Appendix W

Hydrogeological and Hydrological Assessments (GHD 2023)

North Kiaka Mine

Hydrogeological Assessment

Simcoa Operations Pty Ltd

08 March 2023

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			Name	Signature	Name	Signature	Date
S4	01	Marija Rosic	Bob Kinnell		Bob Kinnell		08/03/23

GHD Pty Ltd | ABN 39 008 488 373
999 Hay Street, Level 10
Perth, Western Australia 6000, Australia
T +61 8 6222 8222 | **permail@ghd.com** | ghd.com

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Executive Summary

GHD Pty Ltd (GHD) was engaged by Simcoa Operations Pty Ltd (Simcoa) to undertake a hydrogeological assessment for North Kiaka Mine to ensure the Mining Proposal and Mine Closure Plan are complete and in accordance with DMIRS guidance.

Simcoa operates the existing Moora Quartzite Mine, 15 km north of Moora, and proposes to develop a new quartzite North Kiaka Mine, located approximately 2.5 km north of the existing minesite.

This Report presents an initial understanding of the baseline groundwater levels and quality at the proposed North Kiaka Mine.

The following scope of work was undertaken in order to meet the project objectives:

- Drilling and installation of six monitoring bores, five at North Kiaka (including a dry well) and one at Moora Mine
- Comprehensive laboratory analysis of groundwater samples
- Post-installation groundwater level monitoring
- Preparation of this Report.

Based on the scope of work (section 1.1), the assumptions and limitations (section 1.2), and throughout this Report, the following conclusions are made:

- The interpreted groundwater contours suggest a north-south groundwater flow direction and at a depth between 6 m bgl and 9 m bgl which is consistent with the site topography
- The monitoring program needs to be maintained and continued over the next few years prior to any significant mining activity, in order to develop a more comprehensive understanding of the baseline hydrogeology
- The monitoring network should be reviewed at least annually to reflect the construction and mine schedule
- Several ecosystems are categorised as having low to high potential for groundwater interaction. Several areas of high potential for groundwater interaction may also contain rich stygofauna that may be impacted by dewatering and mining below the water table
- Groundwater level readings are based on a single value collected during December 2022. This may not represent minimum groundwater levels as there is not enough datasets to show seasonal fluctuations
- The salinity of the groundwater is less than that of the Kiaka Creek and therefore no negative impacts from the discharge salinity are anticipated.

This Report is subject to, and must be read in conjunction with, the limitations set out in section 1.2 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

Simcoa Operations Ltd Pty (Simcoa) has engaged GHD Pty Ltd (GHD) to prepare environmental approvals under Part IV and Part V of the *Environmental Protection Act (WA) 1986 (EP Act) and the Mining Act (WA) 1978* for the North Kiaka Project (the Project).

As per the EPA's decision (29 July 2022) and subsequent Notice (15 August 2022), the proposed North Kiaka Project will be assessed as a "significant amendment to an existing approved proposal" meaning impacts are required to be assessed in context of both the existing approved proposal and the referred proposal.

Furthermore prior to commencing mining activities (including clearing and construction), the Project must also be assessed and approved by the Department of Mines, Industry Regulation and Safety (DMIRS) in accordance with the *Mining Act (WA) 1978*.

To ensure the combined mining proposal and mine closure plan contain the requisite information (as per DMIRS guidance), the completion of the hydrogeological assessment was recommended. This Report presents the initial baseline hydrogeological conditions, namely groundwater levels and quality at North Kiaka. The baseline will be critical to understanding any future changes should leaching occur from the North Kiaka Mine waste rock dump, which was identified as a key component in the environmental approval.

1.1 Scope of work

The scope of this study has been designed to meet the requirements of the following EPA and DMIRS guidelines:

- EPA Environmental Factor Guideline – Inland Waters (June 2018)
- DMIRS Guideline: Mining Proposal Guidance – How to prepare in accordance with Part 1 of the Statutory Guidelines for Mining Proposals (v3.0, March 2020)
- DMIRS Statutory Guideline for Mining Proposals (v3.0, March 2020)
- DMIRS Guideline: Mining Closure Plan – How to prepare in accordance with Part 1 of the Statutory Guidelines for Mine Closure Plans (v3.0, March 2020).

The hydrogeological assessment comprises:

- Lithological description
- Hydrogeological information
- Hydrochemistry data
- Details of installed monitoring bores
- Baseline groundwater quality results
- Recommendations for a groundwater monitoring program (including frequency of sampling, parameters for testing and trigger levels).

1.2 Limitations and assumptions

This Report: has been prepared by GHD for Simcoa Operations Pty Ltd and may only be used and relied on by Simcoa Operations Pty Ltd for the purpose agreed between GHD and Simcoa Operations Pty Ltd as set out in section 1.1 of this Report.

GHD otherwise disclaims responsibility to any person other than Simcoa Operations Pty Ltd arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD described in this Report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.3 Location description

The North Kiaka Mine is located 2.5 km north of the existing Moora mining operations which are 15 km north of Moora and approximately 180 km north of Perth in the Wheatbelt region of Western Australia. The location of the North Kiaka mine is shown in Figure 1.

1.4 Topography

The project area contains a series of parallel NNW-SSE trending ridges of bedrock with small valleys between them. The ridges are formed from the higher and more resistant to erosion layers of the Noondine Chert formation and reach topographic heights up to 65 m Australian Height Datum (m AHD). There is a large valley just to the east of the project area and further chert ridges to the south. The ridges vary in cross-section, some having gentle slopes on both sides and others having steeper slopes on one side. There are some steep rock areas, but the slopes are mainly gentle to moderate, with a few being quite steep (M.E. Trudgen & Associates, 2018).

1.5 Land use

The predominant land use within the project area is agricultural, sheep farming and cropping. Valleys between ridges are used as arable land, whereas the ridges tend to be undeveloped with a vegetation cover comprising trees and shrubs of varying density.

To the west of the project area is the north-south aligned Midlands Road, a sealed single-carriageway state highway. A single-track railway (Midland Railway Line) is offset parallel to Midlands Road by approx. 35 m east. To the south, between the proposed mine and the existing mine is Kiaka Road, a west-east orientated, sealed access road. The site is crossed by many light vehicle tracks.

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Horizontal Datum: GDA 1994
Grid: GCS GDA 1994

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Site Locality

Project No.	**12518217**
Revision No.	**A**
Date	**21/02/2023**

FIGURE 1

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Data source: World Imagery: Earthstar Geographics
OpenStreetMap: Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri
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2. Climate

The Moora region has a Mediterranean climate with cool, wet winters and dry, hot summers. The contrast between the wet and dry seasons for 2022 is illustrated in Figure 2, which highlights that monthly rainfall is lowest in January with no precipitation and highest in August with an average of 128.5 mm. This contrasts with the average temperature for 2022, which is highest in January and February (both 36°C), and the lowest in July (17.7°C). (Refer to SILO website (**https://www.longpaddock.qld.gov.au/silo/**) for interpolation details and calculations.)

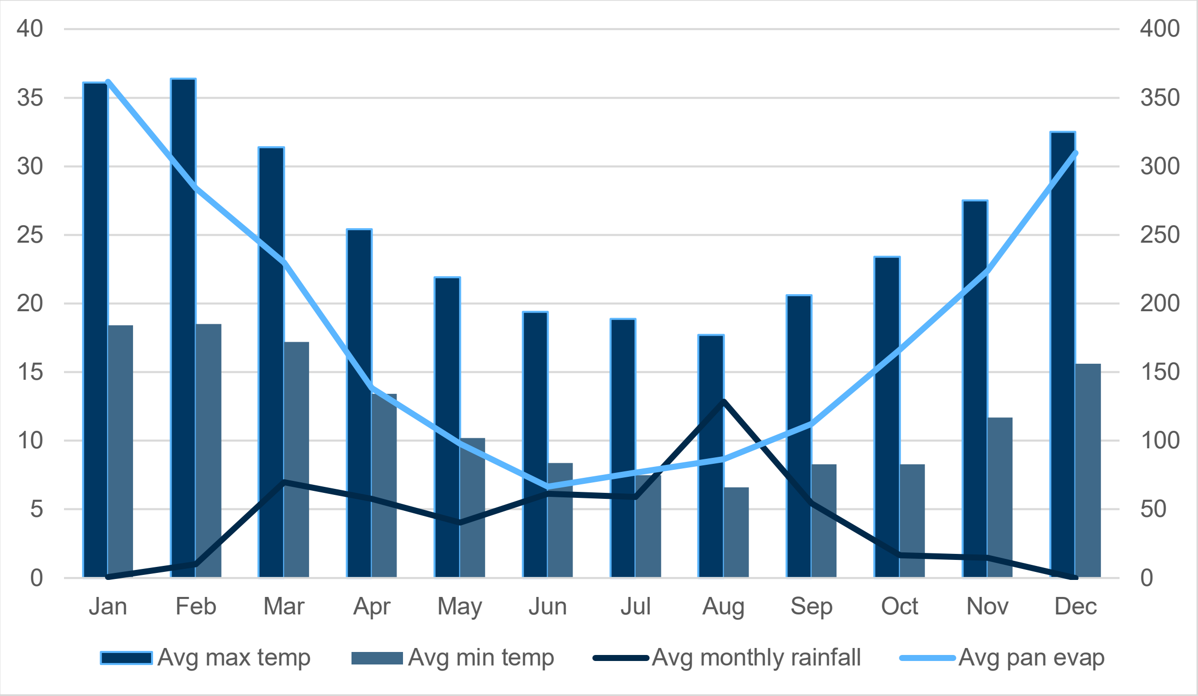


Figure 2 ***Monthly climate statistic for Moora for 2022. Data sourced from SILO (2022), Barberton station 8005***

Figure 3 shows the average annual rainfall at the Barberton weather station (10 km away from Moora). As highlighted with the 10-year moving average, there has been a steady decline in rainfall across the last 30 years.

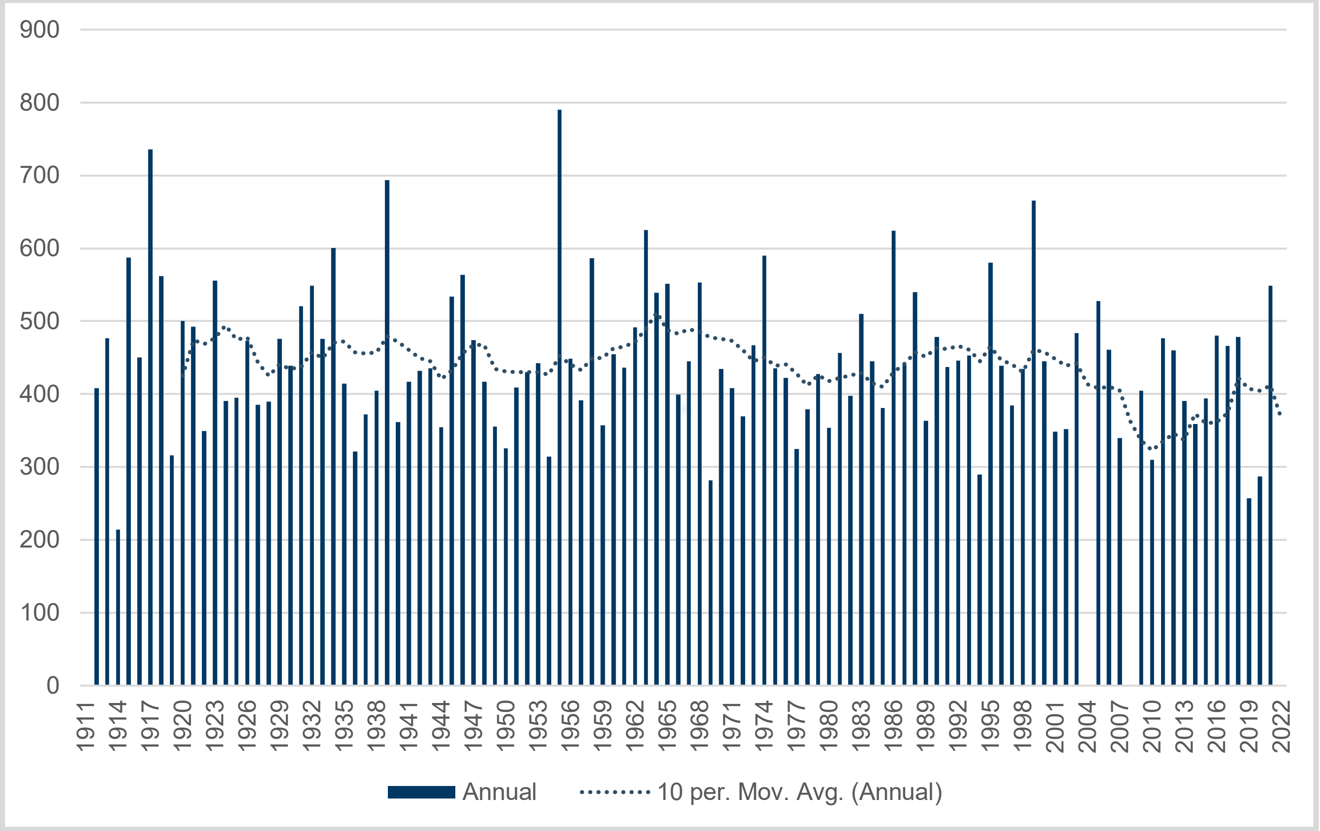


Figure 3 ***Annual rainfall from 1911 to 2022, with ten-year rolling average. Data sourced from SILO (2022), Barberton station 8005***

3. Site background and setting

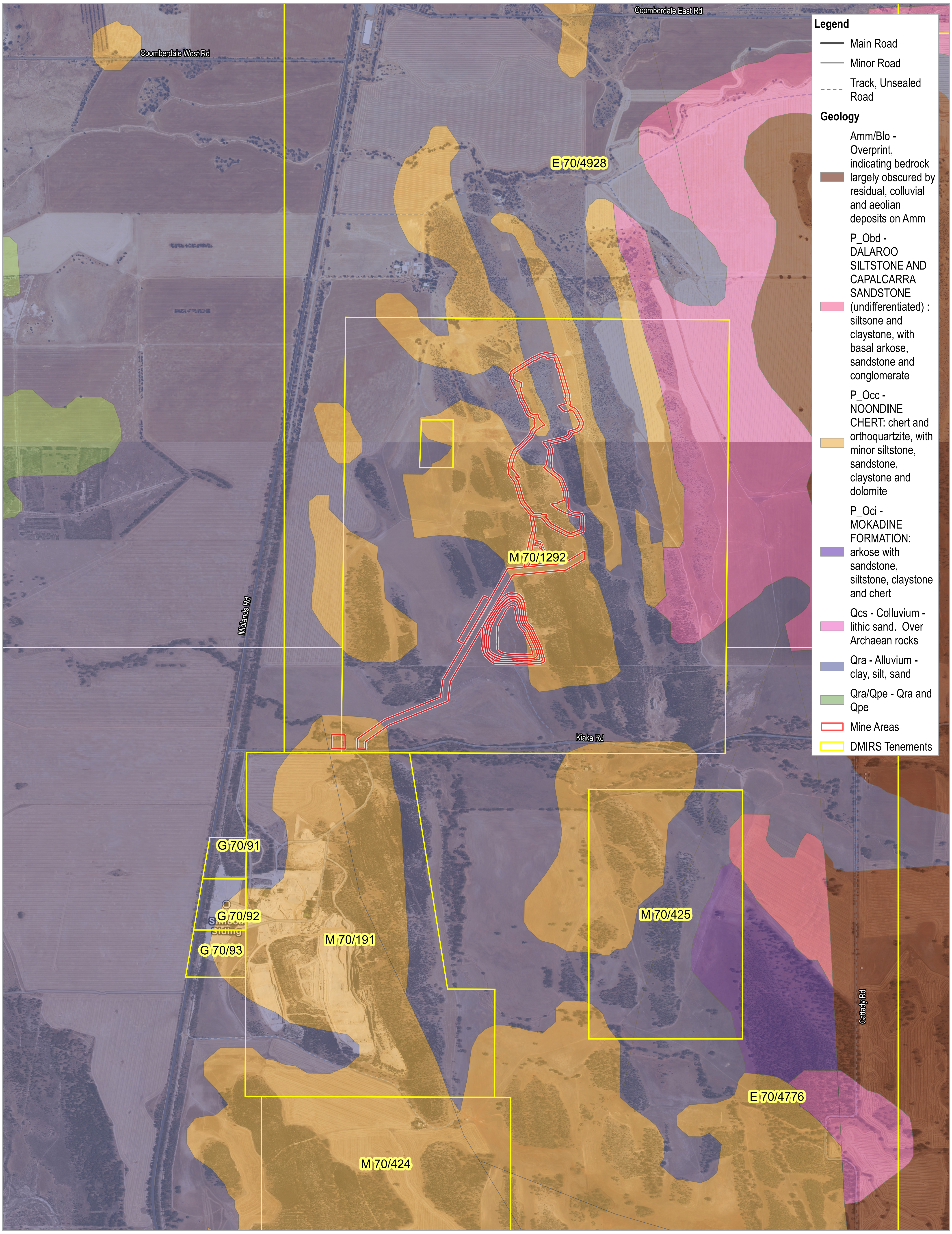
3.1 Regional geology

North Kiaka Mine is situated within the Noondine Chert Stratigraphic unit, which is part of the Coomberdale Subgroup of the Moora Group and is Middle Proterozoic in age. This Proterozoic Coomberdale Subgroup comprises consolidated and weakly metamorphosed sedimentary sequence of shelf carbonates and clastic (chert i.e., Noondine chert (ore body), siltstones, quartzite). In addition, the Subgroup is intruded by dolerite dykes and is broken up considerably by faulting (GSWA, 1982).

The Noondine Chert (orebody) is a silicified, bedded carbonate (siliceous limestone/dolomite). The orebody appears to have been formed by the surface silicification of carbonate rocks. Silicification has been observed to a depth of 75 m. The age of the silicification is uncertain but is probably Tertiary in age (GSWA, 1982).

The Chert (orebody) contains primary minerals such as chlorite, pyrite, apatite and minor remnant carbonates (calcite/dolomite). Iron oxides, titanium oxides and clays occur in the chert near the surface due to secondary weathering processes (Simcoa Operations, 2010).

The chert strikes northerly and dips at 20 to 30 degrees to the west. Faulting is common and cavities occur, which are usually filled with quartz gravel as collapse breccia (GSWA, 1982). Figure 4 shows the geological map of the project area, 1: 250 000, sheet SH 50 – 10 (GSWA, 1982). .



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Horizontal Datum: GDA 1994
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Site Geological Settings

Project No.	**12518217**
Revision No.	**A**
Date	**8/03/2023**

FIGURE 4

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Print date: 08 Mar 2023 - 14:42

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World Imagery: Maxar
OpenStreetMap (Esri Hybrid Reference - WGS84): Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri. Created by: rbrown3

3.2 Regional hydrogeology

A comprehensive hydrogeological investigation of the Moora region has not been undertaken and only limited monitoring data is available (DWER, 2009). However, the hydrogeology of the Moora Region can be divided into:

- Surficial aquifer
- Leederville aquifer
- Fractured rock.

Surficial formations form a shallow localised colluvial and alluvial lens over the underlying formations. The aquifer is composed of sand, silt and clay. The aquifer ranges from saturated to unsaturated across the subarea, with water quality ranging from fresh to brackish (DWER, 2009).

The Leederville Formation is only found along the western edge of the subarea, southwest of the Darling fault. This formation underlies the Parmelia formation and is overlayed by the Dandaragan sandstone. The aquifer compromises shale, sandstone and siltstone. The water quality within the Leederville Formation is generally fresh but high in iron (DWER, 2009).

Fractured rock aquifers are unconfined and present within open saturated fractures of the Capalacarra sandstone and Noondine Chert and Winemaya Quartzite. These aquifers have highly variable hydrogeology and generally have a limited aerial extent. The groundwater quality and quantity are highly variable, with water quality ranging from brackish to saline (DWER, 2009).

Groundwater recharge in the area is via direct rainfall infiltration, with infiltrated rainfall likely to reach the water table within days due to high vertical hydraulic conductivities. The percentage of rainfall recharge to the superficial aquifer is significantly influenced by vegetation density. Due to the uncertainty the recharge rate in the project area and the highly fractured nature of the Chert outcrop, a long-term average of 10% of rainfall has been adopted as the groundwater recharge rate for these areas. Groundwater flow within the superficial aquifer is down gradient towards the discharge boundaries at the ocean and rivers. The quantity of the groundwater flow depends on the hydraulic gradient and the transmissivity of the rock and varies significantly from place to place and between the individual hydrogeological areas.

3.2.1 Site specific hydrogeology

Given the geological and topographical setting, groundwater occurrence at the Project is constrained to fractured rocks aquifers associated with the Proterozoic sedimentary units.

The Perth Basin and associated sedimentary aquifers are located some 5 km east of the Moora quartzite mine (GSWA, 1982).

During groundwater bore testing described in Saprolite Environmental (2012), the pumping rates were between 15 to 33.5 L/s with a maximum drawdown of close to 0.4 metres, indicating high permeability and supporting relatively high yields. The pumping tests were conducted over periods from 7 hours to 7 days. A recovery test of 12 hours immediately followed the constant rate test.

Groundwater monitoring at the Moora quartzite mine Saprolite Environmental (2022) indicates standing groundwater levels close to 210 to 215 m AHD (10 to 20 metres below natural ground level).

The groundwater flow direction at the Moora quartzite mine area is likely to follow the regional topography in a westerly direction towards the Coonderoo River (and wetlands), located some 2.5 km to the west of the western boundary of the Sites. Given the shallow groundwater levels and inferred westerly flow direction, the groundwater is likely to discharge and be of beneficial use to the Coonderoo River and wetlands, identified as saline/hypersaline (Saprolite Environmental, 2012).

Laboratory analysis of the groundwater undertaken during monitoring Saprolite Environmental (2022) indicates a groundwater salinity of 700 to 850 mg/L with the following major ion characteristics:

- Cations dominated by sodium with lesser magnesium and calcium
- Anions dominated equally by carbonate and chloride with relatively low sulfate.

Fractured rock aquifers are considered to be unconfined and are present within open saturated fractures of the Capalcarra sandstone and Noondine Chert and Winemaya Quartzite. These aquifers have highly variable hydrogeology and generally have a limited aerial extent. The groundwater quality and quantity are highly variable, with water quality ranging from brackish to saline (DWER, 2009).

3.3 Existing groundwater use

There has been limited drilling and investigation within the project area. Two production bores were drilled at Moora Quartzite Mine, BH1 in 2001 and BH2 in 2011 (Table 1). The abstraction from the bores is authorised by a groundwater licence 104693 with a total annual allocation of 250,000 KL, owned by Simcoa.

Table 1 Groundwater abstraction licence (104693) within the project area

Bore ID	Easting	Northing	Bore depth (m bgl*)	Comments
BH1	407330.32	6623734.36	30	Fractured rock aquifer
BH2	407524.00	6623624.00	28.3	Fractured rock aquifer

**m below ground level (m bgl)*

Groundwater abstracted for stock or agricultural watering is exempt from licencing and therefore is not registered with the DWER. The location of those bores is summarised in Table 2.

Table 2 Groundwater users for stock or agricultural watering within the project area (DWER, 2022)

Site reference	Easting	Northing	Comment
61713492	407887	6627258	Combined fractured rock
61716621	408270	6627334	Combined fractured rock
61713497	408886	6627574	Combined fractured rock
61713493	408042	6627056	Combined fractured rock
61713540	408463	6626999	Combined fractured rock
61713494	407793	6626391	Combined fractured rock
61713489	409212	6626077	Combined fractured rock

Most stock bores were established early in the pastoral station's development. Due to the relatively low volumes of groundwater required at each location, bores tend to be very shallow, generally less than 10 m deep.

3.4 Groundwater dependent ecosystems (GDEs)

The Bureau of Meteorology *Groundwater Dependent Ecosystems Atlas* identifies that the geomorphic wetlands and drainage systems within the project area are classified as GDEs (BoM, 2022).

The atlas recognises three types of GDEs:

- Subterranean ecosystems (Type 1) including cave and aquifer ecosystems
- Aquatic ecosystems (Type 2) that rely on the surface expression of groundwater – including surface water systems that may have a groundwater component such as rivers, wetlands, and springs
- Terrestrial ecosystems (Type 3) that rely on the subsurface presence of groundwater – including vegetation ecosystems such as forests and riparian vegetation.

GDEs within the project area are identified as Type 2 and Type 3 GDEs.

A review of the flora and vegetation of the proposed North Kiaka Mine (M.E. Trudgen & Associates, 2018) identified several ecosystems that are categorised as having low to high potential for groundwater interaction. Several areas of high potential for groundwater interaction situated in underlying Noondine Chert may also contain rich stygofauna that may be impacted by dewatering and mining below the water table (DPaW, 2013).

4. Groundwater investigation

4.1 Overview of completed work

In order to develop a hydrogeological understanding of the site, the following works have been completed:

- Desktop hydrogeological review, August 2022
- Drilling, installation and airlifting of six monitoring bores, four at North Kiaka Mine, one at Moora Mine and one dry well, December 2022
- Post installation monitoring and sampling, December 2022.

A summary of the above stages is provided in section 4.2 to section 4.4.

4.2 Monitoring bore drilling program

The following section provides a summary of the recent drilling completed. The objective of the drilling program was to install a monitoring bore network at North Kiaka Mine and develop an understanding of baseline water levels and quality.

Drilling was completed between 7th December and 11th December 2022. Six locations were selected, five at North Kiaka Mine and one at Moora Mine. Five bores were drilled and constructed, with one bore (NKMB03) at North Kiaka Mine drilled to 60 m and then abounded as no water was encountered.

All bores were developed using airlifting techniques to remove the fines from the bore and encourage groundwater flow to the bore’s screen interval. Airlifting was completed until purged groundwater ran clear or was relatively free from fines.

A summary of the completed drilling and the bore installation is presented in Table 3 and Table 4 retrospectively. The monitoring bore locations are shown in Figure 5. Hydrogeological logs, including bore installation details are presented as Appendix A.

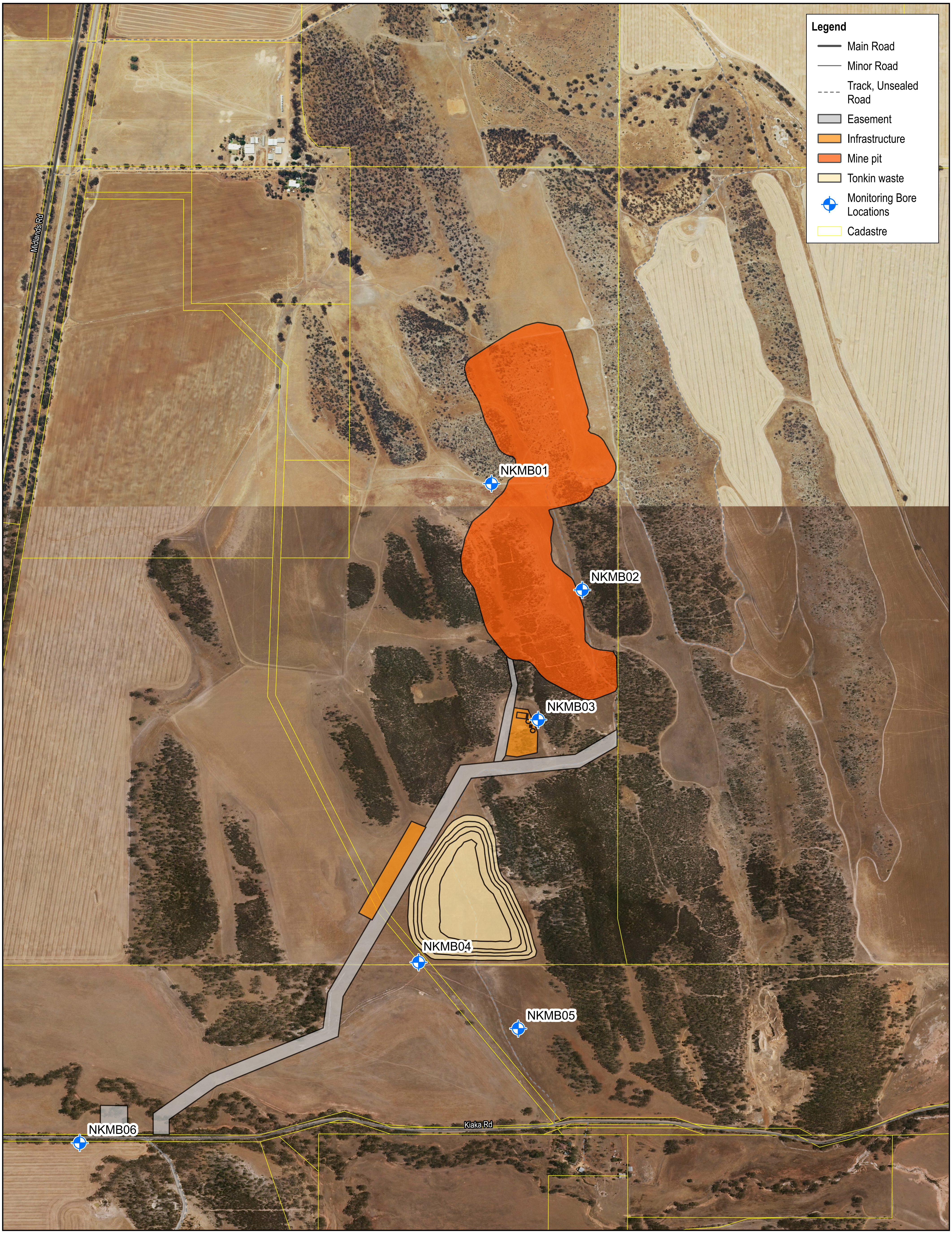
Table 3 Installed monitoring bore details

Bore Id	Easting	Northing	Date drilled	Drilled depth (m bgl)	Screen from (m bgl)	Screen to (m bgl)	Gravel from (m bgl)	Gravel to (m bgl)	Bentonite from (m bgl)	Bentonite to (m bgl)	Backfill from (m bgl)	Backfill to (m bgl)	TOC* (m AHD)	Stick up (m)	Depth to water (m bgl)	Approx static WL (m AHD)
NKMB001	408436	6626733	9/12/2022	34	26	20	34	18	18	17	17	0	234.10	0.97	8.9	225.2
NKMB002	408694	6626456	10/12/2022	52	51	45	52	41	41	40	40	0	250.86	0.84	33.7	217.16
NKMB003	408597	6626035	10/12/2022	60	-	-	-	-	-	-	-	-	-	-	-	-
NKMB004	408294	6625302	8/12/2022	16	15	9	15	7	7	6	6	0	219.99	0.95	6.6	213.39
NKMB005	408536	6625152	7/12/2022	22	19	13	22	12	12	10	10	0	223.58	0.80	7.61	215.97
NKMB006	407429	6624777	9/12/2022	16	13	7	16	6	6	5	5	0	217.03	0.80	6.31	210.72

**TOC- top of casing*

Table 4 *Bore installation summary*

Bore ID	Lithology summary	Screen interval (m bgl)	Water level at installation (m bgl)
NKMB01	**0 – 3 m** Colluvial sand. beige/tan, with course silcrete gravel **3 – 34 m** Chert, mottled milky/grey through profile, silicate band (10-13m), fine moderate quartz gravel in clay matrix (29-31 m)	20– 26	19.0
NKMB02	**0 – 1 m** Sand, brown, with course iron stained silcrete gravels **1 – 7 m** Sand, tan, with course silcrete gravels **7 -44 m** Chert, milky grey, sharp fractures **44 – 47 m** Clay, tan with weathering chert gravels **47 – 52 m** clay, khaki, moderate plasticity, soft	45 – 51	35.0
NKMB03	**0 – 4 m** Sand, cream, with fine to coarse silcrete gravels **4 – 60 m** Clay, red/orange to emerald green, moderate plasticity, soft and fine siliceous gravels 4-11 m only	-	-
NKMB04	**0 – 4 m** Colluvial sand, pale cream, fine grained, some calcrete, ferricrete and nodules of recemented sands **4 – 13 m** Silty clay, light tan to dark brown, moderate plasticity, soft with siliceous and other iron-stained gravels **13 – 16 m** chert and silcrete, with tan/brown sand clay matrix	9 – 15	4.6
NKMB05	**0 – 6 m** Colluvial sand, with course subangular silcrete gravels (0.2-2 cm) **6 – 16 m** Silty clay, pallid to beige, low plasticity, powdery, with fine bands of occasional chert **16 – 22** m Silty clay, tan/brown, possible siltstone, with dark grey/brown fine weathered gravels	13 – 19	6.0
NKM06	**0 – 1 m** Colluvial clay rich sand, brown, with course silcrete gravels **1 – 7 m** Gravelly clay, mottles tan/pink/orange, with fine-grained quartz-rich gravels **7 – 9 m** Gravel with clay matrix, ferricrete and silcrete **9 – 16 m** Gravelly clay, moderate plasticity, soft, quartz-rich gravels	7 – 13	12.0



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Horizontal Datum: GDA 1994
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Monitoring Bore Locations

Project No.	**12518217**
Revision No.	**A**
Date	**21/02/2023**

FIGURE 5

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Print date: 08 Mar 2023 - 14:30

Data source: OpenStreetMap: Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri
WA Now Imagery (SLIP Token):
World Imagery: Maxar
OpenStreetMap (Esri Hybrid Reference - WGS84): Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri. Created by: rbrown3

4.3 Groundwater levels

Standing water levels in the monitoring bores were recorded in December 2022. Water levels were presented within the drilling summary in Table 3. The groundwater contour map is presented in Appendix B. The interpreted groundwater contours suggest a northeast-southwest groundwater flow direction towards Kiaka Creek, which is consistent with the site topography.

4.4 Groundwater quality

4.4.1 Laboratory analysis

Groundwater samples were taken for laboratory analysis to provide a baseline indication of groundwater quality. The samples were analysed for major ions, dissolved metals, nitrates and inorganics. Groundwater samples from December 2022 were submitted with Chain-of-Custody (CoC) documentation for analysis by SGS Australia Pty Ltd. SGS is accredited with the National association of Testing Authorities (NATA) for the nominated analyses. A copy of CoC has been attached as Appendix C.

The analytical suite includes the analytes described in Table 5.

Table 5 Groundwater analytical suite

Analytical program	Location				
	NKMB01	NKMB02	NKMB04	NKMB05	NKMB06
Physico-chem: pH, EC, TDS, TSS, alkalinity, turbidity, cyanide	x	x	x	x	x
Major cations: Ca, Mg, Na, K, S	x	x	x	x	x
Major anions: sulfate, chloride	x	x	x	x	x
Alkalinity: total, carbonate, bicarbonate	x	x	x	x	x
Heavy metals: total of 16	x	x	x	x	x
Speciated nitrogen: nitrite, nitrate	x	x	x	x	x
Anion-cation balance	x	x	x	x	x

4.4.2 Laboratory results

The water quality results have been summarised in Appendix D. The following observations were made from a review of data:

- Groundwater salinity ranged between 360 mg/L TDS and 7,100 mg/L TDS which indicates fresh to saline groundwater quality. The high salinity was recorded at the bore NKMB006, which could suggest some infiltration of saline water from mining activities due to bore’s proximity to the pit
- Consistent with the elevated salinity found in all bores, major ion concentrations are all elevated in these bores
- pH was reported to be neutral to slightly alkaline across the monitoring bore network, with pH ranging from 7.1 to 8.0
- Dissolved metal concentrations of arsenic, cadmium, chromium, and lead were below the limit of reporting (LOR) in all bores
- Dissolved metal concentrations of aluminium, cobalt, copper, iron, manganese, mercury, selenium, and zinc exceeded agricultural irrigation water long-term trigger values (ANZG, 2020)
- Silica concentrations vary between bores. The bore with the highest silica concentration (up to 73 mg/L) is the bore closest to the Moora Mine pit (NKMB006).

The results of cations/ anions grouping for the groundwater samples are presented on the Piper Diagram (Figure 6), which highlights a sodium chloride type of water in all bores, except in bore NKMN004, which is a mixed type.

A summary of the main groundwater analytes is presented in Table 6.

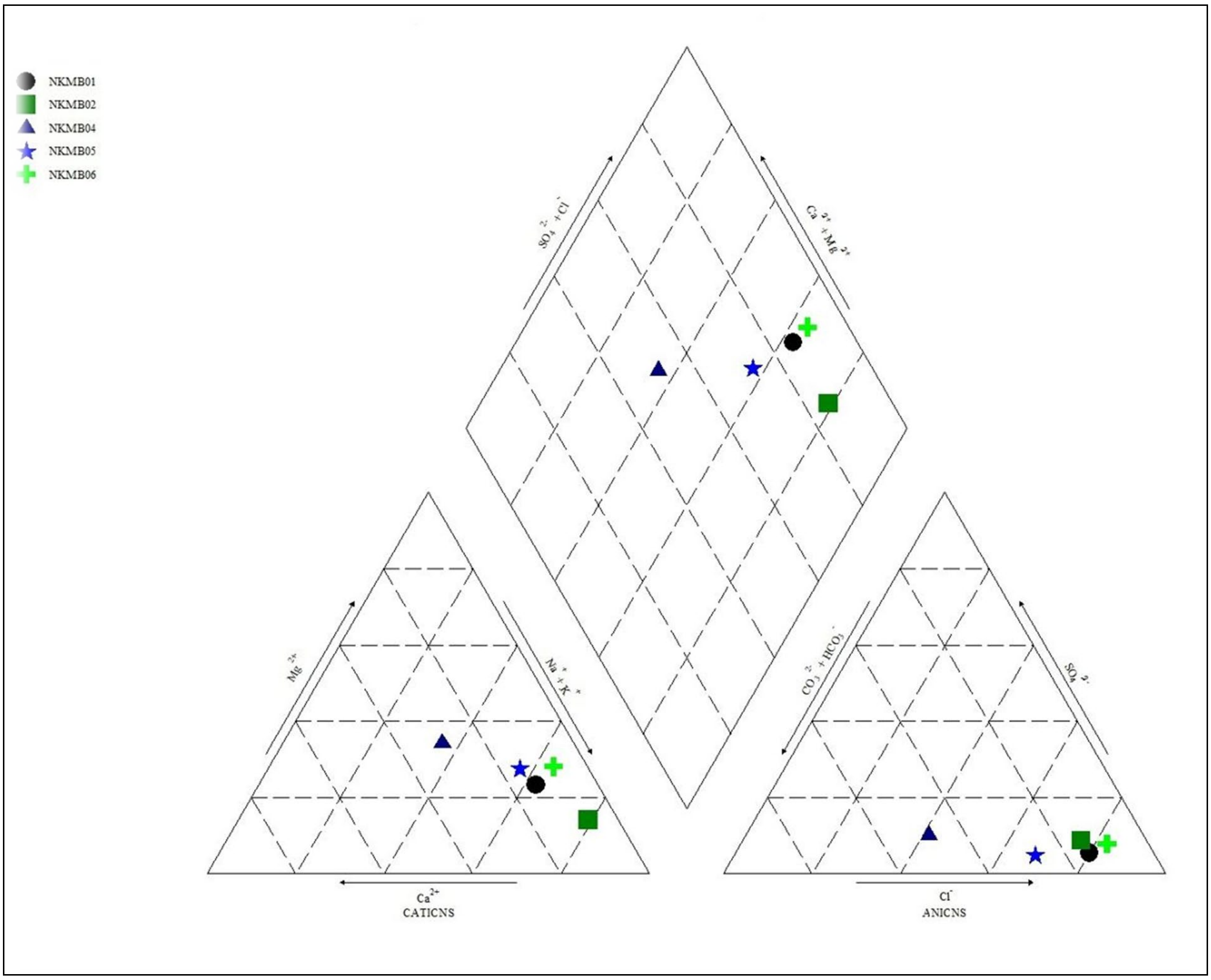

Figure 6 *Piper diagram of groundwater chemistry*

Table 6 *Summary of main groundwater analytes*

Analyte	Number of samples	Median	Minimum	Maximum
pH	5	7.48	7.0	8.0
Total Dissolved Solids (TDS) (mg/L)	5	1,898	380	7,100
Calcium (mg/L)	5	57	14	170
Magnesium (mg/L)	5	94	15	370
Sodium (mg/L)	5	415	57	1,600
Potassium (mg/L)	5	7.4	2.7	18
Chloride (mg/L)	5	836	120	3,300
Sulfate (mg/L)	5	110	11	410
Total alkalinity (mg/L)	5	203	55	520
Manganese (mg/L)	5	88.6	62	140
Aluminium (mg/L)	5	531.4	15	2,500
Iron (mg/L)	5	1,189	14	4,200
Silica (mg/L)	5	41.8	23	73

5. Groundwater monitoring program

5.1 Baseline monitoring

Monitoring of groundwater is required to established pre-mining baseline conditions for key receptors (stock bores) and will be required around operational areas that could have a potential impact on groundwater level and quality such as the waste rock dump.

The baseline monitoring network for North Kiaka currently consists of the recently drilled monitoring bores at the 5 locations discussed in this report. Currently mining is limited to above water table ore. Should mining occur below water table in the future, the current groundwater monitoring network will need to be expanded to broaden the reach of the baseline dataset and in particular to provide an early indication of changes in quality in particular within the main drainages and the groundwater in general.

In order to establish a groundwater monitoring database and to develop a comprehensive understanding of the baseline hydrogeology the monitoring should be continued over the next few years. The monitoring network needs to be reviewed at least annually so that it reflects the construction and mine schedule and their potential to impact water flows and chemistry. In the short term the frequency of the monitoring is recommended as follows:

- Water quality – collect bi-annual samples for laboratory analysis
- Water level – quarterly water level monitoring.

Water samples from each bore and duplicates should be analysed for the suite of analytes as per the list in Table 7, by a NATA accredited laboratory.

Table 7 Proposed quality monitoring parameters

Measurement	Parameters
Field	– pH – EC.
Laboratory	– pH – EC – TDS – Turbidity – Major cations (Ca, Na, Mg, K) – Major anions (Cl, SO_4, HCO_3, NO_3) – Total alkalinity – Bicarbonate alkalinity – Carbonate alkalinity – Silica – Cyanide – Fluoride – Mercury – Nitrogen (NO_2, NO_3) – Dissolved metals (Al, As, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Zn) – Anion-cation balance.

Water chemistry notes:

- All methods and equipment used in water quality sampling is to be used in accordance with the Australian Standard AS/NZS 5667 (1998) and wherever possible, a NATA registered laboratory should undertake the analyses, using NATA accredited analysis methods
- The method (e.g., EC correction factor; gravimetric) used for the determination of TDS must be specified and preferably consistent.

Field test analysis methods shall be conducted in accordance with the equipment manufacturer instructions. In particular, the calibration of field pH/EC meter shall be conducted prior to sampling, in accordance with manufacturer's instructions and field test kits (total acidity and total alkalinity).

The limit of detection must be sufficient for assessment against current and relevant guidelines, including *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).*

Groundwater level monitoring should be undertaken as per following instructions:

- Water levels should be measured from a standard measuring point; for example - top of casing. Any change in the position of the reference point will be recorded and previous measurements adjusted accordingly
- Water levels should be reported as metres below the standard reference point meters below top of casing (m bTOC), m bgl and m AHD
- Water levels should be recorded to the nearest centimetre.

Groundwater monitoring is to be undertaken in accordance with the:

- AS/NZS 5567.11:1998 *Water Quality – Sampling Guidance on Sampling of Groundwaters and Monitoring*
- Sampling Manual 2018 – Environmental Protection Policy 2009.

5.2 Trigger Levels - Definition

Trigger levels should provide an early warning of potential impacts to groundwater. The recommended compliance approach is based on combining ANZECC 2000 and specific site guidelines. However, dissolved metal concentrations of aluminium, cobalt, copper, iron, manganese, mercury, selenium, and zinc exceeded agricultural irrigation water long-term trigger values (ANZG, 2020).Therefore, interim trigger levels should be developed based on a statistical analysis of bi-annual samples over the next couple of years.

Risk of significant change to groundwater levels and quality due to mining is likely to be low as the current mine plan indicates all activity will occur above the water table.

Should mining occur below water table in the future the risk of impacts to groundwater levels and quality will increase as a result of leaching from the proposed waste rock dump and deep saline waters.

The below sections describe the three tiers of monitoring to be included in TLP.

Tier I – Routine monitoring and trigger locations

The first tier consists of the routine monitoring included in the regular groundwater monitoring program for the site. Hydrochemical analysis is to be conducted bi-annually for the comprehensive list of analytical parameters included in section 5.1. Analytical results for each bore should be compared to the established trigger level as part of Tier I monitoring activities. The comparison of the result to the trigger levels will determine if each bore will continue with Tier I monitoring or move to Tier II monitoring during the subsequent monitoring event.

Tier II – Confirmation monitoring

The Tier II confirmation monitoring program will be implemented if a trigger parameter concentration exceeds an established trigger level in two successive sampling events. The Tier II confirmation monitoring program collects a confirmatory water quality sample from the location exhibiting Tier I exceedance during a follow-up monitoring event to confirm Tier I exceedance.

The Tier II elevation will include comparison of the observed water quality to the criteria and the applicable regulatory compliance framework. The comparison will be utilised to determine the appropriate timing and urgency of response. The comparison will also include parameter trend analyses over time and the potential for contributions from possible impact sources.

Tier III – Contingency measures and compliance monitoring

The Tier III involves the implementation and subsequent performance assessment of the necessary contingency measures. Tier III includes ongoing monitoring to assess the effectiveness of any contingency measures implemented until the contingency measures are deemed no longer necessary. The Tier III compliance monitoring program details would be determined in conjunction with developing and implementing preferred contingency measure(s).

5.3 Contingency response plan

As discussed above an evaluation of potential contingency measures should be undertaken if Tier I exceedances are confirmed through and after a Tier II reassessment of the analytical results shows that contingency measures are warranted. As the nature of potential future non-compliance issues cannot be known in advance. It is not appropriate to identify specific contingency plans for implementation that will necessarily best suit the particular situation in the event of potential or actual non-compliance.

In time a site-specific trigger level program (TLP) and contingency response plan (CRP) needs to be developed including defining the various triggers and resultant responses.

6. Summary

The hydrogeological assessment presents an initial baseline for the hydrogeological conditions and groundwater quality at North Kiaka. The baseline will assist in the identification of the potential environmental impact of changes in groundwater levels and quality, if leaching were to occur at the North Kiaka Mine waste rock dump. To define the baseline the following hydrogeological investigations have been completed:

- Desktop hydrogeological review
- Drilling, installation and airlifting of six monitoring bores, five at North Kiaka Mine (including one dry well) and one at Moora Mine
- Post installation monitoring and sampling.

The following are the outcomes of the current hydrogeological investigations:

- The interpreted groundwater contours suggest a north-south groundwater flow direction consistent with the site topography with a water table between 6 and 9 m bgl
- The monitoring program needs to be maintained and continued over the next few years prior to any significant mining activity in order to develop a comprehensive understanding of the baseline hydrogeology
- The monitoring network should be reviewed at least annually to reflect the construction and mine schedule
- Several ecosystems are categorised as having low to high potential for groundwater interaction. Several areas of high potential for groundwater interaction may also contain rich stygofauna that may be impacted by dewatering and mining below the water table
- Groundwater level readings are based on a single value collected during December 2022. This may not represent minimum groundwater levels as there is not enough datasets to show seasonal fluctuations
- The salinity of the groundwater is less than that of the Kiaka Creek and therefore no negative impacts from the discharge salinity are anticipated.

7. References

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Department of Parks and Wildlife (DPaW) (2013). Interim recovery Plan No 388. Kensington.

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Geological Survey of Western Australia (GSWA). (1982). *1:250 000 Geological Series - Explanatory Notes*, Sheet SH/50-10. Moora, Western Australia.

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Saprolite Environmental (2012). *Moora Quartz Mine - Phase 2 Hydrogeological Investigations*.

Saprolite Environmental (2022). *Annual groundwater Monitoring Summary GWL 104693 - Moora Quartzite Mine - 1 January to 31 December 2021*. Report Number: E0202-10 - Ver A.

Simcoa Operations (2010). *Moora Project, Mineralisation Report, Application for Mining Lease*. South West Mineral Field, Western Australia.

Appendix A

Monitoring borehole logs

BOREHOLE LOG NKMB01

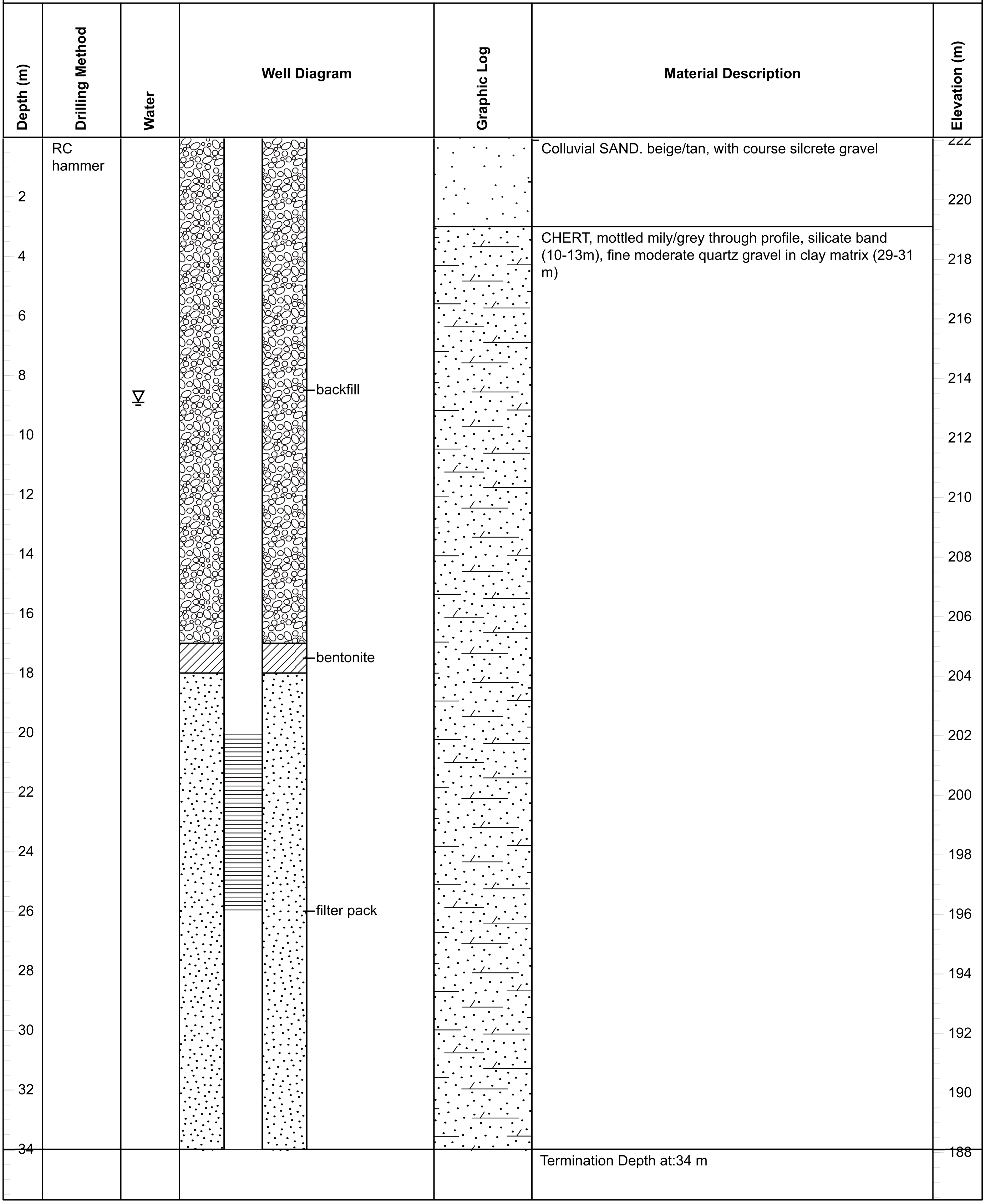
PROJECT NUMBER 12518217
PROJECT NAME Mon. bore completion report
CLIENT Simcoa Pty Ltd
SITE North Kiaka Mine
DATE DRILLED 9/12/2022

DRILL CO Strike Drilling
DRILLER Ashley Marinoni
DRILL METHOD RC Hammer
RIG SDR08
TOTAL DEPTH 34 m

COORDINATES 408433, 6626725
COORD SYS GDA2020_MGA_Zone_50
TOC ELEVATION (m AHD) 244
STICK UP (m) 0.84
LOGGED BY MR

CASING 50 mm 12 uPVC

SURFACE COMPLETION Monument



Colluvial SAND. beige/tan, with course silcrete gravel

CHERT, mottled mily/grey through profile, silicate band (10-13m), fine moderate quartz gravel in clay matrix (29-31 m)

Termination Depth at:34 m

produced by ESlog.ESdat.net on 23 Dec 2022

BOREHOLE LOG NKMB02

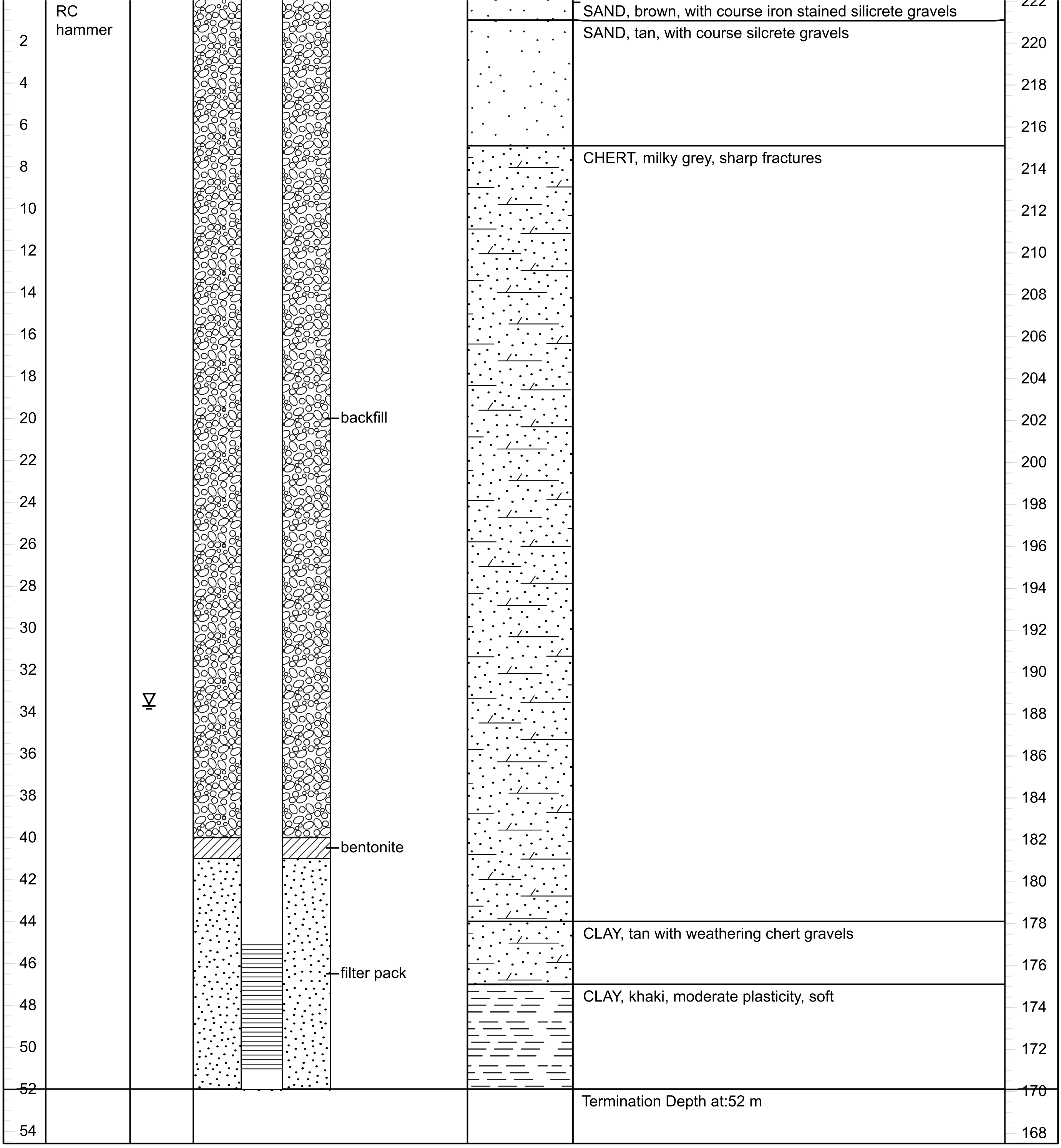
PROJECT NUMBER 12518217
PROJECT NAME Mon. bore completion report
CLIENT Simcoa Pty Ltd
SITE North Kiaka Mine
DATE DRILLED 10/12/2022

DRILL CO Strike Drilling
DRILLER Ashley Marinoni
DRILL METHOD RC Hammer
RIG SDR08
TOTAL DEPTH 52 m

COORDINATES 408692, 6626457
COORD SYS GDA2020_MGA_Zone_50
TOC ELEVATION (m AHD) 244
STICK UP (m) 0.84
LOGGED BY MR

CASING 50 mm 12 uPVC
SURFACE COMPLETION Monument

Depth (m)	Drilling Method	Water	Well Diagram	Graphic Log	Material Description	Elevation (m)



SAND, brown, with course iron stained silicrete gravels

SAND, tan, with course silcrete gravels

CHERT, milky grey, sharp fractures

CLAY, tan with weathering chert gravels

CLAY, khaki, moderate plasticity, soft

Termination Depth at:52 m

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2022

BOREHOLE LOG NKMB04

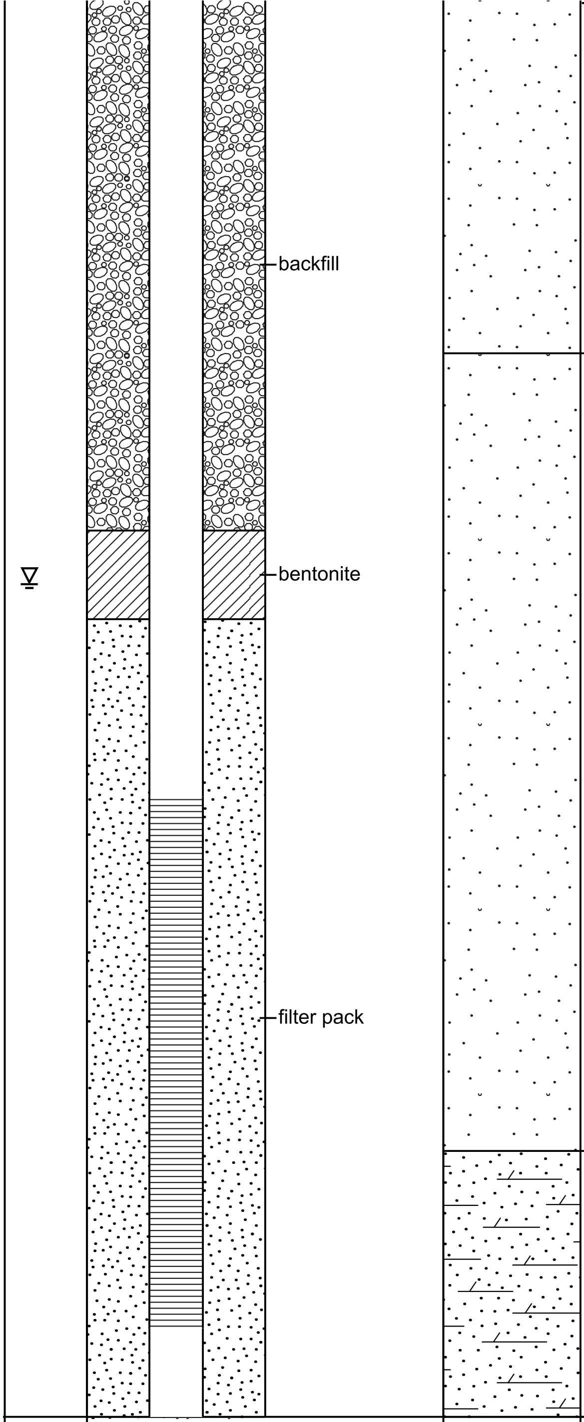
PROJECT NUMBER 12518217
PROJECT NAME Mon. bore completion report
CLIENT Simcoa Pty Ltd
SITE North Kiaka Mine
DATE DRILLED 08/12/2022

DRILL CO Strike Drilling
DRILLER Ashley Marinoni
DRILL METHOD RC Hammer
RIG SDR08
TOTAL DEPTH 16 m

COORDINATES 408295, 6625991
COORD SYS GDA2020_MGA_Zone_50
TOC ELEVATION (m AHD) 222
STICK UP (m) 0.95
LOGGED BY MR

CASING 50 mm 12 uPVC

SURFACE COMPLETION Monument



Depth (m)	Drilling Method	Water	Well Diagram	Graphic Log	Material Description	Elevation (m)
	RC hammer				Colluvial SAND, pale cream, fine grained, some calcrete, ferricrete and nodules of recemented sands	222
1						221
2						220
3			backfill			219
4					Silty CLAY, light tan to dark brown, moderate plasticity, soft with siliceous and other iron stained gravels	218
5						217
6						216
		∇	bentonite			
7						215
8						214
9						213
10						212
11			filter pack			211
12						210
13					CHERT and silcrete, with tan/brown sand clay matrix	209
14						208
15						207
16					Termination Depth at:16 m	206

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2022

BOREHOLE LOG NKMB05

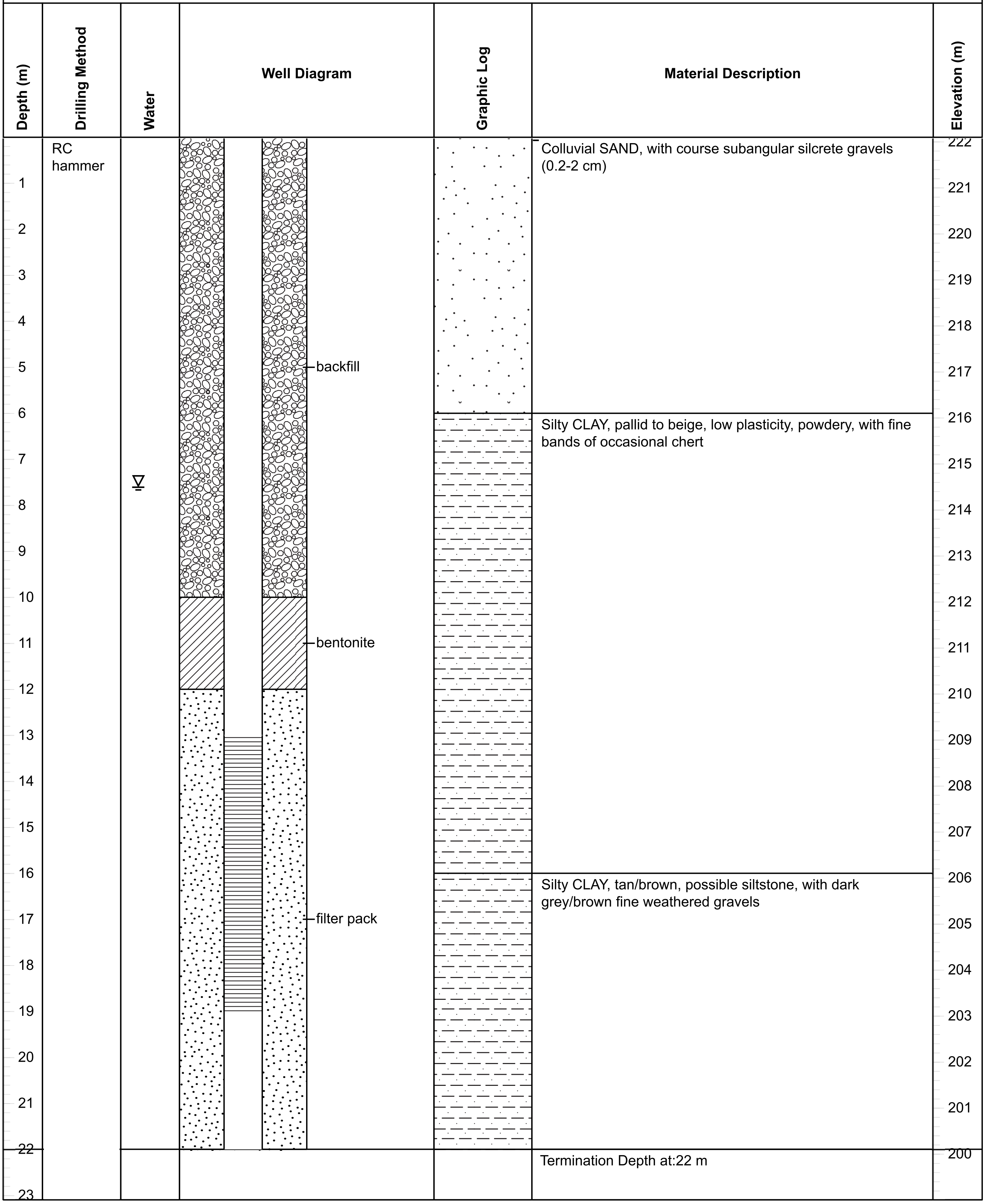
PROJECT NUMBER 12518217
PROJECT NAME Mon. bore completion report
CLIENT Simcoa Pty Ltd
SITE North Kiaka Mine
DATE DRILLED 07/12/2022

DRILL CO Strike Drilling
DRILLER Ashley Marinoni
DRILL METHOD RC Hammer
RIG SDR08
TOTAL DEPTH 22 m

COORDINATES 408529, 6625154
COORD SYS GDA2020_MGA_Zone_50
TOC ELEVATION (m AHD) 226
STICK UP (m) 0.80
LOGGED BY MR

CASING 50 mm 12 uPVC

SURFACE COMPLETION Monument



Colluvial SAND, with course subangular silcrete gravels (0.2-2 cm)

Silty CLAY, pallid to beige, low plasticity, powdery, with fine bands of occasional chert

Silty CLAY, tan/brown, possible siltstone, with dark grey/brown fine weathered gravels

Termination Depth at:22 m

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2022

BOREHOLE LOG NKMB06

PROJECT NUMBER 12518217
PROJECT NAME Mon. bore completion report
CLIENT Simcoa Pty Ltd
SITE North Kiaka Mine
DATE DRILLED 09/12/2022

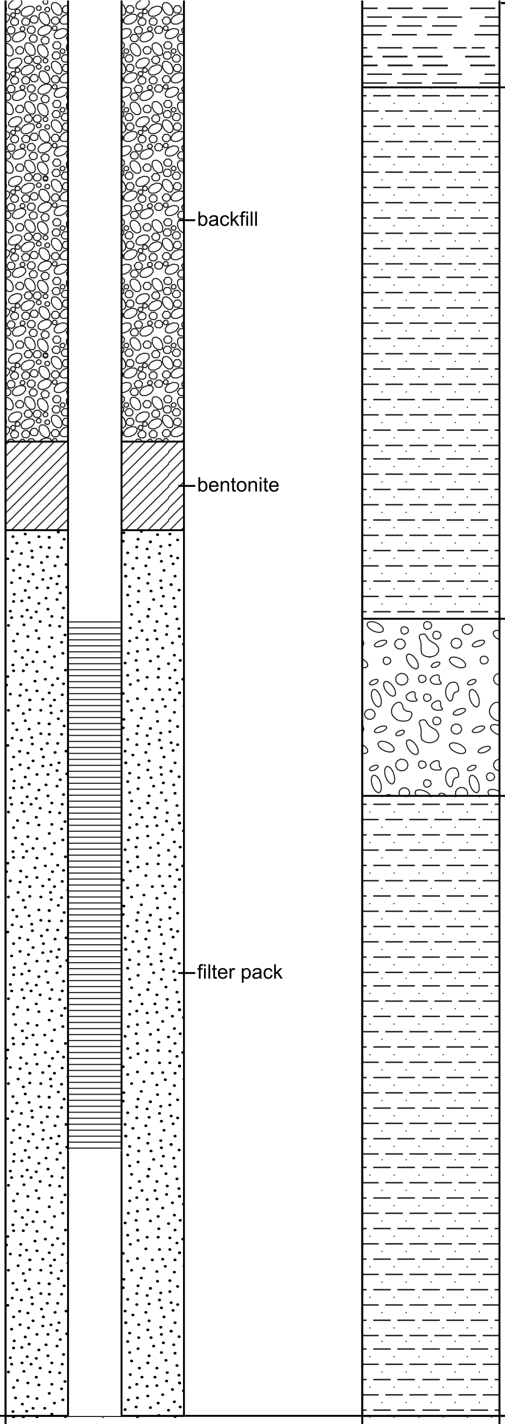
DRILL CO Strike Drilling
DRILLER Ashley Marinoni
DRILL METHOD RC Hammer
RIG SDR08
TOTAL DEPTH 16 m

COORDINATES 407431, 6624790
COORD SYS GDA2020_MGA_Zone_50
TOC ELEVATION (m AHD) 203
STICK UP (m) 0.80
LOGGED BY MR

CASING 50 mm 12 uPVC

SURFACE COMPLETION Monument

Well Diagram | Graphic Log



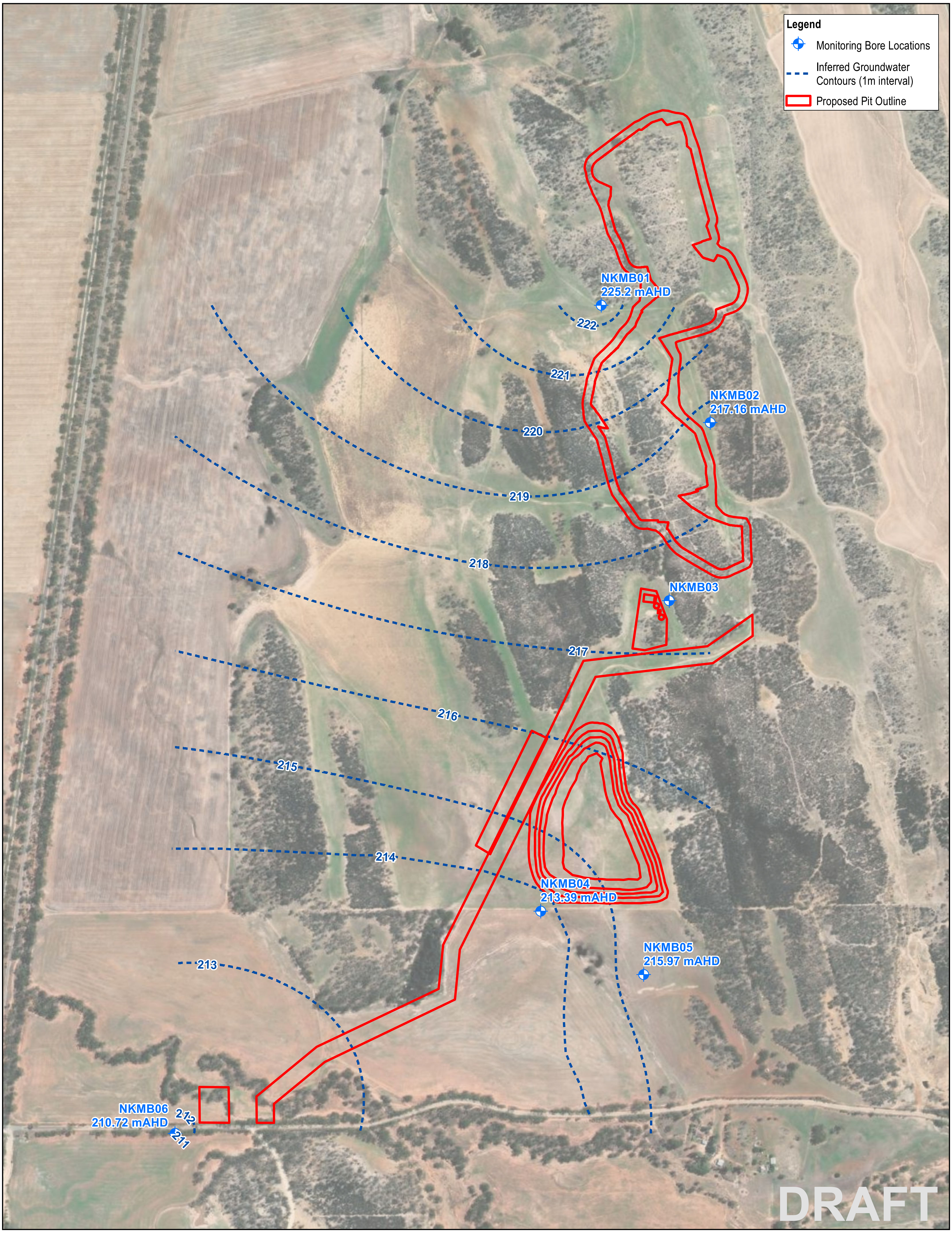
Depth (m)	Drilling Method	Water	Material Description	Elevation (m)
	RC hammer		Colluvial CLAY rich sand, brown, with course silcrete gravels	222
1			Gravelly CLAY, mottles tan/pink/orange, with fine-grained quartz-rich gravels	221
2				220
3				219
4				218
5				217
6		⊻		216
7			GRAVELI with clay matrix, ferricrete and silcrete	215
8				214
9			Gravelly CLAY, moderate plasticity, soft, quartz-rich gravels	213
10				212
11				211
12				210
13				209
14				208
15				207
16			Termination Depth at:16 m	206

Disclaimer This bore log is intended for environmental not geotechnical purposes.

produced by ESlog.ESdat.net on 23 Dec 2022

Appendix B

Groundwater contour map



Data Disclaimer

Paper Size ISO A3
0 50 100 150 200
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

Simcoa Operations Ltd Pty
Hydrogeological Assessment

Project No.	**12518217**
Revision No.	**A**
Date	**01/02/2023**

Groundwater Contour Map

FIGURE B-1

\\ghdnet\ghd\AU\Perth\Projects\61\12518217\GIS\Maps\Deliverables\12518217_002_ContourMap.mxd
Print date: 01 Feb 2023 - 10:31

Data source: GHD: Pit Outline (2023), Monitoring Bores (2023), Contours (2023) Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community. Created by: dbbanatin

Appendix C

Chain of Custody (CoC)

SGS

SGS Environmental Services
28 Reid Road,
Perth Airport
WA 6105
Tel: 08 9373 3500 Fax: 08 9373 3668

ATTN: Sample Receipt
Email: AU.SampleReceipt.Perth@sgs.com

SGS Perth Environmental
PE165612 COC
Received: 22-Dec-2022

CHAIN OF CUSTODY & ANALYSIS REQUEST

Lab ID Number: ____________ *(please quote on all correspondence)*

Page ____ of ____

Please remember to fill in your company details below or attach business card.

Company Name:	GHD Pty Ltd	**Project Name/No:**	North Kiaca
Address:	999 Hay Street Perth 6000	**Purchase Order No:**	
Contact Name:	Marija Rosic	**Results Required Date:**	
Site Contact:		**Telephone:**	6222 8487
SGS Client Contact:		**Email Results to:**	marija.rosic@ghd.com
Laboratory Quotation No:		**Email Invoice to:**	marija.rosic@ghd.com

	ID	Sample Description	Sampling Date/Time *(field record sheet number)*	*Tick as Appropriate*			PRESERVATIVE	NO. OF ITEMS	ANALYSIS REQUESTED. SPECIFY & TICK AS APPROPRIATE												Notes/Guidelines/LOR/ Special instructions
				Solid Sample	Liquid Sample	Other:															
1	NKMB01		21/12		✓			5													1L plastic green
2	NKMB02		21/12		✓			5													1L plastic yellow
SNR. 3	NKMB03		21/12		✓			5													250ml black plastic
4	NKMB04		21/12		✓			5													2x125ml red plastic
5	NKMB05		21/12		✓			5													
6	NKMB06		21/12		✓			5													

Relinquished By:	Date/Time:	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received By:	Date/Time:
Samples Intact: *Yes / No*	Temperature: *Ambient / Chilled / NA*	Sample Security Sealed: *[✓ Yes] / No*	Quarantine: *Yes / No*
Sampling by SGS (circle): *Yes / No*	**Sampler ID:**	**Sampling Method (circle):** AN902, Bore or AN906, Grab	
Comments/ Subcontracting details: *i.e. samples subcontracted to SGS Sydney due to TAT requested*			Hazards: *e.g. may contain Asbestos*

Confidential – uncontrolled document when printed
Authorisation: Pina Caminiti 18/06/2019

Appendix D

Groundwater laboratory quality results

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Marija Rosic
Client	GHD Pty Ltd
Address	(PO Box Y3106 PERTH WA 6832) 239 Adelaide Terrace EAST PERTH WA 6004
Telephone	08 6222 8222
Facsimile	08 6222 8555
Email	marija.rosic@ghd.com
Project	**North Kiara**
Order Number	**12518217**
Samples	5

LABORATORY DETAILS

Manager	Kieran Hopkins
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE165612 R0**
Date Received	22 Dec 2022
Date Reported	09 Jan 2023

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(898/20210).

Metals: LORs raised due to high conductivity.
Metals:Total Al, Fe, Mn & Zn: Spike recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).

SIGNATORIES

Hue Thanh LY
Metals Team Leader

Mary Ann OLA-A
Inorganics Team Leader

MWhite

Melissa WHITE
Laboratory Technician

Rene DIADOO
Laboratory Technician

Tommy CHENG
ICP Chemist

		Sample Number	PE165612.001	PE165612.002	PE165612.004
		Sample Matrix	Water	Water	Water
		Sample Date	21 Dec 2022	21 Dec 2022	21 Dec 2022
		Sample Name	NKMB01	NKMB02	NKMB04
Parameter	Units	LOR			

pH in water Method: AN101 Tested: 22/12/2022

pH**	pH Units	-	7.1	7.5	8.0

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 22/12/2022

Conductivity @ 25 C	µS/cm	2	880	1500	1100

Metals in Water (Dissolved) by ICPOES Method: AN320 Tested: 23/12/2022

Calcium, Ca	mg/L	0.2	20	18	64
Magnesium, Mg	mg/L	0.1	20	22	45
Potassium, K	mg/L	0.1	4.2	8.5	2.7
Sodium, Na	mg/L	0.5	100	230	88
Sulfur, S	mg/L	0.1	6.4	18	18

Alkalinity Method: AN135 Tested: 22/12/2022

Total Alkalinity as CaCO3	mg/L	5	55	95	280
Carbonate Alkalinity as CO3	mg/L	1	<1	<1	<1
Bicarbonate Alkalinity as HCO3	mg/L	5	67	120	340

Sulfate in water Method: AN275 Tested: 23/12/2022

Sulfate, SO4	mg/L	1	20	56	55

Chloride by Discrete Analyser in Water Method: AN274 Tested: 23/12/2022

Chloride, Cl	mg/L	1	220	370	170

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE165612.001 Water 21 Dec 2022 NKMB01	PE165612.002 Water 21 Dec 2022 NKMB02	PE165612.004 Water 21 Dec 2022 NKMB04

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 29/12/2022

Total Dissolved Solids Dried at 175-185°C	mg/L	10	**570**	**810**	**630**

Turbidity Method: AN119 Tested: 22/12/2022

Turbidity	NTU	0.5	**210**	**29**	**6.4**

Reactive Silica by Discrete Analyser Method: AN270 Tested: 23/12/2022

Reactive Silica, SiO_2*	mg/L	0.1	**23**	**43**	**23**

Sulfide by Titration in Water Method: AN149 Tested: 3/1/2023

Sulfide	mg/L	0.5	<0.5	<0.5	<0.5

Cyanide Forms in Water by CFA Method: AN296 Tested: 28/12/2022

Total Cyanide	mg/L	0.004	<0.004	<0.004	<0.004

Fluoride by Ion Selective Electrode in Water Method: AN141 Tested: 23/12/2022

Fluoride by ISE	mg/L	0.1	<0.1	**0.2**	**0.2**

			Sample Number	PE165612.001	PE165612.002	PE165612.004
			Sample Matrix	Water	Water	Water
			Sample Date	21 Dec 2022	21 Dec 2022	21 Dec 2022
			Sample Name	NKMB01	NKMB02	NKMB04
Parameter	Units	LOR				

Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 23/12/2022

Total Aluminium	µg/L	5	**76**	**41**	**15**
Total Arsenic	µg/L	1	<1	<1	<1
Total Cadmium	µg/L	0.1	<0.1	<0.1	<0.1
Total Chromium	µg/L	1	<1	<1	<1
Total Cobalt	µg/L	1	<1	**2**	**1**
Total Copper	µg/L	1	**3**	<1	**1**
Total Iron	µg/L	5	**1700**	**14**	**20**
Total Lead	µg/L	1	<1	<1	<1
Total Manganese	µg/L	1	**62**	**76**	**100**
Total Nickel	µg/L	1	<1	**2**	**3**
Total Selenium	µg/L	1	**2**	**4**	<1
Total Zinc	µg/L	5	**14**	**14**	**16**

Mercury (total) in Water Method: AN311(Perth) /AN312 Tested: 23/12/2022

Total Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 23/12/2022

Aluminium	µg/L	5	<5	**41**	**9**
Arsenic	µg/L	1	<1	<1	<1
Cadmium	µg/L	0.1	<0.1	<0.1	<0.1
Chromium	µg/L	1	<1	<1	<1
Cobalt	µg/L	1	<1	**2**	**1**
Copper	µg/L	1	**3**	<1	**1**
Iron	µg/L	5	<5	**13**	**13**
Lead	µg/L	1	<1	<1	<1
Manganese	µg/L	1	**62**	**74**	**91**
Nickel	µg/L	1	<1	**2**	**3**
Selenium	µg/L	1	**2**	**4**	**1**
Zinc	µg/L	5	**15**	**14**	**16**

Mercury (dissolved) in Water Method: AN311(Perth)/AN312 Tested: 30/12/2022

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 23/12/2022

Nitrite Nitrogen, NO_2 as N	mg/L	0.05	<0.05	<0.05	<0.05
Nitrate Nitrogen, NO_3 as N	mg/L	0.05	**0.08**	<0.05	<0.05

Parameter	Units	LOR	PE165612.001 Water 21 Dec 2022 NKMB01	PE165612.002 Water 21 Dec 2022 NKMB02	PE165612.004 Water 21 Dec 2022 NKMB04
Sample Number / Sample Matrix / Sample Date / Sample Name					
Calculation of Anion-Cation Balance (SAR Calc) Method: AN121 Tested: 3/1/2023					
Sum of Ions*	mg/L	10	**437**	**799**	**700**
Anion-Cation Balance	%	-100	**-3.1**	**-2.8**	**-3.2**

		Sample Number	PE165612.005	PE165612.006
		Sample Matrix	Water	Water
		Sample Date	21 Dec 2022	21 Dec 2022
		Sample Name	NKMB05	NKMB06
Parameter	Units	LOR		

pH in water Method: AN101 Tested: 22/12/2022

pH**	pH Units	-	7.0	7.8

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 22/12/2022

Conductivity @ 25 C	µS/cm	2	530	11000

Metals in Water (Dissolved) by ICPOES Method: AN320 Tested: 23/12/2022

Calcium, Ca	mg/L	0.2	14	170
Magnesium, Mg	mg/L	0.1	15	370
Potassium, K	mg/L	0.1	3.8	18
Sodium, Na	mg/L	0.5	57	1600
Sulfur, S	mg/L	0.1	3.6	150

Alkalinity Method: AN135 Tested: 22/12/2022

Total Alkalinity as CaCO3	mg/L	5	65	520
Carbonate Alkalinity as CO3	mg/L	1	<1	<1
Bicarbonate Alkalinity as HCO3	mg/L	5	80	630

Sulfate in water Method: AN275 Tested: 23/12/2022

Sulfate, SO4	mg/L	1	11	410

Chloride by Discrete Analyser in Water Method: AN274 Tested: 23/12/2022

Chloride, Cl	mg/L	1	120	3300

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE165612.005 Water 21 Dec 2022 NKMB05	PE165612.006 Water 21 Dec 2022 NKMB06

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 29/12/2022

Total Dissolved Solids Dried at 175-185°C	mg/L	10	360	7100

Turbidity Method: AN119 Tested: 22/12/2022

Turbidity	NTU	0.5	13	700

Reactive Silica by Discrete Analyser Method: AN270 Tested: 23/12/2022

Reactive Silica, SiO_2*	mg/L	0.1	47	73

Sulfide by Titration in Water Method: AN149 Tested: 3/1/2023

Sulfide	mg/L	0.5	<0.5	<0.5

Cyanide Forms in Water by CFA Method: AN296 Tested: 28/12/2022

Total Cyanide	mg/L	0.004	<0.004	<0.004

Fluoride by Ion Selective Electrode in Water Method: AN141 Tested: 23/12/2022

Fluoride by ISE	mg/L	0.1	0.1	0.5

		Sample Number	PE165612.005	PE165612.006
		Sample Matrix	Water	Water
		Sample Date	21 Dec 2022	21 Dec 2022
		Sample Name	NKMB05	NKMB06
Parameter	Units	LOR		

Trace Metals (Total) in Water by ICPMS Method: AN022/AN318 Tested: 23/12/2022

Total Aluminium	µg/L	5	**25**	**2500**
Total Arsenic	µg/L	1	<1	<5↑
Total Cadmium	µg/L	0.1	<0.1	<0.5↑
Total Chromium	µg/L	1	<1	**6**
Total Cobalt	µg/L	1	<1	<5↑
Total Copper	µg/L	1	<1	**12**
Total Iron	µg/L	5	**10**	**4200**
Total Lead	µg/L	1	<1	<5↑
Total Manganese	µg/L	1	**65**	**140**
Total Nickel	µg/L	1	**2**	<5↑
Total Selenium	µg/L	1	<1	**12**
Total Zinc	µg/L	5	**21**	<25↑

Mercury (total) in Water Method: AN311(Perth) /AN312 Tested: 23/12/2022

Total Mercury	mg/L	0.00005	<0.00005	**0.00008**

Trace Metals (Dissolved) in Water by ICPMS Method: AN318 Tested: 23/12/2022

Aluminium	µg/L	5	**9**	<25↑
Arsenic	µg/L	1	<1	<5↑
Cadmium	µg/L	0.1	<0.1	<0.5↑
Chromium	µg/L	1	<1	<5↑
Cobalt	µg/L	1	<1	<5↑
Copper	µg/L	1	**1**	<5↑
Iron	µg/L	5	<5	<25↑
Lead	µg/L	1	<1	<5↑
Manganese	µg/L	1	**54**	**100**
Nickel	µg/L	1	**2**	<5↑
Selenium	µg/L	1	<1	**8**
Zinc	µg/L	5	**21**	<25↑

Mercury (dissolved) in Water Method: AN311(Perth)/AN312 Tested: 30/12/2022

Mercury	mg/L	0.00005	<0.00005	<0.00005

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 23/12/2022

Nitrite Nitrogen, NO_2 as N	mg/L	0.05	<0.05	**0.06**
Nitrate Nitrogen, NO_3 as N	mg/L	0.05	**0.09**	**0.09**

Parameter	Units	LOR	PE165612.005	PE165612.006
Sample Matrix			Water	Water
Sample Date			21 Dec 2022	21 Dec 2022
Sample Name			NKMB05	NKMB06

Calculation of Anion-Cation Balance (SAR Calc) Method: AN121 Tested: 3/1/2023

Sum of Ions*	mg/L	10	**288**	**6390**
Anion-Cation Balance	%	-100	**-5.6**	**-0.2**

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-(AU)-[ENV]AN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Alkalinity as CaCO3	LB202647	mg/L	5	<5	0%	100%
Carbonate Alkalinity as CO3	LB202647	mg/L	1	<1		
Bicarbonate Alkalinity as HCO3	LB202647	mg/L	5	<5		

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB202618	mg/L	1	<1	0 - 1%	108%	96%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB202646	µS/cm	2	<2	1%	100%

Cyanide Forms in Water by CFA Method: ME-(AU)-[ENV]AN296

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Cyanide	LB202652	mg/L	0.004	<0.004	2%	92%	71%

Fluoride by Ion Selective Electrode in Water Method: ME-(AU)-[ENV]AN141

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Fluoride by ISE	LB202615	mg/L	0.1	<0.1	0 - 1%	98%	80 - 98%

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311(Perth)/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB202738	mg/L	0.00005	<0.00005	0 - 23%	105 - 119%	86 - 96%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Mercury (total) in Water Method: ME-(AU)-[ENV]AN311(Perth) /AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Mercury	LB202638	mg/L	0.00005	<0.00005	0 - 4%	100%	104%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Calcium, Ca	LB202611	mg/L	0.2	<0.2	1%	97%	92%
Magnesium, Mg	LB202611	mg/L	0.1	<0.1	0 - 1%	102%	99%
Potassium, K	LB202611	mg/L	0.1	<0.1	0 - 1%	97%	84%
Sodium, Na	LB202611	mg/L	0.5	<0.5	0%	95%	89%
Sulfur, S	LB202611	mg/L	0.1	<0.1		97%	

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: ME-(AU)-[ENV]AN258

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrite Nitrogen, NO_2 as N	LB202614	mg/L	0.05	<0.05	0%	89 - 90%
Nitrate Nitrogen, NO_3 as N	LB202614	mg/L	0.05	<0.05	0 - 1%	NA

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB202646	pH Units	-	5.7	0%	100%

Reactive Silica by Discrete Analyser Method: ME-(AU)-[ENV]AN270

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Reactive Silica, SiO_2*	LB202619	mg/L	0.1	<0.10	1%	100%	102%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Sulfate in water Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulfate, SO4	LB202618	mg/L	1	<1	0 - 1%	106%	84 - 87%

Sulfide by Titration in Water Method: ME-(AU)-[ENV]AN149

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Sulfide	LB202766	mg/L	0.5	<0.5	88%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB202674	mg/L	10	<10	1%	106%	104%	3%

Trace Metals (Dissolved) in Water by ICPMS Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium	LB202605	µg/L	5	<5	0%	107%	101%
Arsenic	LB202605	µg/L	1	<1	0%	108%	104%
Cadmium	LB202605	µg/L	0.1	<0.1	0%	110%	100%
Chromium	LB202605	µg/L	1	<1	0%	99%	
Cobalt	LB202605	µg/L	1	<1	0%	98%	
Copper	LB202605	µg/L	1	<1	4%	110%	97%
Iron	LB202605	µg/L	5	<5	0%	106%	107%
Lead	LB202605	µg/L	1	<1	0%	116%	106%
Manganese	LB202605	µg/L	1	<1	2%	96%	97%
Nickel	LB202605	µg/L	1	<1	0%	104%	
Selenium	LB202605	µg/L	1	<1	21%	115%	
Zinc	LB202605	µg/L	5	<5	1%	109%	128%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Trace Metals (Total) in Water by ICPMS   Method: ME-(AU)-[ENV]AN022/AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Total Aluminium	LB202607	µg/L	5	<5	11%	93%	58%
Total Arsenic	LB202607	µg/L	1	<1	0%	90%	97%
Total Cadmium	LB202607	µg/L	0.1	<0.1	0%	97%	97%
Total Chromium	LB202607	µg/L	1	<1	0%	NA	NA
Total Cobalt	LB202607	µg/L	1	<1	5%	88%	95%
Total Copper	LB202607	µg/L	1	<1	0%	92%	95%
Total Iron	LB202607	µg/L	5	<5	17%	110%	-1823%
Total Lead	LB202607	µg/L	1	<1	0%	105%	101%
Total Manganese	LB202607	µg/L	1	<1	6%	89%	133%
Total Nickel	LB202607	µg/L	1	<1	10%	92%	98%
Total Selenium	LB202607	µg/L	1	<1	21%	100%	112%
Total Zinc	LB202607	µg/L	5	<5	8%	83%	157%

Turbidity   Method: ME-(AU)-[ENV]AN119

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Turbidity	LB202640	NTU	0.5	<0.5	1%	104%

METHOD	METHODOLOGY SUMMARY
AN022/AN318	Following acid digestion of un filtered sample, determination of elements at trace level in waters by ICP-MS technique, referenced to USEPA 6020B and USEPA 200.8 (5.4).
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN106	Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present, measured by the conductivity, are present as NaCl.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN113	The Total Dissolved Solids residue may also be ignited at 550 C and volatile TDS (Organic TDS) and non-volatile TDS (Inorganic) can be determined.
AN119	Turbidity by Nepholometry: Small particles in a light beam scatter light at a range of angles. A turbidimeter measures this scatter and reports results compared to turbidity standards, in NTU. This procedure is not suitable for very dark coloured liquids or samples with high solids because light absorption causes artificially low light scatter and low turbidity. Reference APHA 2130B.
AN121	This method is used to calculation the balance of major Anions and Cations in water samples and converts major ion concentration to milliequivalents and then summed. Anions sum and Cation sum is calculated as a difference and expressed as a percentage.
AN121	The sum of cations and anions in mg/L may also be reported. This sums Na, K, Ca, Mg, NH3, Fe, Cl, Total Alkalinity, SO4 and NO3.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN141	Determination of Fluoride by ISE: A fluoride ion selective electrode and reference electrode combination, in the presence of a pH/complexation buffer, is used to determine the fluoride concentration. The electrode millivolt response is measured logarithmically against fluoride concentration. Reference APHA F- C.
AN149	sulfide by Iodometric Titration: sulfide is precipitated as zinc sulfide to overcome interferences with sulphite and thiosulfate. After filtration, sulfide is determined titrimetrically. Reference APHA 4500-S2-
AN258	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.

METHOD	METHODOLOGY SUMMARY
AN270	Reactive forms of silicon in acid solution below pH 2 react with ammonium molybdate ions to form a yellow silicomolybdate which is then reduced with ascorbic acid to produce a blue silicomolybdate complex. Oxalic acid is added to destroy any molybdophosphoric acid. Colourimetric determination by Discrete Analyser.
AN274	Chloride by Discrete Analyse: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN275	Sulfate by Discrete Analyse: sulfate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulfate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN296	This method is applicable to the determination of free, total and weak acid dissociable cyanide in drinking water, soil and domestic and industrial waste of a variety of matrices by using San++ continuous flow analysis
AN311(Perth) /AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions taken from unfiltered sample are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN311(Perth)/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique,, referenced to USEPA 6020B and USEPA 200.8 (5.4).
AN320	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components .
AN320	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.
Calculation	Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
***	Indicates that both * and ** apply.	NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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→ The Power of Commitment

North Kiaka Mine

Surface Water Assessment and Management

SIMCOA Operations Pty Ltd

12 June 2023

→ **The Power of Commitment**

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<tr><td>S3</td><td>DRAFT</td><td>Azella Trevenen</td><td>H Chen, N Gamage, F Hannon</td><td></td><td></td><td></td><td></td></tr>
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GHD Pty Ltd ABN 39 008 488 373
999 Hay Street, Level 10,
Perth, Western Australia 6000, Australia
D +61 8 6222 8554 | **M** +61 430 540 637 | **E** nimal.gamage@ghd.com

Executive Summary

This report investigates the flood modelling for the pre and post-development scenarios of the proposed North Kiaka Mine.

The 2D hydraulic modelling was used to simulate the flood characteristics of the project area for the 10- and 100-year annual exceedance probability (AEP) flood events to simulate the flood depth inundation areas and stream flow velocities for both pre – and post – development scenarios.

The results of the baseline flood modelling identified the following surface water management risks to the North Kiaka development envelope (DE) infrastructure:

- No significant flooding risk is observed during pre-development or post-development, with major flows largely confined to the Kyaka Brook
- Flood levels across the main access road leading into the site from North Kiaka Road are at risk of flooding due to high flows from the Kyaka Brook
- Velocities of concern are limited and confined to Kyaka Brook
- Pit 2 is likely to experience minor runoff directly east of the DE
- The waste rock dump (WRD) is unlikely to be impacted by surface water runoff as it is minor. However, erosion and scour risk may occur when the WRD is built up.

The following surface water management measures have been considered to mitigate the risks to the DE:

- A diversion bund is situated to the east of Pit 2 to divert runoff from higher ground from the east and mitigate volume of water running into Pit 2
- It is recommended that any water diverted from Pit 2 to the surrounding area be monitored and/or treated depending on the water quality to mitigate impacts to the environment
- It is recommended culvert/s are installed to minimise impacts to road infrastructure / avoid flood inundation
- Erosion and scour control measures may need to be considered close to the main access road to the DE where the Brook passes through.

This report is subject to change, and must be read in conjunction with, the limitations set out in section 1.3 and the assumptions and qualifications contained throughout the report.

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Appendices

1. Introduction

1.1 North Kiaka Mine

SIMCOA Operations Pty Ltd (**SIMCOA**) currently operate the Moora Quartzite Mine (Moora Mine), approximately 15 km north of Moora, in the Wheatbelt of Western Australia (WA). The Moora Mine is located on tenements M70/191, G70/91, G70/92, G70/93, and M70/1292 [with activities on M70/1292 limited to mine dewater discharge into Kyaka Brook]. Quartzite ore from Moora Mine is currently transported via covered truck to SIMCOA's Kemerton Smelter (Kemerton Smelter) located in Kemerton Strategic Industrial Area (KSIA), approximately 17 km north-east of Bunbury in the South-West of WA.

SIMCOA is proposing to establish a new quartzite mine, referred to as North Kiaka mine (the Project), immediately north of Moora Mine (with the mine pit located approximately 1.5 to 2 km north of Kiaka Road). The proposed development of the North Kiaka mine is located within tenement M70/1292 and is shown in Appendix A, Figure A.1.

North Kiaka mine has a development envelope (DE) of approximately 216 ha and is bounded by agricultural land to the east and north, the Midlands Road and agricultural land to the west and Kyaka Brook, Moora Mine and agricultural land to the south. The flood study area comprises the North Kiaka DE (collectively referred to as the DE hereafter) and immediate surrounds as shown inin Appendix A, Figure A.2.

A development footprint (DF) and proposed infrastructure are presented in Appendix A, Figure A.2. The DF includes the Tonkin Waste Rock Dump (WRD), Pit 2, access roads, easement, and laydown area.

1.2 Scope of work

Department of Mines, Industry Regulation and Safety (DMIRS) (DMIRS 2023) and the Environmental Protection Authority (EPA 2018) guidelines requires that mining proposals include information on hydrological (surface water) characteristics and stormwater management. GHD has provided this assessment of hydrology and management recommendations in accordance with the DMIRS (2023) and EPA (2018) requirements:

- Frequency and intensity of rainfall
- Historic flood events and maximum rainfall events (duration and magnitude)
- Downstream surface water receptors (i.e Coonderoo catchment), environmental values and beneficial uses
- Surface water management
- Surface water quality characteristics
- Assessment of flooding risk (under baseline conditions)
- Flood modelling/mapping (i.e flood extent and depth) for pre and post development scenario's
- Stormwater management/ engineering controls during operations and at closure (with a focus on protecting constructed landforms).

1.3 Purpose of this report

This Surface Water Assessment and Management report is one of the several supporting documents prepared to consider the environmental and management of the North Kiaka project and to support environmental assessments and referrals.

This document has been prepared on the basis of currently available information, input from other technical studies and key stakeholders to identify key issues, strategies and management actions to guide water management across the mine site.

1.4 Assumptions

This surface water assessment and management document has been prepared based on information derived from a number of reports, investigations and management strategies that have been identified for the DE and DF. Conditions vary across the DE and further investigations should be completed to verify local conditions once site infrastructure design has been substantiated to inform site suitability for the mine post development.

1.5 Limitations

This report has been prepared by GHD for SIMCOA Operations Pty Ltd and may only be used and relied on by SIMCOA Operations Pty Ltd for the purpose agreed between GHD and SIMCOA Operations Pty Ltd as set out in section 1.3 of this report.

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The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by SIMCOA Operations Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Pre-Development setting

2.1 Zoning

The DE is located within the Shire of Moora, under Town Planning Scheme No. 4. The site is surrounded largely by agricultural land with Midlands Road along its western border. Access tracks exist to the northwest and south of the DE. Moora Mine is located within 1 km south of the DE. Further zoning information can be seen on Appendix A, Figure A.3.

2.2 Topography and soil landscape

The DE and surrounds has a rugged landscape, with the highest point situated to the east at 277.5 m AHD and the lowest point at the southwestern corner sitting at 215 m AHD. The DE generally grades east to west, with curved grading in the central part. Small portions of the DE's northern and southern extents may drain towards the nearby brooks (i.e. tributaries of Coonderoo River) as dictated by topography. Elevation for the DE boundary is shown on Appendix A, Figure A.4.

According to the Department of Primary Industries and Regional Development's (DPIRD) soil landscape mapping (2022), and as observed on Appendix A Figure A.5, the main geological features within the site include the following:

- Ranfurly 1 subsystem; level to gently undulating plain being a relict flood plain, partially rejuvenated; loamy earths and clay, some duplex; from alluvium. Featured on the borders of the DE.

- Coorow 7 sub-system; Undulating to gently undulating rises and intervening level to gently undulating flats; Yellow deep sand, pale deep sand and grey sandy duplexes (some alkaline), some yellow sandy earths, and minor loamy earths and duplexes and rock. Located largely in the centre of the DE.
- Burabidge Hill 1 subsystem; Undulating rises to low hills with rock outcrop. granite, migmatite, gneiss. Brown and red loamy and sandy earths, yellow/brown shallow loamy duplex, and some stony soil. York gum-jam woodland. Located on the east boundary of the DE.

The DPIRD (2022) further provides the following land quality attributes for the Coorow 7 subsystem located within the proposed infrastructure area (only relevant attributes have been listed below):

- 0% probability of pHCaCl2 < 4.5 (strongly acidic) at surface and top 80 cm of topsoil;
- 70% probability of high subsurface acidification susceptibility;
- 0% probability of pHCaCl2 > 7 (alkaline) at surface;
- 0% probability of moderate to extreme salinity risk at surface;
- 0% probability of moderate salinity hazard;
- 0% probability of high water repellence susceptibility;
- 20% probability of a very shallow to shallow physical crop rooting depth;
- 30% probability of extremely low to low soil water storage capacity;
- 19% probability of high to extreme wind erosion hazard;
- 3% probability of very high to extreme water erosion hazard;
- 0% probability of very poor to poor site drainage potential;
- 0% probability of moderate to very high waterlogging and inundation risk;
- 0% probability of moderate to high flood hazard; and
- 9% probability of high to extreme phosphorus export hazard.

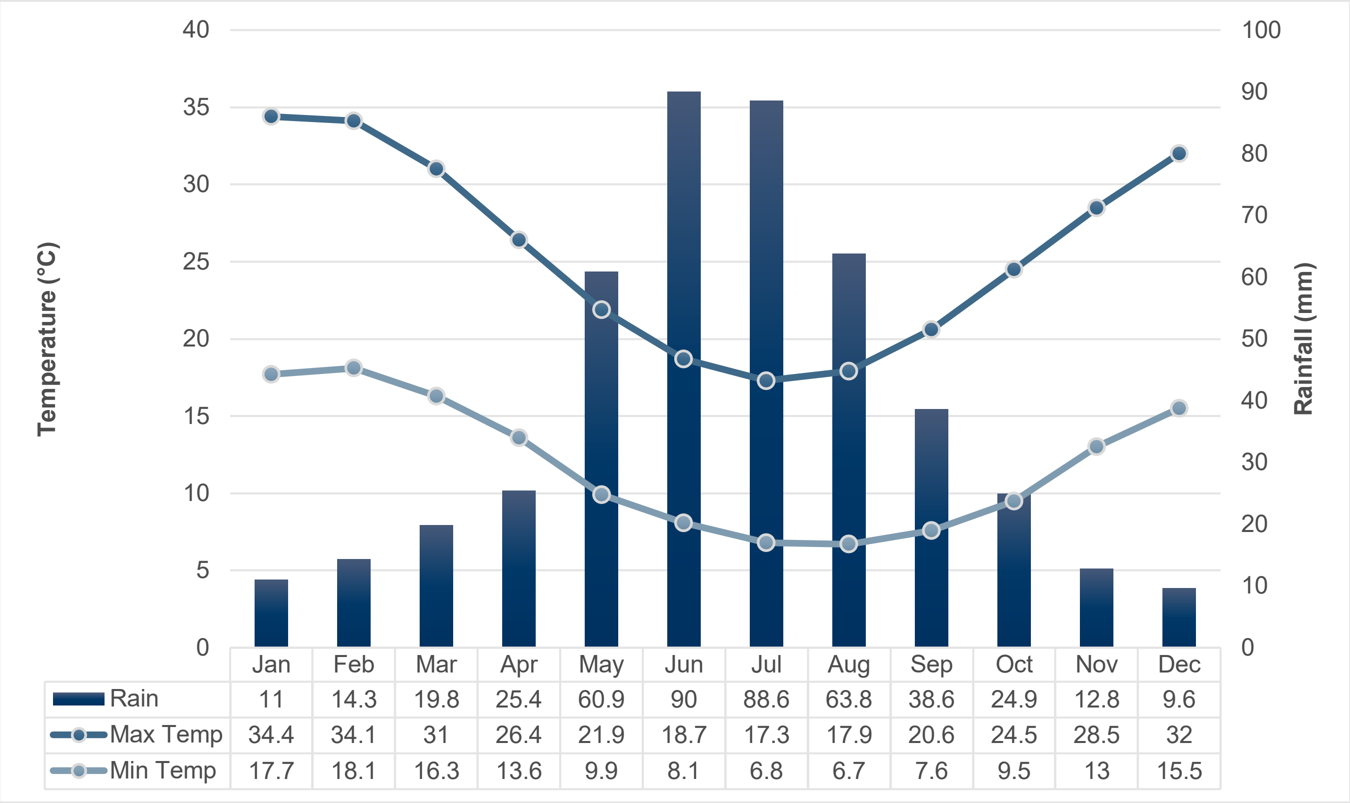
In summary, the findings above indicate that the DE is well drained and has relatively low risk of flooding. There is also a relatively high risk of subsurface acidification, which may impact on potential agricultural activities post closure.

A soil characterisation study was carried out by soil water consultants at the North Kiaka DE in 2019. The study identified that geology within the area comprises of either unweathered quartzite outcrops (with limited topsoil) or weathered/unweathered granite covered by a surficial gravel layer. The study report indicated that the gravel layer's topsoil exhibits high to severe water repellence, which would restrict infiltration of rainfall. Further, the subsoil was simulated to be highly erosion resistant, and the topsoil less so.

2.3 Climate

Climate at the DE is characterised as Mediterranean, with cool wet winters and hot, drier summers. Approximately half of the observed rainfall occurs within the winter months.

The nearest Bureau of Meteorology climate station with long-term data is in Moora located approximately 14 km from the DE (Station number 008151). The mean maximum summer temperature is 33°C and mean maximum winter temperature of 16.9°C (BoM, 2022). Rainfall is highest in winter, and annual rainfall is 465.6 mm (Figure 1).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rain	11	14.3	19.8	25.4	60.9	90	88.6	63.8	38.6	24.9	12.8	9.6
Max Temp	34.4	34.1	31	26.4	21.9	18.7	17.3	17.9	20.6	24.5	28.5	32
Min Temp	17.7	18.1	16.3	13.6	9.9	8.1	6.8	6.7	7.6	9.5	13	15.5

Figure 1 Climate statistics (BoM 2022)

2.4 Climate change

Climate change may be expected to impact on the future rainfall pattern of the study area, however climate change impacts have not been considered in this study.

2.5 Surface water

The DE sits within the Dean Moiler Surface Water Management Area. There is a non-perennial lake to the south-west part of the DE boundary and minor non perennial rivers run across the south-west, central and eastern side of the DE. Coonderoo river, identified as a major river, is located approximately five km to the west of the DE, Appendix A Figure A.6.

The major upstream surface water feature is Kyaka Brook located along the southern boundary of the DE. This Brook leads towards the larger Coonderoo River located approximately two km to the west. Pyre Brook to the north of the DE also flows adjacent to the DE downstream.

2.5.1 Surface water quality

The DWER's Water Information Reporting identifies two surface water quality monitoring sites located immediately downstream of the DE and with minimal influence by flows from other catchments. The DE is located at the Midlands Road crossings of Pyre Brook and Kyaka Brook (see Appendix A, Figure A.2). Grab sampling was performed at both sites once only on 7 September 1999. The measured water quality from these samples is summarised in Table 1.

Table 1 Historical surface water quality measurements at Pyre Brook

Site	Brook Crossing	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
617079	Kyaka Brook	0.96	0.06	6	5
6171079	Pyre Brook	1.1	0.08	5	3

Except for Total Phosphorus, all measured water quality variables are below the recommended values in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018), as detailed in Section 5.5.

2.5.2 Waterlogging

The DE contains two areas identified as susceptible to waterlogging according to DWER (Landgate, 2022). A U-shaped area in the centre of the DE and a small area at the south-west corner of the DE has a 100 percent (very high) waterlogging susceptibility. The remainder of the DE sits within a moderate (0%) waterlogging susceptibility zone. Refer to Appendix A, Figure A.7.

2.6 Groundwater

Hydrogeological investigations conducted by Saprolite Environmental between January to December 2022 at Moora Mine site less than 500 m from the DE suggested that there is no interaction between surface water features and the groundwater table. The investigation involved four monitoring bores between the North WRD and Main Pit in the existing mine, in which the groundwater potentiometric level was surveyed at approximately 210-215 m AHD or 3-20 m below ground level. Water quality was observed to be largely brackish (1000 mg/L – 2000 mg/L) at the site.

Further, a site visit done by GHD personnel on 23 July 2020 did not find any obvious surface expressions of groundwater within the DE.

2.7 Conservation areas

No, Department of Biodiversity, Conservation and Attractions (DBCA) managed lands or national parks occur within a 1 km buffer of the DE.

2.7.1 Environmentally Sensitive Areas

The DE is situated within an environmentally sensitive area (ESA). To view the extent of the ESA, see Appendix A, Figure A.8.

2.7.2 Areas of ecological importance

The North Kiaka DE (216.42 ha) is located within agricultural land and 124.83 ha of the DE has historically been cleared. Remnant vegetation is found in small fragments, with 87.57 ha of native vegetation present, representing approximately 40% of the DE.

Remnant native vegetation that is localised to rocky outcrops within the North Kiaka DE was surveyed in 2012 and 2018 by Trudgen *et al*. Vegetation alliances mapped within the North Kiaka DE and Disturbance Footprint (DF) are described in the ERD (GHD, 2023).

Vegetation alliances were assessed to be representative of Threatened Ecological Community (TEC) 'Heath dominated by one or more *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region' (DPAW, 2013b) (hereafter referred to as the Coomberdale TEC). Vegetation alliances 13, 15, 16 and 17 comprise core TEC alliances and 9 and 11 comprise buffer vegetation alliances. Further description of the Coomberdale TEC is provided in the ERD (GHD, 2023).

Vegetation fringing the Kyaka Brook was surveyed by Actis (2011) and confirmed to consist of *Casuarina obesa* and *Eucalyptus loxophleba* subsp. *loxophleba* trees over a sparse understorey dominated by introduced grasses and herbs.

Threatened fauna and flora exist within the DE, including five threatened species and one Priority 4 flora species. Endangered fauna is noted to exist west of the DE across Midland Road. See Appendix A, Figure A.9 for further detail.

2.7.3 Wetlands

There are no RAMSAR wetlands or nationally important wetlands listed within, or in 1 km of the DE.

2.7.4 Groundwater dependent ecosystems

The Bureau of Meteorology *Groundwater Dependent Ecosystems Atlas* identifies that the geomorphic wetlands and drainage systems within the DE are classified as Groundwater Dependent Ecosystems (GDEs) (Bureau of Meteorology, 2023).

The atlas recognises three types of GDEs:

- **Subterranean ecosystems (Type 1)** – including cave and aquifer ecosystems.
- **Aquatic ecosystems (Type 2)** that rely on the surface expression of groundwater – including surface water systems that may have a groundwater component such as rivers, wetlands, and springs.
- **Terrestrial ecosystems (Type 3)** that rely on the subsurface presence of groundwater – including vegetation ecosystems such as forests and riparian vegetation.

GDEs within the study area are identified as Type 3 GDEs only, of low to high moderate potential GDE (national assessment). See Appendix A, Figure A.11.

GHD’s (2023) desktop assessment of GDE’s within the Moora Mine concluded that none of the vegetation types recorded within the DE are considered to be GDEs reliant on the surface expression of groundwater or sub-surface presence of groundwater within the rooting depth of the ecosystem based on their species composition and location within the landscape. The majority of vegetation within the survey area (including the Coomberdale Chert TEC) occurs on ridges and upper slopes in shallow soils with underlying chert. The depth of groundwater on these areas of ridges and slopes ranges from 16 to 20 mbgl (Saprolite Environmental 2016). Although there is limited to no data available on maximum root depths of these species, it is unlikely that they are accessing groundwater at this depth. Trudgen (2012) noted in the assessment of ridges that there were a number of deaths of dominant species *Regelia megacephala* at the time which was attributed to a drier than average winter season, indicating that this species is entirely reliant on surface water. The GHD (2023) GDE assessment focussed on the assessment of the relationship between significant vegetation and groundwater only, rather than an assessment of the likelihood of occurrence and impact from the drawdown activities on all GDEs (ie stygofauna).

The zone of groundwater drawdown anticipated to occur as a result of mine dewatering operations at Moora Mine is expected to be confined by the eastern and western ridges which are likely to form impenetrable barriers to groundwater movement (Saprolite Environmental 2016). To the north and south a maximum 1.5 km radius of influence would potentially extend, however remnant vegetation that occurs in these areas is also on hilltops and ridges, with the exception of the flow line to the north which is a seasonally inundated channel with narrow fringing band of vegetation (dominated by A*cacia acuminata*) within cleared farmland, the species composition of which indicates that it is unlikely to be reliant on ground water levels.

The Noondine Chert geological unit, which occurs within the survey area is known to contain palaeokarst and subsurface voids that provide highly suitable habitat for stygofauna. A pilot stygofauna study within the study area conducted in 2005 recorded four taxa within local groundwater (Knott and Goater , 2005) and a further study in by Bennelongia (2023) at the Moora Mine found indicates a moderately significant to rich assemblage of stygofauna occurs in the DE, expanding substantially on the results of the survey conducted by Knott and Goater (2005). Connectivity was difficult to assess with a relatively small number of samples, but appears to be low to moderate; some taxa are known from only one borehole, while others are known from two.

The presence of four new species from only seven sampled boreholes indicates that a substantial but unknown stygofauna community exists in the area surrounding Moora Mine. It is possible that some or all of the new species detected, or other species as yet undetected, may be endemic to groundwater systems in and around the DE. The impacts from Moora Mine operations remains unknown given the absence of sampling effort in the region to date and the lack of biological information about species potentially present.

By contrast, several of the species recovered in the field survey are widespread, and thus will not be significantly affected by activities. The cyclopoid copepods *Mesocyclops brooksi* and *Paracyclops chiltoni* are both distributed widely across Western Australia (Atlas of Living Australia, 2023). The species complex of enchytraeids recovered in the field survey is likewise widespread. Rotifers and nematodes are not considered in assessments of environmental impact partly because they tend to be widespread.

The specimen of *Hanseniella* recovered belongs to a group (Symphyla) with relatively poorly resolved taxonomy in Western Australia. This means makes it difficult to compare the animals found in Moora Mine with those collected elsewhere and determine a species range.

While nine holes were successfully sampled, five could not be accessed and/or were damaged or blocked. Two of these holes occur in Cairn Hill (Class A reserve to the South of the DE) and are a sufficient distance from the proposal area to provide a reference sample to shed light on the interconnectivity of subterranean populations. For example, the southern bores may have yielded additional species, or may have yielded species already collected elsewhere in the proposal area. Without further sampling, it is not possible to speculate further.

For a baseline survey to clarify the results of desktop assessment, the number of holes sampled was adequate. However, given that the diversity and abundance of stygofauna were higher than expected, the number of holes sampled is overall not sufficient to provide a clear picture of the stygofauna community in Moora Mine and by extension, the North Kiaka DE.

While the specimens collected constitute a relatively substantial assemblage of stygofauna given the low number of holes sampled, the results for troglofauna are less clear. The absence of definitive troglofauna in the field survey does not necessarily indicate troglofauna do not occur in the area. Rather, the small number of holes sampled (two) restricts conclusions about the diversity and abundance of any troglofauna present.

2.8 Contaminated sites

There are no registered contaminated sites at the DE or within 1 km proximity of the study area (SLIP 2022).

2.9 Heritage

2.9.1 Aboriginal heritage

The North Kiaka DE has been subject to a number of heritage surveys and review of the following online inquiry systems (accessed January 2023):

- Aboriginal Heritage Inquiry System
- Heritage Council Database
- Protected Matters Search Tool.

Brad Goode and Associates (2019) reports on the results of heritage surveys previously undertaken in proximity to the North Kiaka DE, the recent archaeological survey undertaken by (2019) of the North Kiaka DE, and recent consultation undertaken with the Yued NTC group.

As reported by Brad Goode and Associates (2019) and as a result of a desktop search there is one Registered Aboriginal Heritage Site in the North Kiaka DE, Table 2.2, Appendix A, Figure A.11.

Table 2.2 DPLH Aboriginal Sites and Heritage places search results

ID	Name	Status	Type
5141	Kiaka Site Complex 1-3	Registered Site	Artefacts/Scatter, Water Source

An additional two Registered Aboriginal Heritage Sites (artefacts/scatter), Kiaka Brook 1 (Site ID 4658) and Kiaka Brook 2 (Site ID 4659), occur within tenement M70/191 south of the North Kiaka DE.

The archaeological Aboriginal heritage survey conducted by Johnson (2019) in December of 2018, did not locate the Kiaka Road Scarred Tree (Site ID 4605). In September 2020, the Aboriginal Cultural Materials Committee (ACMC) reassessed the registered Kiaka Road Scarred Tree (Site ID 4605) and determined the Site no longer meets section 5 of the AH Act and it has subsequently been removed from the Aboriginal heritage sites register.

Brad Goode and Associates (2022) undertook archaeological investigations to determine the precise location and extent of the Site 4658 ‘Kiaka Brook 1’ and Site 4751 ‘Koolera Well’, located adjacent to SIMCOA’s current mining operations north of Moora, Western Australia.

The Site 4658 ‘Kiaka Brook 1’ artefact scatter was identified close to the coordinates given on the DPLH (WA) List of Registered Aboriginal Sites (Aboriginal Heritage Inquiry System, AHIS), near the top of a hill immediately east of a large open pit or quarry where mining has been undertaken in the past. It was determined that the area containing the Site 4658 artefact scatter may have been utilised in the past for agricultural purposes and therefore has been universally disturbed.

No new ethnographic sites or archaeological Aboriginal heritage sites or places, were recorded during the recent heritage survey (Johnson, 2019), or during consultation with the Yued NTC group (Brad Goode and Associates, 2019).

The *Moodjar* Christmas trees (*Nuytsia floribunda*), which grow in association with ridgeline vegetation, were identified by Johnson (2019) as culturally significant to the Yued people due to their association with spirits of the deceased. The *Moodjar* does not meet DPLH criteria for Registered Aboriginal Sites under the AH Act.

Indigenous interests of the Coomberdale TEC

The Coomberdale TEC Interim Recovery Plan (DPaW 2013) states the threatened community “contains sites that are known to have particular Aboriginal significance”. The plan makes recommendations for consultation with the “South West Aboriginal Land and Sea Council (SWALSC) and in particular, the Yued Working Party” if “potentially damaging ground disturbance is proposed”.

2.9.2 Other heritage sites

No other Australian heritage sites were identified within a 1 km radius of the North Kiaka DE (DCCEEW, 2022).

3. Model Set-Up

The flood modelling undertaken in this study considered the following Annual Exceedance Probabilities (AEP's) for the existing and post-development conditions for the following design rainfall scenarios:

- Pre-development: 10% (1 in 10), and 1% (1 in 100) AEP flood event
- Post-development: 10% (1 in 10), and 1% (1 in 100) AEP flood event

The DF and infrastructure and survey data included in each of these scenarios is detailed in Section 1.1. The flood models were set up using the available information, with preference given to more accurate data in the event of a duplication.

3.1 Catchments and flow paths

The topographic data (LiDAR) imported from the ELVIS online database (2022) was used to calculate the streams and catchments leading into the DE. CatchmentSIM terrain processing software was used to define the catchment boundary, which defined the upstream boundary extent of the flood model (See Appendix B, Figure B.1).

3.2 Flood modelling

The Digital Elevation Model (DEM) was generated as a grid of 10 m square cells. Adoption of DEM cell sizes smaller than the selected value was considered impractical given the relatively low resolution of the contour datasets above. Flood modelling methodology, data, and parameters used are summarised in Appendix C.

4. Pre-development Modelling Results

The pre-development modelling scenario considers the current DE topography and landscape. For further information regarding the flood modelling see Appendix C.

4.1 Pre-development flood depth and velocity

Pre-development flood modelling at North Kiaka Mine showed minor flooding of 0.05 – 0.2 m depth occurs across the DE where there is limited or no direct impact from the upstream catchment (Kyaka Brook) during the 10% and 1% AEP storms. Minor tributaries are observed to flow down-gradient of the eastern border of the DE from north to south. As the DE is situated on a sloping gradient (east to west/south), minor local ponding is observed across the DE. Most surface water runoff ponds at Kyaka Brook or further to the west outside the DE.

Flood depth figures covering the DE and its surrounds are provided in Appendix B, Figures B.2 and Figure B.3.

Estimated 1% AEP flood depth in Kyaka Brook, which is running along the southern border of the De, is around 1 m. Access roads leading into the site may be impacted by the Kyaka Brook flooding, and appropriate culvert structure may be required to maintain site access during flooding.

Maximum flood velocities estimated within the DE is around 0.4 m/s for 10% AEP storms and 1.0 m/s for 1% AEP storms. Velocities of concern are flood velocities that are 2.0 m/s or greater that could result in soil erosion (Austroads, 2023). Velocities of concern during the 10% and 1% AEP storm are observed to be restricted to Kyaka Brook. Flood velocity figures are provided in Appendix B, Figures B.4 and Figure B.5.

5. Post-development Modelling Results

5.1 Proposed surface water controls

The post-development modelling assumes the following stormwater controls were put in place for the 10% and 1% AEP flood modelling.

- 1x Diversion bund (0.5m height) bordering the east of Pit 2; and
- 1x Culvert near the entrance of the site underneath the access road intercepting Kyaka Brook stream (See Appendix B, Figure B.6).

The proposed mining plan at North Kiaka DE involves progressive excavation of Pit 2 to levels at or below the water table in the near future. This would necessitate discharge of pit dewater to the adjacent Pyre or Kyaka Brook. If this is the case SIMCOA is required to provide some form of monitoring and treatment of groundwater to ensure groundwater is maintaining the ecology of the surface water at Pyre or Kyaka Brook.

The proposed design levels or predicted elevation data for this infrastructure were not made available for the purposes of this assessment. Flood modelling methodology, data, and parameters used are summarised in Appendix C.

5.2 Post-development flood depth and velocity

5.2.1 Diversion bund

Pit 2 as based on previous catchment modelling (discussed previously), is expected to only be impacted by direct rainfall and minor surface water runoff from the crest of the hill located to the east. The diversion bund situated along the east face of Pit 2 is positioned to divert the surface water runoff from the east and direct it around Pit 2 in a northerly direction. The flooding along the diversion bund is minimal as it is situated on a decline, with maximum flood heights reaching approximately 0.3 m above ground level for 1% AEP storms. A 0.5 m bund height is deemed satisfactory in preventing excess runoff into pit 2.

Post-development flood modelling estimated a maximum velocity of around 0.1- 0.3 m/s and a maximum flow rate of 0.05 - 0.25 m3/s for the 10% and 1% AEP storm respectively along the diversion bund.

Only a small volume of stormwater (~20.7 m^3 during a 10% AEP event) is diverted by the diversion bund. Slight ponding is observed along the eastern border of Pit 2, and the diversion bund may need to be moved closer to the side of the pit to prevent this from occurring by diverting a greater volume of the rainfall down gradient.

Post development flood depth and velocity figures covering wider area are provided in Appendix B, Figures B.7, Figures B.8, Figures B.9 and Figure B.10.

5.2.2 Culverts

Post-development flood modelling observed high flood depths (>2.0 m) along the Kyaka Brook. However, allowing an appropriate set-back distance from the 1% AEP flood extent, the risk of impact to proposed infrastructure is low.

A culvert was positioned towards the entrance of North Kiaka Road, in which the Kyaka Brook intersects. This is the only location across the site that is impacted by the upstream catchment and is likely to experience higher velocities and flooding during major rainfall events that will impact site access. The maximum flood depth estimated was around 0.6 m for the 10% AEP event and around 1.0 m for the 1% AEP event along the Kyaka Brook, refer Figure B.8 and Figure B.9. This flood depth may vary as the topography data used for this assessment may have not captured the bathymetry of the Brook.

The maximum velocity estimated along Kyaka Brook is around 1.0 m/s and 1.5 m/s for 10% and 1% AEP events. The culvert located at the entrance of the access road, intercepting Kyaka Brook stream has a maximum flood velocity of 0.12 m/s and 0.3 m/s and a maximum discharge of 3.9 m3/s and 18.7 m3/s respectively for 10% and 1% AEP storm events. Considering mine life, erosion control measures have only been considered for 10% AEP storm events. Approximately 10 culverts of 450 mm diameter will be required to maintain trafficability of the access road during a 10% AEP event. This requires further assessment during subsequent design stages.

5.3 Issues and risks to proposed infrastructure

The following risks and issues have been assessed in relation to the locations of proposed infrastructure:

- Buildings:
  - Proposed infrastructure areas based on current topography is observed to experience minor ponding during a 1% AEP event.
  - Building foundation levels should be raised 300 mm above 1% AEP flood level or above ground level whichever is higher.
- WRD:
  - There are no major flow paths passing through the proposed WRD location. Minor runoff from the road adjacent to the WRD and from the north is likely to drain towards this area. Flow diversion channels around the WRD need to be considered during further design development stages.
  - High velocity runoff can be expected from the WRD depending to the design side slopes. Erosion and scour protection controls may need to be considered in this case during WRD design development stages. Further runoff from the WRD may need to be diverted so that runoff from the WRD does not impact the road directly west of the WRD, refer Appendix B, Figure B.8 and Figure B.10.
- Pit 2:
  - Minor runoff is expected to flow into the pit from the area in between the pit and the proposed diversion levee. Runoff expected into the pit for 10% (1 in 10) AEP is around ~101 kL (0.25 m^3/s) and for 1% (1 in 100) AEP is ~3,800 kL (0.3 m^3/s).
  - Any pit water requires water quality monitoring and treatment to ensure maintenance of the ecology of the surface water before it is discharging to, either Pyre or Kyaka Brook.
  - Risk to Kyaka Brook is possible if ‘dirty runoff’ or water from Pit 2 is diverted to the brook. A surface water management and monitoring plan should be developed to maintain surface water quality of Kyaka Brook and downstream Coonderoo River.
- Access road:
  - No erosion or scour risk is expected to occur along or near the road as estimated velocities are less than 2 m/s, refer Appendix B, Figure B.10.

5.4 Proposed surface water management measures

The following stormwater management and diversion infrastructure is proposed to address:

- Risk of inundation in pit
  - Diversion bund situated east of the pit
- Pit water
  - Management of collected water in the pit to external environment to maintain integrity of surrounding environment. Appropriate water quality control measures and monitoring to be put in place to ensure appropriate regulation of mine site water release to the downstream environment.
- Road drainage
  - Subject to traffic load requirements, the minimum cover over culverts to the finished surface level for all culverts shall be within standards.
- WRD runoff management
  - Additional channels may be required to divert water between WRD and main access road
  - Diversion channels around WRD and sedimentation pond may be required to manage sediment runoff.
- Scour protection:
  - Upstream and downstream of culverts

    - At all sections along WRD where high velocity runoff is expected to occur
- Other management measures
    - Where appropriate drainage channels may need to be considered in the future to trap ‘dirty’ runoff from pads and other infrastructure on-site and prevent pollution of the surrounding environment.

6. Recommendations

The following recommendations for the North Kiaka Mine are made based on the results outlined in previous sections:

- Diversion bund west of Pit 2 to intercept direct rainfall and reduce pumping in pit 2.
- Culvert underneath southern access road to reduce road flooding and maintain site operations.
- A surface water management and monitoring plan should be developed to ensure the development of the mine does not impact downstream environments including Kyaka Brook and Coonderoo River.

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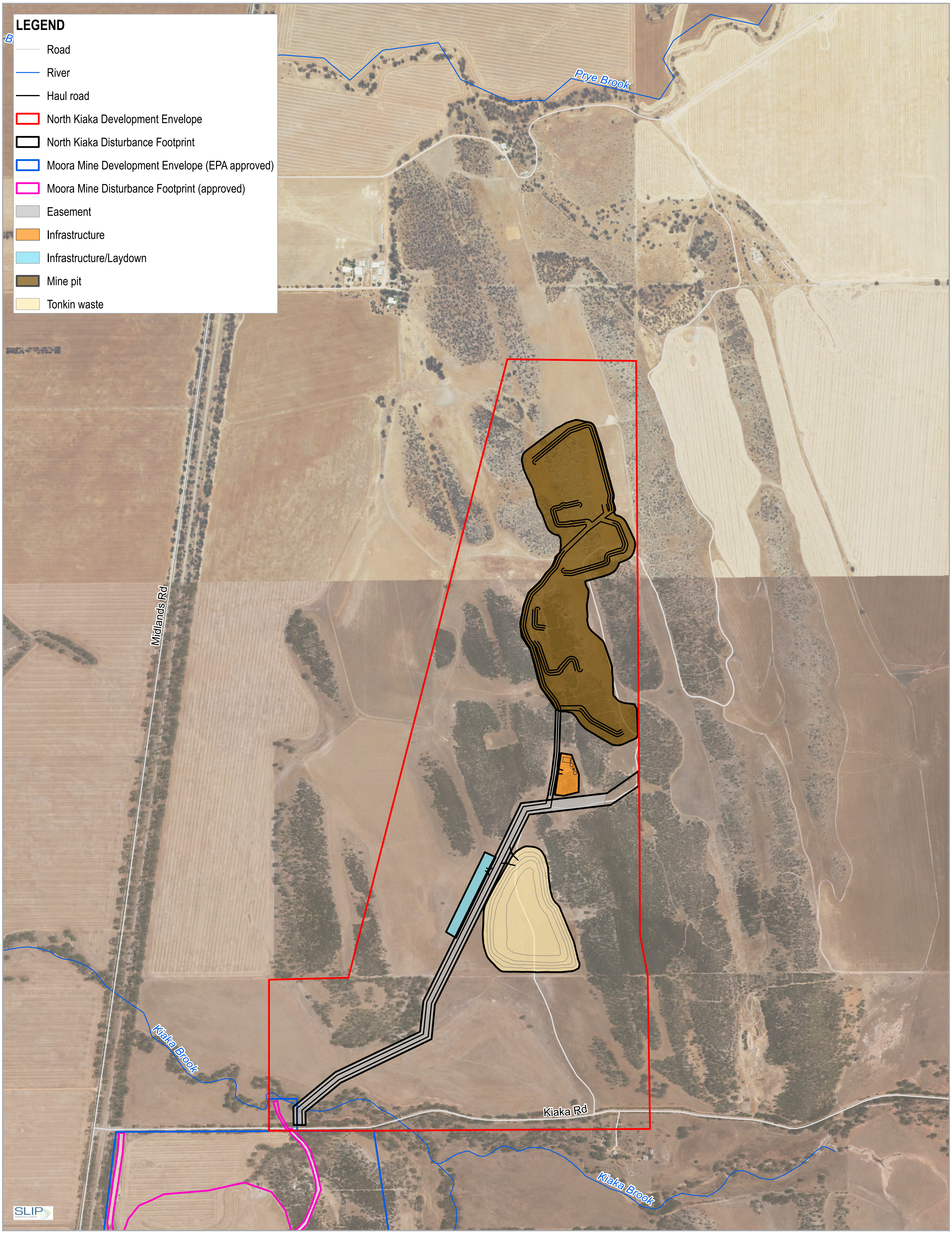
Appendix A

Surface Water Study Figures

List of Figures



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Proposal Development Envelope and Disturbance Footprint

Project No. 12518217
Revision No. 0
Date 22/05/2023

FIGURE A-1

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/24/2023**

Project Locality

FIGURE A-2

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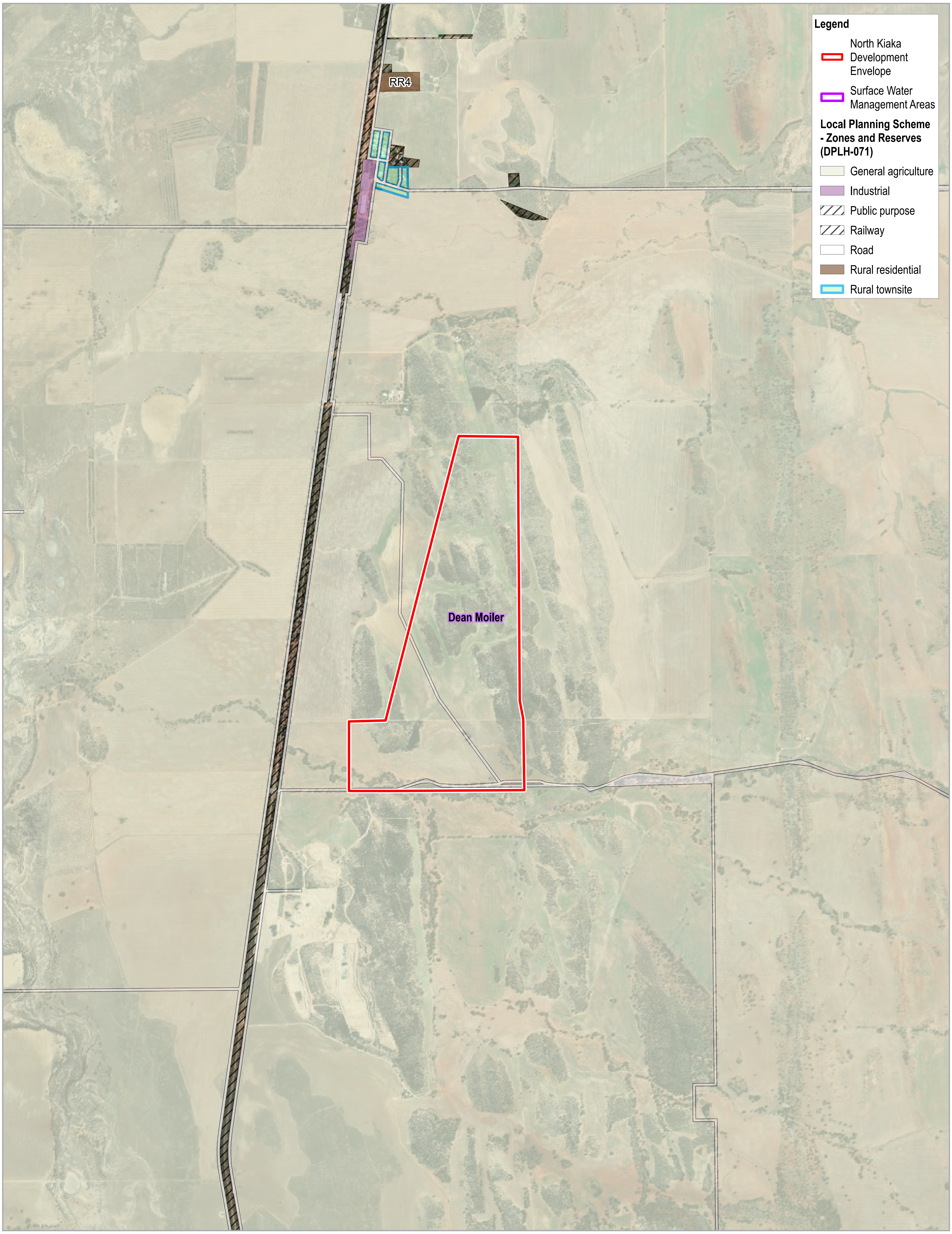

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

Local Planning Scheme and Surface Water Management Areas

FIGURE A-3

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/27/2023**

Topography

FIGURE A-4

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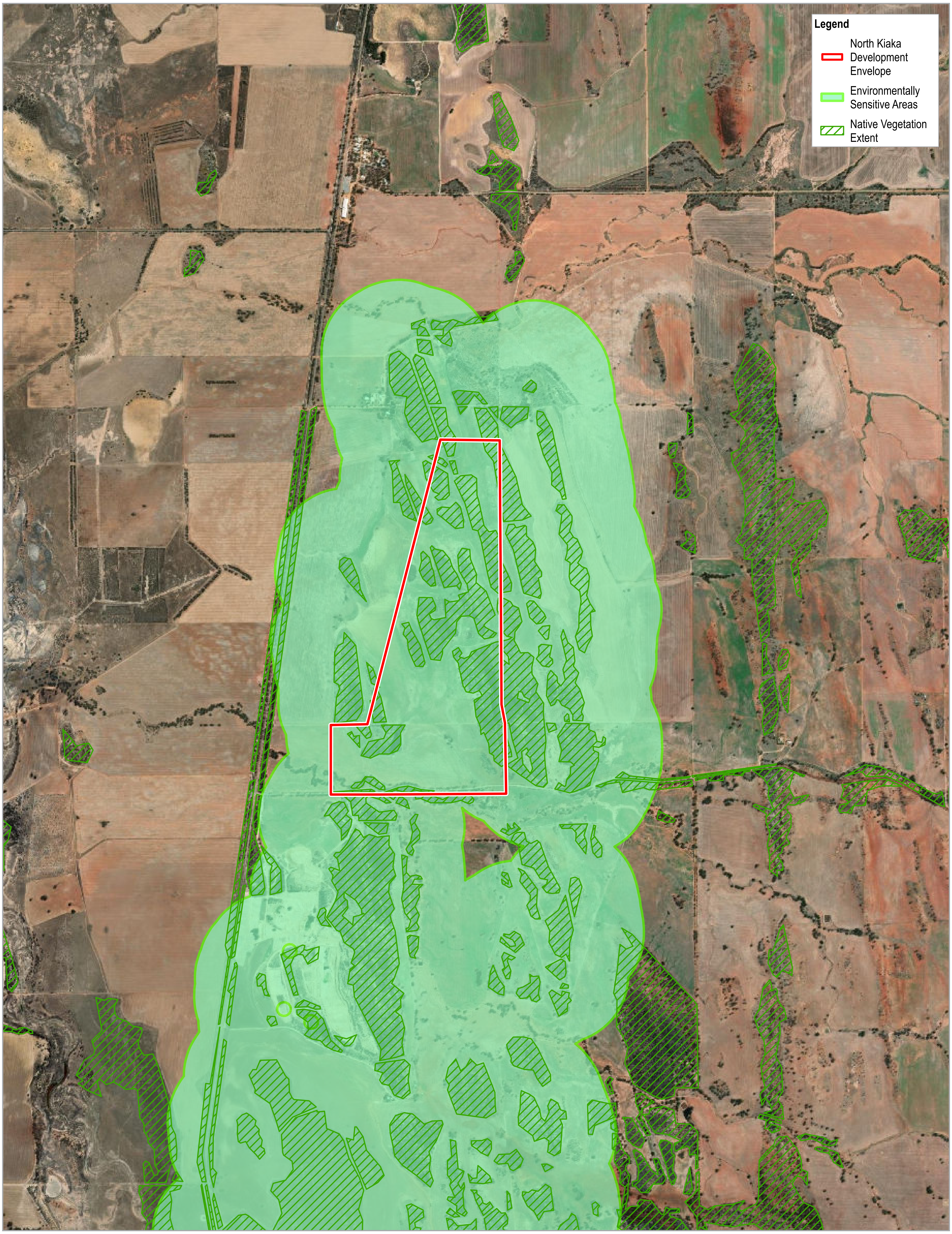

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

Conservation Areas

FIGURE A-5

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Map Projection: Transverse Mercator
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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Conservation Significant Flora and Fauna

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

FIGURE A-6

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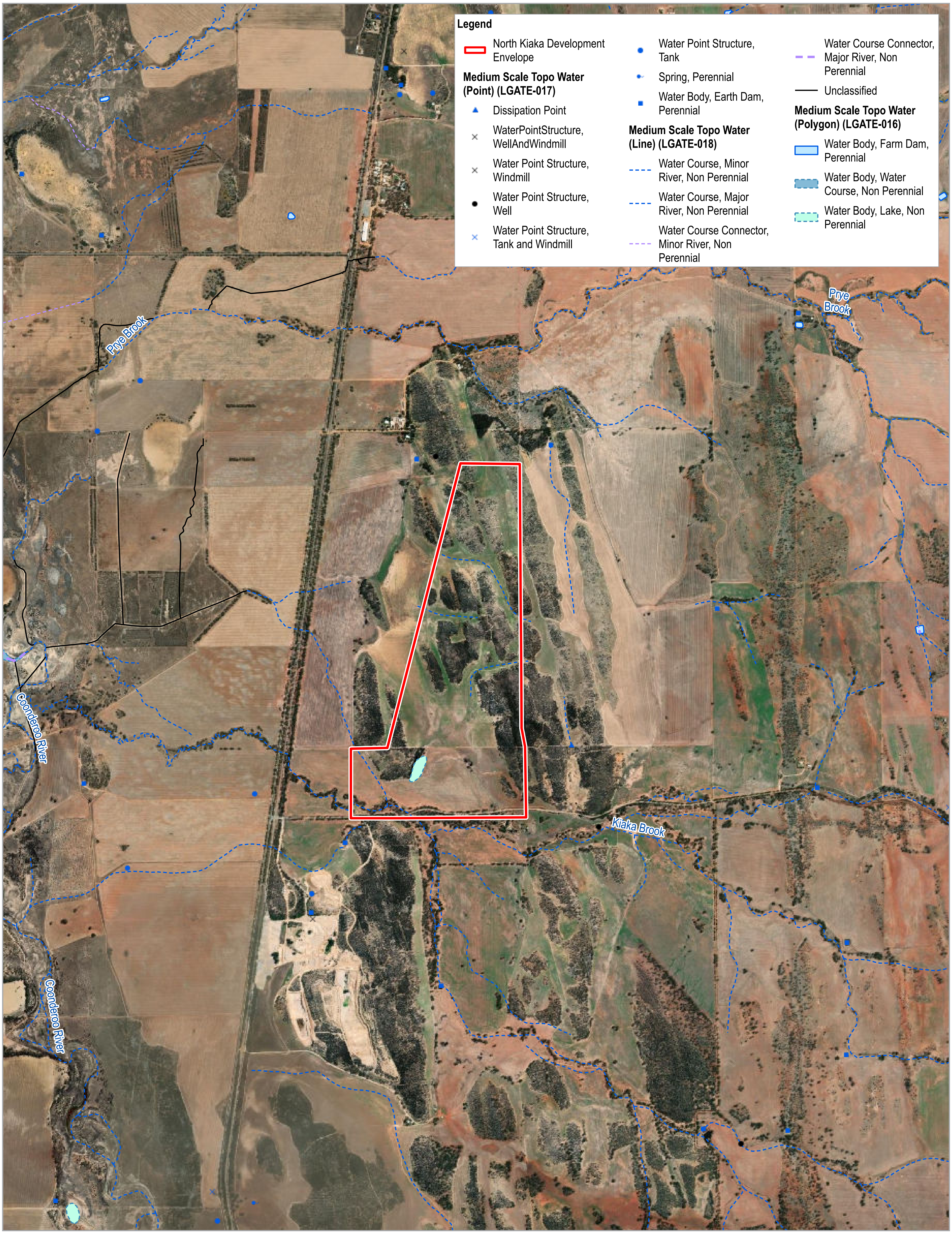

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N

Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Surface Water and Hydrology

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

FIGURE A-7

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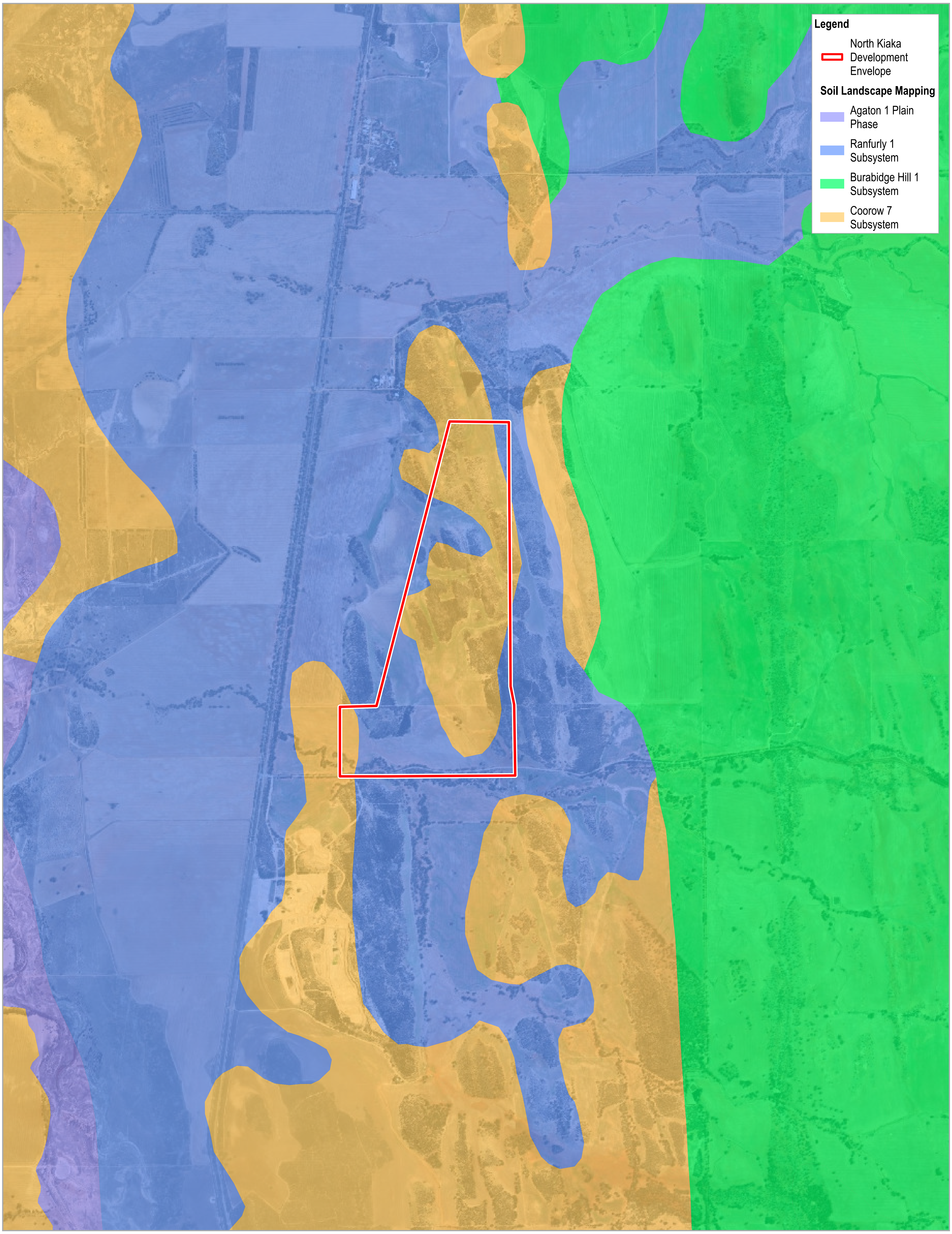

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Grid: GDA 1994 MGA Zone 50

N

Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

Soil Landscapes

FIGURE A-8

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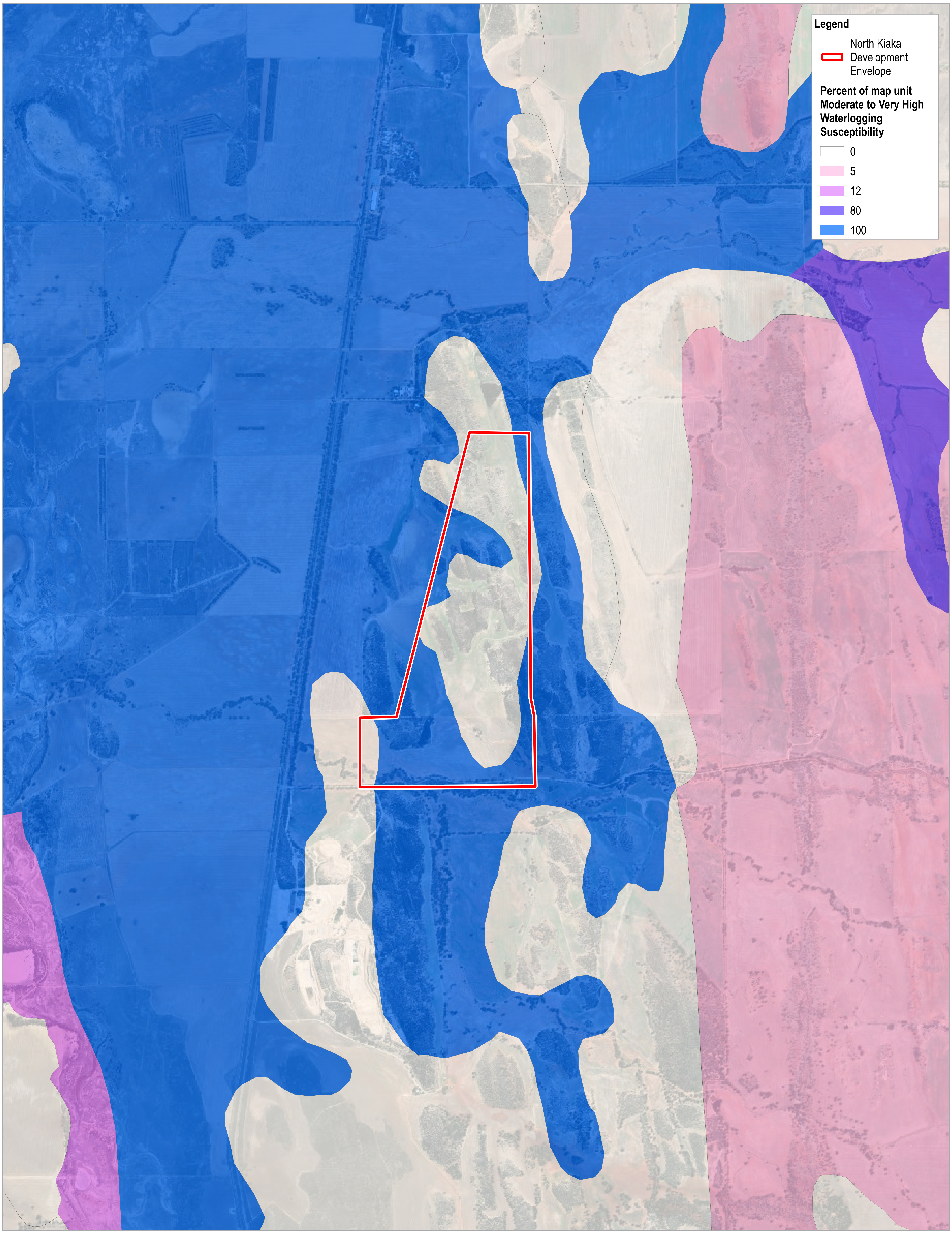

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/9/2023**

Waterlogging Susceptibility

FIGURE A-9

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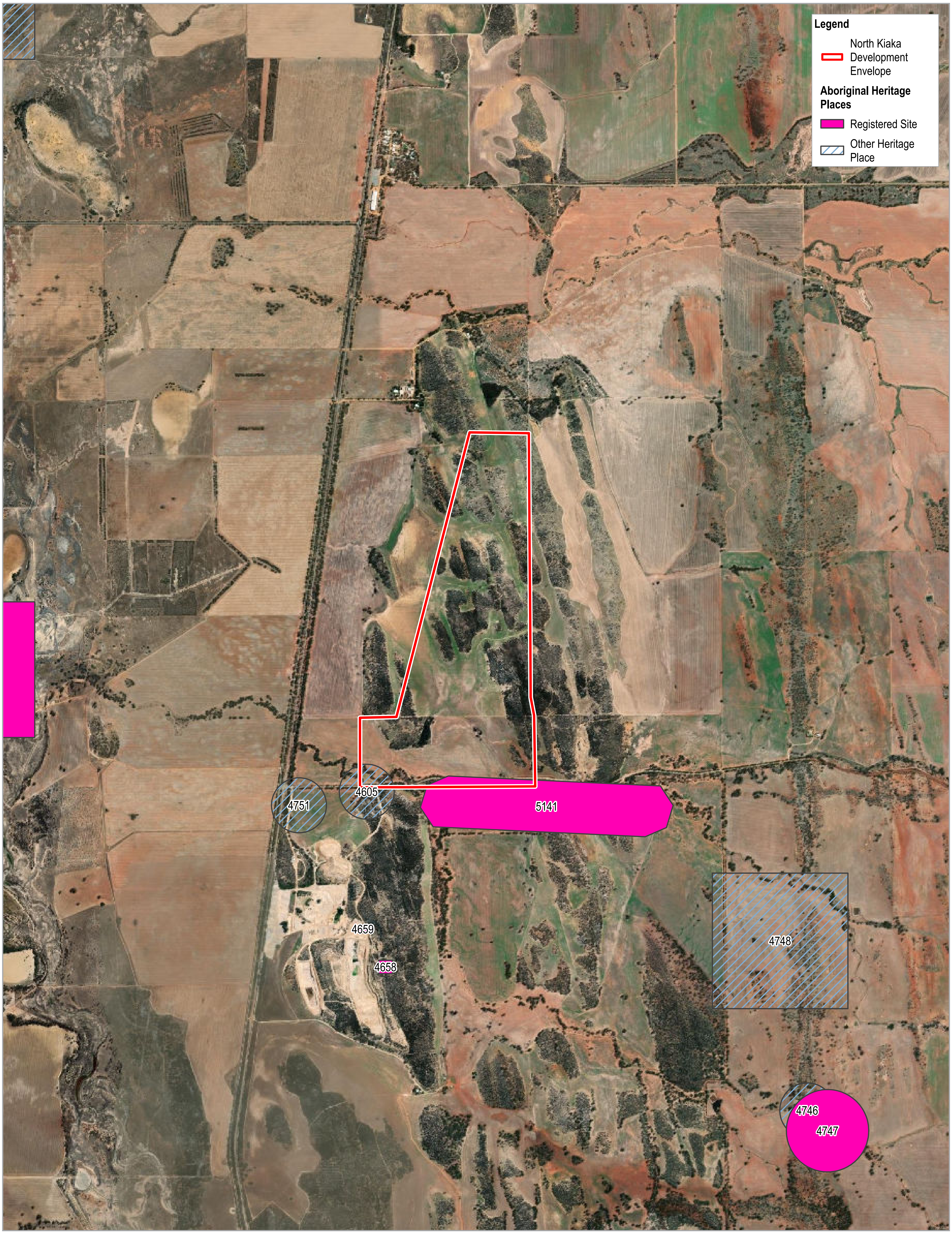

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/14/2023**

Aboriginal Heritage Sites

FIGURE A-10

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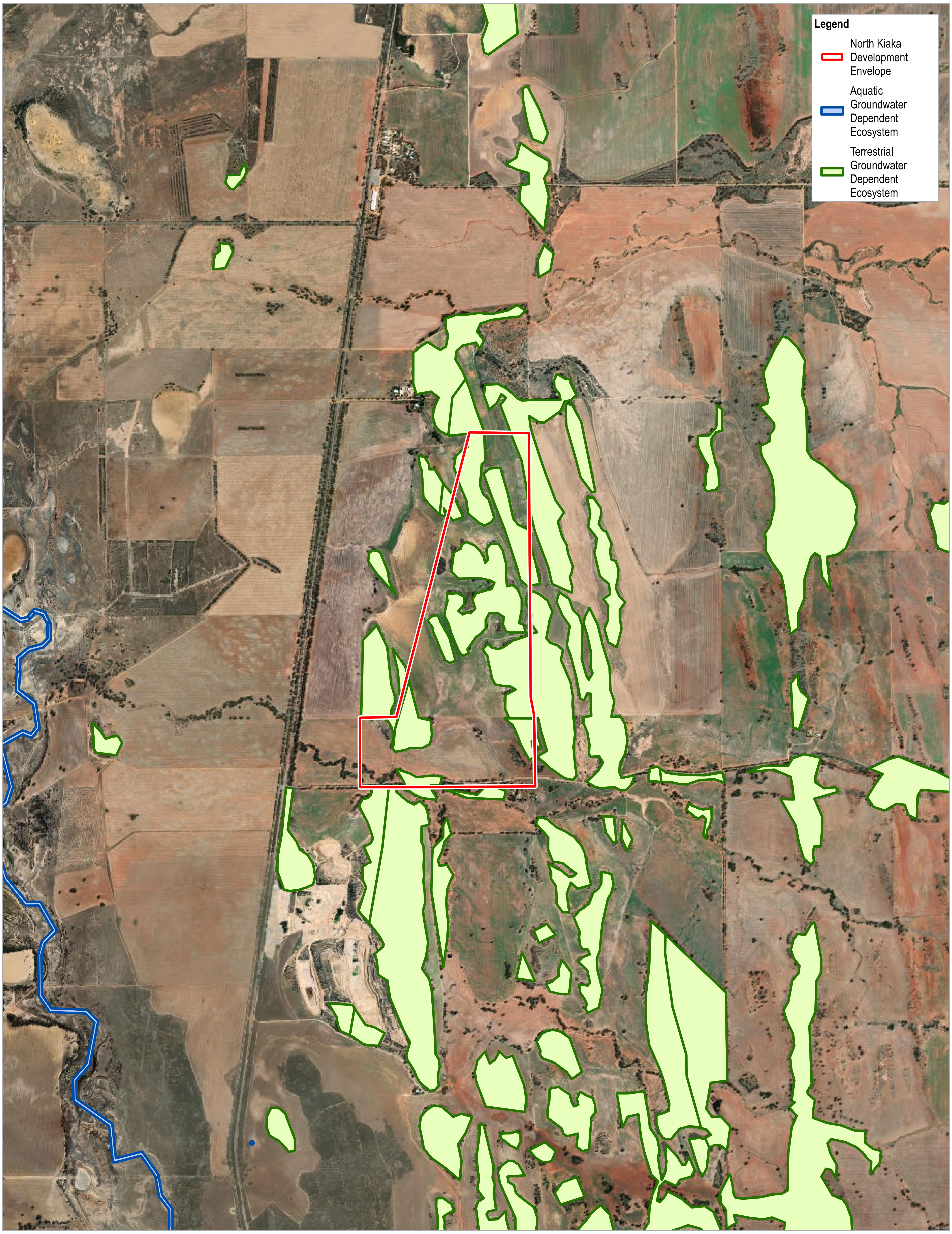

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Simcoa Operations Pty Ltd
Simcoa Section 38 Environmental Approvals

Project No.	**12518217**
Revision No.	**0**
Date	**3/13/2023**

Groundwater Dependent Ecosystems

FIGURE A-11

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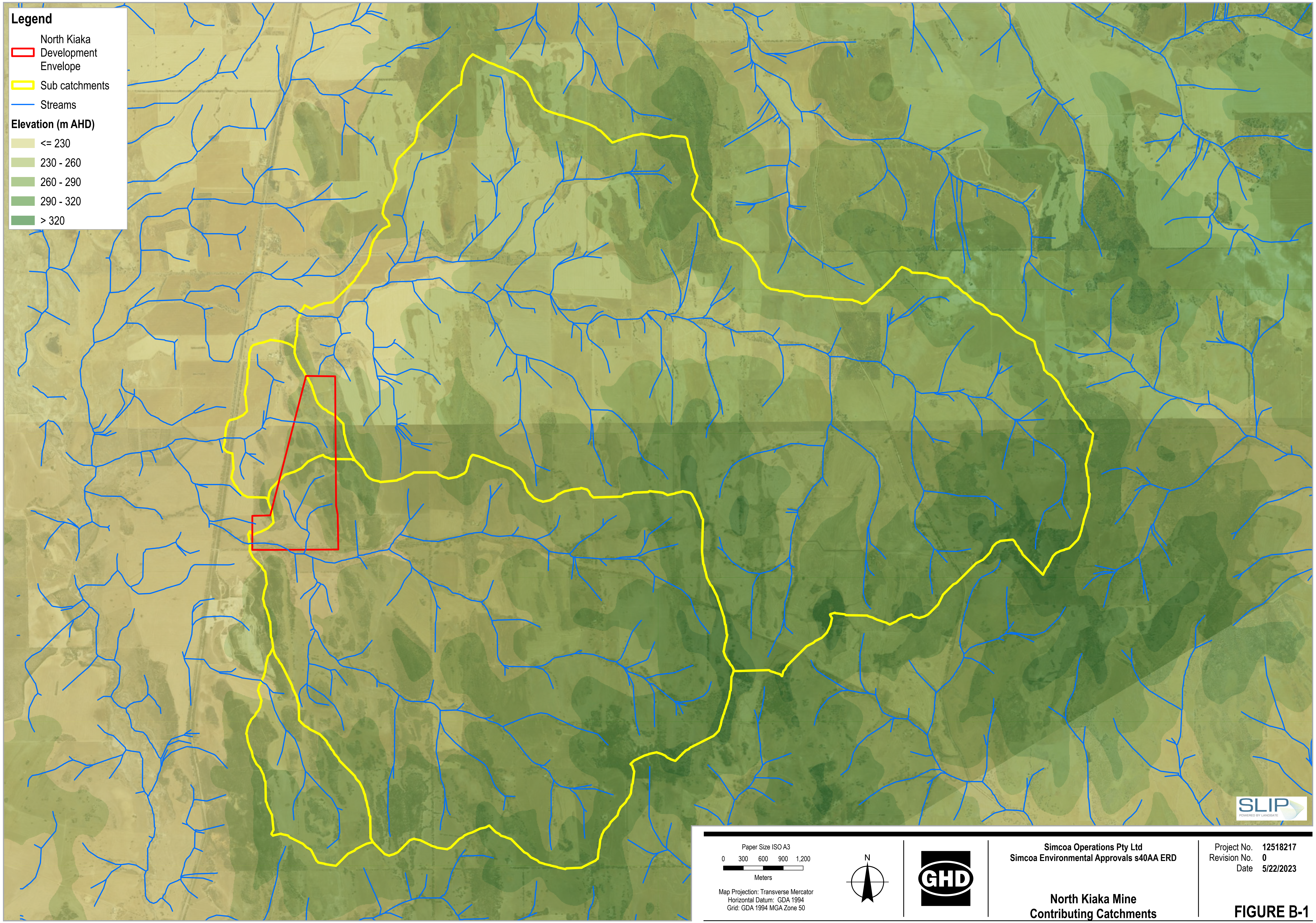
Appendix B

Result Figures

List of Result Figures



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Grid: GDA 1994 MGA Zone 50

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

North Kiaka Mine
Contributing Catchments

Project No.	12518217
Revision No.	0
Date	5/22/2023

FIGURE B-1

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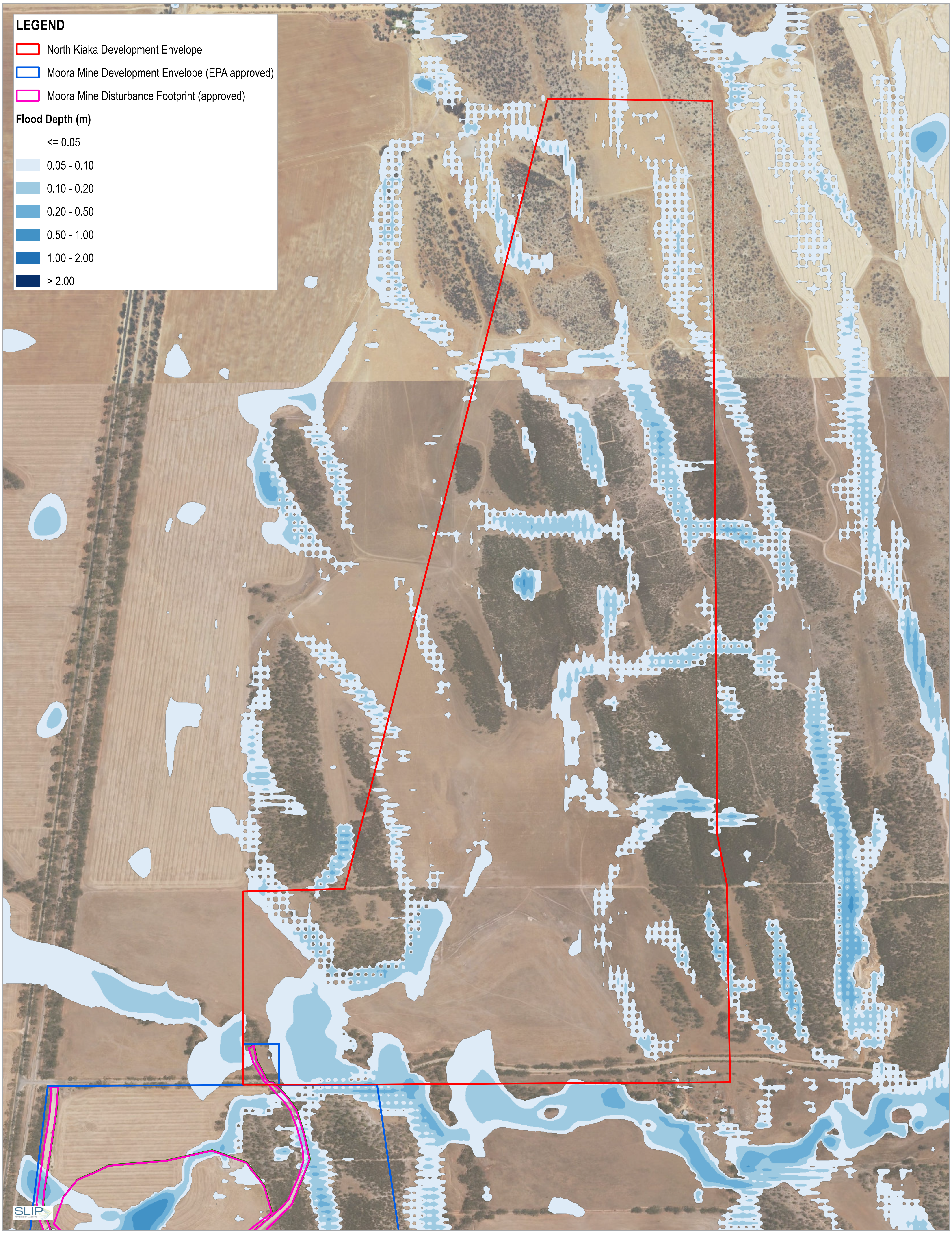

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Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Pre-development
10% (1 in 10) AEP Flood Depth

Project No.	**12518217**
Revision No.	**0**
Date	**19/05/2023**

FIGURE B-2

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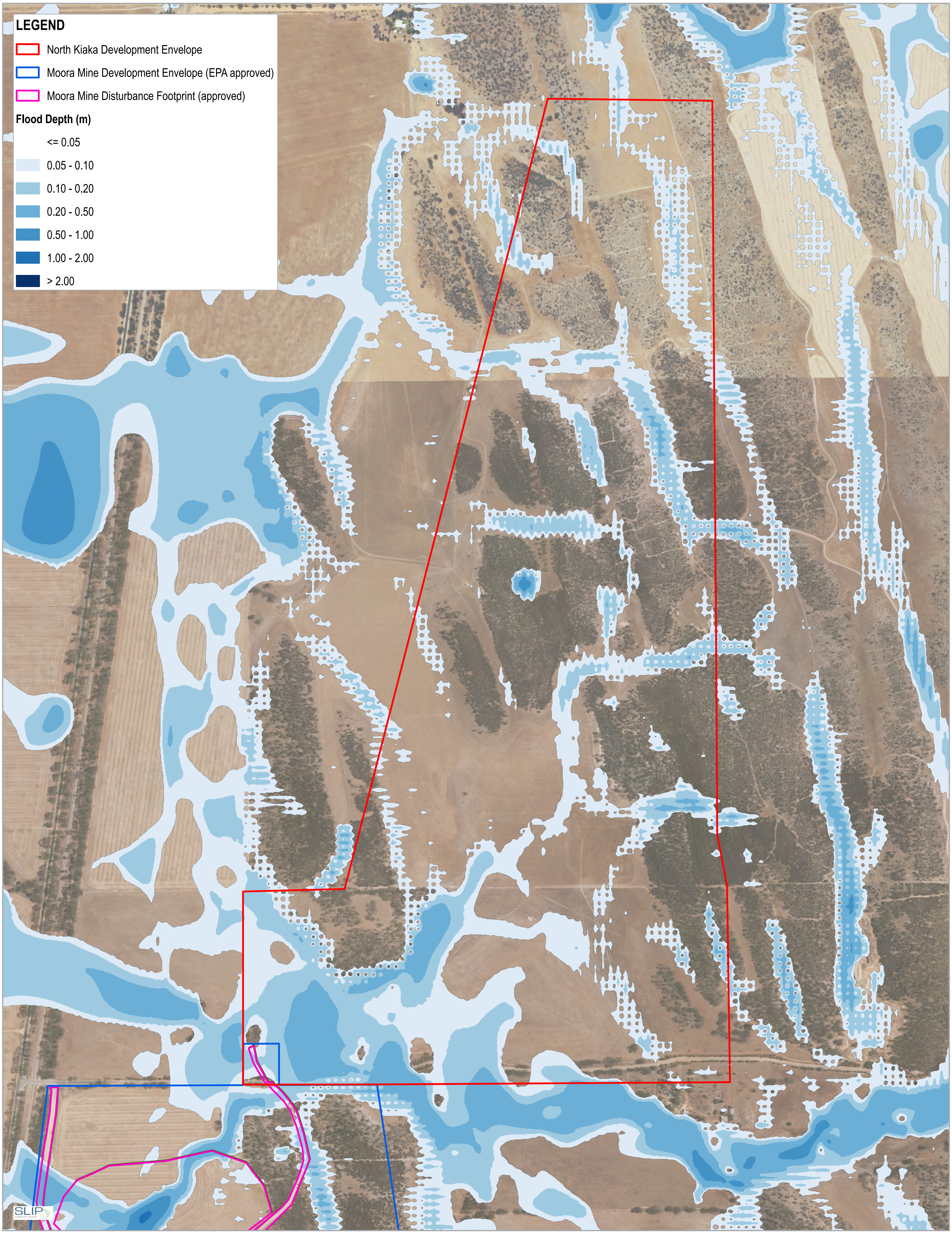

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Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Pre-development
1% (1 in 100) AEP Flood Depth

Project No.	**12518217**
Revision No.	**0**
Date	**19/05/2023**

FIGURE B-3

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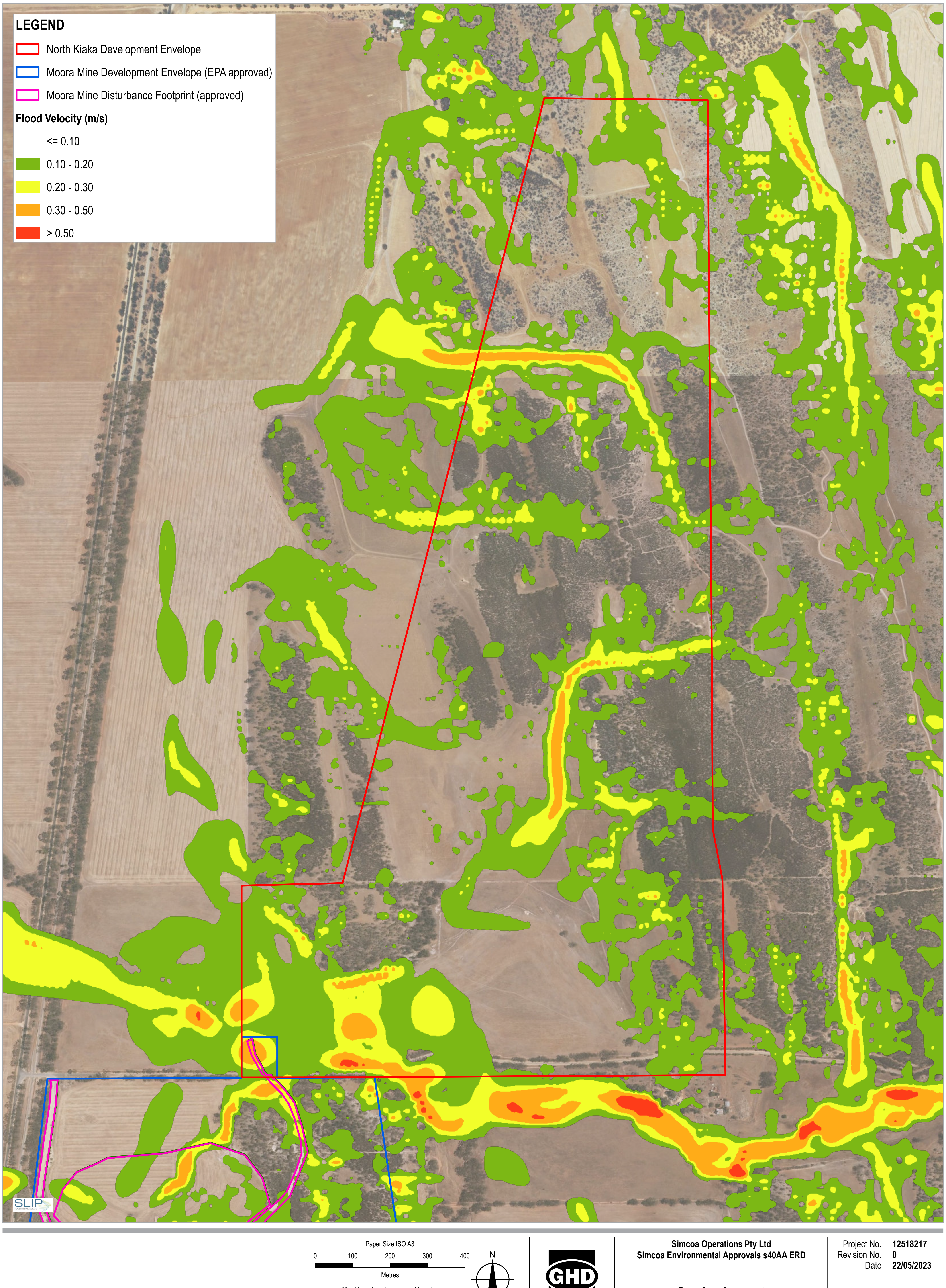

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Metres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Project No. **12518217**
Revision No. **0**
Date **22/05/2023**

Pre-development
10% (1 in 10) AEP Flood Velocity

FIGURE B-4

\\ghdnet\ghd\AU\Perth\Projects\61\12518217\GIS\Maps\Working\12518217_Figures\12518217_Figures.aprx
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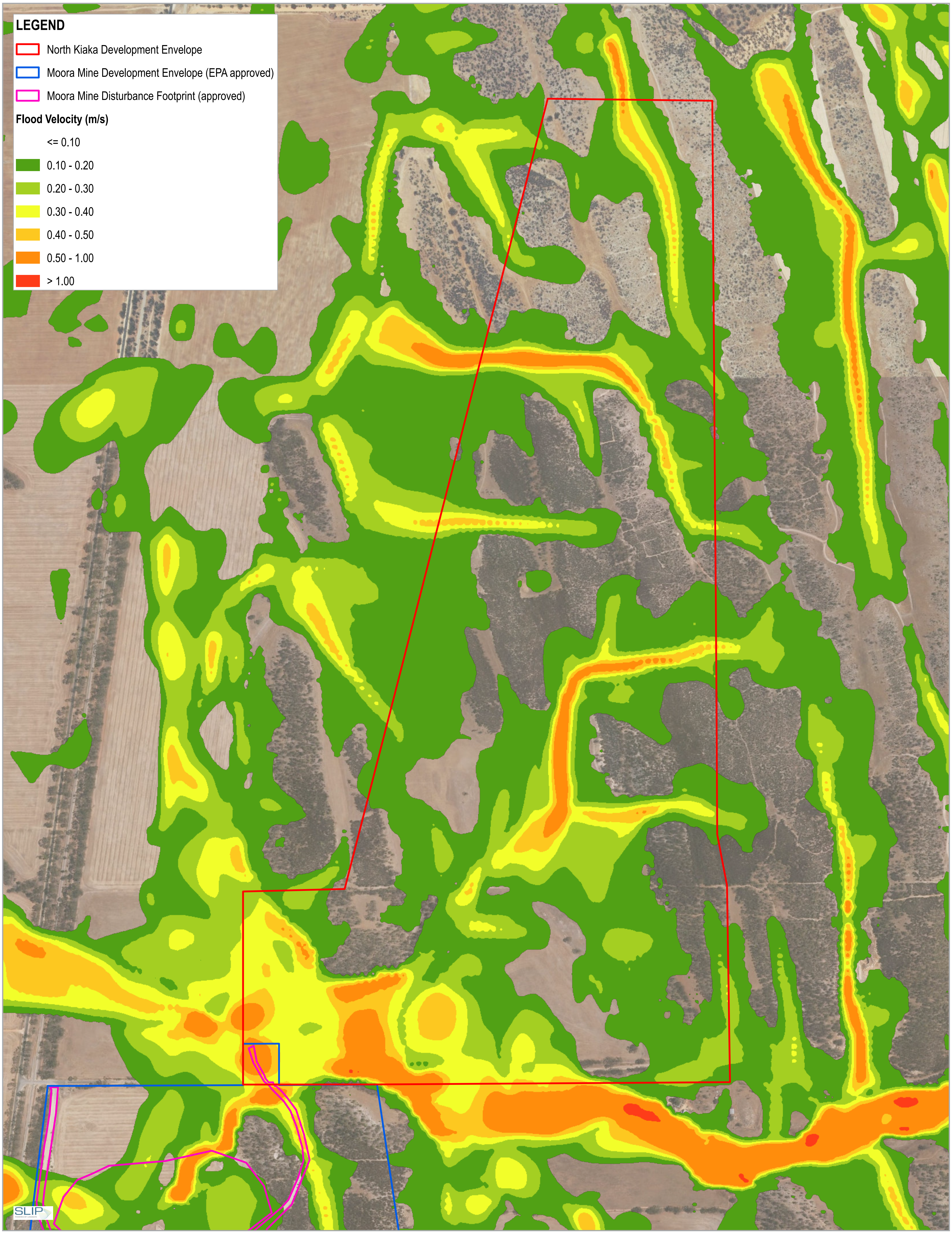

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Grid: GDA 1994 MGA Zone 50

GHD

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Project No.	**12518217**
Revision No.	**0**
Date	**22/05/2023**

Pre-development
1% (1 in 100) AEP Flood Velocity

FIGURE B-5

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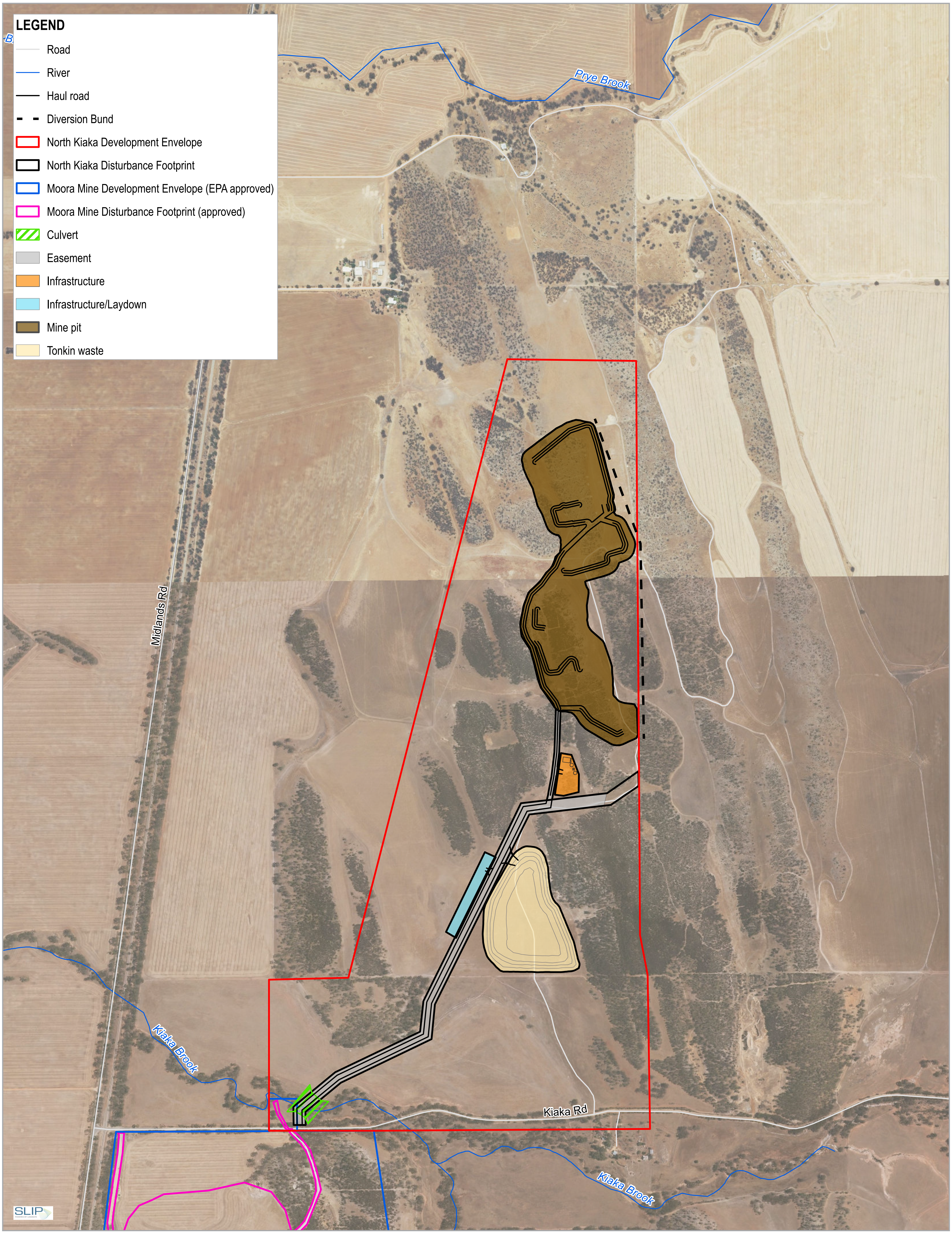

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Grid: GDA 1994 MGA Zone 50

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Proposed Surface Water Controls

Project No. **12518217**
Revision No. **0**
Date **22/05/2023**

FIGURE B-6

\\ghdnet\ghd\AU\Perth\Projects\61\12518217\GIS\Maps\Working\12518217_Figures\12518217_Figures.aprx
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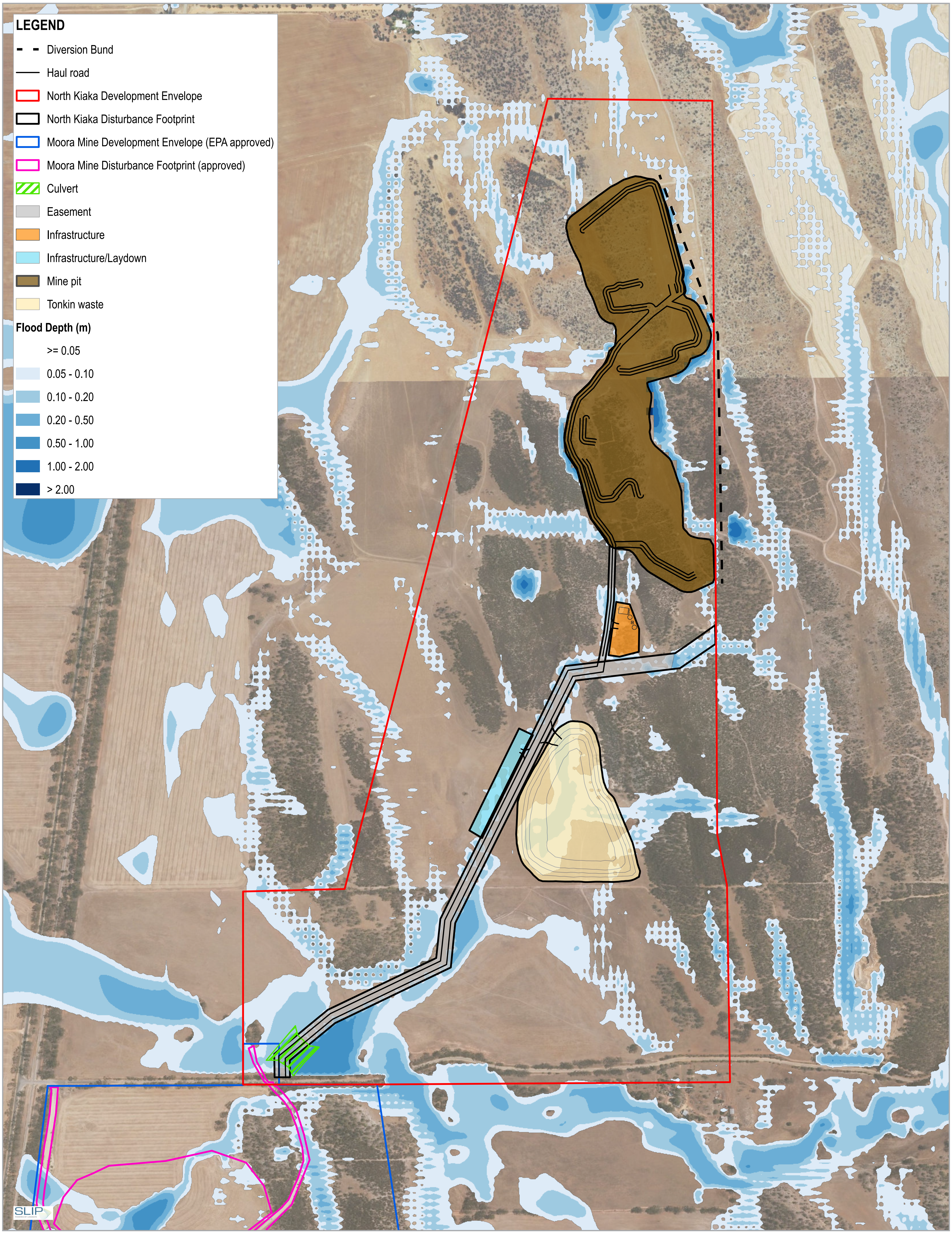

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Post-development
10% (1 in 10) AEP Flood Depth

Project No.	**12518217**
Revision No.	**0**
Date	**19/05/2023**

FIGURE B-7

\\ghdnet\ghd\AU\Perth\Projects\61\12518217\GIS\Maps\Working\12518217_Figures\12518217_Figures.aprx
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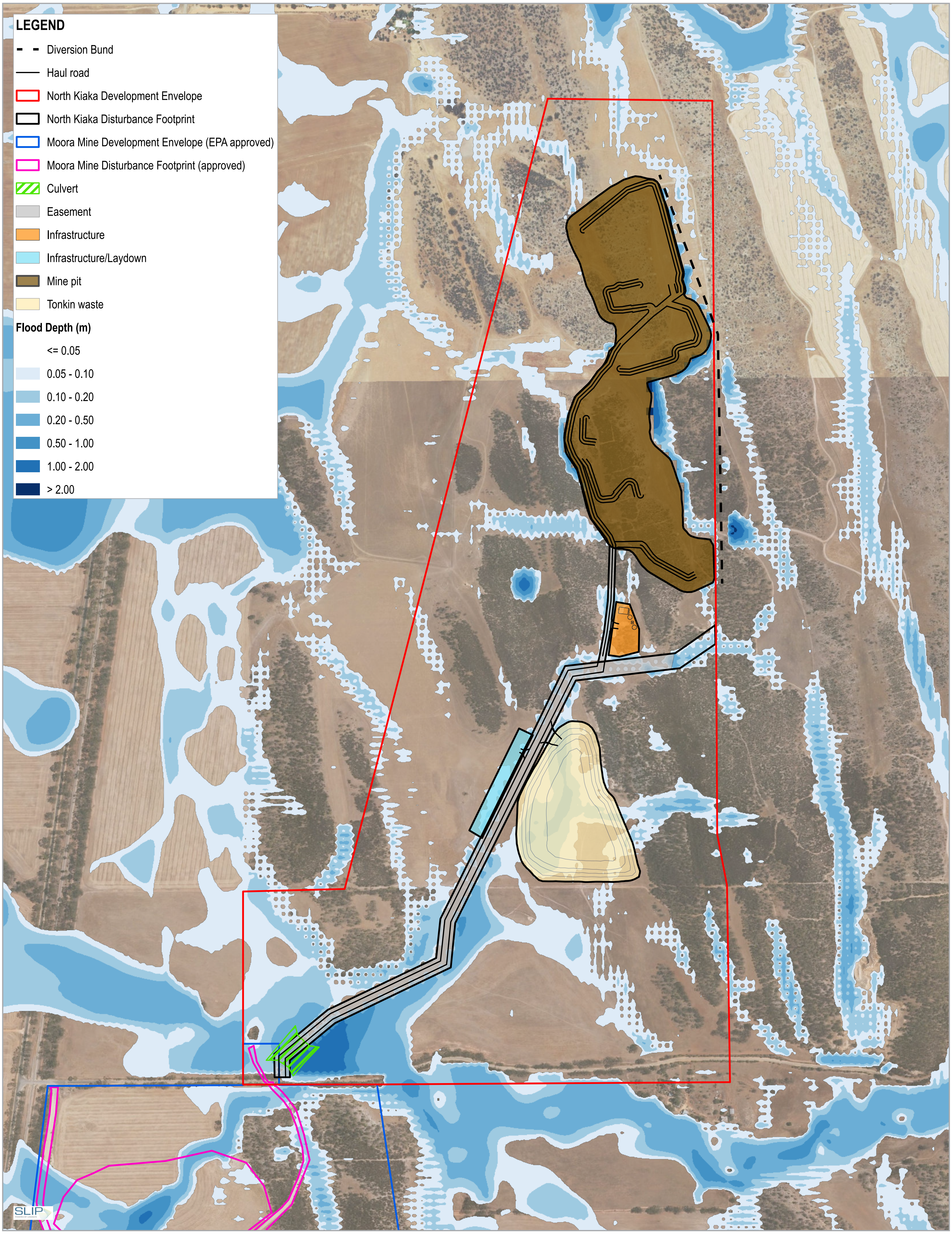

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Metres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Post-development
1% (1 in 100) AEP Flood Depth

Project No.	**12518217**
Revision No.	**0**
Date	**19/05/2023**

FIGURE B-8

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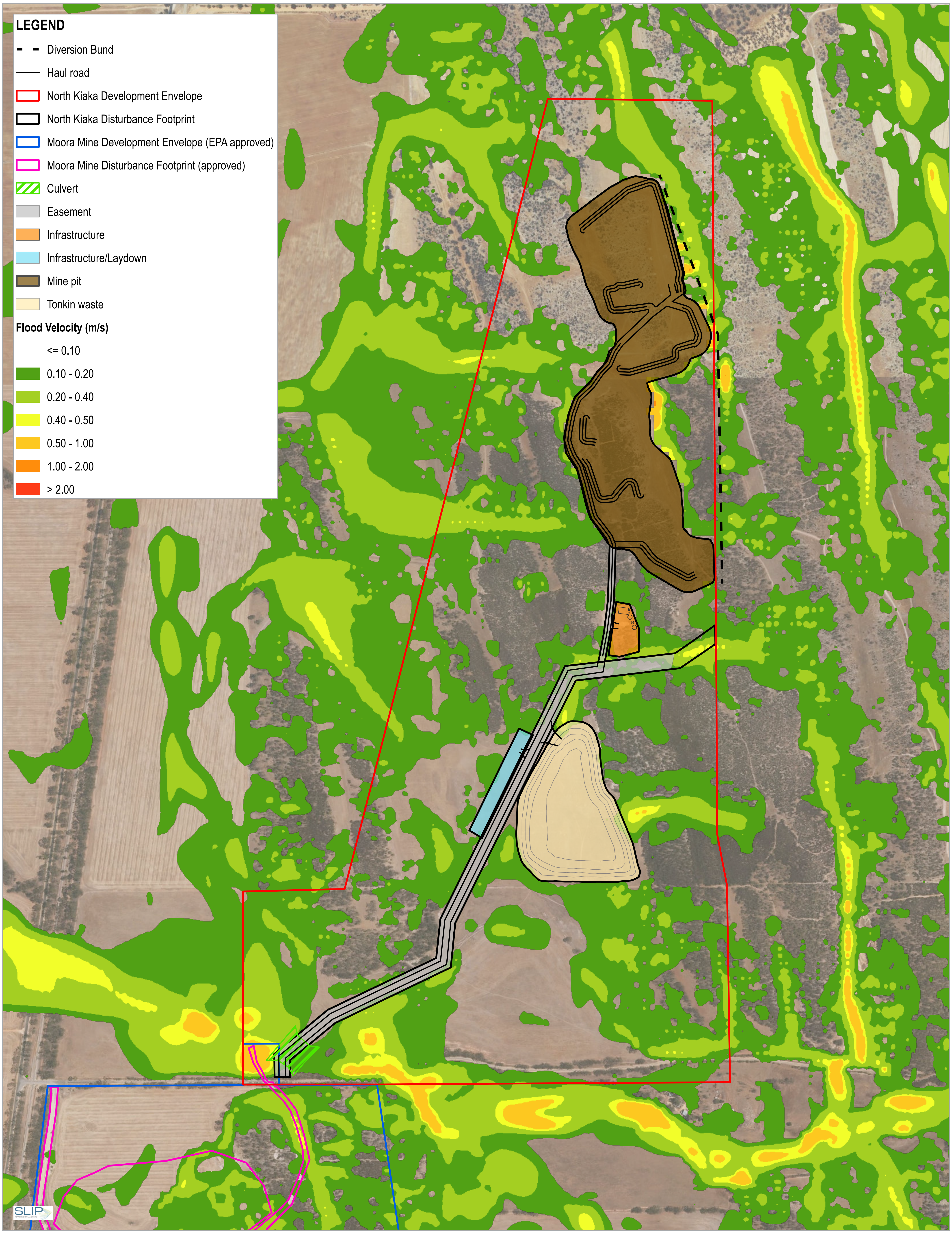

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Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Post-development
10% (1 in 10) AEP Flood Velocity

Project No. **12518217**
Revision No. **0**
Date **22/05/2023**

FIGURE B-9

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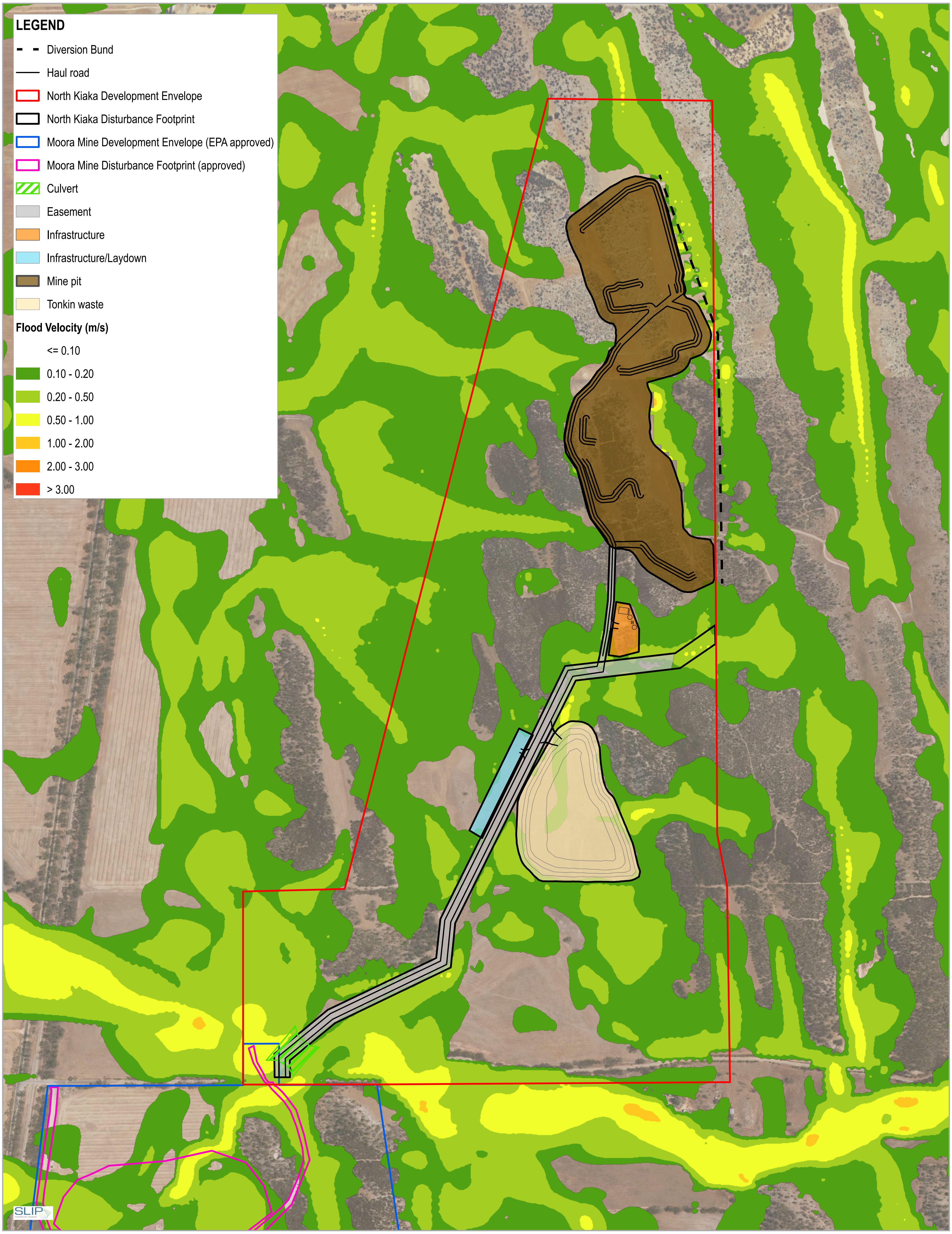

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Metres

Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 50

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Simcoa Operations Pty Ltd
Simcoa Environmental Approvals s40AA ERD

Post-development
1% (1 in 100) AEP Flood Velocity

Project No.	**12518217**
Revision No.	**0**
Date	**22/05/2023**

FIGURE B-10

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Appendix C

Flood Modelling Methodology

Flood Model Configuration

Hydraulic modelling of the Kiaka Mine DE was undertaken using the TUFLOW hydrodynamic modelling software (BMT, 2018). The model was configured using TUFLOW HPC (Heavily Parallelised Compute) version 2020-10-AD-iSP-w64. TUFLOW HPC is an explicit solver for the full 2D Shallow Water Equations. The scheme is both volume and momentum conserving, can be applied with adaptive or fixed time stepping, and is unconditionally stable (BMT, 2018).

Model Scenarios

The flood modelling undertaken in this study considered the following AEPs for the existing and post-development conditions for the following design rainfall scenarios:

- Pre-development: 1 in 10, and 1 in 100 AEP flood event
- Post-development: 1 in 10, and 1 in 100 AEP flood event

The DE, DF and infrastructure and survey data included in each of these scenarios is detailed in Section 1.1. The flood models were set up using the available information, with preference given to more accurate data in the event of a duplication.

Modelling Approach

DRAINS modelling software to be used to delineate the main catchment flow and determine the critical storms for the site.

The rain-on-grid procedure was used for the flood modelling for the areas that do not interact with the upstream catchment, involves the application of net rainfall on the surface. The following approach was adopted:

- Delineate catchments and two-dimensional model area from LIDAR contour data
- Identify suitable Initial Loss (IL) – Continuing Loss (CL) values based on available information
- Obtain representative site rainfall Intensity-Frequency-Duration (IFD) and temporal pattern data
- Develop the surrounding catchment areas using CatchmentSIM
- Develop a DRAINS model for the major catchment using CatchmentSIM and ARR Data
- Develop a TUFLOW rain-on-grid model and run the ensemble temporal patterns
- Determine the maximum flood depth from the median flood depth estimated for each duration rainfall.

Design rainfall

The 1 in 10, and 1 in 100 AEP design rainfall hyetographs to be applied over the modelling domain were derived in accordance to Chapter 3 in Book 8 of the *Australian Rainfall and Runoff* (ARR) 2019 (Ball, et al., 2022) and involved the following tasks (in no particular order):

- Extraction of design rainfall depths for all 24 standard durations (ranging from 10 minutes to 168 hours) from the Bureau of Meteorology's Design Rainfall Data System (2016);
- Application of rainfall areal reduction factors as prescribed in Chapter 4 in Book 2 of ARR 2019; and

- Application of rainfall temporal patterns as defined by the Generalised Short Duration Method (for both short and intermediate durations) and Revised Generalised Tropical Storm Method (for both intermediate and long durations).

Rainfall Intensity-Frequency-Duration (IFD) data obtained from the Bureau of Meteorology (2022) is presented in Table 3.

Table 3 Design Rainfall Depths

Duration	10%	1%
1 min	0.6	0.9
2 min	1.7	2.8
3 min	2.8	4.5
4 min	3.8	6.1
5 min	4.7	7.6
10 min	8.3	13.2
15 min	10.7	17.1
20 min	12.6	20
25 min	14	22.4
30 min	15.2	24.4
45 min	18.1	29.1
1 hour	20.3	32.7
1.5 hour	23.6	38.3
2 hour	26.3	42.7
3 hour	30.8	50
4.5 hour	36.3	60
6 hour	41.2	69.1
9 hour	48.5	82.7
12 hour	53.9	92.2
18 hour	61.7	106.7
24 hour	67.2	116
30 hour	71.2	123
36 hour	74.2	128.9
48 hour	78.5	136
72 hour	83.5	143.2
96 hour	86.9	145.4
120 hour	89.8	146.6
144 hour	92.8	146.7
168 hour	96	146.9

Topography

The pre-development scenario considers the current site topography and landscape. The following data was used to generate the Digital Elevation Model (DEM) used in the model:

- DEM data from the ELVIS database (2022) which encompassed the wider region (30m cell size)
- LIDAR survey data of the North Kiaka Mine area (10m cell size) (supplied by Simcoa on 15 July 2020)

The post-development scenarios include the design for managing surface water for proposed Pit 2 and other site infrastructure. The following data was used to generate the (DEM) used in the model:

- Topography data included in the existing pre-development modelling as described above;
- Road infrastructure raised 1m above ground level (m AGL);
- Diversion bund added to the east face of Pit 3, 1m AGL; and
- Culverts added along access road following Kyaka Brook.

The post-development footprint areas including the Tonkin Waste Rock Dump (WRD), access roads, easement and laydown area elevations were not modelled on the DEM. The final design levels or surface for these landforms were not available for the purposes of this assessment, and is a limitation in the model set up.

Boundary Conditions

Normal flow boundary condition was used at the downstream sides of the model boundary to allow the water flow out from the model area.

Soils and Losses

The flood model utilises an initial-continuing loss approach to estimate rainfall loss and excess. The loss values to be adopted were inferred from the *ARR Data Hub* (Babister, et al., 2022).

The hub provided regional loss estimates throughout the whole of Australia (other than the interior arid region) at a resolution of about 2.5 km.

For the initial loss, the *ARR Data Hub* (Babister, et al., 2022) indicated a regional loss estimate of 55 mm, and a continuing loss value of 4.1 mm/hr (weighted average by catchment area).

Hydraulic roughness

The following constant Manning's 'n' roughness values were applied in the applicable areas across the site for both the predevelopment and post-development areas of the site (DPIRD, 2022):

- 0.075 - flood plain / pasteurised land (default)
- 0.05 – Flood plains / light brush
- 0.03 – natural streams (clean and straight)

The post-development infrastructure including the easement, laydown area, infrastructure, and Tonkin WRD and access roads was assumed to largely consist of compacted gravel and a hydraulic roughness value of 0.025 was applied using the proposed development shapefile.

Pit 2 was modelled as impervious, by removing the area from the model boundary (2d_code) in QGIS.

DRAINS

As outlined in the scope DRAINS software was used to assess the impacts of flooding on roads and the site. DRAINS was used to model the Kyaka Brook outflow, crossing the North Kiaka road and the proposed access road leading into North Kiaka Mine DE. The total catchment area was developed using CatchmentSIM software. The Kyaka Brook catchment area otherwise referenced as the upstream flow, when assessed against the areal topography is considered the only catchment area that will cross over and potentially impact the site during an extreme weather event. ARR Data (2022) was imported into DRAINS to accurately assess the median flow within the upstream catchment. Initial loss and continuing loss conditions for the DRAINS results used the provided ARR data results of 55 IL and 4.1 CL.

The DRAINS software was used to simulate 6 design storm durations, ranging from 30-minutes to 24-hours, for the 10% and 1% AEP rainfall events for the south-east catchment from the site, to identify the critical duration for Kyaka Brook. This critical duration was adopted for the whole site to maintain continuity throughout the model. The critical duration events were identified to be:

- 10% AEP 24 Hour Storm (TP03)
- 1% AEP 12 Hour Storm (TP10)