follows:

- The impacts of the project over the UWIR period and the life of the mine have been assessed and approved under the EP Act as part of the grant of the Ironbark No.1 EA.
- The approved mining operations will result in localised drawdown in the water table and depressurisation of the Leichhardt Seam.
- The other potential aquifers and shallow formations (i.e. the Tertiary basalt, Tertiary sediments and alluvium) are largely unsaturated, and are not predicted to be affected by the project.
- The project will not impact surface waters or alluvial aquifers during the UWIR period because:
 - alluvium is mostly absent from the project site and its surrounds;
 - where present, alluvium is typically dry and unsaturated and does not represent a significant aquifer; and
 - the significant depth of cover over the project mining area during the UWIR period (up to 200 m) and the low permeability interburden of the Permian and Triassic sediments will reduce significant depressurisation of the shallow formations; and
- There are no groundwater users or other sensitive receptors near the mining area and therefore no significant groundwater impacts as a result of the project.
- There is a very low potential for groundwater contamination as a result of the project.

10 References

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- National Water Commission (2011), "*Australian groundwater-dependent ecosystems toolbox part 1: assessment framework*", Commonwealth of Australia, 2011.
- Panday S., Langevin C.D., Niswonger R.G., Ibaraki M. and Hughes, J.D. (2013): "*MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*"; U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.
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LEGEND

- Creeks
- Project Mining Lease Boundary
- Broadlea North Coal Mine
- Burton Coal Mine
- Burton Pit

- Mine progression (Year)**
- Year 01
 - Year 02
 - Year 03

Ironbark No. 1 UWIR (IRB5001.001)

Mine location and setting

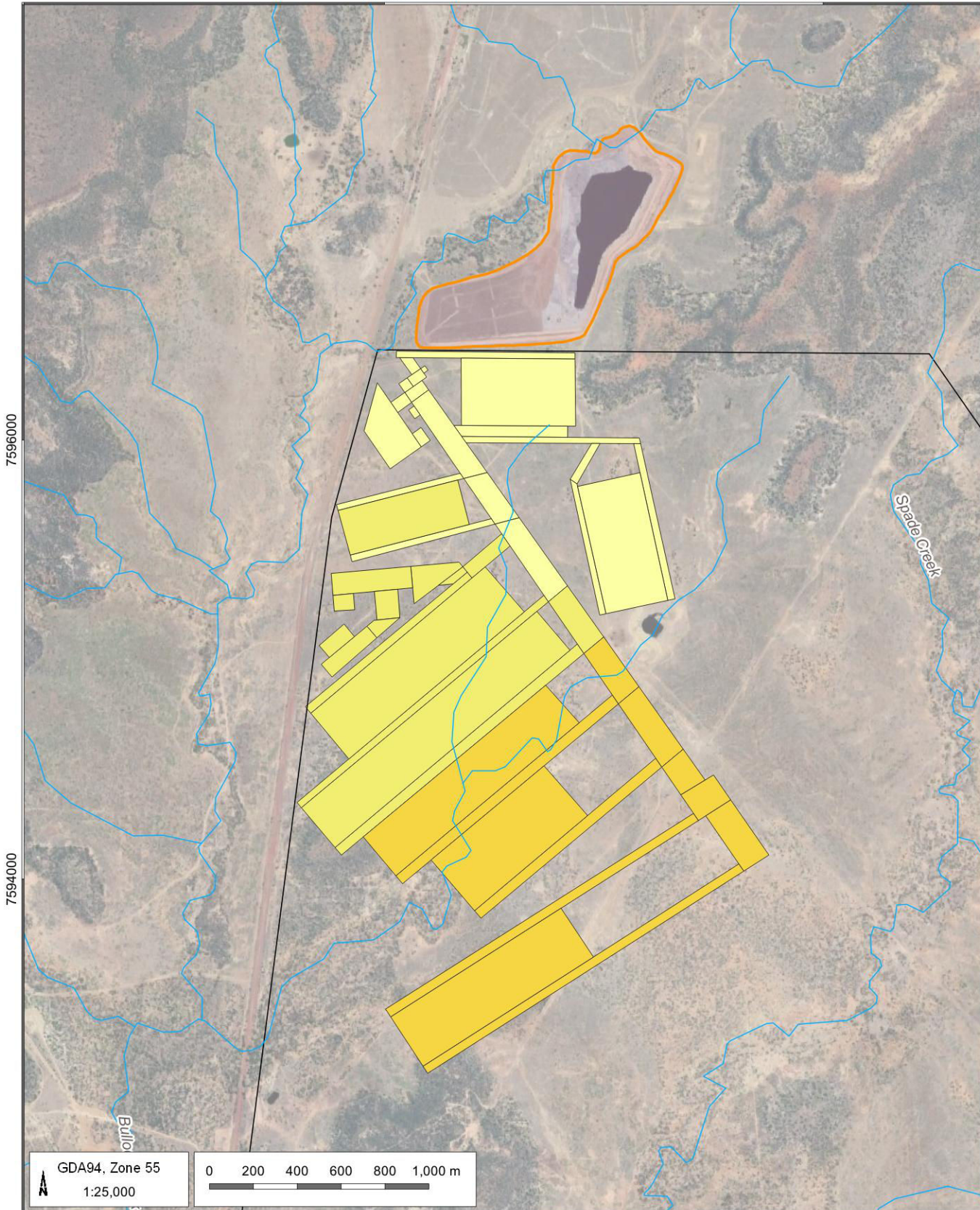


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13/09/2022

FIGURE No:
1

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LEGEND

- Creeks
- Project Mining Lease Boundary
- Burton Pit

Mine progression (Year)

- Year 01
- Year 02
- Year 03

Ironbark No. 1 UWIR (IRB5001.001)

Mine layout

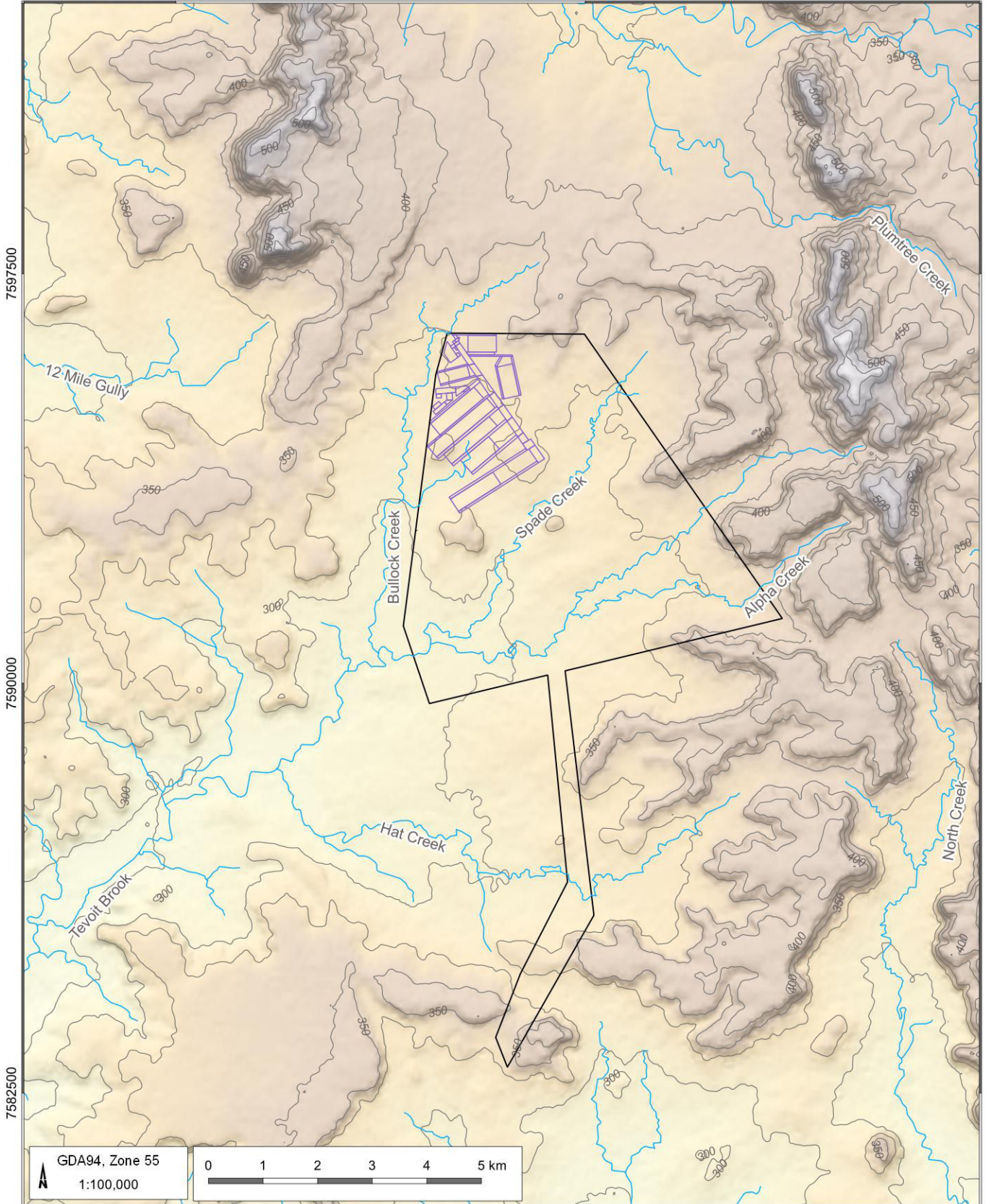


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FIGURE No:
2

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LEGEND

- Creeks
- Project Mining Lease Boundary
- Mine plan

Elevation (mAHD)

- 275.0
- 325.0
- 350.0
- 450.0
- 500.0
- 550.0
- Elevation contour

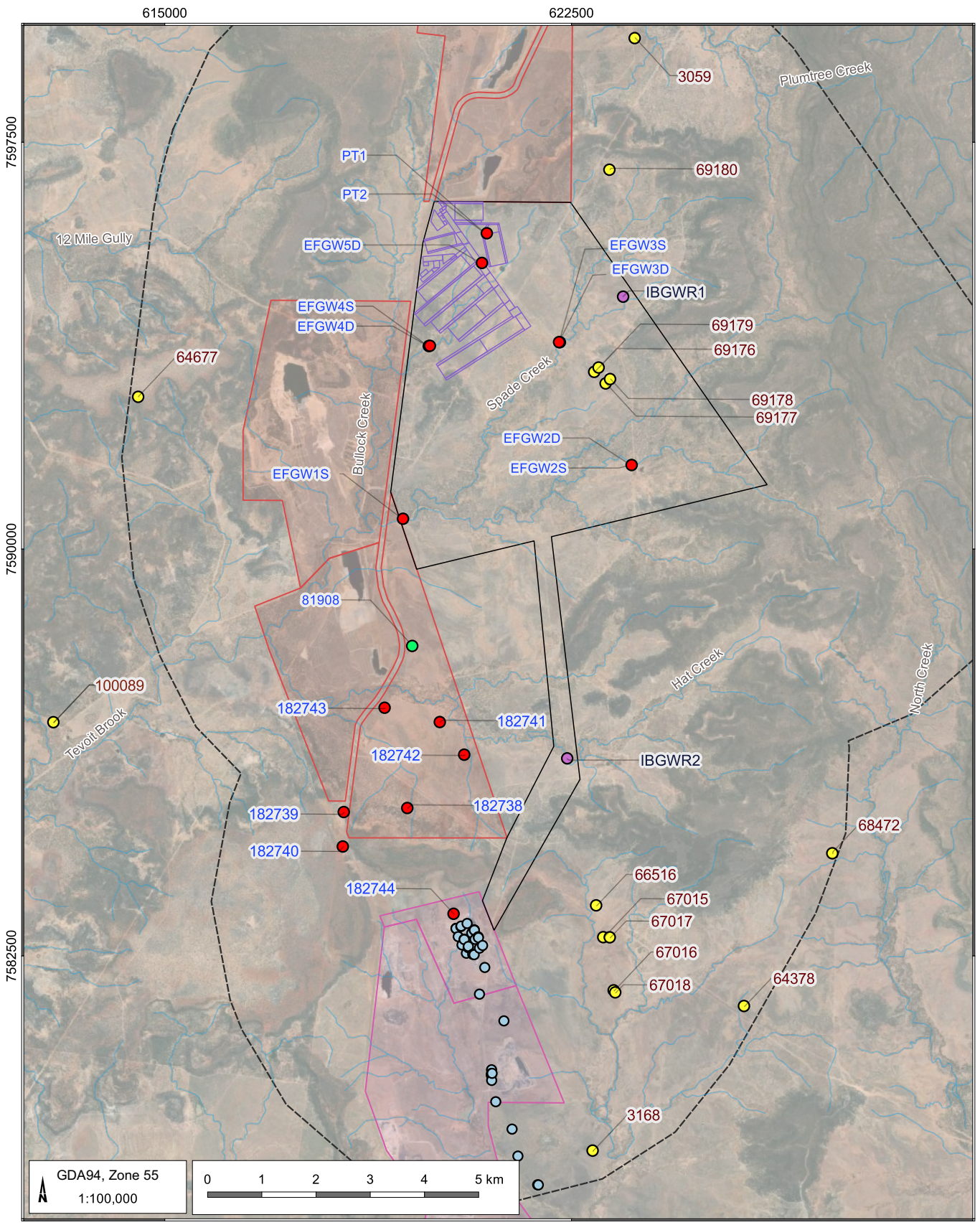
Ironbark No. 1 UWIR (IRB5001.001)

Topography and drainage



DATE
20/09/2022

FIGURE No:
3



GDA94, Zone 55
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LEGEND

- Creeks
- Project Mining Lease Boundary
- Broadlea North Coal Mine
- Burton Coal Mine
- Mine plan
- 5km radius Project Mining Lease Boundary

- Mine groundwater monitoring bores
- Reference bore
EFGW 1S : BoreID
- Registered watersupply bore
- Broadlea North Mine borefield groundwater monitoring network
- CSG appraisal well
3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

DRDMW registered bores



DATE
11/08/2023

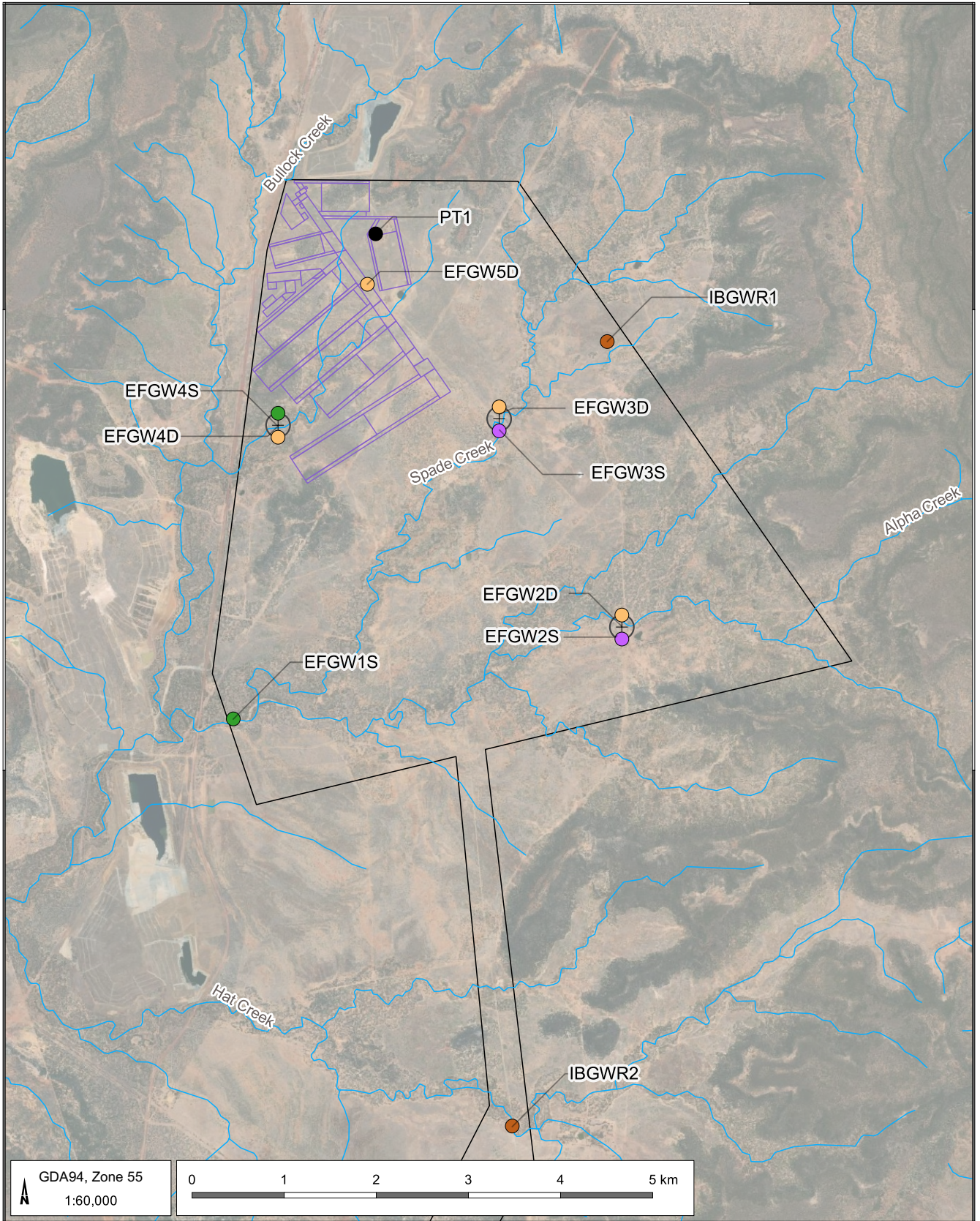
FIGURE No:
4

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LEGEND

- Creeks
- Project Mining Lease Boundary
- Mine plan

EA Table E1 groundwater monitoring bores

- Alluvial bores
- Dry alluvial bores
- Shallow overburden bores
- Leichhardt Seam bores
- Reference bore

EFGW1S : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

Mine groundwater monitoring network



DATE
13/10/2022

FIGURE No:
5

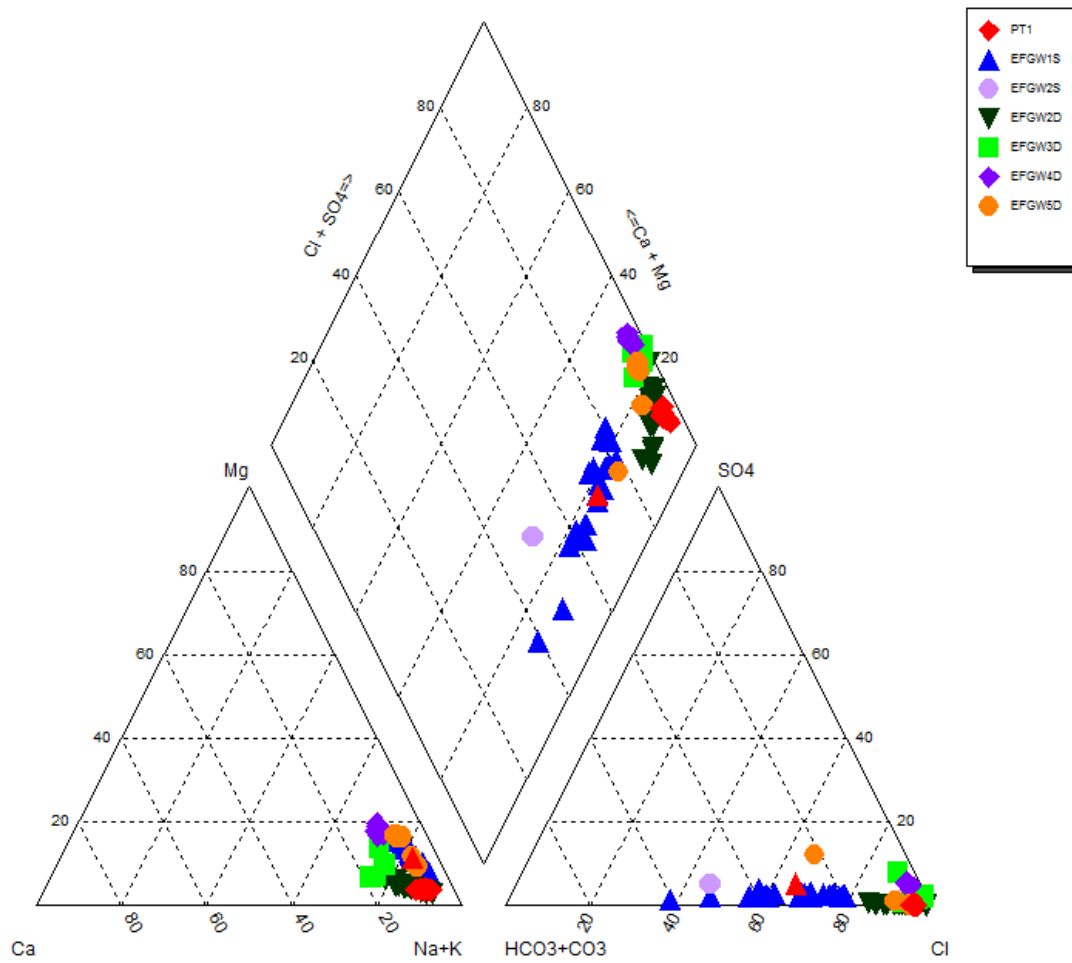
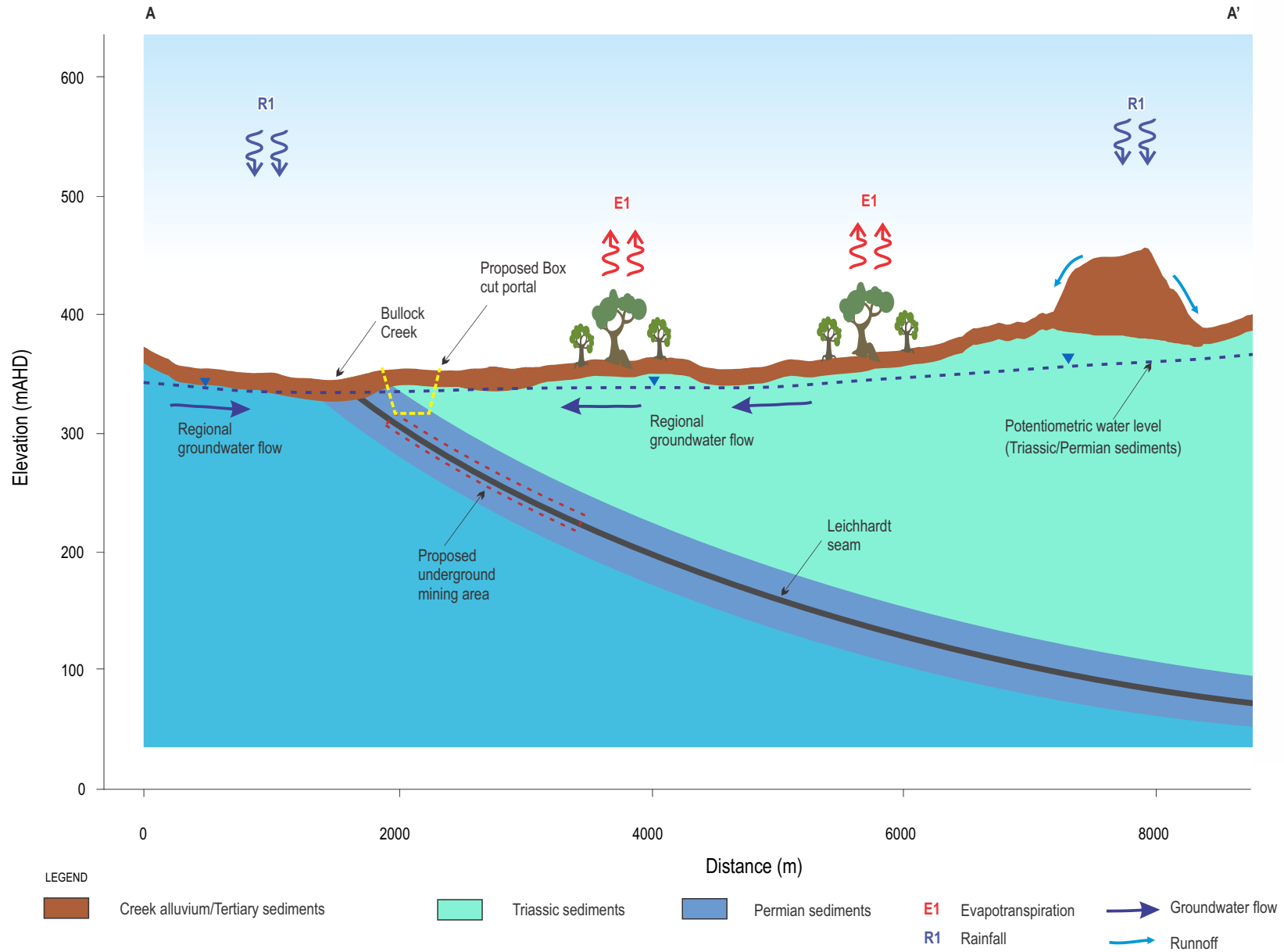


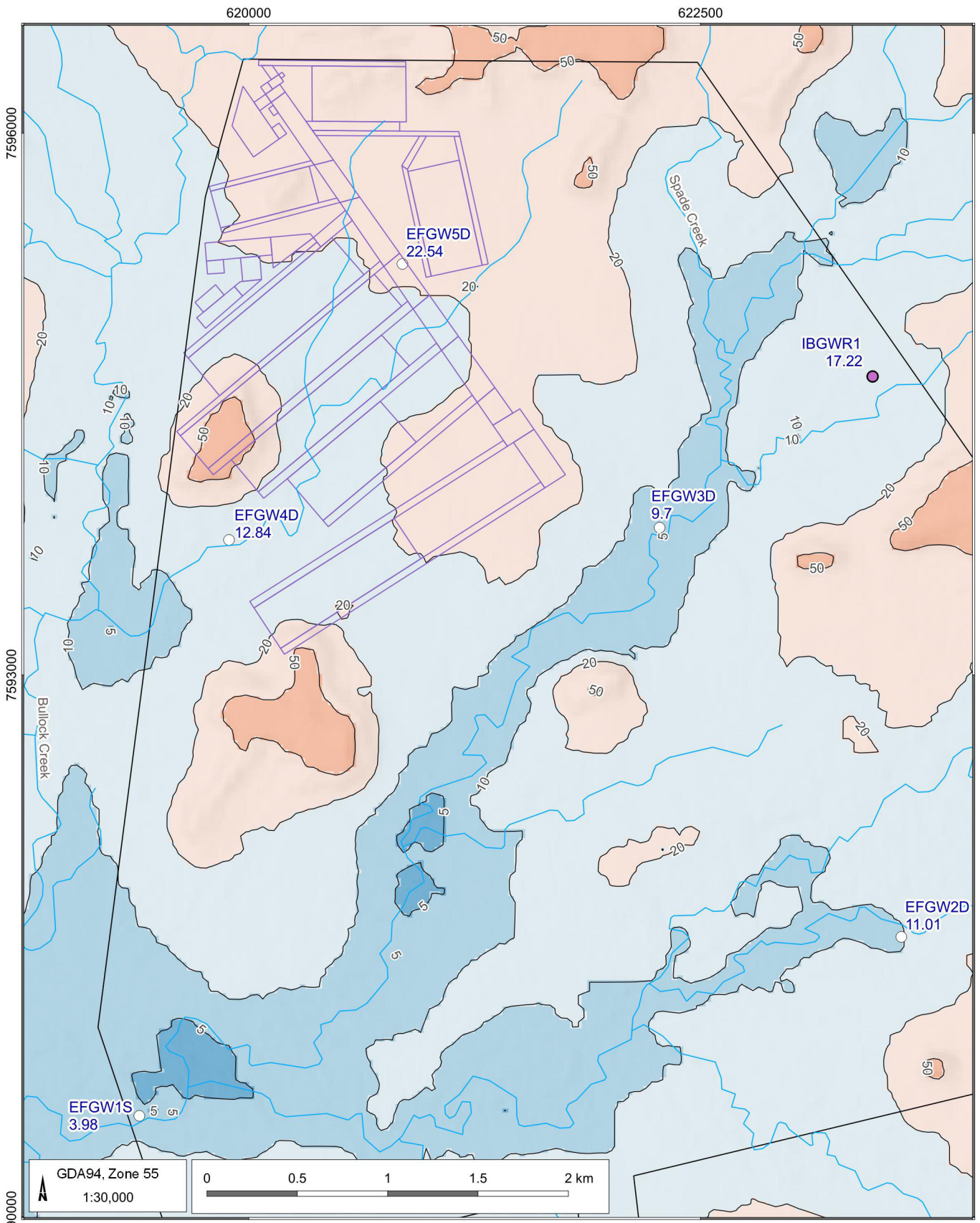
Figure 6 Piper diagram



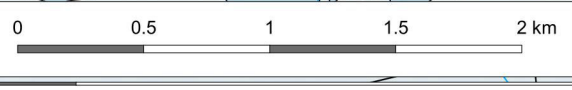
Conceptual hydrogeological model (A - A')

Figure - 7

Ironbark No. 1 UWIR (IRB5001.001)



GDA94, Zone 55
1:30,000



- LEGEND
- Creeks
 - Project Mining Lease Boundary
 - Mine plan
 - Mine monitoring bore
EFGW2D : BoreID
13.2 : Water table depth (mbgl)
 - Reference bore

- Water table depth (mbgl)
- <= 0
 - 0 - 5
 - 5 - 10
 - 10 - 20
 - 20 - 50
 - 50 - 100
 - Contour line

Ironbark No. 1 UWIR (IRB5001.001)

Interpreted depth to water table - August 2022

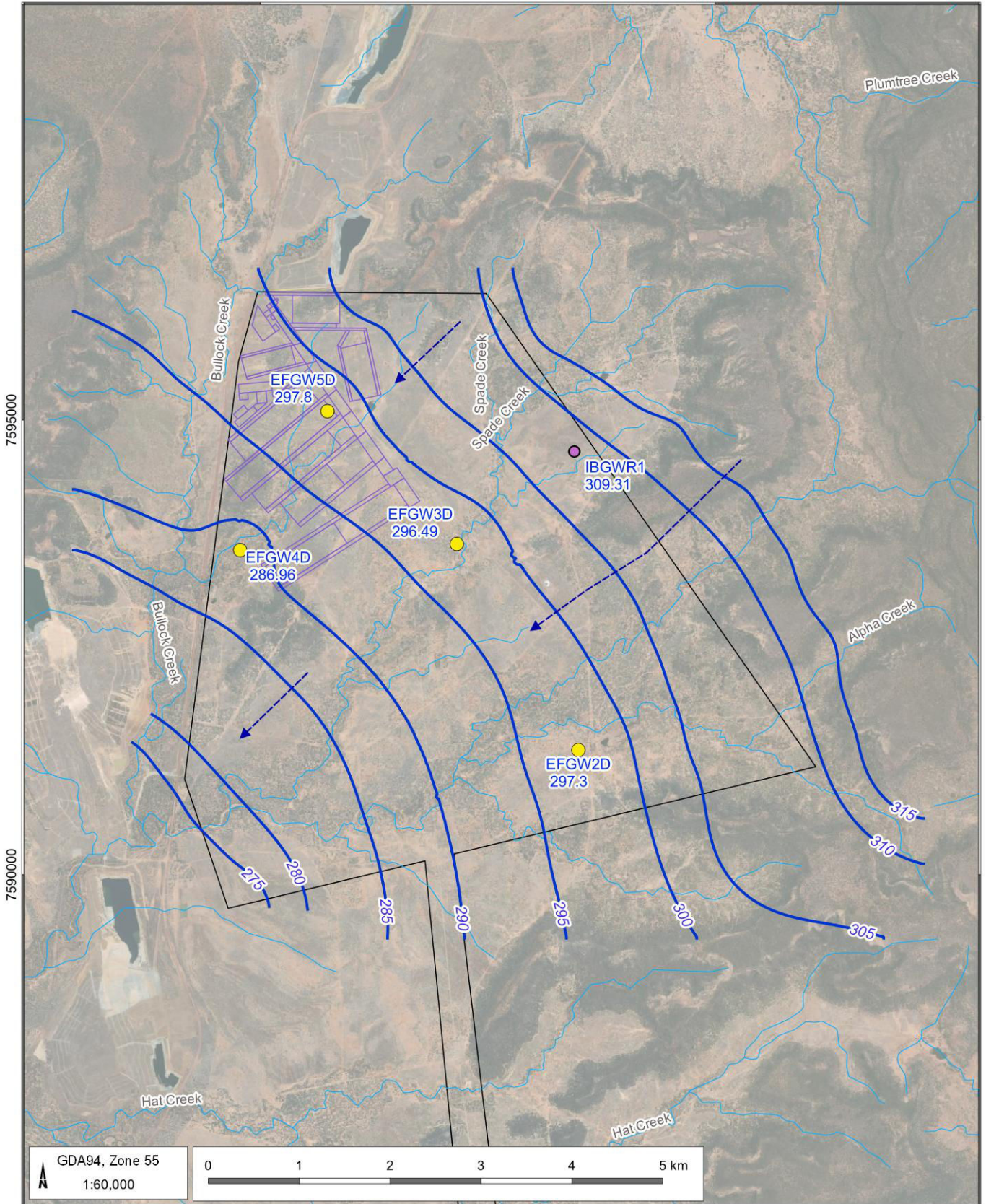


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21/09/2022

FIGURE No:
8

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LEGEND

- Creeks
- Project Mining Lease Boundary
- Mine plan

- Depth bore (EFGW - series)
EFGW2D : BoreID
297.31 : Groundwater elevation (mAHd)
- Reference bore

- Groundwater contour (mAHd)
- Flow direction

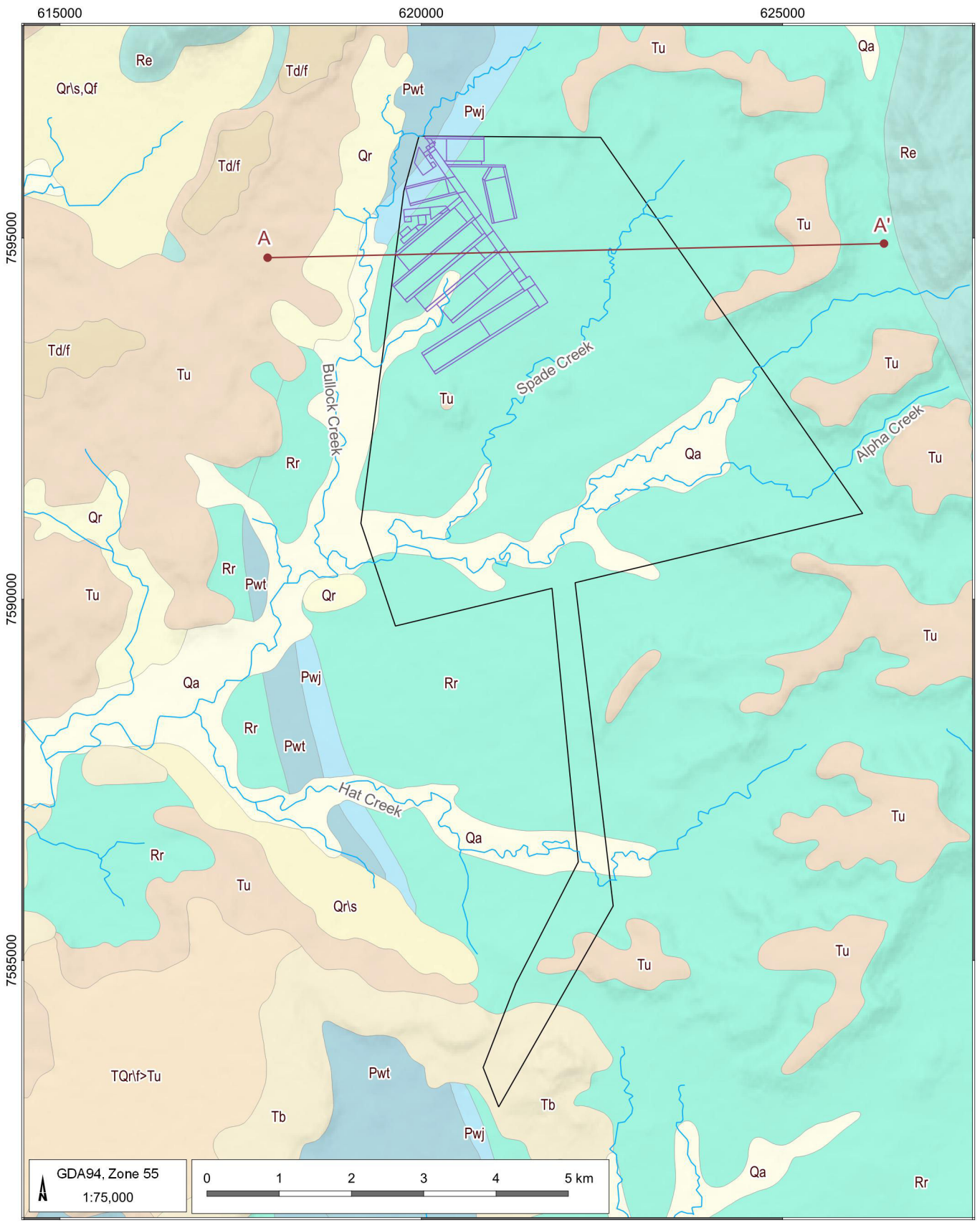
Ironbark No. 1 UWIR (IRB5001.001)

Interpolated groundwater contours - August 2022



DATE
21/09/2022

FIGURE No:
9



LEGEND

- Creeks
- Conceptual cross section line (A -A')
- Project Mining Lease Boundary
- Mine plan

- Creek alluvium**
- Qa - Quaternary alluvium
 - Qa/f - Alluvial fan
 - Qr/s - Residual soil/colluvium
 - Qr - Residual soil/colluvium

- Tertiary sediments**
- TQr/f > Tu - Sutor Formation
 - Tb - Tertiary basalt
 - Td/f - Ferricrete
 - Tu - Tertiary sediments
- Triassic sediments**
- Re - Clematis Group
 - Rr - Rewan Group
- Permian sediments**
- Pwj - Rangal Coal Measures
 - Pwt - Fort Cooper Coal Measures

Ironbark No. 1 UWIR (IRB5001.001)

Surface geology



AGE

DATE
20/09/2022

FIGURE No:
10

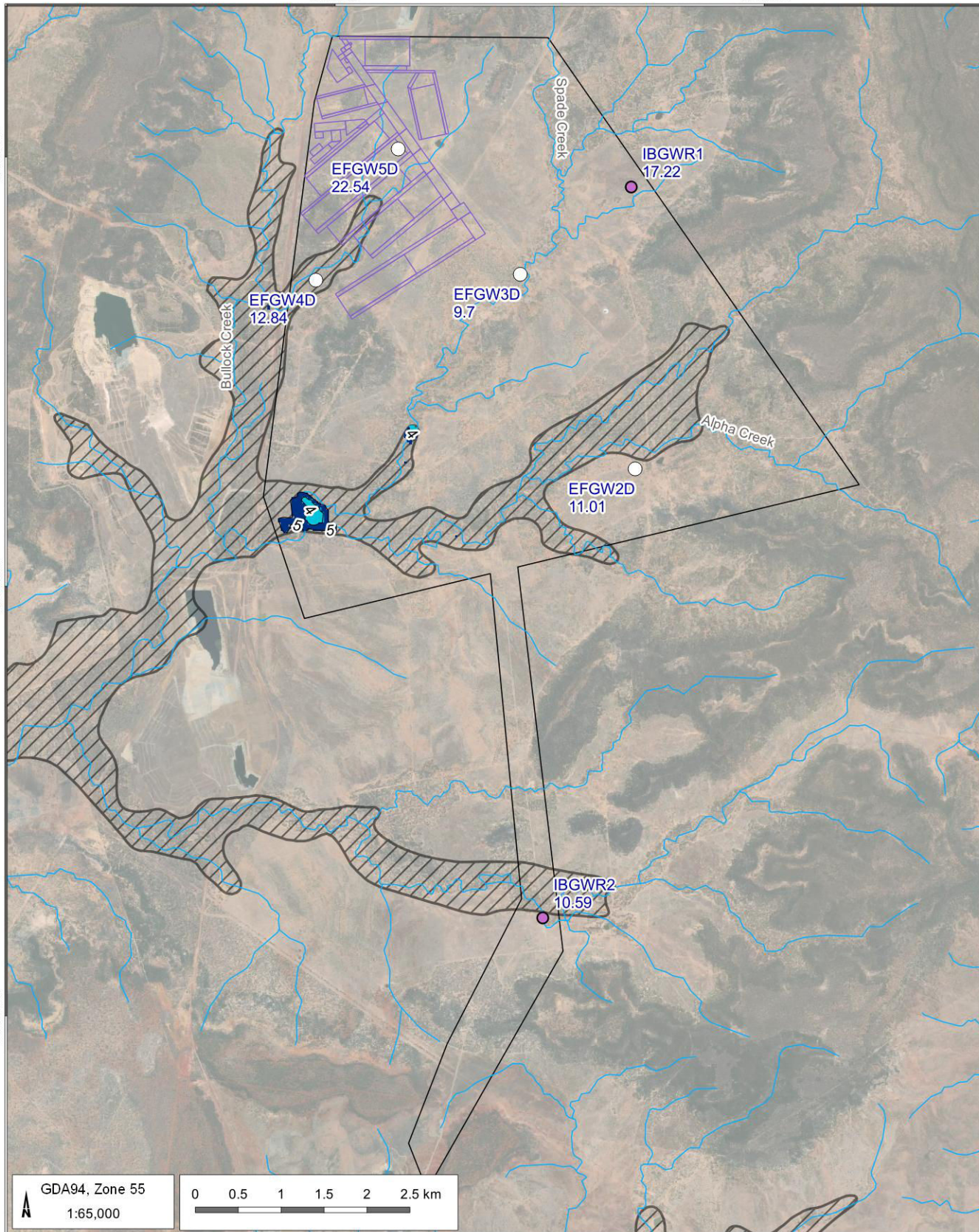
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LEGEND

- Creeks
- Project Mining Lease Boundary
- Mine plan
- Alluvium extent
- Deep bore
EFGW2D : BoreID
10.53 : Water table depth (mbgl)
- Reference bore

Depth to water table (m)

- ≤ 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- Contour line

Ironbark No. 1 UWIR (IRB5001.001)

Saturated alluvium extents - August 2022



DATE
21/09/2022

FIGURE No:
11



Figure 12 Drainage line photographs in Project area

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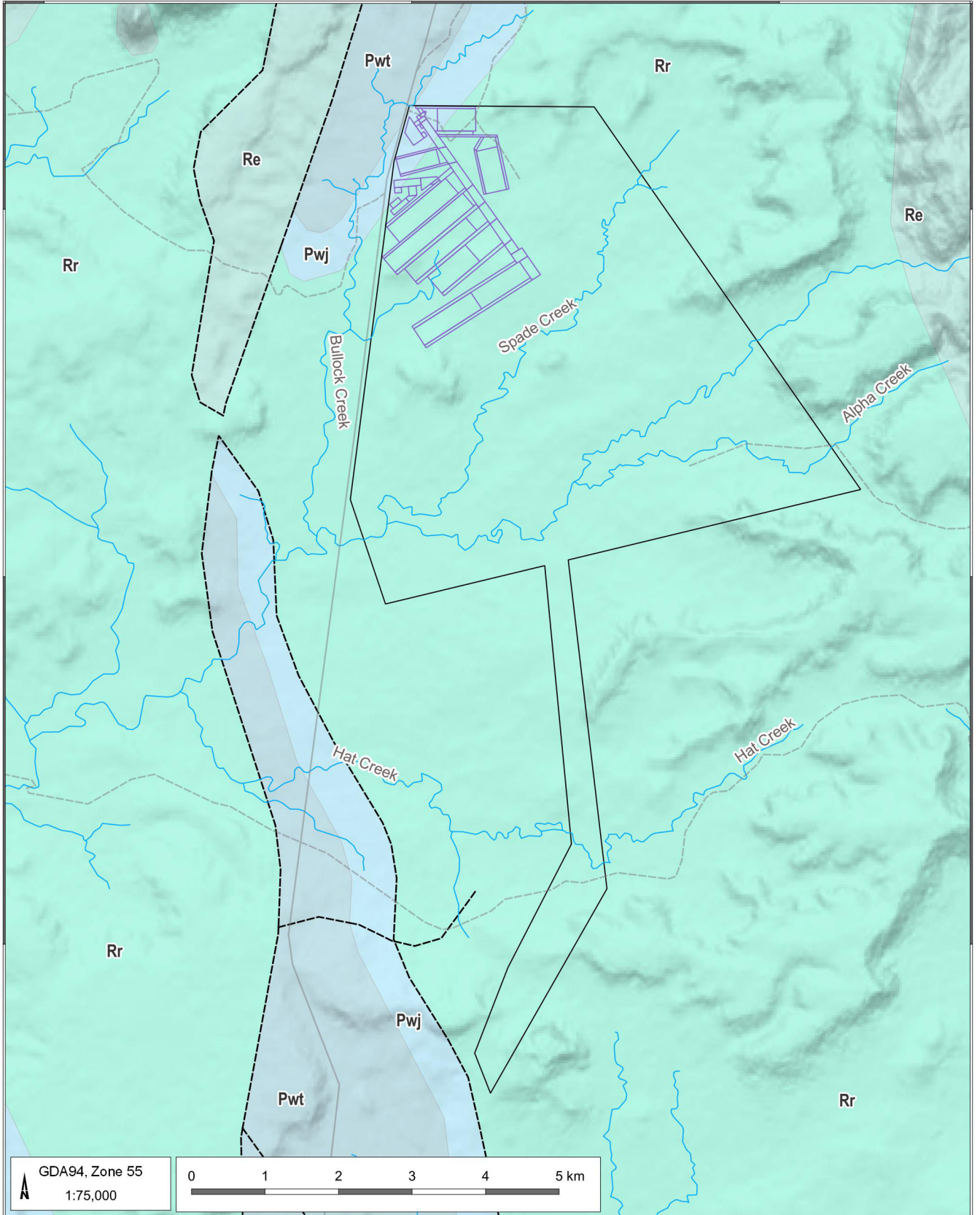
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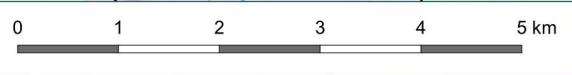
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LEGEND

- Road
- - - Track
- Creeks
- - - Fault
- Project Mining Lease Boundary
- ▭ Mine plan

Solid geology

- Re-Clematis Group
- Rr-Rewan Formation
- Pwj-Rangal Coal Measures
- Pwt-Fair Hill Formation/Fort Cooper Coal Measures

Ironbark No. 1 UWIR (IRB5001.001)

Bowen Basin geology



DATE
20/09/2022

FIGURE No:
13

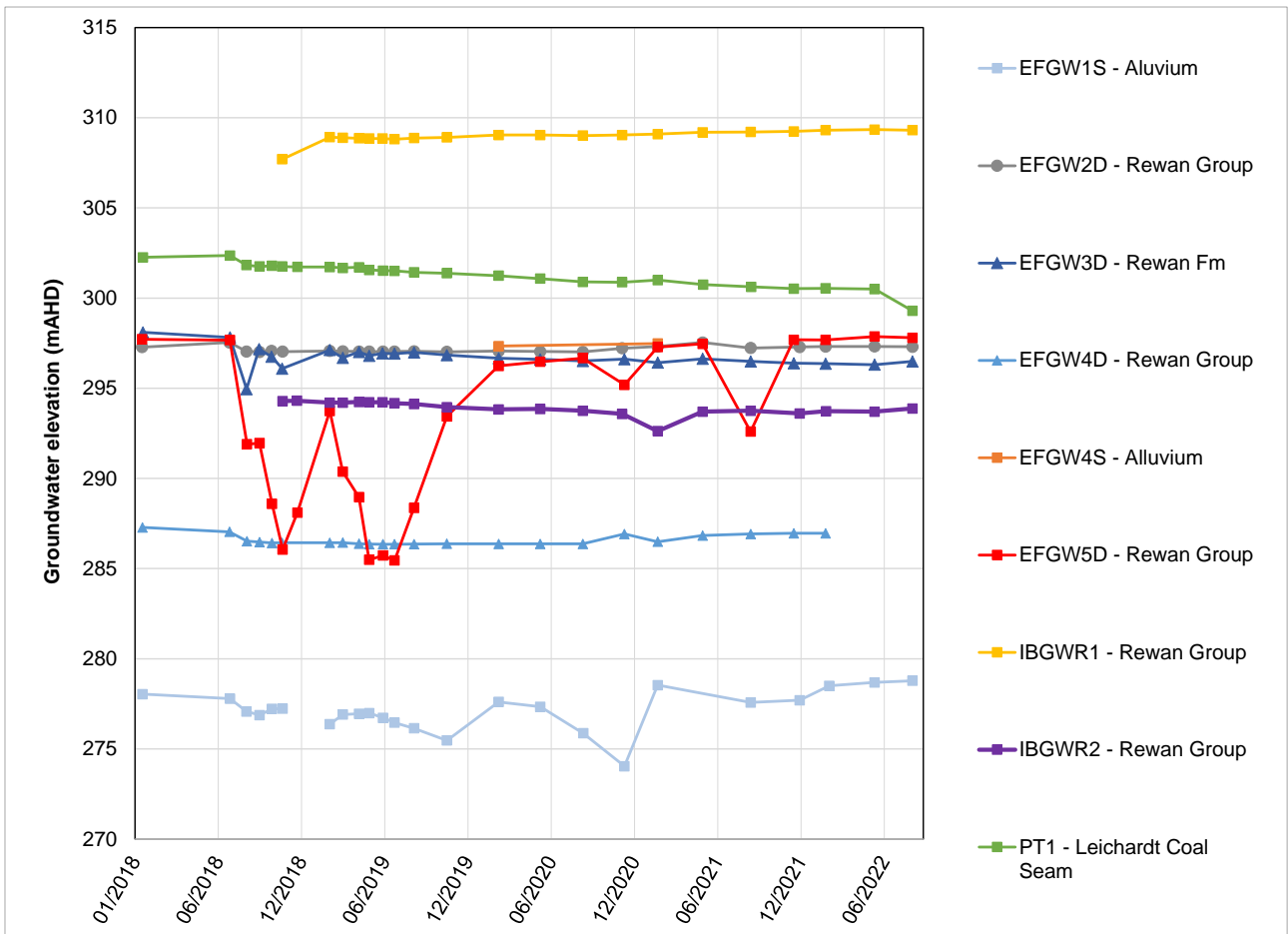
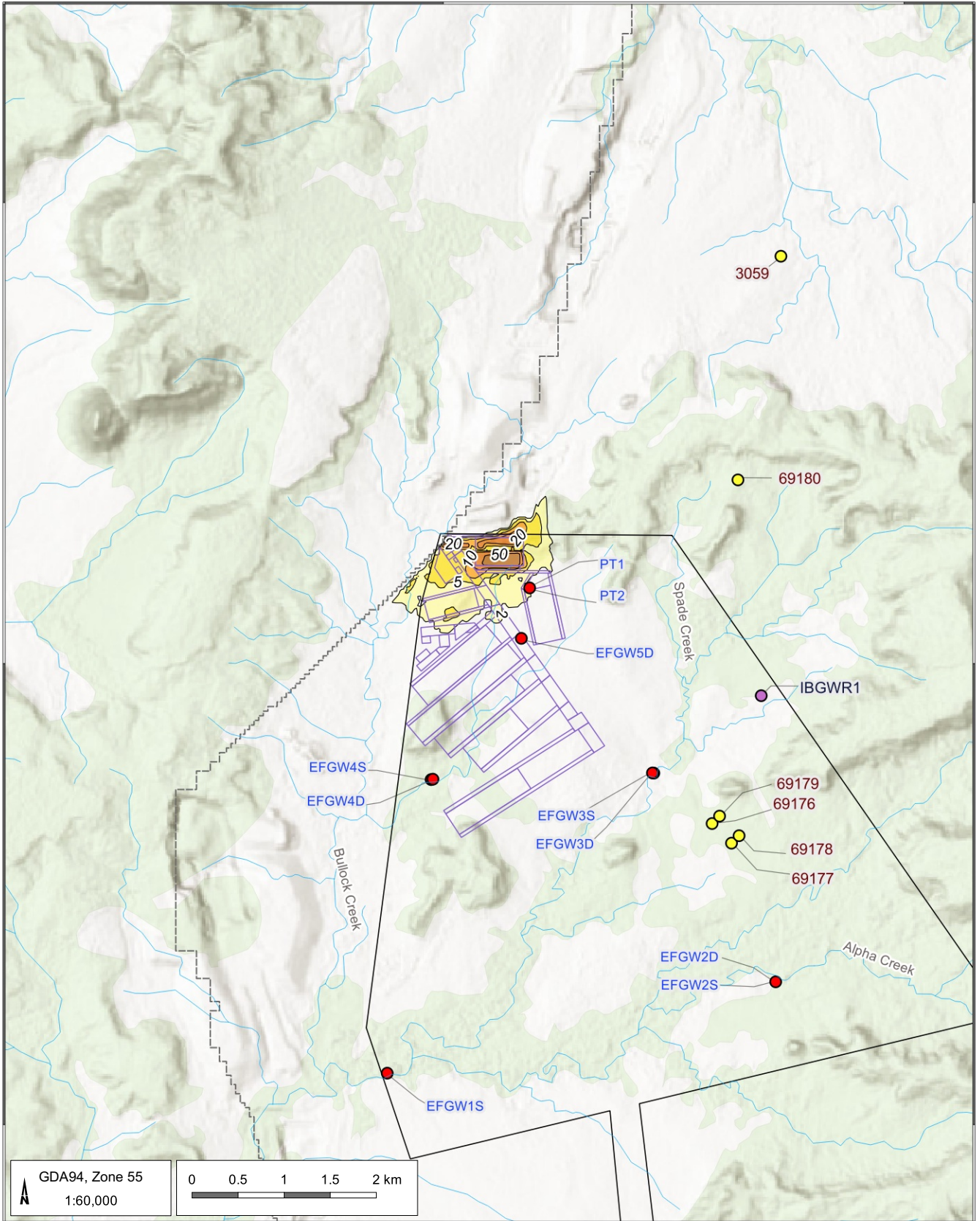


Figure 14 Measured groundwater levels in monitoring bores



LEGEND

- Creeks
- Drawdown contour (m)
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation

Drawdown (m)

- | | |
|--|--|
| 0 - 2 | 10 - 20 |
| 2 - 5 | 20 - 50 |
| 5 - 10 | 50 - 100 |

- Mine groundwater monitoring bores
- Reference bore
- EFGW 1S : BoreID
- CSG appraisal well
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

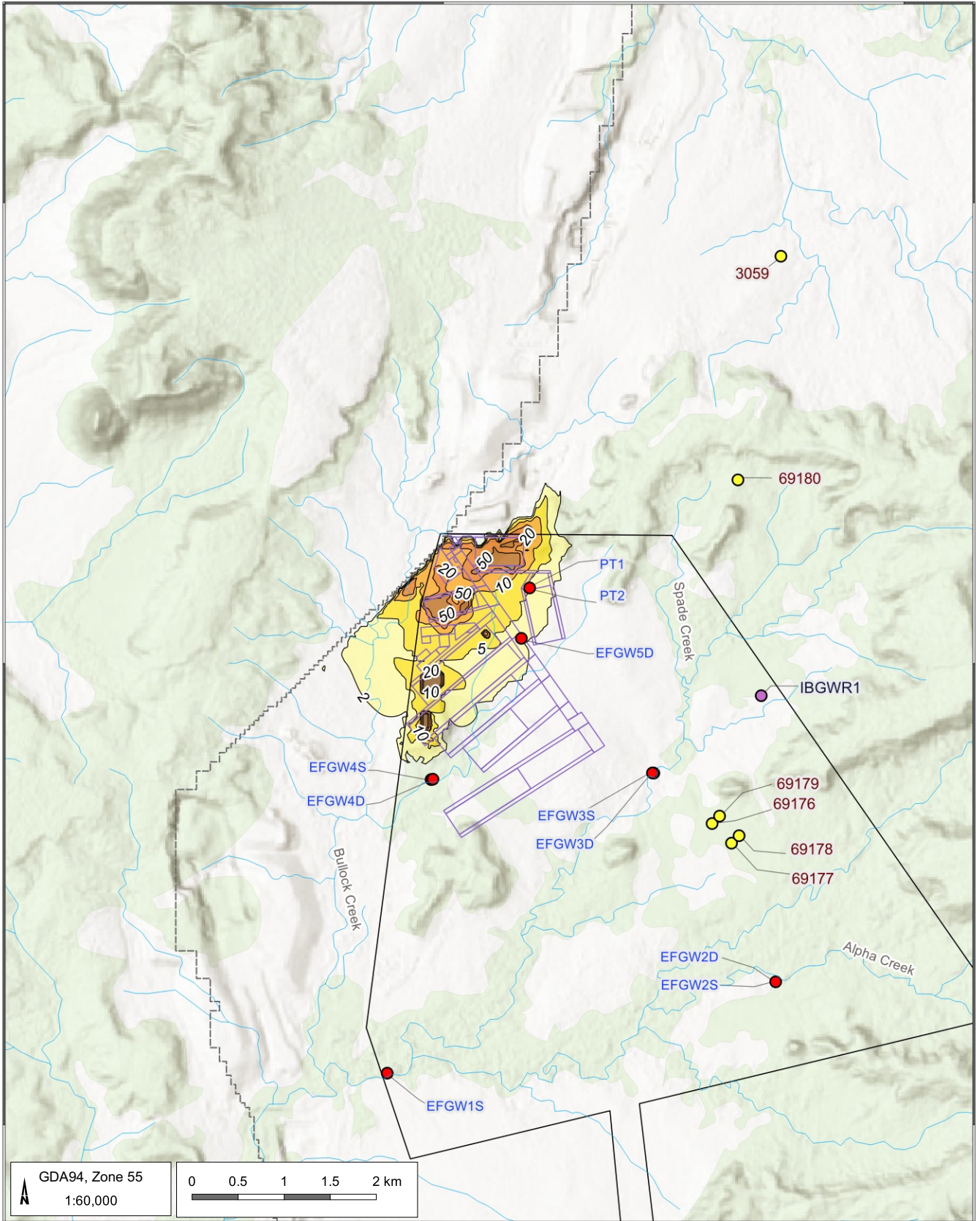
Predicted drawdown in water table at the end of UWIR Year 1



AGE

DATE
11/08/2023

FIGURE No:
15



GDA94, Zone 55
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0 0.5 1 1.5 2 km

LEGEND

- Creeks
- Drawdown contour (m)
- ▭ Project Mining Lease Boundary
- - - Limit of Leichhardt seam subcrop
- ▭ Mine plan
- Vegetation

Drawdown (m)

- | | |
|-----------|-------------|
| □ 0 - 2 | ■ 20 - 50 |
| □ 2 - 5 | ■ 50 - 100 |
| □ 5 - 10 | ■ 100 - 200 |
| □ 10 - 20 | |

- Mine groundwater monitoring bores
- Reference bore
- EFGW1S : BoreID
- CSG appraisal well
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

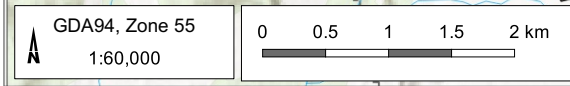
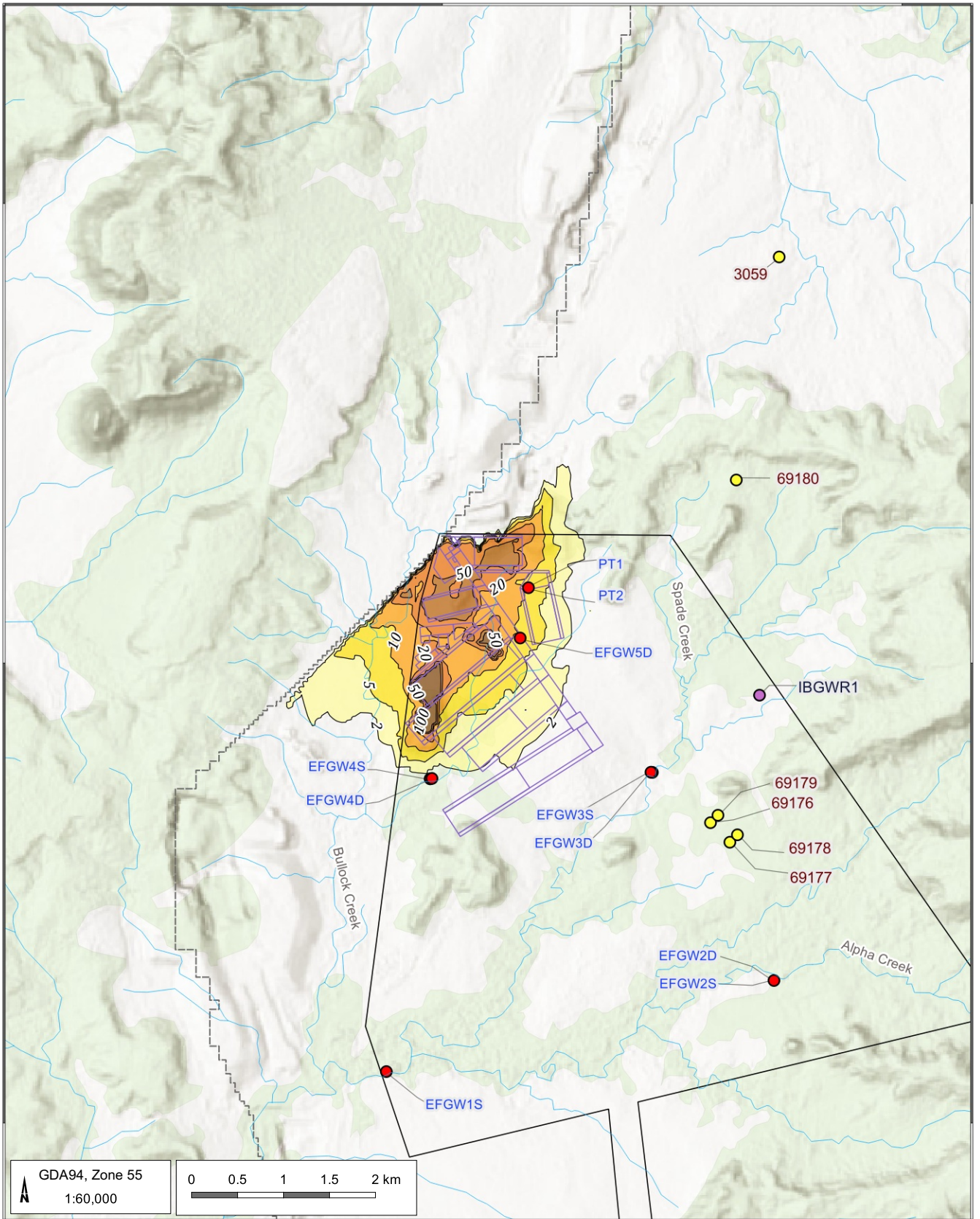
Predicted drawdown in water table at the end of UWIR Year 2



AGE

DATE
11/08/2023

FIGURE No:
16



LEGEND

- Creeks
- Drawdown contour (m)
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation

Drawdown (m)

- | | |
|--|---|
| 0 - 2 | 20 - 50 |
| 2 - 5 | 50 - 100 |
| 5 - 10 | 100 - 200 |
| 10 - 20 | 200 - 500 |

- Mine groundwater monitoring bores
- Reference bore
- EFGW1S : BoreID
- CSG appraisal well
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

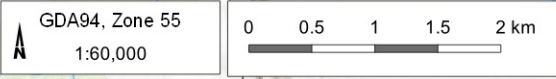
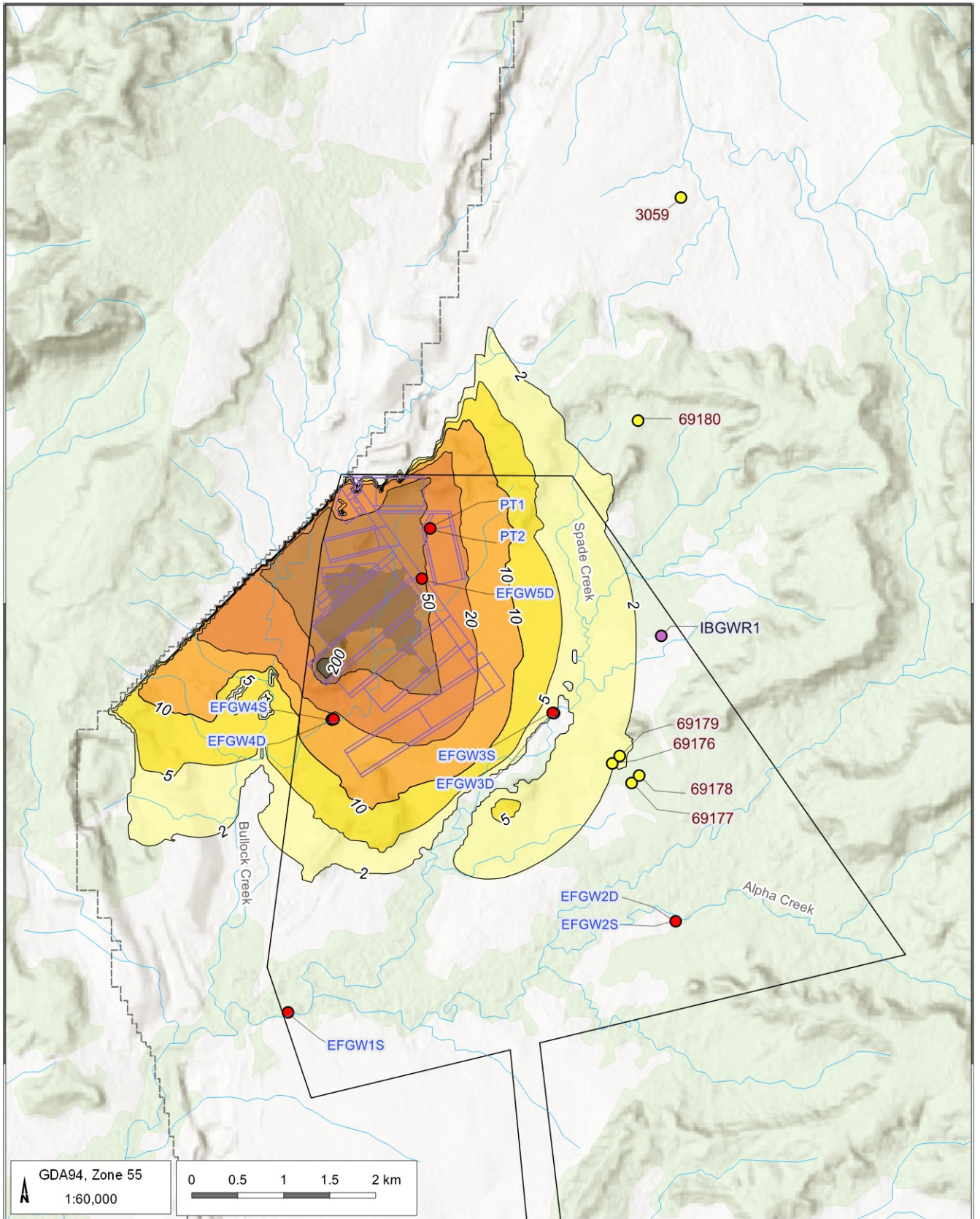
Predicted drawdown in water table at the end of UWIR Year 3 (IAA)



AGE

DATE
11/08/2023

FIGURE No:
17



LEGEND

- Creeks
- Drawdown contour (m)
- ▭ Project Mining Lease Boundary
- ▭ Limit of Leichhardt seam subcrop
- ▭ Mine plan
- ▭ Vegetation

Drawdown (m)	
0 - 2	20 - 50
2 - 5	50 - 100
5 - 10	100 - 200
10 - 20	200 - 500

- Mine groundwater monitoring bores
- Reference bore
- EFGW1S : BoreID
- CSG appraisal well
- 3168 : BoreID

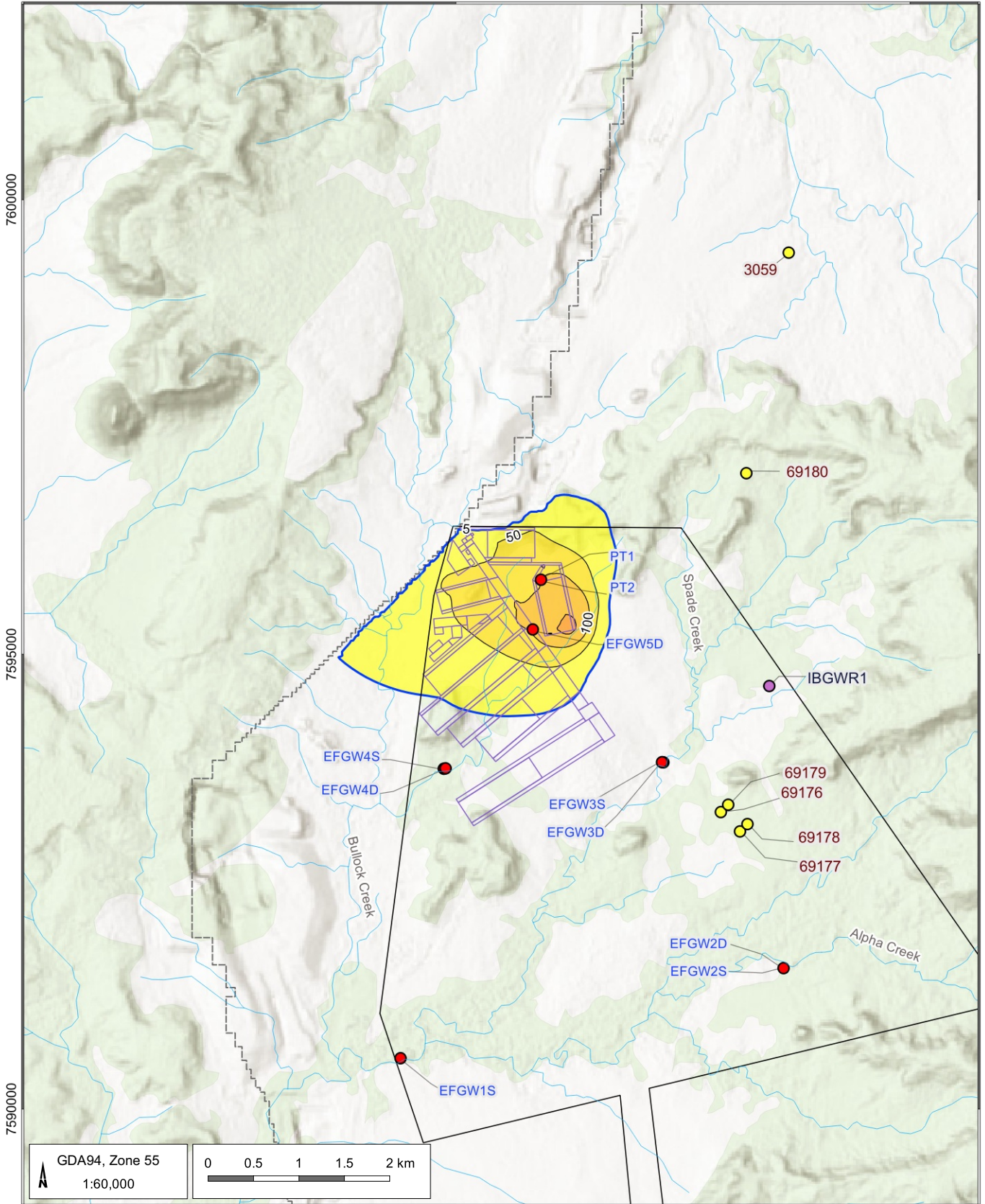
Ironbark No. 1 UWIR (IRB5001.001)

Predicted drawdown in water table at the end of mining (LTAA)



DATE 11/08/2023

FIGURE No: 18



LEGEND

- Creeks
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation
- Drawdown contour (m)
- Immediate Affected Area (IAF)

Drawdown (m)	
0 - 5	150 - 200
5 - 50	200 - 250
50 - 100	250 - 300
100 - 150	

- Mine groundwater monitoring bores
- Reference bore
- EFGW1S : BoreID
- CSG appraisal well
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

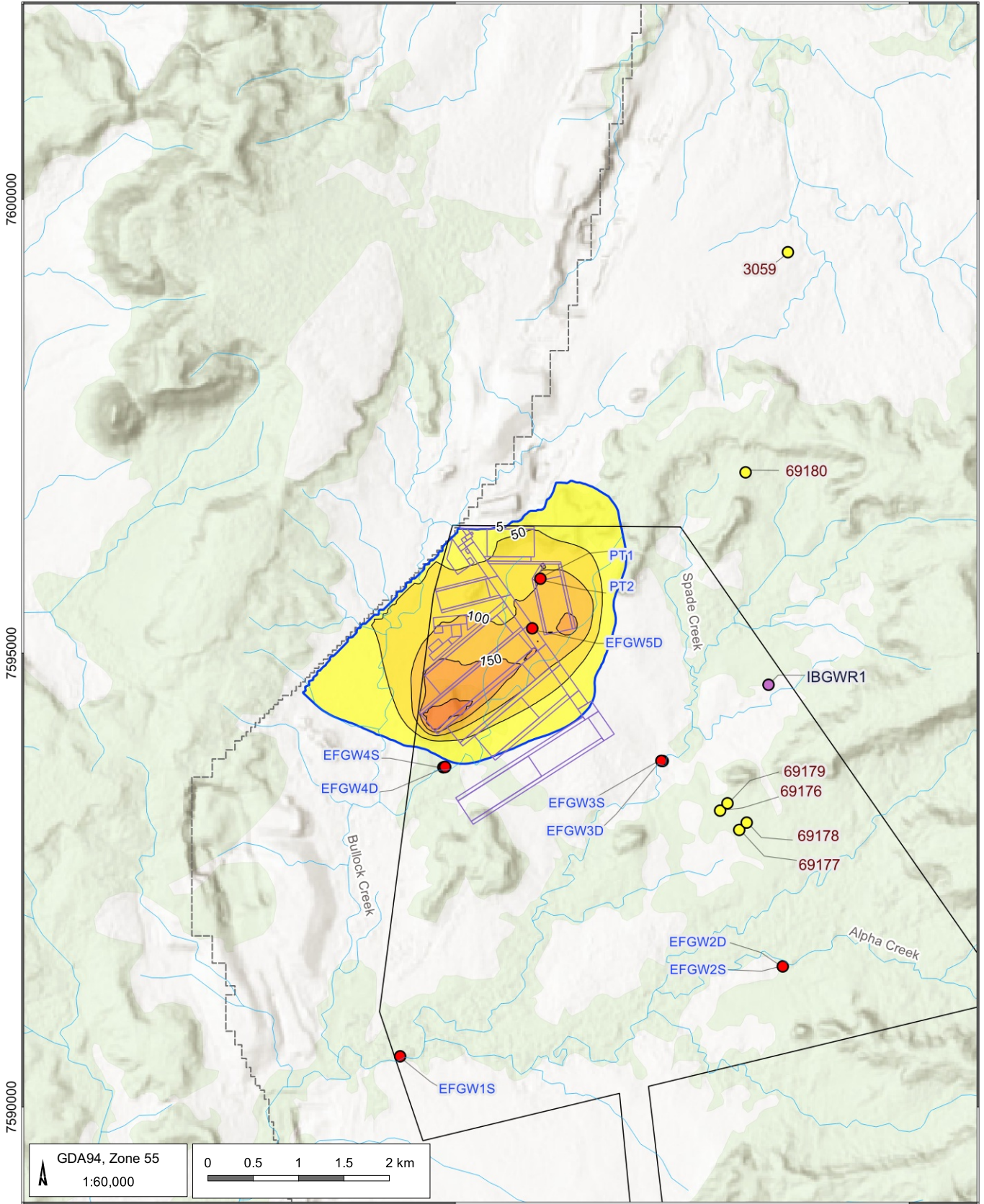
Predicted Depressurisation in the Leichhardt Seam at the end of UWIR Year 1



AGE

DATE
11/08/2023

FIGURE No:
19



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LEGEND

- Creeks
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation
- Drawdown contour (m)
- Immediate Affected Area (IAF)

Drawdown (m)

- 0 - 5
- 5 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250

- Mine groundwater monitoring bores
- Reference bore
- EFGW 1S : BoreID
- CSG appraisal well
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

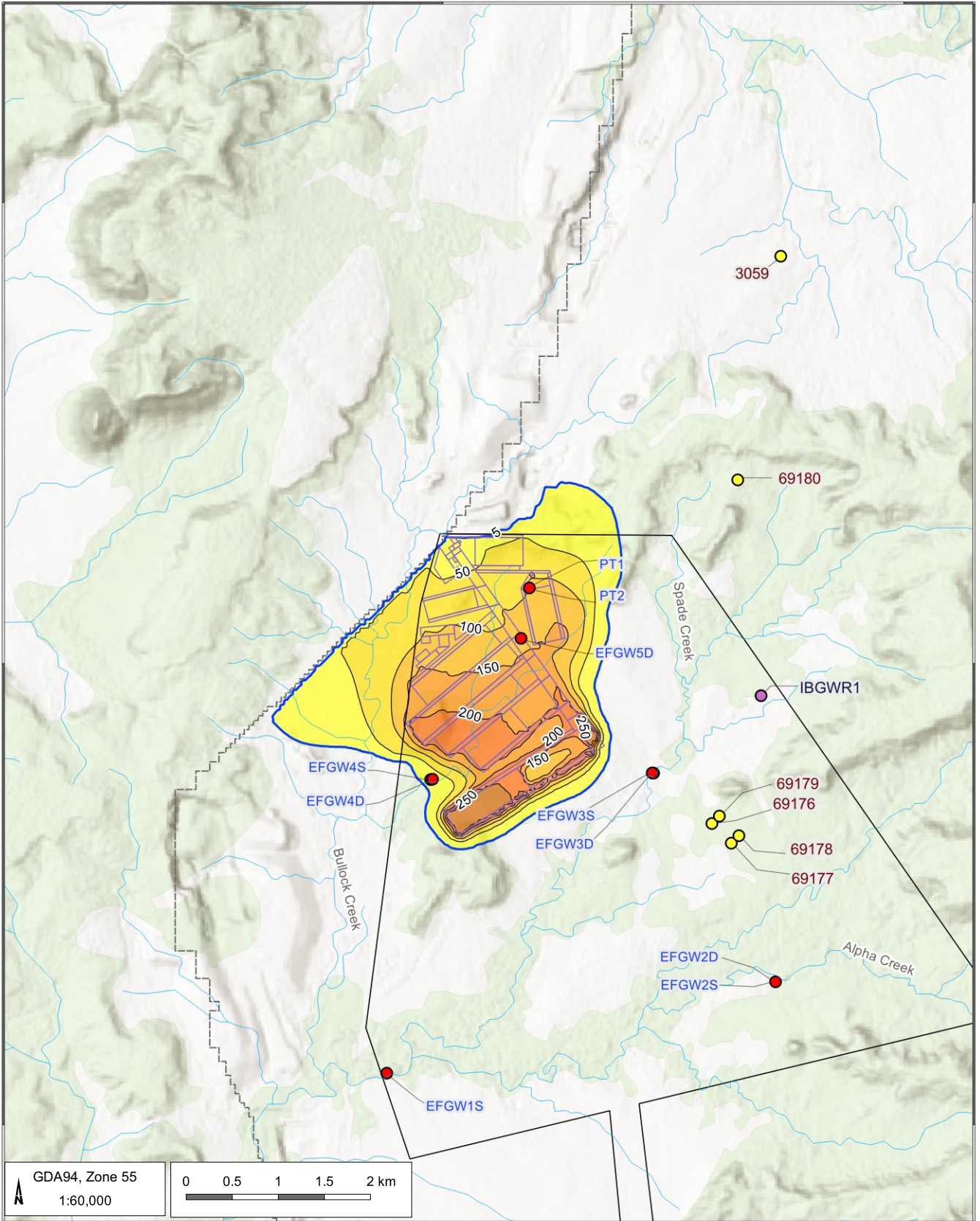
Predicted drawdown in water table at the end of UWIR Year 2



AGE

DATE
11/08/2023

FIGURE No:
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LEGEND

- Creeks
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation
- Drawdown contour (m)
- Immediate Affected Area (IAF)

Drawdown (m)

0 - 5	200 - 250
5 - 50	250 - 300
50 - 100	300 - 350
100 - 150	350 - 400
150 - 200	400 - 450

- Mine groundwater monitoring bores
- Reference bore
EFGW1S : BoreID
- CSG appraisal well
3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

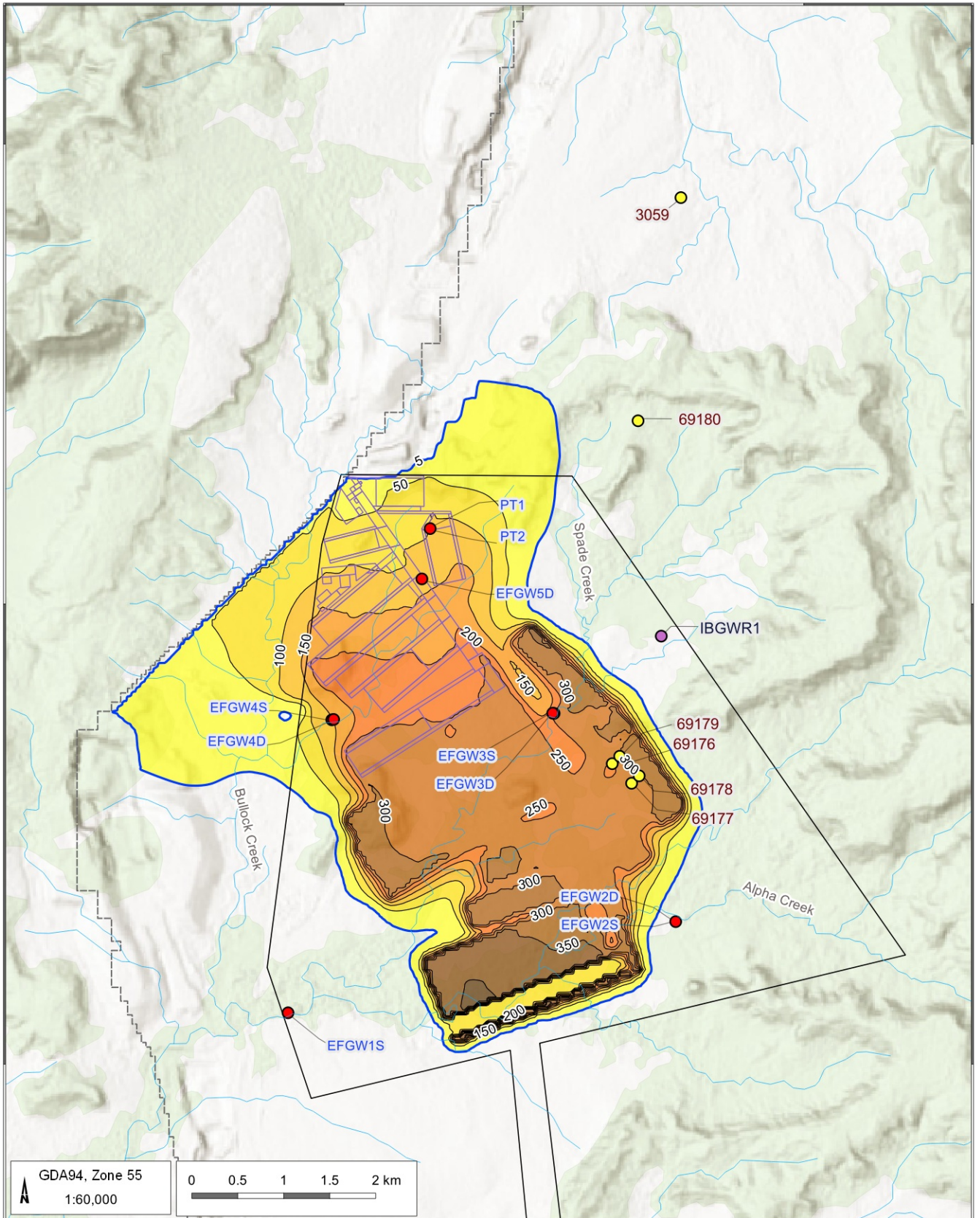
Predicted Depressurisation in the Leichhardt Seam at the end of UWIR Year 3 (IAA)



AGE

DATE
11/08/2023

FIGURE No:
21



LEGEND

- Creeks
- Project Mining Lease Boundary
- Limit of Leichhardt seam subcrop
- Mine plan
- Vegetation
- Drawdown contour (m)
- Long-Term Affected Area (LTAA)

Drawdown (m)	
	0 - 5
	5 - 50
	50 - 100
	100 - 150
	150 - 200
	200 - 250
	250 - 300
	300 - 350
	350 - 400
	400 - 450

- Mine groundwater monitoring bores
- Reference bore
- CSG appraisal well
- EFGW1S : BoreID
- 3168 : BoreID

Ironbark No. 1 UWIR (IRB5001.001)

Predicted Depressurisation in the Leichhardt Seam at the end of mining (LTAA)



AGE

DATE
11/08/2023

FIGURE No:
22

Appendix A

Laboratory analysis results

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW1S	EFGW1S	EFGW1S
Sample Date			09/07/08	17/01/18	25/07/18	30/08/18
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.27	7.84	7.59	7.53
Electrical Conductivity	µS/cm	1	3,550	6,360	5,500	5,700
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	466	596	777	785
Dissolved Major Ions						
Calcium	mg/L	1	37	102	76	83
Magnesium	mg/L	1	42	119	105	104
Sodium	mg/L	1	576	1,090	1,010	1,060
Potassium	mg/L	1	5	7	5	6
Chloride	mg/L	1	740	1,720	1,330	1,450
Sulfate	mg/L	1	78	66	68	80
Dissolved Metals						
Aluminium	mg/L	0.01	-	<0.01	-	-
Arsenic	mg/L	0.001	0.001	0.002	<0.001	0.001
Cadmium	mg/L	0.0001	0.0001	<0.0001	-	-
Cobalt	mg/L	0.001	-	0.005	-	-
Copper	mg/L	0.001	<0.001	<0.001	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.685	1.73	2.78	1.27
Nickel	mg/L	0.001	0.004	0.007	-	-
Zinc	mg/L	0.005	0.011	0.073	0.024	0.026
Iron	mg/L	0.05	0.75	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	-	0.004	0.001	0.002
Lead	mg/L	0.001	-	0.011	<0.001	0.004
Manganese	mg/L	0.001	-	2.7	2.84	1.44
Zinc	mg/L	0.005	-	0.364	0.041	0.072
Iron	mg/L	0.05	-	12.1	0.43	2.27
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	-	-	<20	<20
C10 - C14 Fraction	µg/L	50	-	-	<50	<50
C15 - C28 Fraction	µg/L	100	-	-	<100	<100
C29 - C36 Fraction	µg/L	50	-	-	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	-	-	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20			<20	<20
>C10 - C16 Fraction	µg/L	100			<100	<100
>C16 - C34 Fraction	µg/L	100			<100	<100
>C34 - C40 Fraction	µg/L	100			<100	<100
>C10 - C40 Fraction (sum)	µg/L	100			<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100			<100	<100
BTEXN						
Benzene	µg/L	1			<1	<1
Toluene	µg/L	2			<2	<2
Ethylbenzene	µg/L	2			<2	<2
meta- & para-Xylene	µg/L	2			<2	<2
ortho-Xylene	µg/L	2			<2	<2
Total Xylenes	µg/L	2			<2	<2
Sum of BTEX	µg/L	1			<1	<1
Naphthalene	µg/L	5			<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW1S	EFGW1S	EFGW1S
Sample Date			27/09/18	24/10/18	16/11/18	26/02/19
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.71	7.92	7.63	6.39
Electrical Conductivity	µS/cm	1	4,050	2,320	4,560	276
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	728	632	649	606
Dissolved Major Ions						
Calcium	mg/L	1	42	17	56	50
Magnesium	mg/L	1	49	20	66	63
Sodium	mg/L	1	710	425	882	785
Potassium	mg/L	1	4	2	5	6
Chloride	mg/L	1	823	415	1,080	1,100
Sulfate	mg/L	1	44	23	55	52
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	<0.001	<0.001	0.003	<0.001
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.256	0.364	0.24	0.423
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	0.027	0.031	0.034	0.012
Iron	mg/L	0.05	<0.05	<0.05	0.14	<0.05
Total Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	<0.001	<0.001	0.003	<0.001
Lead	mg/L	0.001	0.001	<0.001	<0.001	0.001
Manganese	mg/L	0.001	0.256	0.412	0.252	0.434
Zinc	mg/L	0.005	0.036	0.046	0.04	0.03
Iron	mg/L	0.05	0.9	0.71	0.51	0.65
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW1S	EFGW1S	EFGW1S
Sample Date			26/03/19	30/04/19	22/05/19	21/06/19
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	5.85	5.81	5.77	6.03
Electrical Conductivity	µS/cm	1	277	277	277	277
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	593	677	727	636
Dissolved Major Ions						
Calcium	mg/L	1	58	62	33	98
Magnesium	mg/L	1	77	80	44	107
Sodium	mg/L	1	939	958	701	1,190
Potassium	mg/L	1	5	5	4	7
Chloride	mg/L	1	1,380	1,460	837	1,780
Sulfate	mg/L	1	60	67	38	66
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	0.002
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.114	0.178	0.048	0.53
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.032	0.011	0.01	0.008
Iron	mg/L	0.05	<0.05	0.05	<0.05	1.01
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.001	0.002	0.001	0.001
Lead	mg/L	0.001	0.004	0.005	0.003	0.002
Manganese	mg/L	0.001	0.258	0.325	0.152	0.257
Zinc	mg/L	0.005	0.086	0.069	0.048	0.029
Iron	mg/L	0.05	3.32	4.04	2.61	1.3
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW1S	EFGW1S	EFGW1S
Sample Date			16/07/19	27/08/19	06/11/19	26/02/20
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	6.3	6.61	7.29	5.15
Electrical Conductivity	µS/cm	1	276	276	275	278
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	709	642	591	642
Dissolved Major Ions						
Calcium	mg/L	1	66	47	35	95
Magnesium	mg/L	1	77	61	46	112
Sodium	mg/L	1	1,070	831	634	1,070
Potassium	mg/L	1	6	5	4	6
Chloride	mg/L	1	1,880	1,180	949	1,590
Sulfate	mg/L	1	66	49	41	77
Dissolved Metals						
Aluminium	mg/L	0.01			<0.01	<0.01
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	0.001
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.163	0.057	0.011	1.93
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.008	0.006	0.012	0.016
Iron	mg/L	0.05	<0.05	<0.05	<0.05	0.15
Total Metals						
Aluminium	mg/L	0.01			0.03	0.13
Arsenic	mg/L	0.001	0.002	<0.001	<0.001	0.001
Lead	mg/L	0.001	0.006	0.002	<0.001	<0.001
Manganese	mg/L	0.001	0.4	0.145	0.038	2.3
Zinc	mg/L	0.005	0.061	0.026	0.015	0.022
Iron	mg/L	0.05	5.28	1.43	0.08	0.4
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW1S	EFGW1S	EFGW1S
Sample Date			26/05/20	27/08/2020	24/11/2020	04/02/2021
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	5.42	6.89	8.72	4.22
Electrical Conductivity	µS/cm	1	277	276	274	279
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	731	878	851	750
Dissolved Major Ions						
Calcium	mg/L	1	39	45	42	44
Magnesium	mg/L	1	47	50	52	55
Sodium	mg/L	1	668	695	668	695
Potassium	mg/L	1	4	4	4	4
Chloride	mg/L	1	899	933	813	795
Sulfate	mg/L	1	54	44	37	70
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	<0.001	<0.001	0.001	<0.001
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.42	1.17	0.055	1.8
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.039	0.116	0.413	0.058
Iron	mg/L	0.05	0.08	0.34	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.71	0.18	0.19	0.15
Arsenic	mg/L	0.001	0.002	<0.001	0.001	0.001
Lead	mg/L	0.001	0.004	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.53	1.17	0.101	1.93
Zinc	mg/L	0.005	0.096	0.199	0.411	0.075
Iron	mg/L	0.05	0.96	0.63	0.42	0.51
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID		EFGW1S	EFGW1S	EFGW1S	EFGW1S	
Sample Date		24/08/21	08/12/21	10/02/22	19/05/22	
Aquifer		Alluvium	Alluvium	Alluvium	Alluvium	
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	5.18	5.06	4.26	4.07
Electrical Conductivity	µS/cm	1	278	278	279	279
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	754	950	759	710
Dissolved Major Ions						
Calcium	mg/L	1	19	57	34	21
Magnesium	mg/L	1	26	70	44	27
Sodium	mg/L	1	438	806	601	473
Potassium	mg/L	1	6	5	4	3
Chloride	mg/L	1	335	890	633	446
Sulfate	mg/L	1	16	2	3	4
Dissolved Metals						
Aluminium	mg/L	0.01	0.02	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.001	0.002	0.002	<0.001
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001		<0.001
Manganese	mg/L	0.001	1.62	4.34	3.59	0.002
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.011	<0.005		<0.005
Iron	mg/L	0.05	0.18	5.54	1.86	<0.05
Total Metals						
Aluminium	mg/L	0.01	4.01	0.29	0.08	0.22
Arsenic	mg/L	0.001	0.004	0.003	0.003	0.001
Lead	mg/L	0.001	0.003	<0.001		<0.001
Manganese	mg/L	0.001	1.7	4.29	3.77	3.08
Zinc	mg/L	0.005	0.162	0.051		0.032
Iron	mg/L	0.05	3.34	6.92	3.78	2.02
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	30	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	910	290	<100
C29 - C36 Fraction	µg/L	50	160	1130	240	<50
C10 - C36 Fraction (sum)	µg/L	50	160	2040	530	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	200	2010	520	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	200	2010	520	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW1S	EFGW2S	EFGW2D	EFGW2D
Sample Date			09/08/22	09/07/08	09/07/08	16/01/18
Aquifer			Alluvium	Alluvium	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	3.98	7.19	7.46	8.18
Electrical Conductivity	µS/cm	1	279	1,040	12,400	5,870
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	684	225	263	293
Dissolved Major Ions						
Calcium	mg/L	1	25	20	276	78
Magnesium	mg/L	1	31	18	81	18
Sodium	mg/L	1	522	150	2,070	1,130
Potassium	mg/L	1	3	1	18	6
Chloride	mg/L	1	463	148	4,000	1,660
Sulfate	mg/L	1	8	22	110	6
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	-	-	<0.01
Arsenic	mg/L	0.001	0.001	<0.001	0.012	0.01
Cadmium	mg/L	0.0001		<0.0001	<0.0001	<0.0001
Cobalt	mg/L	0.001		-	-	<0.001
Copper	mg/L	0.001		<0.001	0.002	<0.001
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	2.98	0.01	1.34	0.389
Nickel	mg/L	0.001		<0.001	0.002	<0.001
Zinc	mg/L	0.005	0.007	0.011	0.01	<0.005
Iron	mg/L	0.05	<0.05	<0.05	0.22	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.06	-	-	
Arsenic	mg/L	0.001	0.002	-	-	0.01
Lead	mg/L	0.001	<0.001	-	-	0.001
Manganese	mg/L	0.001	3.31	-	-	0.445
Zinc	mg/L	0.005	0.041	-	-	0.026
Iron	mg/L	0.05	1.35	-	-	1.39
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	-	-	-
C10 - C14 Fraction	µg/L	50	<50	-	-	-
C15 - C28 Fraction	µg/L	100	<100	-	-	-
C29 - C36 Fraction	µg/L	50	<50	-	-	-
C10 - C36 Fraction (sum)	µg/L	50	<50	-	-	-
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20			
>C10 - C16 Fraction	µg/L	100	<100			
>C16 - C34 Fraction	µg/L	100	<100			
>C34 - C40 Fraction	µg/L	100	<100			
>C10 - C40 Fraction (sum)	µg/L	100	<100			
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100			
BTEXN						
Benzene	µg/L	1	<1			
Toluene	µg/L	2	<2			
Ethylbenzene	µg/L	2	<2			
meta- & para-Xylene	µg/L	2	<2			
ortho-Xylene	µg/L	2	<2			
Total Xylenes	µg/L	2	<2			
Sum of BTEX	µg/L	1	<1			
Naphthalene	µg/L	5	<5			

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			24/07/18	30/08/18	27/09/18	23/10/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8.15	7.75	7.76	7.91
Electrical Conductivity	µS/cm	1	5,610	9,430	9,230	8,790
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	385	168	177	177
Dissolved Major Ions						
Calcium	mg/L	1	88	238	198	223
Magnesium	mg/L	1	20	56	44	48
Sodium	mg/L	1	1,100	1,830	1,660	1,650
Potassium	mg/L	1	7	11	10	10
Chloride	mg/L	1	1,590	3,340	3,080	2,590
Sulfate	mg/L	1	12	3	3	2
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	0.013	0.009	0.01	0.009
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.241	1.13	1.4	1
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	<0.005	0.006	0.008	0.023
Iron	mg/L	0.05	<0.05	0.06	<0.05	0.08
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.032	0.01	0.014	0.013
Lead	mg/L	0.001	0.102	0.001	0.007	0.017
Manganese	mg/L	0.001	5.55	1.18	1.4	1.49
Zinc	mg/L	0.005	0.533	0.006	0.059	0.123
Iron	mg/L	0.05	151	0.8	12	12.4
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	60
C15 - C28 Fraction	µg/L	100	1180	<100	140	260
C29 - C36 Fraction	µg/L	50	1280	<50	100	150
C10 - C36 Fraction (sum)	µg/L	50	2460	<50	240	470
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	2020	<100	200	350
>C34 - C40 Fraction	µg/L	100	1210	<100	<100	130
>C10 - C40 Fraction (sum)	µg/L	100	3230	<100	200	480
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	6
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	6
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			16/11/18	26/02/19	26/03/19	30/04/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8	8	7.57	7.56
Electrical Conductivity	µS/cm	1	8,150	7,120	7,600	8,900
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	196	263	230	202
Dissolved Major Ions						
Calcium	mg/L	1	151	122	189	187
Magnesium	mg/L	1	37	34	52	51
Sodium	mg/L	1	1,490	1,310	1,720	1,620
Potassium	mg/L	1	9	11	11	10
Chloride	mg/L	1	2,500	1,960	2,440	2,810
Sulfate	mg/L	1	3	6	6	8
Dissolved Metals						
Aluminium	mg/L	0.01	-	0.012	0.008	0.007
Arsenic	mg/L	0.001	0.008	0.012	0.008	0.007
Cadmium	mg/L	0.0001	-			
Cobalt	mg/L	0.001	-			
Copper	mg/L	0.001	-			
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.578	0.584	0.89	0.933
Nickel	mg/L	0.001	-			
Zinc	mg/L	0.005	0.012	0.03	0.034	0.037
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.01	0.013	0.011	0.009
Lead	mg/L	0.001	0.003	0.002	0.004	0.002
Manganese	mg/L	0.001	0.635	0.614	1.02	1.04
Zinc	mg/L	0.005	0.035	0.048	0.099	0.058
Iron	mg/L	0.05	1.9	0.41	3.39	2.32
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	140	160	370	150
C29 - C36 Fraction	µg/L	50	<50	<50	50	<50
C10 - C36 Fraction (sum)	µg/L	50	140	160	420	150
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	150	160	400	140
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	150	160	400	140
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			22/05/19	21/06/19	16/07/19	27/08/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.98	7.45	7.52	7.66
Electrical Conductivity	µS/cm	1	8,630	9,130	8,960	8,960
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	217	178	222	200
Dissolved Major Ions						
Calcium	mg/L	1	192	235	211	202
Magnesium	mg/L	1	50	49	54	48
Sodium	mg/L	1	1,680	1,660	1,770	1,670
Potassium	mg/L	1	10	11	11	10
Chloride	mg/L	1	2,980	2,910	2,750	2,710
Sulfate	mg/L	1	7	2	7	1
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.007	0.008	0.007	0.007
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.929	0.955	0.948	1.05
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.032	0.042	0.04	0.036
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.009	0.01	0.009	0.01
Lead	mg/L	0.001	0.002	0.002	0.003	0.003
Manganese	mg/L	0.001	0.902	1.02	0.989	1.01
Zinc	mg/L	0.005	0.056	0.05	0.07	0.071
Iron	mg/L	0.05	0.56	0.56	0.88	0.76
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	210	170	160	250
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	210	170	160	250
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	240	180	160	260
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	240	180	160	260
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			06/11/19	26/02/20	26/05/20	26/08/2020
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.5	7.87	7.86	7.81
Electrical Conductivity	µS/cm	1	8,210	8,220	7,910	8,380
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	235	247	228	228
Dissolved Major Ions						
Calcium	mg/L	1	156	152	156	190
Magnesium	mg/L	1	43	40	39	42
Sodium	mg/L	1	1,460	1,540	1,540	1,580
Potassium	mg/L	1	10	9	10	10
Chloride	mg/L	1	2,580	2,380	2,400	2,580
Sulfate	mg/L	1	8	7	2	4
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.007	0.01	0.011	0.009
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.837	0.747	0.722	0.836
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.059	0.049	0.034	0.046
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.08	0.52	0.1	<0.01
Arsenic	mg/L	0.001	0.008	0.012	0.012	0.01
Lead	mg/L	0.001	0.001	0.004	0.001	0.001
Manganese	mg/L	0.001	0.865	0.837	0.763	0.839
Zinc	mg/L	0.005	0.062	0.087	0.044	0.052
Iron	mg/L	0.05	0.16	0.97	0.24	0.07
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	60	<50	<50	<50
C15 - C28 Fraction	µg/L	100	420	500	240	<100
C29 - C36 Fraction	µg/L	50	80	50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	560	550	240	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	440	510	260	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	440	510	260	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			19/11/2020	04/02/2021	12/05/21	24/08/21
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.96	7.92	7.32	8.11
Electrical Conductivity	µS/cm	1	7,010	5,920	13,200	5,130
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	266	292	101	330
Dissolved Major Ions						
Calcium	mg/L	1	112	78	425	57
Magnesium	mg/L	1	30	23	106	17
Sodium	mg/L	1	1,260	1,180	2,560	1,050
Potassium	mg/L	1	8	7	15	6
Chloride	mg/L	1	2,220	1,760	5,180	1,560
Sulfate	mg/L	1	2	3	<1	2
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.01	0.014	0.006	0.013
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	0.002	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.66	0.416	2.27	0.308
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.091	0.072	0.128	0.054
Iron	mg/L	0.05	<0.05	<0.05	0.33	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.01	0.06	3.43	0.09
Arsenic	mg/L	0.001	0.011	0.014	0.008	0.015
Lead	mg/L	0.001	0.005	0.004	0.008	<0.001
Manganese	mg/L	0.001	0.589	0.442	2.53	0.314
Zinc	mg/L	0.005	0.099	0.078	0.164	0.062
Iron	mg/L	0.05	0.08	0.16	5.27	0.2
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	320	300	110	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	320	300	110	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	310	280	110	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	310	280	110	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW2D	EFGW2D	EFGW2D	EFGW2D
Sample Date			08/12/21	02/02/2022	19/05/22	09/08/22
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8.04	7.89	8.04	8.04
Electrical Conductivity	µS/cm	1	5,330	5,210	5,790	5,000
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	333	346	366	332
Dissolved Major Ions						
Calcium	mg/L	1	69	57	60	70
Magnesium	mg/L	1	20	17	17	18
Sodium	mg/L	1	1,080	1,010	1,050	1,130
Potassium	mg/L	1	7	6	6	7
Chloride	mg/L	1	1,520	1,630	1,630	1,590
Sulfate	mg/L	1	<1	1	<1	4
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.012	0.012	<0.001	0.011
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.377	0.358	<0.001	0.358
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.022	0.01	<0.005	<0.005
Iron	mg/L	0.05	<0.05	<0.05	<0.05	0.05
Total Metals						
Aluminium	mg/L	0.01	0.03	0.04	0.02	0.06
Arsenic	mg/L	0.001	0.012	0.014	0.01	0.012
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.393	0.381	0.474	0.366
Zinc	mg/L	0.005	0.027	0.012	0.012	0.016
Iron	mg/L	0.05	0.12	0.1	0.05	0.16
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	110	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	110	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			09/07/08	18/01/18	25/07/18	30/08/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.24	7.96	7.71	7.51
Electrical Conductivity	µS/cm	1	20,700	17,900	17,400	17,800
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	424	626	340	254
Dissolved Major Ions						
Calcium	mg/L	1	510	486	504	536
Magnesium	mg/L	1	325	222	214	228
Sodium	mg/L	1	3,380	3,290	3,280	3,570
Potassium	mg/L	1	48	31	32	33
Chloride	mg/L	1	6,750	6,410	6,100	6,570
Sulfate	mg/L	1	800	45	161	138
Dissolved Metals						
Aluminium	mg/L	0.01	-	0.05	-	-
Arsenic	mg/L	0.001	0.01	<0.001	0.001	<0.001
Cadmium	mg/L	0.0001	0.0003	<0.0001	-	-
Cobalt	mg/L	0.001	-	<0.001	-	-
Copper	mg/L	0.001	0.001	<0.001	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.9	0.96	0.964	0.955
Nickel	mg/L	0.001	0.003	0.008	-	-
Zinc	mg/L	0.005	0.012	<0.005	<0.005	<0.005
Iron	mg/L	0.05	1.43	0.13	<0.05	0.49
Total Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	-	0.003	<0.001	0.001
Lead	mg/L	0.001	-	0.008	0.002	0.002
Manganese	mg/L	0.001	-	1.27	1.02	0.979
Zinc	mg/L	0.005	-	0.166	0.106	0.114
Iron	mg/L	0.05	-	16	0.84	1.8
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	-	-	480	610
C10 - C14 Fraction	µg/L	50	-	-	60	120
C15 - C28 Fraction	µg/L	100	-	-	<100	110
C29 - C36 Fraction	µg/L	50	-	-	60	60
C10 - C36 Fraction (sum)	µg/L	50	-	-	120	290
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20			470	600
>C10 - C16 Fraction	µg/L	100			<100	120
>C16 - C34 Fraction	µg/L	100			130	150
>C34 - C40 Fraction	µg/L	100			<100	<100
>C10 - C40 Fraction (sum)	µg/L	100			130	270
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100			<100	120
BTEXN						
Benzene	µg/L	1			<1	<1
Toluene	µg/L	2			<2	<2
Ethylbenzene	µg/L	2			<2	<2
meta- & para-Xylene	µg/L	2			<2	<2
ortho-Xylene	µg/L	2			<2	<2
Total Xylenes	µg/L	2			<2	<2
Sum of BTEX	µg/L	1			<1	<1
Naphthalene	µg/L	5			<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			26/09/18	23/10/18	15/11/18	26/02/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.43	7.55	7.24	7.63
Electrical Conductivity	µS/cm	1	17,700	18,100	18,200	18,100
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	129	84	69	72
Dissolved Major Ions						
Calcium	mg/L	1	657	698	766	625
Magnesium	mg/L	1	163	160	168	187
Sodium	mg/L	1	3,400	3,380	3,620	3,320
Potassium	mg/L	1	34	35	37	44
Chloride	mg/L	1	6,410	6,540	6,420	6,170
Sulfate	mg/L	1	149	168	200	190
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	<0.001	0.006	0.003	0.004
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.751	0.585	0.542	0.742
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	<0.005	0.059	0.062	0.077
Iron	mg/L	0.05	0.3	0.19	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	0.001	0.007	0.004	0.004
Lead	mg/L	0.001	0.001	0.002	0.001	0.002
Manganese	mg/L	0.001	0.751	0.651	0.549	0.767
Zinc	mg/L	0.005	0.028	0.111	0.059	0.086
Iron	mg/L	0.05	0.87	0.9	0.39	0.16
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	300	140	<20	100
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	340	140	<20	90
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	120	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	120	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	4	4	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	4	4	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			26/03/19	30/04/19	22/05/19	20/06/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.08	7.04	7.41	6.87
Electrical Conductivity	µS/cm	1	18,100	19,100	19,200	19,600
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	53	52	53	57
Dissolved Major Ions						
Calcium	mg/L	1	705	685	713	760
Magnesium	mg/L	1	158	160	171	165
Sodium	mg/L	1	3,380	3,310	3,620	3,380
Potassium	mg/L	1	35	34	36	35
Chloride	mg/L	1	6,990	6,830	7,030	7,180
Sulfate	mg/L	1	186	187	192	192
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.001	0.002	<0.005	0.002
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.005	<0.001
Manganese	mg/L	0.001	0.684	0.64	0.699	0.598
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.093	0.032	0.069	0.059
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.002	0.002	<0.005	0.002
Lead	mg/L	0.001	0.001	<0.001	<0.005	<0.001
Manganese	mg/L	0.001	0.701	0.661	0.778	0.625
Zinc	mg/L	0.005	0.1	0.034	0.095	0.052
Iron	mg/L	0.05	0.74	0.13	0.24	0.13
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	120	110
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	120	110
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	140	100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	140	100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			16/07/19	27/08/19	06/11/19	26/02/20
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.05	7.23	7.07	7.49
Electrical Conductivity	µS/cm	1	19,600	19,200	19,300	20,100
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	61	67	82	79
Dissolved Major Ions						
Calcium	mg/L	1	741	656	607	615
Magnesium	mg/L	1	173	168	164	177
Sodium	mg/L	1	3,470	3,290	3,100	3,520
Potassium	mg/L	1	36	34	33	34
Chloride	mg/L	1	6,720	6,510	6,790	6,720
Sulfate	mg/L	1	178	194	175	192
Dissolved Metals						
Aluminium	mg/L	0.01			<0.01	<0.01
Arsenic	mg/L	0.001	0.002	0.002	0.003	0.002
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.519	0.631	0.7	0.713
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.055	0.048	0.101	0.057
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01			0.09	0.04
Arsenic	mg/L	0.001	0.003	0.004	0.003	0.003
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.552	0.603	0.72	0.85
Zinc	mg/L	0.005	0.086	0.065	0.096	0.054
Iron	mg/L	0.05	0.17	0.08	0.22	0.12
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	30
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	110	110	250	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	110	110	250	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	30
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	110	110	270	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	110	110	270	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			26/05/20	26/08/2020	24/11/2020	04/02/2021
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.27	7.46	7.35	7.27
Electrical Conductivity	µS/cm	1	19,000	19,200	19,300	18,900
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	71	86	96	88
Dissolved Major Ions						
Calcium	mg/L	1	640	710	616	576
Magnesium	mg/L	1	182	173	188	190
Sodium	mg/L	1	3,590	3,470	3,470	3,560
Potassium	mg/L	1	35	34	35	36
Chloride	mg/L	1	7,890	6,980	7,390	6,880
Sulfate	mg/L	1	186	180	184	163
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.002	0.002	0.002	0.002
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.748	0.691	0.732	0.726
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.127	0.009	0.081	0.016
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.08	0.26	0.08	0.06
Arsenic	mg/L	0.001	0.003	0.002	0.002	0.002
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.77	0.694	0.811	0.774
Zinc	mg/L	0.005	0.149	0.023	0.079	0.019
Iron	mg/L	0.05	0.27	0.43	0.2	0.16
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	20	20	40	40
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	400	<100	<100	<100
C29 - C36 Fraction	µg/L	50	60	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	460	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	20	20	40	30
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	430	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	430	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW3D	EFGW3D
Sample Date			12/05/21	24/08/21	25/11/21	02/02/2022
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.17	7.55	7.49	7.5
Electrical Conductivity	µS/cm	1	17,800	18,000	18,200	16,600
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	92	97	99	103
Dissolved Major Ions						
Calcium	mg/L	1	584	509	554	516
Magnesium	mg/L	1	199	198	203	196
Sodium	mg/L	1	3,550	3,420	3,590	3,290
Potassium	mg/L	1	36	33	34	31
Chloride	mg/L	1	7,020	7,020	6,590	6,970
Sulfate	mg/L	1	154	153	167	136
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.001	0.002	0.001	<0.001
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.855	0.921	0.959	0.992
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.013	0.009	0.006	0.01
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.07	0.1	0.07	0.1
Arsenic	mg/L	0.001	0.001	0.002	0.001	0.001
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.895	0.956	0.966	1.01
Zinc	mg/L	0.005	0.012	0.013	0.009	0.012
Iron	mg/L	0.05	0.25	0.23	0.28	0.47
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	50	40	70	50
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	50	40	60	50
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW3D	EFGW3D	EFGW4D	EFGW4D
Sample Date			19/05/22	09/08/22	09/07/08	17/01/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.69	7.59	6.87	7.52
Electrical Conductivity	µS/cm	1	20,400	15,700	34,400	25,300
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	111	102	418	376
Dissolved Major Ions						
Calcium	mg/L	1	559	527	557	610
Magnesium	mg/L	1	227	206	638	535
Sodium	mg/L	1	3,820	3,580	4,260	4,330
Potassium	mg/L	1	39	34	118	77
Chloride	mg/L	1	7,310	7,260	9,400	8,890
Sulfate	mg/L	1	140	129	692	618
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	0.02	-	<0.01
Arsenic	mg/L	0.001	0.001	0.001	<0.001	0.002
Cadmium	mg/L	0.0001			0.0001	<0.0001
Cobalt	mg/L	0.001			-	0.001
Copper	mg/L	0.001			0.002	<0.001
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.04	0.99	0.898	0.797
Nickel	mg/L	0.001			0.004	0.002
Zinc	mg/L	0.005	0.009	0.011	0.015	<0.005
Iron	mg/L	0.05	<0.05	0.33	4.63	4.22
Total Metals						
Aluminium	mg/L	0.01	0.06	0.01	-	
Arsenic	mg/L	0.001	0.001	0.001	-	0.002
Lead	mg/L	0.001	<0.001	<0.001	-	<0.001
Manganese	mg/L	0.001	1.02	1.03	-	0.797
Zinc	mg/L	0.005	0.012	0.019	-	<0.005
Iron	mg/L	0.05	0.28	0.15	-	4.22
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	40	60	-	-
C10 - C14 Fraction	µg/L	50	<50	<50	-	-
C15 - C28 Fraction	µg/L	100	<100	<100	-	-
C29 - C36 Fraction	µg/L	50	<50	<50	-	-
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	-
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	40	60		
>C10 - C16 Fraction	µg/L	100	<100	<100		
>C16 - C34 Fraction	µg/L	100	<100	<100		
>C34 - C40 Fraction	µg/L	100	<100	<100		
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100		
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100		
BTEXN						
Benzene	µg/L	1	<1	<1		
Toluene	µg/L	2	<2	<2		
Ethylbenzene	µg/L	2	<2	<2		
meta- & para-Xylene	µg/L	2	<2	<2		
ortho-Xylene	µg/L	2	<2	<2		
Total Xylenes	µg/L	2	<2	<2		
Sum of BTEX	µg/L	1	<1	<1		
Naphthalene	µg/L	5	<5	<5		

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW4D	EFGW4D
Sample Date			24/07/18	31/08/18	27/09/18	24/10/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.93	7.11	7.1	7.48
Electrical Conductivity	µS/cm	1	24,600	22,700	28,600	16,100
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	439	445	463	442
Dissolved Major Ions						
Calcium	mg/L	1	602	605	632	628
Magnesium	mg/L	1	583	607	593	591
Sodium	mg/L	1	4,470	4,640	4,600	4,510
Potassium	mg/L	1	81	84	84	81
Chloride	mg/L	1	8,570	8,790	8,330	8,640
Sulfate	mg/L	1	636	734	631	590
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	0.003	0.003	0.002	0.002
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.964	0.768	0.728	0.72
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	<0.005	<0.005	0.02	0.031
Iron	mg/L	0.05	4.47	4.06	4.11	4.1
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.003	0.003	0.002	0.002
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.756	0.768	0.755	0.72
Zinc	mg/L	0.005	<0.005	<0.005	0.02	0.031
Iron	mg/L	0.05	4.47	4.06	4.11	4.1
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	220	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	220	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	220	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	220	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW4D	EFGW4D
Sample Date			15/11/18	26/02/19	26/03/19	30/04/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	6.9	7.77	7	6.86
Electrical Conductivity	µS/cm	1	28,800	25,600	25,900	26,800
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	416	420	445	451
Dissolved Major Ions						
Calcium	mg/L	1	656	586	606	591
Magnesium	mg/L	1	651	649	595	611
Sodium	mg/L	1	4,870	4,520	4,470	4,480
Potassium	mg/L	1	87	106	83	80
Chloride	mg/L	1	8,780	8,520	9,300	9,290
Sulfate	mg/L	1	698	691	683	668
Dissolved Metals						
Aluminium	mg/L	0.01	-			
Arsenic	mg/L	0.001	0.002	0.002	0.002	0.002
Cadmium	mg/L	0.0001	-			
Cobalt	mg/L	0.001	-			
Copper	mg/L	0.001	-			
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.74	0.694	0.751	0.714
Nickel	mg/L	0.001	-			
Zinc	mg/L	0.005	0.015	0.014	0.015	0.012
Iron	mg/L	0.05	3.8	3.15	3.59	4.04
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.002	0.002	0.002	0.002
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.74	0.694	0.751	0.714
Zinc	mg/L	0.005	0.015	0.014	0.015	0.012
Iron	mg/L	0.05	3.8	3.15	3.59	4.04
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW4D	EFGW4D
Sample Date			22/05/19	21/06/19	16/07/19	27/08/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.47	6.84	6.78	6.99
Electrical Conductivity	µS/cm	1	25,800	27,400	27,400	28,400
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	452	414	448	463
Dissolved Major Ions						
Calcium	mg/L	1	610	642	664	584
Magnesium	mg/L	1	628	696	625	592
Sodium	mg/L	1	4,800	4,900	4,640	4,550
Potassium	mg/L	1	83	90	85	83
Chloride	mg/L	1	9,120	9,260	8,600	8,520
Sulfate	mg/L	1	704	670	677	633
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	0.002
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.005	<0.005	<0.001
Manganese	mg/L	0.001	0.741	0.783	0.723	0.749
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	<0.025	<0.025	<0.025	0.009
Iron	mg/L	0.05	1.95	4.1	4.04	4.28
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	0.002
Lead	mg/L	0.001	<0.005	<0.005	<0.005	<0.001
Manganese	mg/L	0.001	0.741	0.783	0.723	0.749
Zinc	mg/L	0.005	<0.025	<0.025	<0.025	0.009
Iron	mg/L	0.05	1.95	4.1	4.04	4.28
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW4D	EFGW4D
Sample Date			06/11/19	26/02/20	26/05/20	26/08/2020
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	6.81	7.37	7.25	7.43
Electrical Conductivity	µS/cm	1	29,200	26,700	26,300	25,800
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	452	438	414	428
Dissolved Major Ions						
Calcium	mg/L	1	528	572	584	639
Magnesium	mg/L	1	561	592	601	570
Sodium	mg/L	1	4,170	4,770	4,740	4,610
Potassium	mg/L	1	77	85	84	82
Chloride	mg/L	1	9,330	9,060	8,740	9,080
Sulfate	mg/L	1	614	707	627	665
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	0.02	<0.01	<0.01
Arsenic	mg/L	0.001	0.002	0.005	0.002	0.003
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.696	0.276	0.725	0.828
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.011	<0.005	0.008	0.129
Iron	mg/L	0.05	3.64	5.34	3.57	3.63
Total Metals						
Aluminium	mg/L	0.01	<0.01	0.02	<0.01	<0.01
Arsenic	mg/L	0.001	0.002	0.005	0.002	0.003
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.696	0.276	0.725	0.828
Zinc	mg/L	0.005	0.011	<0.005	0.008	0.129
Iron	mg/L	0.05	3.64	5.34	3.57	3.63
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	60	<50	<50
C15 - C28 Fraction	µg/L	100	<100	570	<100	<100
C29 - C36 Fraction	µg/L	50	<50	110	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	740	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	630	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	630	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW4D	EFGW4D
Sample Date			24/11/2020	04/02/2021	12/05/21	24/08/21
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.25	7.38	6.88	7.09
Electrical Conductivity	µS/cm	1	26,100	21,600	27,100	25,500
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	431	390	409	391
Dissolved Major Ions						
Calcium	mg/L	1	587	564	582	586
Magnesium	mg/L	1	602	588	638	615
Sodium	mg/L	1	4,600	4,680	4,890	4,810
Potassium	mg/L	1	88	89	87	89
Chloride	mg/L	1	9,630	8,900	9,130	9,140
Sulfate	mg/L	1	616	692	694	726
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.05	<0.05
Arsenic	mg/L	0.001	0.002	0.003	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	0.002	0.002	<0.005	<0.005
Manganese	mg/L	0.001	0.808	0.796	0.994	1.04
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.295	0.265	0.244	0.141
Iron	mg/L	0.05	3.68	4.07	4.4	4.72
Total Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.05	<0.05
Arsenic	mg/L	0.001	0.002	0.003	<0.005	<0.005
Lead	mg/L	0.001	0.002	0.002	<0.005	<0.005
Manganese	mg/L	0.001	0.808	0.796	0.994	1.04
Zinc	mg/L	0.005	0.295	0.265	0.244	0.141
Iron	mg/L	0.05	3.68	4.07	4.4	4.72
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	360	150	<100	120
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	360	150	<50	120
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	320	130	<100	110
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	320	130	<100	110
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW4D	EFGW4D	EFGW5D	EFGW5D
Sample Date			25/11/21	02/02/2022	09/07/08	16/01/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.4	7.25	8.16	8.15
Electrical Conductivity	µS/cm	1	21,100	22,600	1,970	10,400
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	372	432	172	429
Dissolved Major Ions						
Calcium	mg/L	1	614	521	19	120
Magnesium	mg/L	1	618	563	18	140
Sodium	mg/L	1	4,740	4,360	304	1,870
Potassium	mg/L	1	89	79	14	41
Chloride	mg/L	1	8,810	9,320	378	3,460
Sulfate	mg/L	1	706	726	92	44
Dissolved Metals						
Aluminium	mg/L	0.01	<0.05	<0.01	-	0.02
Arsenic	mg/L	0.001	<0.005	0.002	0.003	<0.001
Cadmium	mg/L	0.0001			0.0002	<0.0001
Cobalt	mg/L	0.001			-	<0.001
Copper	mg/L	0.001			0.002	<0.001
Lead	mg/L	0.001	<0.005	<0.001	0.002	<0.001
Manganese	mg/L	0.001	1.06	1.01	0.063	0.23
Nickel	mg/L	0.001			0.013	<0.001
Zinc	mg/L	0.005	0.033	0.043	0.036	<0.005
Iron	mg/L	0.05	4.92	5.06	0.06	<0.05
Total Metals						
Aluminium	mg/L	0.01	<0.05	<0.01	-	
Arsenic	mg/L	0.001	<0.005	0.002	-	0.002
Lead	mg/L	0.001	<0.005	<0.001	-	0.003
Manganese	mg/L	0.001	1.06	1.01	-	0.251
Zinc	mg/L	0.005	0.033	0.043	-	0.051
Iron	mg/L	0.05	4.92	5.06	-	0.3
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	20	20	-	-
C10 - C14 Fraction	µg/L	50	<50	<50	-	-
C15 - C28 Fraction	µg/L	100	<100	<100	-	-
C29 - C36 Fraction	µg/L	50	<50	<50	-	-
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	-
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	20	<20		
>C10 - C16 Fraction	µg/L	100	<100	<100		
>C16 - C34 Fraction	µg/L	100	<100	<100		
>C34 - C40 Fraction	µg/L	100	<100	<100		
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100		
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100		
BTEXN						
Benzene	µg/L	1	<1	<1		
Toluene	µg/L	2	<2	<2		
Ethylbenzene	µg/L	2	<2	<2		
meta- & para-Xylene	µg/L	2	<2	<2		
ortho-Xylene	µg/L	2	<2	<2		
Total Xylenes	µg/L	2	<2	<2		
Sum of BTEX	µg/L	1	<1	<1		
Naphthalene	µg/L	5	<5	<5		

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			25/07/18	31/08/18	27/09/18	24/10/18
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8.02	7.42	7.41	7.67
Electrical Conductivity	µS/cm	1	20,600	21,600	20,400	20,700
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	552	567	536	493
Dissolved Major Ions						
Calcium	mg/L	1	295	306	336	334
Magnesium	mg/L	1	444	456	451	461
Sodium	mg/L	1	3,860	4,020	4,030	3,950
Potassium	mg/L	1	76	78	80	78
Chloride	mg/L	1	7,520	7,620	7,360	7,670
Sulfate	mg/L	1	<1	2	<1	16
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	0.005	0.003	0.004	0.004
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.25	0.332	0.307	0.256
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	0.007	0.115	0.016	0.016
Iron	mg/L	0.05	7.37	4.34	9.44	11.1
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.01	0.007	0.004	0.005
Lead	mg/L	0.001	0.02	0.025	0.003	0.001
Manganese	mg/L	0.001	0.651	0.464	0.307	0.312
Zinc	mg/L	0.005	0.176	0.383	0.041	0.037
Iron	mg/L	0.05	69	15.8	16.1	16.1
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	130	130	30	60
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	490	140	140	140
C29 - C36 Fraction	µg/L	50	280	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	770	140	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	130	120	40	60
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	680	150	<100	<100
>C34 - C40 Fraction	µg/L	100	230	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	910	150	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	2
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			16/11/18	18/12/18	26/02/19	26/03/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.22	7.4	7.59	7.11
Electrical Conductivity	µS/cm	1	20,900	23,900	21,200	22,600
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	451	473	458	468
Dissolved Major Ions						
Calcium	mg/L	1	357	263	284	326
Magnesium	mg/L	1	520	438	488	476
Sodium	mg/L	1	4,440	3,920	3,920	4,130
Potassium	mg/L	1	85	80	100	81
Chloride	mg/L	1	7,870	7,500	7,660	8,360
Sulfate	mg/L	1	3	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	-	-		
Arsenic	mg/L	0.001	0.004	0.004	0.002	0.004
Cadmium	mg/L	0.0001	-	-		
Cobalt	mg/L	0.001	-	-		
Copper	mg/L	0.001	-	-		
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.261	0.238	0.245	0.255
Nickel	mg/L	0.001	-	-		
Zinc	mg/L	0.005	0.021	0.016	0.014	0.015
Iron	mg/L	0.05	10	9.73	3.07	10.1
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.004	0.005	0.004	0.005
Lead	mg/L	0.001	0.001	0.002	0.001	<0.001
Manganese	mg/L	0.001	0.273	0.258	0.25	0.272
Zinc	mg/L	0.005	0.033	0.046	0.04	0.036
Iron	mg/L	0.05	13.4	12.7	8.96	13.5
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	30	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	30	30	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			30/04/19	22/05/19	21/06/19	16/07/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.22	7.64	7.01	7.1
Electrical Conductivity	µS/cm	1	22,500	22,600	23,400	23,000
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	463	466	433	463
Dissolved Major Ions						
Calcium	mg/L	1	294	330	383	350
Magnesium	mg/L	1	481	506	471	507
Sodium	mg/L	1	4,060	4,390	4,100	4,310
Potassium	mg/L	1	80	84	83	86
Chloride	mg/L	1	8,140	8,150	8,340	7,940
Sulfate	mg/L	1	3	3	<1	2
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.003	<0.005	0.004	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.005	<0.001	<0.005
Manganese	mg/L	0.001	0.234	0.215	0.229	0.232
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.01	<0.025	0.024	<0.025
Iron	mg/L	0.05	9.7	8.52	9.19	9.13
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.004	<0.005	0.004	<0.005
Lead	mg/L	0.001	<0.001	<0.005	<0.001	<0.005
Manganese	mg/L	0.001	0.224	0.261	0.241	0.247
Zinc	mg/L	0.005	0.033	0.035	0.034	0.042
Iron	mg/L	0.05	10.6	11.1	10.6	9.95
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	60	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	60	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			27/08/19	06/11/19	26/02/20	26/05/20
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.26	7.12	7.68	7.48
Electrical Conductivity	µS/cm	1	22,800	22,600	24,000	21,700
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	470	487	457	457
Dissolved Major Ions						
Calcium	mg/L	1	322	280	298	312
Magnesium	mg/L	1	474	419	459	477
Sodium	mg/L	1	4,100	3,540	4,180	4,340
Potassium	mg/L	1	83	77	82	84
Chloride	mg/L	1	7,670	7,900	8,130	8,060
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01		<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.004	0.003	0.002	0.003
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.233	0.238	0.744	0.262
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.024	0.023	0.202	0.02
Iron	mg/L	0.05	9.73	7.82	3.43	10.1
Total Metals						
Aluminium	mg/L	0.01		0.07	0.17	0.12
Arsenic	mg/L	0.001	0.006	0.004	0.003	0.004
Lead	mg/L	0.001	<0.001	<0.001	0.002	0.002
Manganese	mg/L	0.001	0.243	0.237	0.885	0.261
Zinc	mg/L	0.005	0.107	0.042	0.207	0.082
Iron	mg/L	0.05	9.96	9.45	4.77	9.29
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	110	110	350
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	110	110	350
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	120	120	360
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	120	120	360
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			26/08/2020	24/11/2020	04/02/2021	12/05/21
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.49	7.55	7.67	7.21
Electrical Conductivity	µS/cm	1	23,900	23,300	21,100	21,800
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	462	464	420	440
Dissolved Major Ions						
Calcium	mg/L	1	338	298	289	298
Magnesium	mg/L	1	454	480	476	499
Sodium	mg/L	1	4,150	4,200	4,280	4,430
Potassium	mg/L	1	79	84	88	90
Chloride	mg/L	1	8,150	8,650	8,010	8,500
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.003	0.003	0.003	0.003
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.251	0.266	0.27	0.289
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.019	0.012	<0.005	0.01
Iron	mg/L	0.05	9.24	9.38	9.46	9.78
Total Metals						
Aluminium	mg/L	0.01	2.53	1.42	10.3	0.9
Arsenic	mg/L	0.001	0.007	0.006	0.006	0.008
Lead	mg/L	0.001	0.007	0.002	0.005	0.002
Manganese	mg/L	0.001	0.314	0.304	0.327	0.322
Zinc	mg/L	0.005	0.326	0.281	0.235	0.233
Iron	mg/L	0.05	17.5	14	34.1	13.4
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	30	<20	30
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	290	<100	240	<100
C29 - C36 Fraction	µg/L	50	70	<50	140	<50
C10 - C36 Fraction (sum)	µg/L	50	360	<50	380	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	30	<20	40
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	340	<100	340	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	340	<100	340	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	EFGW5D	EFGW5D	EFGW5D
Sample Date			24/08/21	25/11/21	02/02/2022	19/05/22
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.74	7.57	7.54	7.75
Electrical Conductivity	µS/cm	1	21,000	20,900	19,900	24,100
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	469	453	482	514
Dissolved Major Ions						
Calcium	mg/L	1	253	301	270	244
Magnesium	mg/L	1	481	498	470	557
Sodium	mg/L	1	4,150	4,470	4,060	4,710
Potassium	mg/L	1	79	89	78	96
Chloride	mg/L	1	8,260	7,900	8,620	8,380
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.05
Arsenic	mg/L	0.001	0.004	0.004	0.003	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.005
Manganese	mg/L	0.001	0.289	0.287	0.289	0.026
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.008	0.01	0.009	<0.025
Iron	mg/L	0.05	10.6	10.6	10.8	<0.05
Total Metals						
Aluminium	mg/L	0.01	2.06	0.53	0.74	0.89
Arsenic	mg/L	0.001	0.008	0.007	0.006	0.006
Lead	mg/L	0.001	0.002	0.001	0.001	0.001
Manganese	mg/L	0.001	0.3	0.3	0.321	0.323
Zinc	mg/L	0.005	0.213	0.15	0.125	0.117
Iron	mg/L	0.05	13.6	12.3	12.5	13.6
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	40	40	30
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	110	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	110	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	30	30	30
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	120	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	120	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			EFGW5D	PT1	PT1	PT1
Sample Date			09/08/22	18/01/18	25/07/18	30/08/18
Aquifer			Rewan	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.7	8.03	8.09	7.71
Electrical Conductivity	µS/cm	1	18,300	11,600	11,200	11,000
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	458	236	233	231
Dissolved Major Ions						
Calcium	mg/L	1	293	178	146	168
Magnesium	mg/L	1	496	50	50	51
Sodium	mg/L	1	4,410	2,250	2,190	2,260
Potassium	mg/L	1	84	10	10	10
Chloride	mg/L	1	8,340	4,050	3,800	3,880
Sulfate	mg/L	1	<1	1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	-	-
Arsenic	mg/L	0.001	0.004	0.014	0.013	0.01
Cadmium	mg/L	0.0001		<0.0001	-	-
Cobalt	mg/L	0.001		<0.001	-	-
Copper	mg/L	0.001		<0.001	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.318	0.032	0.028	0.028
Nickel	mg/L	0.001		<0.001	-	-
Zinc	mg/L	0.005	0.074	0.008	<0.005	0.01
Iron	mg/L	0.05	10.7	0.28	0.65	0.15
Total Metals						
Aluminium	mg/L	0.01	0.74			
Arsenic	mg/L	0.001	0.006	0.015	0.015	0.012
Lead	mg/L	0.001	0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.299	0.049	0.029	0.029
Zinc	mg/L	0.005	0.096	0.013	0.012	0.009
Iron	mg/L	0.05	12.5	0.75	0.77	0.71
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	30	-	<20	<20
C10 - C14 Fraction	µg/L	50	<50	-	<50	<50
C15 - C28 Fraction	µg/L	100	<100	-	140	<100
C29 - C36 Fraction	µg/L	50	<50	-	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	-	140	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	30		<20	<20
>C10 - C16 Fraction	µg/L	100	<100		<100	<100
>C16 - C34 Fraction	µg/L	100	<100		160	<100
>C34 - C40 Fraction	µg/L	100	<100		<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100		160	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100		<100	<100
BTEXN						
Benzene	µg/L	1	<1		<1	<1
Toluene	µg/L	2	<2		<2	<2
Ethylbenzene	µg/L	2	<2		<2	<2
meta- & para-Xylene	µg/L	2	<2		<2	<2
ortho-Xylene	µg/L	2	<2		<2	<2
Total Xylenes	µg/L	2	<2		<2	<2
Sum of BTEX	µg/L	1	<1		<1	<1
Naphthalene	µg/L	5	<5		<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	PT1
Sample Date			27/09/18	24/10/18	15/11/18	18/12/18
Aquifer			Coal seam	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.8	7.91	7.61	7.83
Electrical Conductivity	µS/cm	1	11,100	10,900	10,800	11,000
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	224	235	213	206
Dissolved Major Ions						
Calcium	mg/L	1	179	181	189	141
Magnesium	mg/L	1	49	51	56	51
Sodium	mg/L	1	2,230	2,230	2,420	2,160
Potassium	mg/L	1	10	10	10	10
Chloride	mg/L	1	3,810	3,290	3,560	3,390
Sulfate	mg/L	1	<1	<1	18	2
Dissolved Metals						
Aluminium	mg/L	0.01	-	-	-	-
Arsenic	mg/L	0.001	0.012	0.013	0.012	0.01
Cadmium	mg/L	0.0001	-	-	-	-
Cobalt	mg/L	0.001	-	-	-	-
Copper	mg/L	0.001	-	-	-	-
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.029	0.028	0.028	0.033
Nickel	mg/L	0.001	-	-	-	-
Zinc	mg/L	0.005	0.011	0.01	0.005	0.007
Iron	mg/L	0.05	0.6	0.76	0.7	0.44
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.014	0.012	0.013	0.012
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.03	0.03	0.027	0.034
Zinc	mg/L	0.005	<0.005	0.012	0.009	0.012
Iron	mg/L	0.05	0.81	0.74	0.79	0.83
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	30
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	PT1
Sample Date			26/02/19	26/03/19	30/04/19	22/05/19
Aquifer			Coal seam	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8.09	7.52	7.65	7.97
Electrical Conductivity	µS/cm	1	10,900	10,800	11,200	11,200
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	213	218	223	222
Dissolved Major Ions						
Calcium	mg/L	1	138	180	148	174
Magnesium	mg/L	1	50	50	51	53
Sodium	mg/L	1	2,100	2,220	2,170	2,360
Potassium	mg/L	1	12	10	9	10
Chloride	mg/L	1	3,460	3,620	3,730	3,650
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.003	0.004	0.009	0.008
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.024	0.012	0.026	0.025
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.008	<0.005	0.008	0.012
Iron	mg/L	0.05	<0.05	0.2	0.49	0.44
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.01	0.011	0.011	0.012
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.025	0.028	0.026	0.028
Zinc	mg/L	0.005	0.007	0.008	0.012	0.018
Iron	mg/L	0.05	0.51	0.76	0.75	0.68
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	PT1
Sample Date			21/06/19	16/07/19	27/08/19	06/11/19
Aquifer			Coal seam	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.45	7.54	7.67	7.56
Electrical Conductivity	µS/cm	1	11,500	11,400	11,200	11,200
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	209	222	228	223
Dissolved Major Ions						
Calcium	mg/L	1	209	182	168	138
Magnesium	mg/L	1	50	54	50	44
Sodium	mg/L	1	2,250	2,380	2,230	1,890
Potassium	mg/L	1	10	10	10	9
Chloride	mg/L	1	3,600	3,620	3,360	3,540
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01				<0.01
Arsenic	mg/L	0.001	0.01	0.009	0.008	0.008
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.026	0.024	0.027	0.024
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.01	0.01	0.014	0.01
Iron	mg/L	0.05	0.62	0.49	0.43	0.41
Total Metals						
Aluminium	mg/L	0.01				<0.01
Arsenic	mg/L	0.001	0.01	0.012	0.012	0.009
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.026	0.028	0.031	0.024
Zinc	mg/L	0.005	0.009	0.017	0.023	0.009
Iron	mg/L	0.05	0.72	0.78	0.67	0.66
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	PT1
Sample Date			26/02/20	26/05/20	26/08/2020	19/11/2020
Aquifer			Coal seam	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8	7.85	7.79	7.92
Electrical Conductivity	µS/cm	1	11,300	11,200	11,400	11,400
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	204	202	222	188
Dissolved Major Ions						
Calcium	mg/L	1	154	152	167	194
Magnesium	mg/L	1	47	49	47	47
Sodium	mg/L	1	2,280	2,300	2,290	2,120
Potassium	mg/L	1	10	10	10	9
Chloride	mg/L	1	3,390	3,550	3,600	3,790
Sulfate	mg/L	1	<1	<1	<1	6
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.003	0.009	0.01	0.003
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.248	0.024	0.029	0.135
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.031	0.012	0.036	0.049
Iron	mg/L	0.05	8.66	0.5	0.55	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.03	<0.01	<0.01	0.07
Arsenic	mg/L	0.001	0.004	0.011	0.01	0.004
Lead	mg/L	0.001	<0.001	<0.001	<0.001	0.002
Manganese	mg/L	0.001	0.278	0.026	0.03	0.137
Zinc	mg/L	0.005	0.068	0.01	0.047	0.075
Iron	mg/L	0.05	11	0.67	0.65	0.34
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	190
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	190
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	190
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	190
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	PT1
Sample Date			04/02/2021	13/05/21	25/08/21	25/11/21
Aquifer			Coal seam	Coal seam	Coal seam	Coal seam
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	8.01	7.59	7.95	7.84
Electrical Conductivity	µS/cm	1	11,000	10,800	11,000	10,900
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	212	204	216	216
Dissolved Major Ions						
Calcium	mg/L	1	135	143	116	143
Magnesium	mg/L	1	48	50	48	50
Sodium	mg/L	1	2,340	2,370	2,220	2,390
Potassium	mg/L	1	10	11	10	11
Chloride	mg/L	1	3,950	3,950	4,030	3,650
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	0.03	<0.01
Arsenic	mg/L	0.001	0.007	0.01	0.009	0.008
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.073	0.03	0.031	0.029
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.056	0.008	0.017	0.007
Iron	mg/L	0.05	<0.05	0.61	0.98	0.48
Total Metals						
Aluminium	mg/L	0.01	0.03	0.06	0.04	0.01
Arsenic	mg/L	0.001	0.007	0.014	0.01	0.009
Lead	mg/L	0.001	0.002	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.083	0.033	0.031	0.029
Zinc	mg/L	0.005	0.067	0.012	0.014	0.011
Iron	mg/L	0.05	0.24	1.33	0.56	0.69
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			PT1	PT1	PT1	IBGWR1
Sample Date			02/02/2022	19/05/22	09/08/22	15/11/18
Aquifer			Coal seam	Coal seam	Coal seam	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.83	7.97	7.91	7.28
Electrical Conductivity	µS/cm	1	10,500	12,100	10,000	28,100
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	223	241	229	72
Dissolved Major Ions						
Calcium	mg/L	1	128	127	141	1280
Magnesium	mg/L	1	47	45	50	394
Sodium	mg/L	1	2,190	2,260	2,410	5,080
Potassium	mg/L	1	10	10	10	49
Chloride	mg/L	1	3,970	4,200	4,100	9,650
Sulfate	mg/L	1	<1	<1	<1	6
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	
Arsenic	mg/L	0.001	0.007	<0.001	0.007	0.008
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.005
Manganese	mg/L	0.001	0.028	<0.001	0.03	5.44
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.01	<0.005	0.032	0.034
Iron	mg/L	0.05	0.4	<0.05	0.58	0.53
Total Metals						
Aluminium	mg/L	0.01	0.01	<0.01	0.02	
Arsenic	mg/L	0.001	0.008	0.006	0.008	0.007
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.031	0.024	0.028	5.44
Zinc	mg/L	0.005	0.013	0.02	0.017	0.039
Iron	mg/L	0.05	0.7	0.36	0.72	1.4
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	160
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	40
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	124
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	124
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR1	IBGWR1	IBGWR1	IBGWR1
Sample Date			26/02/19	26/03/19	30/04/19	22/05/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.52	7.17	7.19	7.5
Electrical Conductivity	µS/cm	1	24,900	28,900	27,300	27,600
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	78	83	77	80
Dissolved Major Ions						
Calcium	mg/L	1	1130	1190	1160	1200
Magnesium	mg/L	1	359	344	354	365
Sodium	mg/L	1	4,510	4,550	4,630	4,960
Potassium	mg/L	1	58	46	45	47
Chloride	mg/L	1	9,620	10,400	10,600	10,000
Sulfate	mg/L	1	18	18	4	3
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.006	0.009	0.007	0.008
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.005
Manganese	mg/L	0.001	5.59	6.25	5.59	5.6
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.048	0.05	0.042	0.038
Iron	mg/L	0.05	0.37	0.87	0.91	1.01
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	0.007	0.01	0.009	0.01
Lead	mg/L	0.001	<0.001	0.001	<0.001	<0.005
Manganese	mg/L	0.001	5.59	6.35	5.75	6.48
Zinc	mg/L	0.005	0.05	0.059	0.05	0.085
Iron	mg/L	0.05	0.57	1.66	1.43	2.1
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	120	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	120	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	120	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	120	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR1	IBGWR1	IBGWR1	IBGWR1
Sample Date			20/06/19	16/07/19	27/08/19	06/11/19
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.01	7.27	7.24	6.97
Electrical Conductivity	µS/cm	1	28,700	29,600	31,900	32,500
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	76	76	78	79
Dissolved Major Ions						
Calcium	mg/L	1	1270	1370	1170	1040
Magnesium	mg/L	1	395	377	348	317
Sodium	mg/L	1	4,930	4,920	4,640	4,230
Potassium	mg/L	1	50	49	46	44
Chloride	mg/L	1	9,890	10,200	9,920	10,400
Sulfate	mg/L	1	3	<1	2	2
Dissolved Metals						
Aluminium	mg/L	0.01				<0.01
Arsenic	mg/L	0.001	0.007	0.005	0.006	0.006
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.005	<0.001	<0.001
Manganese	mg/L	0.001	5.8	6.24	5.63	5.16
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.029	0.084	0.076	0.154
Iron	mg/L	0.05	0.97	0.05	0.75	0.57
Total Metals						
Aluminium	mg/L	0.01				0.02
Arsenic	mg/L	0.001	0.007	0.007	0.009	0.007
Lead	mg/L	0.001	<0.005	<0.005	<0.001	<0.001
Manganese	mg/L	0.001	5.6	5.83	5.25	5.34
Zinc	mg/L	0.005	0.045	0.098	0.109	0.143
Iron	mg/L	0.05	2.9	1.23	0.97	0.75
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	100	110	100	290
C29 - C36 Fraction	µg/L	50	<50	<50	<50	50
C10 - C36 Fraction (sum)	µg/L	50	100	110	100	340
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	120	120	100	300
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	120	120	100	300
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR1	IBGWR1	IBGWR1	IBGWR1
Sample Date			26/02/20	26/05/20	26/08/2020	19/11/2020
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.46	7.33	7.38	7.36
Electrical Conductivity	µS/cm	1	28,500	28,600	28,700	28,400
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	76	73	72	82
Dissolved Major Ions						
Calcium	mg/L	1	1120	1180	1210	1130
Magnesium	mg/L	1	327	381	331	371
Sodium	mg/L	1	4,700	5,420	4,800	4,670
Potassium	mg/L	1	47	48	44	48
Chloride	mg/L	1	10,300	10,300	10,000	10,200
Sulfate	mg/L	1	<1	<1	<1	<1
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.05	<0.01	<0.05
Arsenic	mg/L	0.001	0.01	0.008	0.007	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.005	<0.001	<0.005
Manganese	mg/L	0.001	0.024	6.46	4.9	6.55
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.012	0.084	0.159	0.422
Iron	mg/L	0.05	0.51	1.42	1.49	0.46
Total Metals						
Aluminium	mg/L	0.01	<0.01	<0.05	0.04	0.21
Arsenic	mg/L	0.001	0.01	0.008	0.008	0.006
Lead	mg/L	0.001	<0.001	<0.005	0.002	0.013
Manganese	mg/L	0.001	0.027	6.22	5.81	5.52
Zinc	mg/L	0.005	0.012	0.083	0.158	0.473
Iron	mg/L	0.05	0.76	1.65	1.81	1.71
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	160	160	<100	610
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	160	160	<50	610
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	160	160	<100	600
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	160	160	<100	600
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR1	IBGWR1	IBGWR1	IBGWR1
Sample Date			04/02/2021	12/05/21	24/08/21	25/11/21
Aquifer			Rewan	Rewan	Rewan	Rewan
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.16	7.03	7.52	7.34
Electrical Conductivity	µS/cm	1	27,100	28,800	28,300	27,800
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	71	72	78	83
Dissolved Major Ions						
Calcium	mg/L	1	1150	1120	1130	1220
Magnesium	mg/L	1	356	370	375	384
Sodium	mg/L	1	4,800	4,930	5,100	5,110
Potassium	mg/L	1	47	46	51	50
Chloride	mg/L	1	10,200	10,300	10,400	10,100
Sulfate	mg/L	1	<1	<1	<1	3
Dissolved Metals						
Aluminium	mg/L	0.01	<0.05	<0.05	<0.05	<0.05
Arsenic	mg/L	0.001	0.005	0.007	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.005	<0.005	<0.005
Manganese	mg/L	0.001	6.21	6.12	6.2	6.55
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.247	0.222	0.17	0.027
Iron	mg/L	0.05	1.48	1.4	1.65	1.99
Total Metals						
Aluminium	mg/L	0.01	<0.05	1.32	0.08	<0.05
Arsenic	mg/L	0.001	0.006	0.009	<0.005	<0.005
Lead	mg/L	0.001	<0.005	0.007	<0.005	<0.005
Manganese	mg/L	0.001	6.32	6.52	5.88	5.85
Zinc	mg/L	0.005	0.242	0.244	0.158	<0.026
Iron	mg/L	0.05	1.92	3.26	1.85	2.16
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	400	110	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	400	110	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	370	110	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	370	110	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR1	IBGWR1	IBGWR1	IBGWR2
Sample Date			02/02/2022	19/05/22	09/08/22	16/11/18
Aquifer			Rewan	Rewan	Rewan	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.37	7.52	7.47	6.91
Electrical Conductivity	µS/cm	1	26,700	29,400	21,200	28,500
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	87	91	86	807
Dissolved Major Ions						
Calcium	mg/L	1	1040	1150	1180	410
Magnesium	mg/L	1	335	398	373	835
Sodium	mg/L	1	4,450	5,160	5,180	6,020
Potassium	mg/L	1	44	54	50	60
Chloride	mg/L	1	10,800	9,920	10,600	9,790
Sulfate	mg/L	1	1	<1	<1	977
Dissolved Metals						
Aluminium	mg/L	0.01	<0.01	<0.05	<0.05	
Arsenic	mg/L	0.001	0.003	<0.005	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.005	<0.005	<0.005
Manganese	mg/L	0.001	6.18	6.31	6.33	1.4
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.038	0.036	0.031	<0.025
Iron	mg/L	0.05	1.6	<0.05	2.3	0.11
Total Metals						
Aluminium	mg/L	0.01	0.06	<0.05	0.1	
Arsenic	mg/L	0.001	0.004	<0.005	<0.005	<0.001
Lead	mg/L	0.001	<0.001	<0.005	<0.005	<0.001
Manganese	mg/L	0.001	5.76	6.09	6.85	1.62
Zinc	mg/L	0.005	0.046	0.048	0.038	0.014
Iron	mg/L	0.05	1.82	1.51	2.52	1.91
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	30
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	120	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	120	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	110	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	110	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	19
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	19
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR2	IBGWR2	IBGWR2	IBGWR2
Sample Date			17/12/18	26/02/19	26/03/19	30/04/19
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.15	7.75	6.86	6.74
Electrical Conductivity	µS/cm	1	34,100	27,100	30,500	29,600
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	795	801	813	829
Dissolved Major Ions						
Calcium	mg/L	1	320	388	472	376
Magnesium	mg/L	1	723	814	825	844
Sodium	mg/L	1	5,460	5,610	6,190	6,510
Potassium	mg/L	1	57	73	62	59
Chloride	mg/L	1	9,850	9,810	10,600	10,600
Sulfate	mg/L	1	966	971	980	1000
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.001	<0.001	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.001	<0.001	<0.005	<0.005
Manganese	mg/L	0.001	1.36	1.21	1.36	1.34
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.01	0.016	<0.025	<0.025
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.005	<0.001	<0.005	<0.005
Lead	mg/L	0.001	<0.005	0.001	<0.005	<0.005
Manganese	mg/L	0.001	1.5	1.26	1.29	1.24
Zinc	mg/L	0.005	<0.026	0.017	<0.026	<0.026
Iron	mg/L	0.05	0.85	0.31	2.06	1.68
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	8	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	8	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR2	IBGWR2	IBGWR2	IBGWR2
Sample Date			22/05/19	20/06/19	16/07/19	27/08/19
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.46	6.81	6.9	7.06
Electrical Conductivity	µS/cm	1	30,200	31,600	31,600	35,400
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	848	791	844	857
Dissolved Major Ions						
Calcium	mg/L	1	396	414	406	382
Magnesium	mg/L	1	813	873	782	760
Sodium	mg/L	1	5,960	6,080	5,720	5,670
Potassium	mg/L	1	59	61	58	58
Chloride	mg/L	1	10,300	10,400	10,600	10,200
Sulfate	mg/L	1	1030	969	977	938
Dissolved Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	<0.001
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.005	<0.005	<0.001
Manganese	mg/L	0.001	1.24	1.3	1.21	1.26
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	<0.025	<0.025	0.033	0.013
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01				
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	0.001
Lead	mg/L	0.001	<0.005	<0.005	<0.005	<0.001
Manganese	mg/L	0.001	1.51	1.38	1.31	1.22
Zinc	mg/L	0.005	<0.026	<0.026	0.037	0.021
Iron	mg/L	0.05	2.25	0.63	0.22	0.41
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR2	IBGWR2	IBGWR2	IBGWR2
Sample Date			06/11/19	26/02/20	26/05/20	26/08/2020
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	6.88	7.47	7.36	7.47
Electrical Conductivity	µS/cm	1	34,600	33,200	31,100	33,200
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	841	767	775	780
Dissolved Major Ions						
Calcium	mg/L	1	396	448	381	407
Magnesium	mg/L	1	795	884	797	866
Sodium	mg/L	1	5,700	6,480	6,340	6,410
Potassium	mg/L	1	57	64	59	62
Chloride	mg/L	1	10,600	11,200	10,800	11,100
Sulfate	mg/L	1	968	1000	946	1000
Dissolved Metals						
Aluminium	mg/L	0.01	<0.05	<0.01	<0.05	<0.05
Arsenic	mg/L	0.001	<0.005	0.007	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.001	<0.005	<0.005
Manganese	mg/L	0.001	1.2	4.76	1.37	1.38
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	<0.025	0.112	<0.025	0.22
Iron	mg/L	0.05	<0.05	0.69	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	<0.05	0.19	0.11	0.24
Arsenic	mg/L	0.001	<0.005	0.008	<0.005	0.001
Lead	mg/L	0.001	<0.005	0.001	<0.005	0.004
Manganese	mg/L	0.001	1.33	6.24	1.34	1.34
Zinc	mg/L	0.005	<0.026	0.108	<0.026	0.211
Iron	mg/L	0.05	0.07	1.46	0.13	0.42
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR2	IBGWR2	IBGWR2	IBGWR2
Sample Date			19/11/2020	04/02/2021	12/05/21	24/08/21
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.31	7.66	6.83	7.61
Electrical Conductivity	µS/cm	1	32,600	23,700	32,700	31,300
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	722	692	778	769
Dissolved Major Ions						
Calcium	mg/L	1	466	439	408	418
Magnesium	mg/L	1	892	844	861	865
Sodium	mg/L	1	6,200	6,310	6,430	6,550
Potassium	mg/L	1	68	64	62	65
Chloride	mg/L	1	11,400	11,000	11,000	11,000
Sulfate	mg/L	1	1020	970	986	964
Dissolved Metals						
Aluminium	mg/L	0.01	<0.05	<0.05	<0.05	<0.05
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	0.009	<0.005	0.007	<0.005
Manganese	mg/L	0.001	1.6	1.69	1.6	1.57
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.18	0.193	0.223	0.202
Iron	mg/L	0.05	0.15	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	0.13	0.32	0.07	0.12
Arsenic	mg/L	0.001	<0.005	<0.005	<0.005	<0.005
Lead	mg/L	0.001	0.01	<0.005	0.008	<0.005
Manganese	mg/L	0.001	1.46	1.75	1.58	1.52
Zinc	mg/L	0.005	0.199	0.211	0.209	0.23
Iron	mg/L	0.05	0.3	0.37	0.13	0.23
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	700	<100
C29 - C36 Fraction	µg/L	50	<50	<50	430	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	1130	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	1040	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	260	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	1300	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix A – Water Quality – Laboratory Analyses (Project No. IRB5001.001)

Sample ID			IBGWR2	IBGWR2	IBGWR2	IBGWR2
Sample Date			08/12/21	03/02/22	19/05/22	09/08/22
Aquifer			Alluvium	Alluvium	Alluvium	Alluvium
Analyte	Units	LOR*				
Water Quality Indicators						
pH Value	pH Unit	0.01	7.41	7.26	7.66	7.43
Electrical Conductivity	µS/cm	1	31,900	30,100	32,900	22,500
Alkalinity						
Carbonate Alkalinity	mg/L	1	<1	<1	<1	<1
Bicarbonate Alkalinity	mg/L	1	762	842	848	795
Dissolved Major Ions						
Calcium	mg/L	1	382	340	188	385
Magnesium	mg/L	1	822	775	896	862
Sodium	mg/L	1	6,220	5,760	6,660	6,530
Potassium	mg/L	1	60	57	69	68
Chloride	mg/L	1	10,900	11,300	11,600	11,300
Sulfate	mg/L	1	964	1010	1000	970
Dissolved Metals						
Aluminium	mg/L	0.01	<0.05	<0.01	<0.05	<0.05
Arsenic	mg/L	0.001	<0.005	0.002	<0.005	<0.005
Cadmium	mg/L	0.0001				
Cobalt	mg/L	0.001				
Copper	mg/L	0.001				
Lead	mg/L	0.001	<0.005	<0.001	<0.005	<0.005
Manganese	mg/L	0.001	1.45	1.36	1.2	1.56
Nickel	mg/L	0.001				
Zinc	mg/L	0.005	0.041	0.035	<0.025	<0.025
Iron	mg/L	0.05	0.55	<0.05	<0.05	<0.05
Total Metals						
Aluminium	mg/L	0.01	<0.05	0.18	0.07	<0.05
Arsenic	mg/L	0.001	<0.005	<0.001	<0.005	<0.005
Lead	mg/L	0.001	<0.005	<0.001	<0.005	<0.005
Manganese	mg/L	0.001	1.58	1.6	1.43	1.92
Zinc	mg/L	0.005	0.045	0.036	<0.026	<0.026
Iron	mg/L	0.05	0.65	0.39	0.11	<0.05
Total Petroleum Hydrocarbons						
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	<50	<50
Total Recoverable Hydrocarbons						
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100	<100	<100	<100	<100
BTEXN						
Benzene	µg/L	1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5

*Laboratory limit of reporting

Appendix B

Numerical modelling

B1 Numerical modelling

The predicted impact on the groundwater regime from groundwater abstraction in relation to mine development has previously been assessed through development and simulation of a numerical groundwater model (Hansen Bailey, 2018). The focus of this part of the assessment is identification of impact above the trigger drawdown levels in the IAA and the LTAA.

B1.1 Model code

Simulation of groundwater flow for the Project site was undertaken using the MODFLOW-USG code (Panday et al., 2015), referred to as USG for the remainder of the report. The input files for the USG model were created using Fortran code and a USG edition of the Groundwater Data Utilities by Watermark Numerical Computing. These were used to allow for the additional capabilities of USG. The mesh was generated using Algomesh (HydroAlgorithmics, 2014).

B1.2 Model domain

The model grid domain was designed to account for the future likely drawdown attributable to the project. The model boundaries are sufficiently distant to the project and its surrounds, such that there is no undue influence on the model predictions from the boundary assumptions. Where necessary, natural hydrogeological boundaries such as geological units and regional catchment boundaries, have been adopted in the model.

The model domain is approximately 27 km wide (west to east direction) and 35 km long (north to south direction) as shown in Figure B 1. Grid spacing across the model domain is variable, with refinement around the mine site and locations of groundwater level observations. The model cell size becomes larger away from these key areas. The model domain was discretised into 23 layers comprising 40,596 cells (31,259 active cells, 9,337 inactive cells) for the whole model. Cell sizes range from approximately 50 m by 50 m within the mining area around, up to 500 m by 500 m outside the project site (Figure B 1).

The vertical discretisation of the model is described by the geological layers. Geological surfaces have been extrapolated across the numerical model from the Leichhardt Seam structure determined from exploration drilling data. To the east of the project area, the coal seam dips towards the axis of the Nebo Syncline where it becomes relatively deep. The actual depth of the coal seam aquifer in this area is uncertain as there has been no coal or gas exploration east of the project area. For the purposes of the model, a constant dip based on that observed in the project area was assumed and projected from the mapped subcrop/outcrop areas to the axis of the syncline. An average seam thickness of 4.5m is assumed in the model.

The hydraulic properties of the model are based on the initial parameters established from data collected in Section 4 of the main report. The parameters have been calibrated for a better fit to the available data. In addition, the range of regional parameters were used as a reference to set the valid ranges of the model calibration.

B1.3 Model boundary conditions

The model domain is surrounded by “no flow” boundaries marked by the outcrop/subcrop of the Rangel Coal Measures, and the thrust fault zone to the east of the Carborough Range. The base of Layer 23 in the model was also assumed to be a “no flow” boundary, which does not allow any exchange of water between the model domain and the surrounding areas.

B1.4 Recharge and evapotranspiration

A uniform recharge was applied to the uppermost layer in the model that represents the topographic surface. The rate of recharge to the aquifers was determined from model calibration at 5.6mm/year/m², which is equivalent to approximately 1% of average annual rainfall.

Evapotranspiration was applied to the same uppermost model layer at a constant rate of 2,366.60 mm/year/m², or 6.48 mm/day/m². An “extinction depth” of 8 m was applied, below which evapotranspiration does not occur.

B1.5 Rivers

Creeks are represented using the river package. The river bed is incised into the land surface, and the river water level is always equal to the river bed elevation. This means the river is dry and will remove groundwater from the system when groundwater head rises above river bed elevation.

B1.6 Mining progression

Mining progression was modelled using drain boundary condition. Drain cells were placed at the base of the mined layer with cell conductance set to 100 m²/day.

B1.7 Hydraulic parameters

The horizontal hydraulic conductivity (Kh) and vertical hydraulic conductivity (Kv) for interburden (layers 2 to 21 and layer 23), and coal seams (layer 22) were set as depth-dependant Figure B 2. Storage parameters (specific yield Sy and specific storage Ss) were set as constant per each hydrostratigraphic unit. All hydraulic properties across the model domain are summarized in Table B 1 which presents the hydraulic parameters adopted for the model following calibration process.

Table B 1 Hydraulic parameters

Layer	Parameter	Value
Layer 1 Weathered Material (Regolith)	Horizontal Hydraulic Conductivity [kh]	0.5 m/day
	Vertical Hydraulic Conductivity [kv]	10% of kh
	Specific Yield [Sy]	5 %
	Specific Storage [Ss]	5 x 10 ⁻⁵
Layers 2 to 21 Rewan Group	Horizontal Hydraulic Conductivity [kh]	variable with depth (exponential dependence): Kh = K0xe(slope×depth); where: K0 = 1.94×10 ⁻² slope = -2.70×10 ⁻² upper limit = 2.50×10 ⁻³ lower limit = 1.00×10 ⁻⁶
	Vertical Hydraulic Conductivity [kv]	variable with depth (exponential dependence): 0.01×Kh
	Specific Yield [Sy]	0.01 %
	Specific Storage [Ss]	1 x 10 ⁻⁶
	Horizontal Hydraulic Conductivity [kh]	variable with depth (exponential dependence): Kh = K0xe(slope×depth); where: K0 = 3.814×10 ⁻¹ slope = -2.70×10 ⁻² upper limit = 5.00×10 ⁻² lower limit = 1.00×10 ⁻⁶
Layer 22 Rangal Coal Seams	Vertical Hydraulic Conductivity [kv]	variable with depth (exponential dependence): 0.1×Kh
	Specific Yield [Sy]	1.0 %
	Specific Storage [Ss]	5 x 10 ⁻⁶
	Horizontal Hydraulic Conductivity [kh]	variable with depth (exponential dependence): Kh = K0xe(slope×depth); where: K0 = 3.814×10 ⁻¹ slope = -2.70×10 ⁻² upper limit = 5.00×10 ⁻² lower limit = 1.00×10 ⁻⁶

Layer	Parameter	Value
Layer 23 Fort Cooper Coal Measures (Model Base)	Horizontal Hydraulic Conductivity [kh]	variable with depth (exponential dependence): $K_h = K_0 e^{(\text{slope} \times \text{depth})}$; where: $K_0 = 1.94 \times 10^{-2}$ slope = -2.70×10^{-2} upper limit = 2.50×10^{-3} lower limit = 1.00×10^{-6}
	Vertical Hydraulic Conductivity [kv]	1% of kh
	Specific Yield [Sy]	0.01 %
	Specific Storage [Ss]	1×10^{-6}

B1.8 Model Setup for Impact Assessment

The predictive simulation required the steady state model to be converted to transient flow conditions to predict the zone of depressurisation induced by dewatering the coal seams. The transient simulation includes the period from January 2018 through to December 2022 with the initial starting conditions being those determined from the steady state analysis. Depressurisation of groundwater from the numerical model is simulated using the Drain package (DRN) to represent the underground mining progression. Dewatering of the Burton pit occurs during this period. The model run then extends out to cover the proposed 16 years of mining at Ironbark.

The drain cells representing mining extend the entire thickness of the Leichhardt Coal Seams represented by Layer 22.

B1.9 Modelling results

Results of the predictive model run were evaluated at the end of the UWIR period (31/12/2025). For the prediction of mining impacts heads in layer 1 (weathered surface zone) and layer 22 (Leichhardt Coal Seam) were extracted together with model flow budgets. Comparison between mining and null scenarios (no mining) was used to produce drawdown extents for each year.

B1.10 Water budgets

The differences between calculated model inflows and outflows at the completion of the prediction run, expressed as percent of discrepancy was 0.01%, indicating an accurate numerical solution and overall stability of the model. Table B 2 presents the water budget inputs and outputs for the steady state phase of the model. Table B 3 summarizes total flows through different boundary conditions throughout the full UWIR period of three years.

Table B 2 Groundwater budget – steady state model (ML/day)

Layer	Parameter	Value
Parameter	Input	Output
Rainfall recharge (RCH)	0.0.095	0
Evapotranspiration (EVT)	0	0.095
Storage	0	0
Mining (DRN)	0	0
River leakage (RIV)	0	0
Totals	0.095	0.095

Table B 3 Groundwater budget – transient model (ML total)

Parameter	Input (ML)	Output (ML)
Rainfall recharge (RCH)	277	0
Evapotranspiration (EVT)	0	279
Storage	394	6
Mining (DRN)	0	386
River leakage (RIV)	0	0
Totals	671	671

B1.11 Sensitivity

The predicted drawdown extents are dependent on the hydraulic properties of the geological layers that have been adopted in the model. These are based on calibrated aquifer parameters, however the sensitivity of the predicted drawdown extents to changes in the properties was assessed.

Each parameter was increased (+) or decreased (-) by half order of magnitude. Since hydraulic conductivity is depth-dependent, the value that was increased and decreased was K0 (initial hydraulic conductivity at depth of 0 m). It should be noted that changes to these parameters impacts the calibration of the model, therefore changes that cause significant deviations from the baseline prediction are considered unlikely.

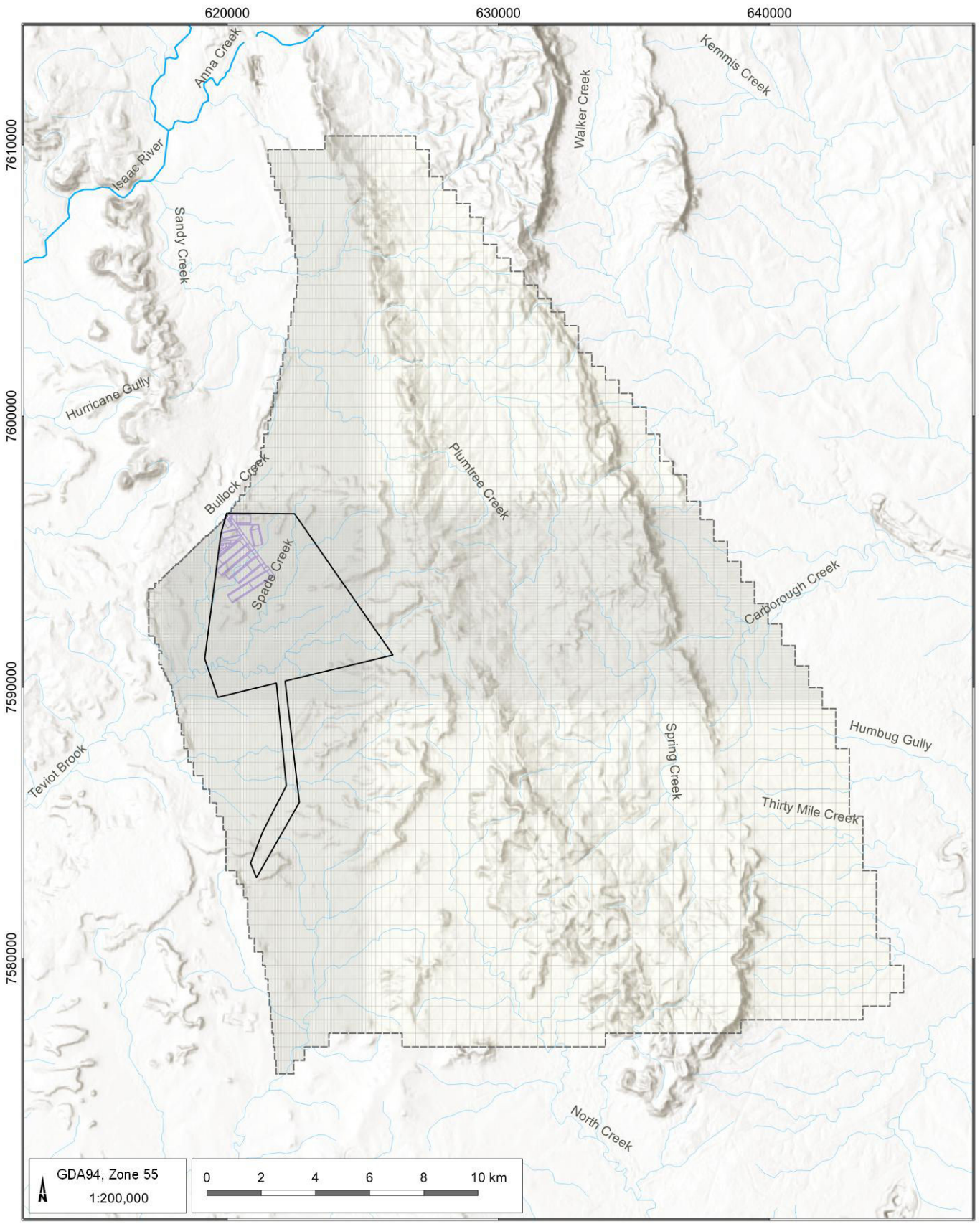
Figure B 3 shows the predicted UWIR mine inflows. Figure B 4 shows the rates of groundwater inflow over time for the multiple sensitivity scenarios. The model is most sensitive to an increase in specific yield, while other parameters do not cause deviations as far from the baseline. The model is least sensitive to a decrease in specific storage.

Table B 4 summarises the cumulative inflow volume (ML) for each sensitivity scenario.

Table B 4 Cumulative inflow volumes for sensitivity scenarios

Sensitivity scenario	Cumulative inflow volume (ML)
Baseline	230.1
K+	269.2
K-	176.6
Ss+	244.6
Ss-	218.8
Sy+	240.0
Sy-	219.6

Changes to the post-mining drawdown caused by each sensitivity scenario are shown in Figure B 5.



LEGEND

- Limit of Leichardt seam subcrop
- Model mesh
- Mine plan

Ironbark No. 1 UWIR (IRB5001.001)

Numerical model domain



DATE
21/09/2022

FIGURE No:
B-1

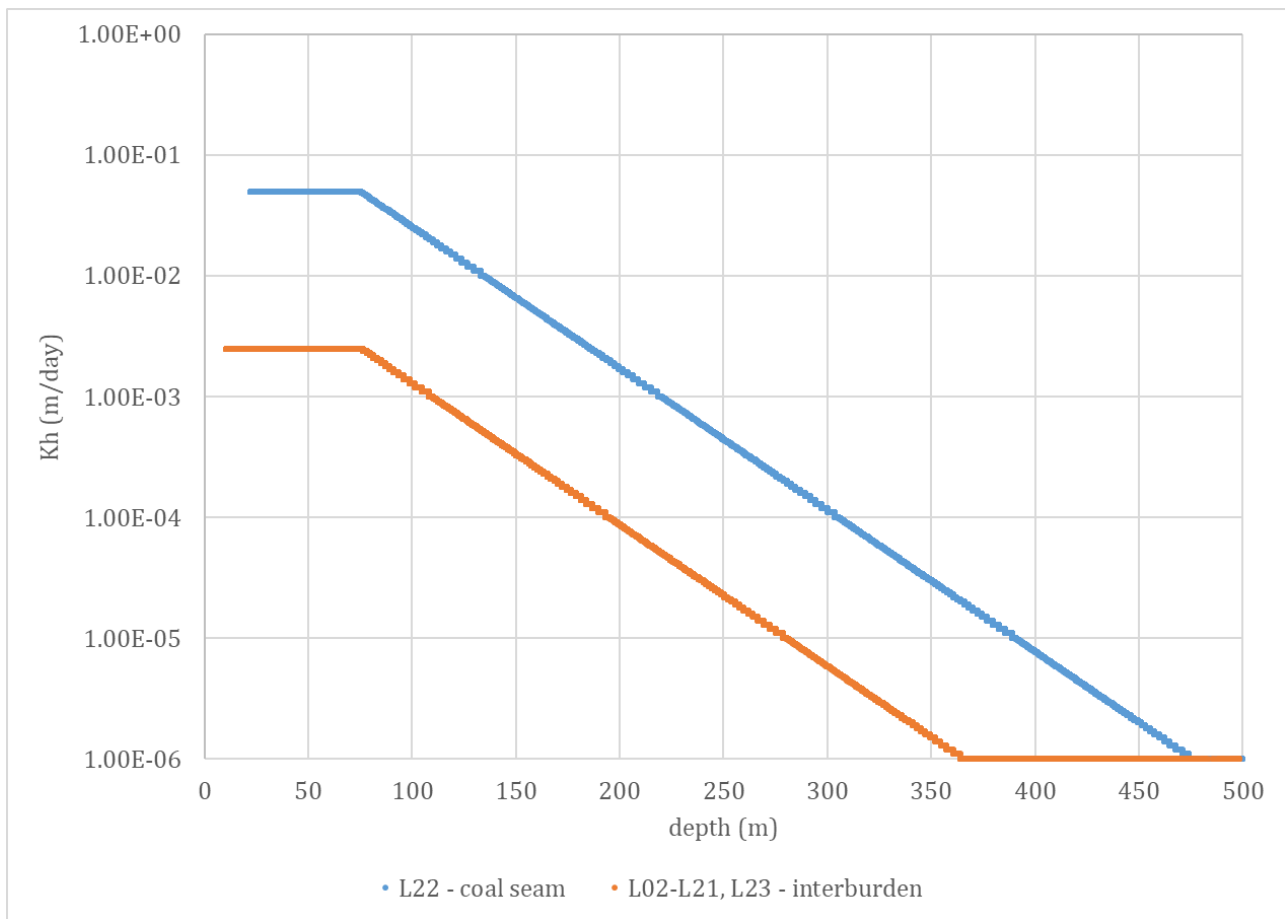


Figure B 2 Depth dependence of horizontal hydraulic conductivity – Interburden (layers 2-21 and 23) and coal seams (layer 22)

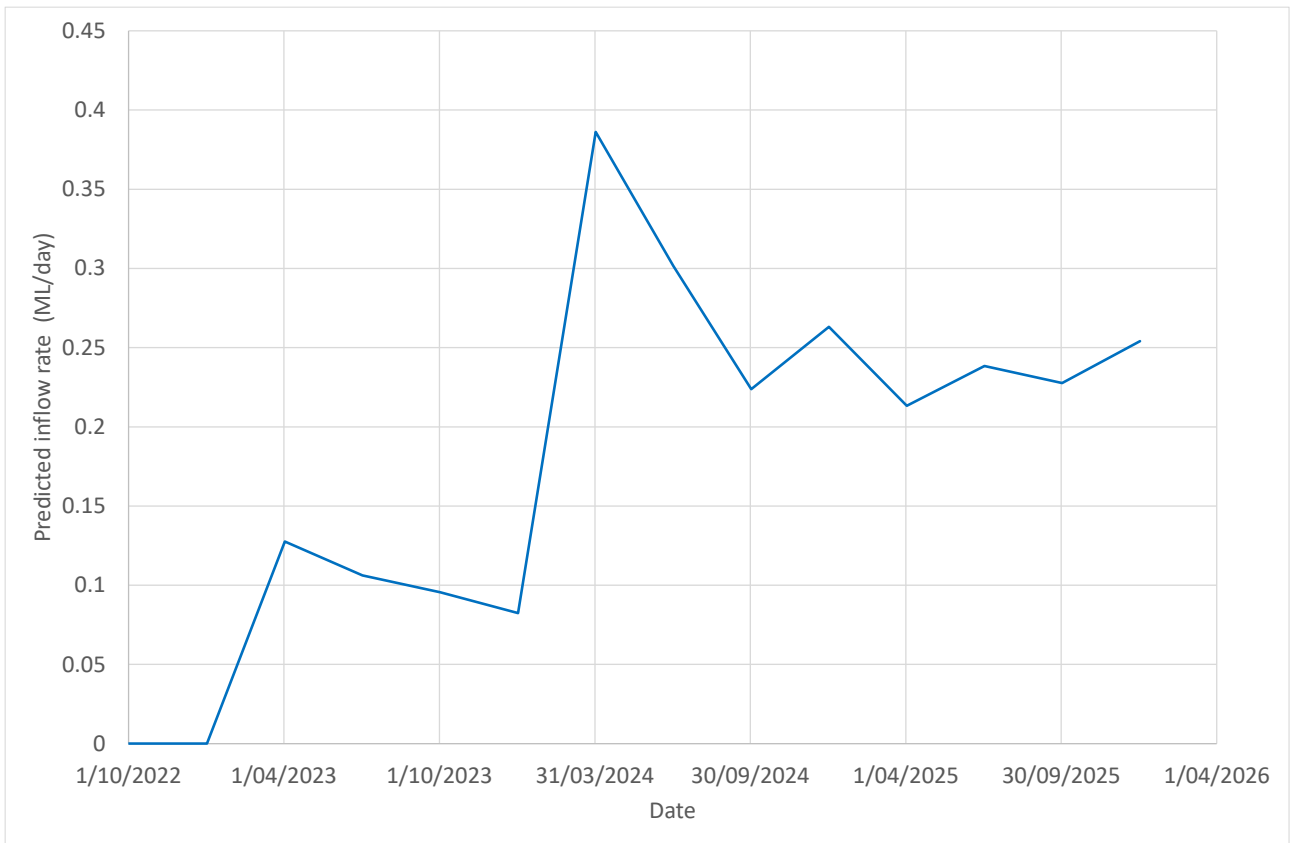


Figure B 3 Predicted UWIR mine inflows

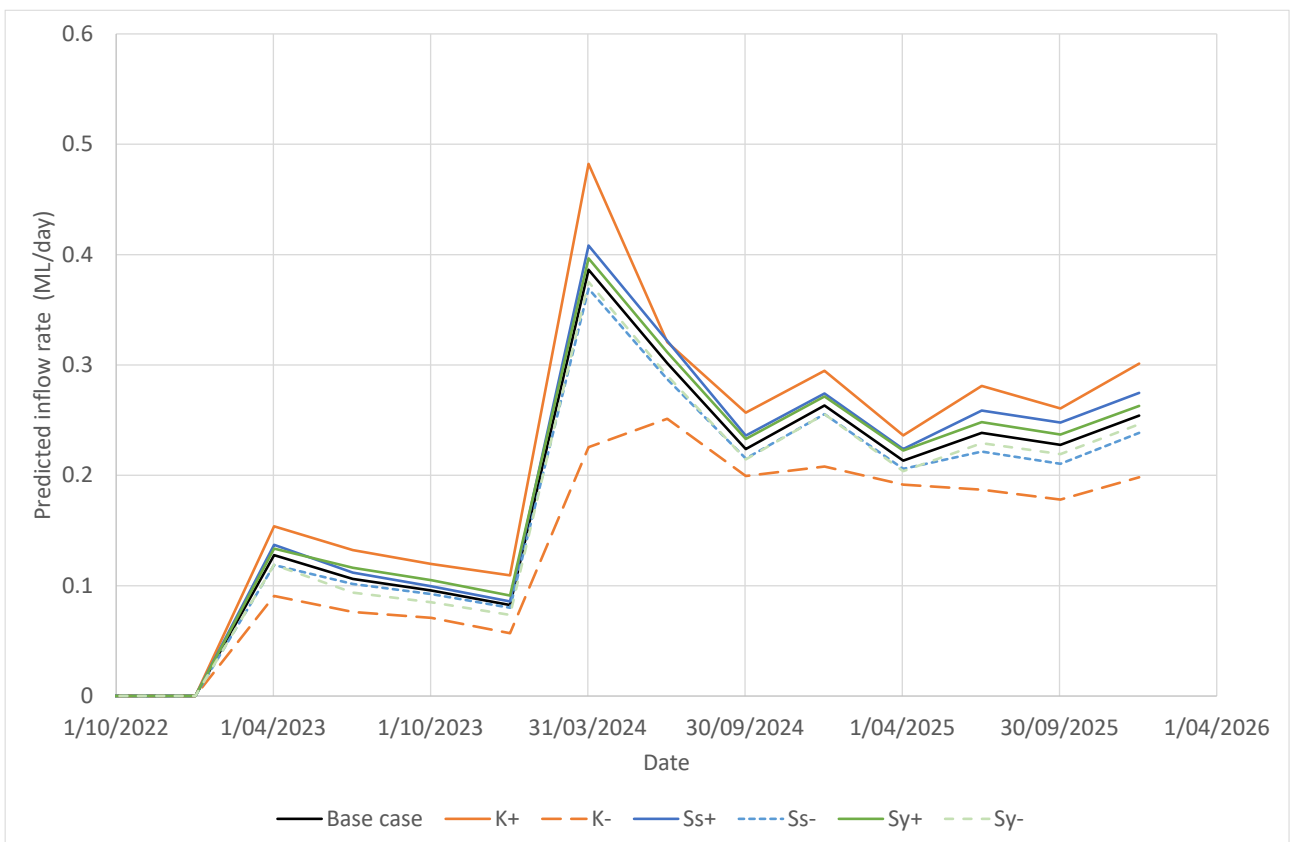
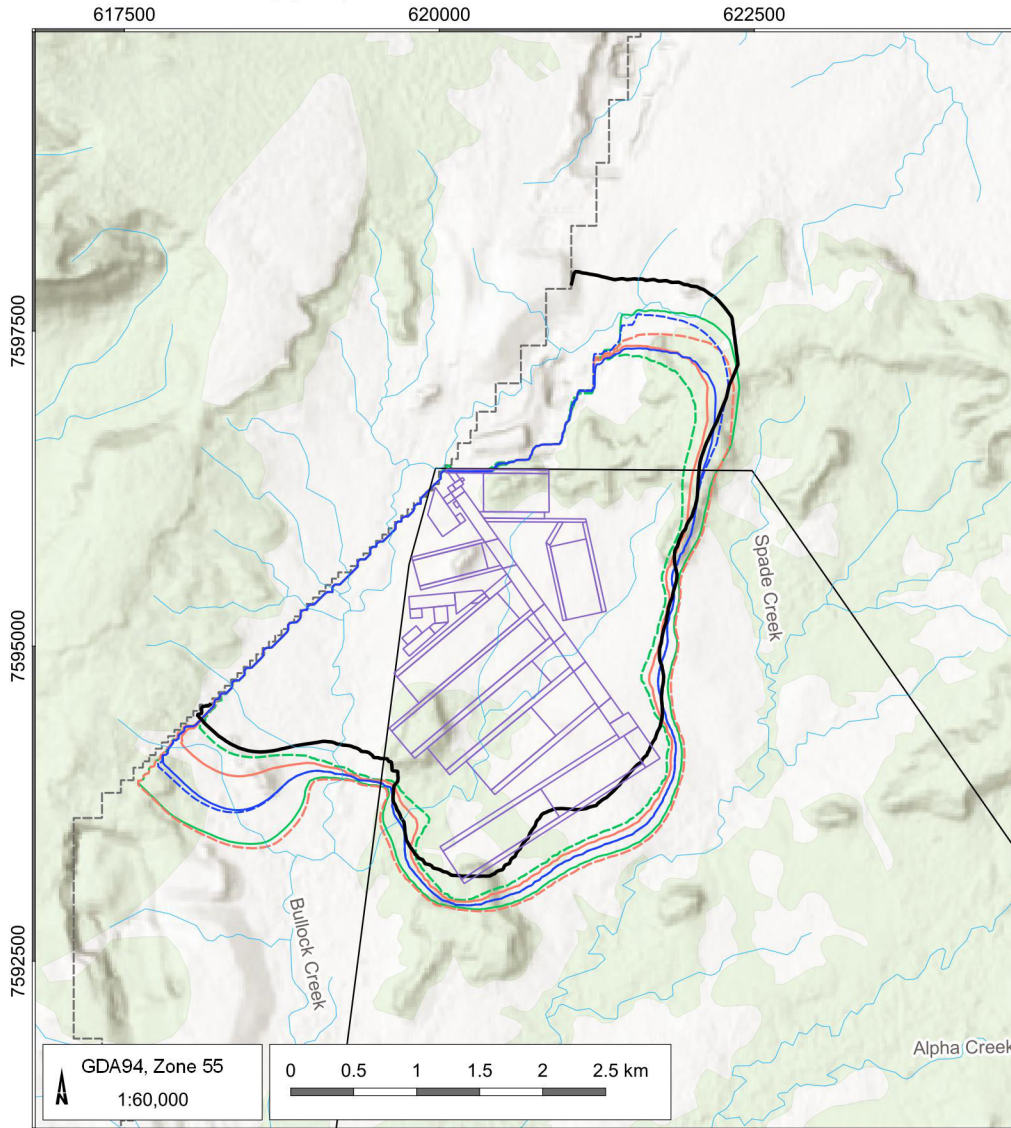
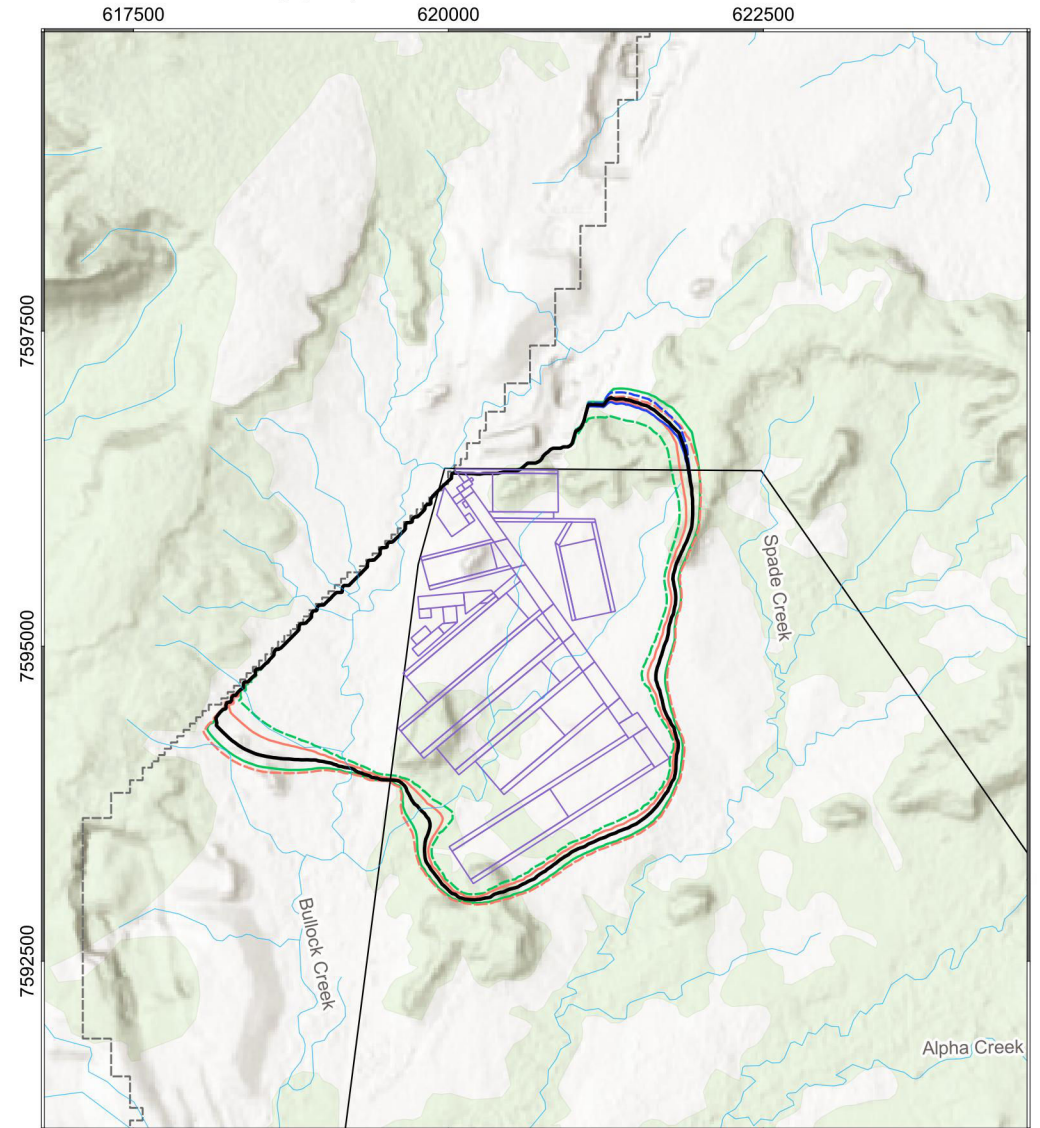


Figure B 4 Average inflow rates for sensitivity scenarios

Drawdown sensitivity (1 m)



Drawdown sensitivity (5 m)



- LEGEND**
- Creeks
 - Project Mining Lease Boundary
 - Limit of Leichardt seam subcrop
 - Vegetation
 - Mine plan

— Baseline (1m & 5m drawdown)

- Drawdown sensitivity**
- Sy+
 - Sy-
 - Ss+
 - Ss-
 - K+
 - K-

Ironbark No. 1 UWIR (IRB5001.001)



Predicted drawdown - Sensitivity analysis layer 22 drawdown contours

DATE
21/09/2022

FIGURE No:
B-5