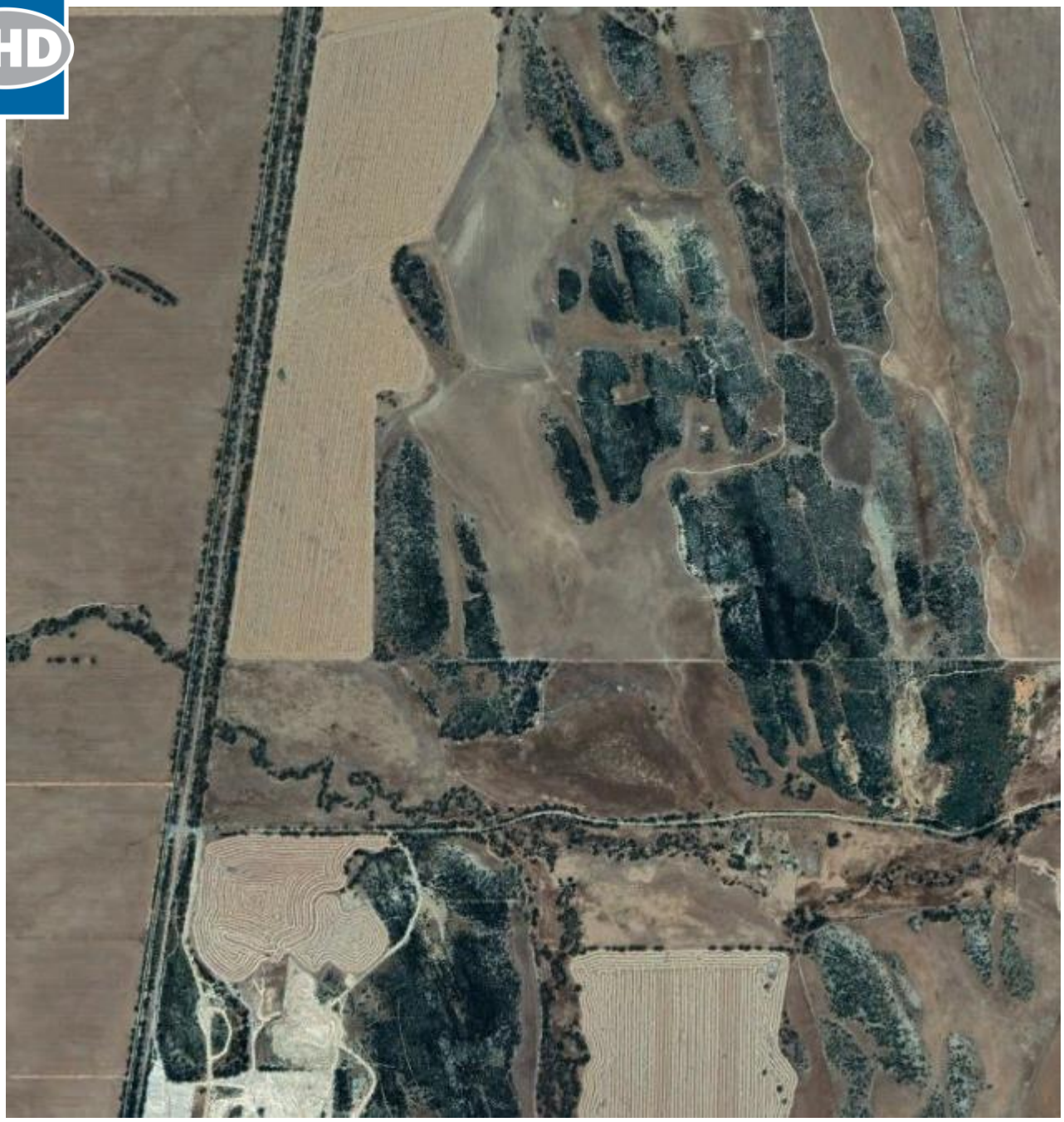
Appendix E

Geotechnical Desktop Assessment (GHD 2019a)



Simcoa Operations Pty. Ltd.

North Kiaka Approvals and Supporting Studies

Geotechnical Desktop Study

September 2021

Executive Summary

Introduction

Simcoa Operations Pty. Ltd. (Simcoa) operates the Moora Quartzite Mine (the Existing Mine) located 15 km north of Moora, Western Australia. Simcoa propose to develop a new greenfield quartzite mine (the Proposed Mine) located approximately 2.5 km north of the Existing Mine.

As part of the proposal, various mine infrastructure will be relocated from the Existing Mine to the Proposed Mine. This geotechnical desktop study examines the haul roads, haul road bridge, and two earthwork pads. The study assesses existing information and provides recommendations for geotechnical site investigation.

Information Extents

Previous ground information data has been gathered from 21 sources. The information is predominantly focussed on the Existing Mine, providing a commentary on the regional and local geology, and historical groundwater pumping trials. A database of 674 assay exploration boreholes undertaken at the Proposed Mine is available. The boreholes were drilled open-hole and basic geology is therefore, inferred from arisings at 2 m centres. No geotechnical lithological descriptions, insitu tests, geotechnical laboratory testing data or geotechnical parameters are available.

Geology

The site is underlain by Noondine Chert, which outcrops in NNW-SSE trending parallel ridges. Between the ridges are gentle sloping valleys infilled with Colluvium at the margins and Alluvium elsewhere. Historical investigations are limited to the ridges and no information is available regarding the depth of valley soils. Where valleys are narrow and aligned parallel/perpendicular with ridges, they may represent preferentially weathered Dolerite Dykes.

Groundwater

Groundwater levels at the Existing Mine were monitored every month in 2018. Groundwater depths at the Proposed Mine are inferred to be between 11 to 14 m depth at the West Earthworks Pad and 42 to 45 m depth at the East Earthworks Pad.

Acid Sulphate Soils (ASS)

There are no known occurrences of ASS in the Coomberdale Sub-group. There is a low probability of encountering ASS in the Alluvium.

Geotechnical Risks

Limited information is available for the geological model and material engineering characteristics, particularly at the bridge and earthwork pads. Key risks stemming from this include: total settlement and differential settlement of structures, haul road sub-grade suitability, rock excavatability and support measures, karst collapse and Acid Sulphate Soils.

Recommended Site Investigation

The recommended scope is a total of four geotechnical boreholes with groundwater monitoring installations, 20 No test pits paired with Dynamic Cone Penetrometers, and four geophysical transects. Target depths range between 3 m for test pits and 30 m for boreholes.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the report.

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1. Introduction

1.1 General

Simcoa Operations Pty. Ltd. (Simcoa) is considering implementing three potential projects for their Western Australia (WA) operations. GHD Pty. Ltd. (GHD) has been commissioned to provide engineering support services for Proposal No. 2, whereby it is proposed to develop a new greenfield quartzite mine at North Kiaka.

As part of engineering support to this proposal, a geotechnical desktop study will be conducted for the haul roads, access roads and earthwork pads (study area), as shown in Figure 1. This report represents the findings of the study, which was carried out in accordance with the scope of work outlined in GHD's proposal: Proposal for North Kiaka Mine Expansion, Approvals Engineering Support, Revision 1, dated 30th October 2018.

1.2 Purpose of this Report

The purpose of this report is to provide the following:

- A summary of the available geotechnical information relevant to the study area;
- An overall understanding of the likely ground and groundwater conditions at the study area, including any available information regarding soil parameters; and
- Recommendations regarding the extent and type of future geotechnical investigation fieldwork.

1.3 Scope

The scope of work outlined in GHD's proposal to Simcoa comprised a desktop study, undertaken to identify geotechnical data including soil parameters and geological information relevant to the site engineering.

1.4 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 1.2 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 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. Project Background

2.1 Existing Infrastructure and Proposed Development

Simcoa operates the Moora Quartzite Mine (the Existing Mine) and the Kemerton Silicon Smelter (the Smelter). The Existing Mine is located 15 km north of Moora, in the Shire of Moora, WA. The Existing Mine produces high purity quartzite which is transported offsite via truck to the Smelter, located near Bunbury, WA.

Proposal option No. 2 is to develop a new greenfield quartzite mine at North Kiaka (the Proposed Mine), located approximately 2.5 km northeast of the Existing Mine, as shown in Figure 1.

As part of the proposal, various mine infrastructure will be relocated from the Existing Mine to the Proposed Mine. This study will examine the haul roads, access roads and two earthwork pads. Various infrastructure will be required, including but not limited to:

- Haul Road:
    - Cut and fill; and
    - Bridge over Kyaka Brook.
- East Earthworks Pad (approx. 213,300 m^2):
    - Processing Area; and
    - Workshops.
- West Earthworks Pad (approx. 29,400 m^2):
    - Administration buildings;
    - Product stockpiles; and
    - Weighbridge.

2.2 Existing Information

A review of data from previous investigations conducted in the vicinity of the study area was carried out by GHD. Data from multiple past investigations were reviewed, along with publicly available geological and groundwater information. The data and findings are outlined overleaf, in Table 1.

Table 1: Existing Geotechnical, Geological and Groundwater Information

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
Geological Survey of Western Australia	1:250,000 Geological Series – MOORA, Sheet SH 50-10, 1st Edition, 1982	Geological map of Moora	Regional surface geology	-	Surface geology in study area is mapped as Coomberdale Sub-group intruded by northeast-southwest trending Amphibolite dykes. The Coomberdale Sub-group is surrounded by Alluvium Normal faults trending north-south are inferred to be present to the west and east of the Proposed Mine site. The hanging walls face each other and are centred on the site The Darling Fault is inferred to be approximately 6.3 km west of the site Map extract has been used in Figure 2
Geological Survey of Western Australia	1:250,000 Geological Series – Explanatory Notes: Sheet SH 50-10: Moora, Western Australia, 1982	Explanatory notes to the geological map	Regional geological history	-	Dykes are between 1 m and 10 m thick and tend not to exceed 1 or 2 km in length. Dykes are doleritic and vary in grain size
Government of Western Australia	Landgate Online Viewer; 2019	Historical aerial images	Aerial images dating between 2000 and 2017 showing change	-	No visible ground surface disturbances or fill placements

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
			in surrounding land use		
Commenwealth Scientific and Industrial Research Organisation	Australian Soil Resource Information System; 2015	Digital maps of Acid Sulphate Soil (ASS) Risk	Shows local site geology in terms of ASS risk	-	Areas mapped as Coomberdale Sub-group are shown to have “No Known Occurrence” of ASS risk; Areas mapped as Alluvium show an ASS risk of “Low Probability”
Simcoa Operations Pty Ltd	Moora Project, Mineralisation Report; August 2010	Discussion of historical assay exploration drilling	Regional and local geology summary	Four HQ rotary drilled holes (MKDDH1-MKDDH4) to a maximum depth of 30 m in 2010. The precise location, factual core logs and core photographs are not included	The Coomberdale Sub-group consists of bedded chert, chert breccia, orthoquartzite, silicified limestone and dolomite, and contains significant siliceous sandstone and siltstone beds, and minor claystone The chert contains significant quantities of kaolin and other clays, particularly at depth Dolerite dykes are present within the Coomberdalte sub-group Cavities are noted during drilling, with no scale of the void given
Simcoa Operations Pty Ltd	Moora Quartzite Mine, Closure Plan; January 2018	Existing Mine closure plan	Site historical milestones, local geology, soil and	-	The Coomberdale Sub-group outcrop as a series of low stony hills and ridges. The chert is fine grained, exhibits banding which is brecciated and strongly faulted

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
			groundwater summaries pH and sulphate laboratory assessment summary		The area is characterised by shallow soils of red sandy earth and loam. Soil is generally absent on the hill slopes and crests The Kyaka Brook, 500 m north of the Existing Mine discharges to the clay pans and samphire flats of the Coonderoo River The principal groundwater aquifer in the region is hosted by the Noondine Chert which is extensively fractured and cavernous. The salinity of the water ranges from fresh to brackish and pH is slightly alkaline A groundwater well on site showed water levels in the aquifer to vary with minor seasonal water level fluctuations correlated with direct rainfall recharge
Simcoa Operations Pty Ltd	Moora Quartzite Mine (M70/191) – Notice of Intent; March 1992	Discussion on a proposed pit expansion	Geological summary at 2 m centres	-	Chert beds dip at between 20° to 30° west
Simcoa Operations Pty Ltd	Excel database: Expl_Data_Tonkin.xlsx; no date	Survey coordinates and assay details for 674 boreholes	Drilling comments and very basic lithology	674 boreholes	Ferruginous chert beds encountered at ground level may be up to 10 m thick (MK009)

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
					Kaolin beds have been encountered at 10 to 12 m depth and can be up to 24 m thick (MK018) Combinations of ferruginous, kaolin and chert may form beds between 2 to 14 m thick (MK039) Dolerite is typically weathered Cavities stopped drilling in 48 boreholes and clay was observed throughout two holes up to 22 m depth (MK226 and MK231)
Simcoa Operations Pty Ltd	Excel database: 109290 Soil and Waste Rock Analysis; (no date)	Chemical test results on five soil samples	Sulphate and pH test results	-	Sulphate and pH test results
Simcoa Operations Pty Ltd	Email from Kees Visser (Simcoa) to Michael Ashley (GHD); 15th January 2019; Subject: Materials Characterisation	A series of responses from Simcoa to questions direct by GHD regarding available site information	Explanation of lithology symbols used in assay borehole database Local geology summary	-	Cavities have been encountered throughout the deposit, which are sometimes empty and sometimes filled with gravel of quartz. The area contains surface depressions from collapsed underground caverns

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
Snowden Group Pty Ltd	Kiaka Hills Mine Development Plan; November 2012	Development plan for the Proposed Mine and discussion on mineral resources	Discussion on historical assay drilling	-	Many past boreholes have not reached a target depth of 40 m during open hole drilling due to cavities or blockages
Maunsell & Partners Pty Ltd	Report of the survey for aboriginal sites at the area proposed for a quarry development by Cliffs International Ltd; July 1985	Review of aboriginal sites at the Existing Mine	Geological summary	-	The region is part of the Yilgarn Block, a sub-division of the ancient Western shield that comprises Archaean rocks. In the survey area, a group of sedimentary rocks of the Proterozoic, known as the Moora Group, lie unconformally over these. A member of this group, the Coomberdale chert, forms numerous groups of stony hills and ridges The area is 8 km east of the Darling Fault, on the Darling Plateau The landscape is gently undulating, dissected by the stony hills and ridges Surface hydrology comprises a system of southwest flowing intermittent streams such as the Kyaka Brook which flows north of the Existing Mine
Industrial Mineral Services Pty Ltd	Moora Quartzite Mine (M70/191) – Notice of Intent; May 2001	Discussion on a proposed pit expansion	Groundwater summary	-	The groundwater level is approximately 20 m below surface at the Existing Mine

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
Saprolite Pty Ltd	E0201-02_A Moora Quartz Mine – Phase 2 Hydrogeological Investigations, October – November 2011; March 2012	Discussion of a groundwater pumping trial	Composite drilling log with basic lithological description for four wells Groundwater summary	-	Borehole MB02 encountered a combination of laterite and quartz between ground level and 2 m depth, with samples comprising iron rich red-brown hard siliceous ferricrete fragments and red-brown clay. This extended to 4 m depth in MB03. The laterite was underlain by light to dark grey amorphous quartz for a further 28 m+ BH02 recorded a 4 m deep siliceous void at 28 m depth (188 m above Australian Height Datum (mAHD)) which gave no drilling resistance
Saprolite Pty Ltd	Memorandum; Moora Quartz Mine – Technical Desktop Review; August 2016	Desktop review of groundwater pumping trials at site	Hydrology	-	The direction of natural groundwater flow is from south-east to north-west towards the wetlands and discharge playa lakes some 3 to 5 km to the north-west
Saprolite Pty Ltd	E0202-07_A Annual Groundwater Monitoring Summary for GWL 104693 – Moora Quartz Mine January to December 2018; February 2019	Discussion on regional hydrogeology and a groundwater monitoring regime	Groundwater level data summarised on a monthly bases Chemical analysis of groundwater	-	A groundwater well on site showed water levels in the aquifer to vary with minor seasonal water level fluctuations correlated with direct rainfall recharge Groundwater levels vary annually between 210.94 to 214.24 mAHD

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
M.E. Trudgen & Associates	Comparison of the Flora and Vegetation of the proposed North Kiaka Mine Area to Other Parts of the Coomberdale Chert Threatened Ecological Community; March 2018	Discussion on Flora	Geology, topography and soils summary	-	The survey area contains parts of a series of more or less parallel northerly-southerly trending ridges of chert, with swales between them. The ridges are formed from the higher, more resistant to erosion, parts of the Noondine Chert Formation. There is a larger valley just east of the survey area and more chert ridges to the west. The ridges vary in cross section, some having gentle slopes on both sides, or steeper slopes on one side. There are some steep rocky areas, but the slopes are mainly gentle to moderate, with a few being quite steep The soils on the chert ridges vary in depth from skeletal on the blocky outcropping chert, to gravelly, loamy sands lower down the slopes. The surface soil was often pale grey, silty, fine sand. The soils in the valleys between the ridges are deeper over clay and broken rock
M.E. Trudgen & Associates	An Extension of a Flora Survey, Floristic Analysis and Vegetation Survey of Area of the Coomberdale Chert	Discussion on Flora	Topographical summary	-	The areas north of Kiaka Road that were surveyed have a series of more or less parallel north-south trending ridges of chert, with small valleys between them. East of the easternmost of these there is a larger valley. There is an overall slope

Source	Database, project and/or document	Content	Data relevant to this project	Past investigation locations with the site boundary	Ground and groundwater data summary; other relevant information
	TEC to Include a Further Area; March 2012				from east to west, with the western ridges lower than the eastern ones. The ridges vary considerably in cross section, some having gentle slopes on both sides and others (often narrower) having quite steep sides. There were some steep rocky areas, but the slopes are mainly gentle to moderate, with a few being quite steep
Actis Environmental Services	Proposed Discharge Evaluation: Coonderoo River Wetlands; December 2011	Analysis of potential mine water discharge sites	Hydrology Summary	-	Palaeo-channels cross the Proposed Mine site and are the mechanism for deposition of the Alluvium
Google Inc.	Google Earth Pro; 2019	Historical aerial imagery and street view imagery	Geo-spatial site imagery	-	Shallow depth of Kyaka Brook visually confirmed
Department of Parks and Wildlife	Jingemia Cave Interpretation	Visitor information to Jingemia Cave	Extent of karst landforms	-	Bedrock is confirmed to have karst present

2.3 Information Extents

Previous ground information data has been gathered from 21 sources. The information is predominantly focussed on the Existing Mine, providing a commentary on the regional and local geology, and historical groundwater pumping trials.

A database of 674 assay exploration boreholes undertaken between 2004 and 2014 at the Proposed Mine is available. The boreholes have been open-hole drilled to a maximum depth of 42 m. Lithological comments based on gravel chip arisings are available at 2 m centres. No geotechnical lithological descriptions, insitu tests, geotechnical laboratory testing data or geotechnical parameters are available. The extent of the boreholes has been displayed on Figure 3.

3. Regional Information

3.1 Regional Geology

The geological map providing 1:250,000 coverage of the study area is the MOORA sheet SH 50 – 10 (Geological Survey of Western Australia, 1982). An excerpt of the map relative to the Proposed Mine site is presented in Figure 2.

The region is part of the Yilgarn Block, a sub-division of the ancient Western shield that comprises Archaean rocks (4000 – 2500 Ma). Across the study area, a group of sedimentary and volcaniclastic rocks of the Middle Proterozoic (1600 – 1000 Ma), known as the Moora Group, lie unconformally over these Archaean basement rocks. The Noondine Chert (previously Coomberdale Chert), a member of the Coomberdale Sub-group of the Moora Group, stretches approximately 150 km north of Moora to Three Springs and outcrops as a series of low stony hills and ridges across the study area. The unit is typically between 700 m to 1000 m thick. (Geological Survey of Western Australia, 1982).

The Noondine Chert appears to have been formed by the surface silicification of carbonate rocks (siliceous limestone/dolomite). The silicification has been observed to a depth of 75 m below surface, the date of which is uncertain but is considered to be Tertiary (66 – 2.58 Ma) in age. The regional strike is generally between 10 and 20 degrees west of north and dips are westwards at about 20 degrees (Simcoa Operations Pty Ltd, 1992).

The Noondine Chert is intruded by dolerite dykes and is broken up by strike and transverse faults. Dolerite dykes are generally steeply dipping, up to 10 m wide and strike in a NNW direction, parallel to major faults. (Parker, 2010). Approximately 750 m east of the East Earthworks Pad is a major normal fault (downthrown west) which marks the contact with Archaean basement rocks. Over 6 km west of the study area is the Darling Fault (downthrown west), which marks a contact with younger Cretaceous (145 – 66 Ma) sedimentary rocks. At the southwest boundary of the study area, a normal fault (downthrown east) trends NNE/SSW along the general alignment of Midlands road.

The area between exposed bedrock outcrops is covered by Cainozoic sediments (<66 Ma), the genesis of which was complex and protracted such that distinguishing more recent Quaternary deposits (<2.58 Ma) is subjective. Additionally, continual reworking of sediments by historical rivers and more recent agricultural practices has resulted in the merging of one unit with another. The principally mapped sediment being Alluvium (Geological Survey of Western Australia, 1982).

3.2 Regional Groundwater

The surface hydrology comprises a system of west flowing intermittent shallow streams such as Kyaka Brook (between the Existing Mine and the Proposed Mine), and Prye Brook (2.3 km north of the Proposed Mine) which discharge into the clay pans and samphire flats of the Coonderoo River (2 km west of the Existing Mine) (Saprolite, 2012). The Coonderoo River flows from north to south to join the Moore River, and only flows after heavy rainfall (Simcoa Operations Pty Ltd, 2018).

The principal groundwater aquifer in the region is hosted by the Noondine Chert which is extensively fractured and cavernous. High bore yields are common and local groundwater is used to supply the townships of Moora and Watheroo (Simcoa Operations Pty Ltd, 2018). Groundwater recharge generally occurs via limited infiltration of rainwater to a semi-confined aquifer at 20 m depth (Saprolite Pty Ltd, 2012).

4. Local Information

4.1 Current Land Use

The current land use at the Proposed Mine study area is predominately agricultural. 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. The site is crossed by many light vehicle tracks, although no structures are visible in aerial imagery.

To the west of the study area is the north-south aligned Midlands Road, a sealed single carriageway state highway. A single track railway (Midlands 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 trending, sealed access road. The haul road starts near the intersection between Kiaka Road and Midlands Road. In the southwest, both Midlands Road and Kiaka Road pass over Kyaka Brook. The brook is a shallow northwest-southeast aligned stream and is lined with trees.

4.2 Topography

The study area contains a series of more or less parallel NNW-SSE trending ridges of bedrock, with small infilled valleys between them. The ridges are formed from the higher and more resistant to erosion parts of the Noondine Chert Formation, and reach topographic heights up to 65 m (spot height RL+ 281 m Australian Height Datum (mAHD)) above the adjacent valleys (Government of Western Australia, 2019). There is a larger valley just east of the study area and further chert ridges to the south (at the Existing Mine). The ridges vary in cross section, some having gentle slopes on both sides, and others (often narrower) having steeper slopes on one side. There are some steep rocky areas, but the slopes are mainly gentle to moderate, with a few being quite steep. (M.E. Trudgen & Associates, 2018). The infilling valleys have gentle slopes coalescing on a central point between ridge peaks.

Starting at Kiaka Road (RL+ 216 mAHD), the haul road follows the alignment in Figure 1 for approx. 316 m before encountering Kyaka Brook. The brook flows under the haul road route, Midlands Railway Line and Midlands Road. It is approximately 2 m deep. Approximately 684 m further along the alignment the footslope of the first ridge (RL+ 217 mAHD) is encountered. The ridge rises to 23 m height (RL+ 239 mAHD) over 364 m width before re-entering a valley at RL+ 228 mAHD; which is the proposed start location of the West Earthworks Pad. The width of the valley is approx. 640 m, with a central high point at RL+ 225 mAHD; with open ends gently sloping NNW-SSE to approx. RL+ 220 mAHD. The haul road connecting the West Earthworks Pad to the East Earthworks Pad is approx. 700 m long. It progresses gently upslope along an approx. 50 m wide, west-east aligned valley. The East Earthworks Pad is sited on a small valley between parallel ridges. The area is gently sloping west-east uphill from approx. RL+ 255 mAHD to RL+ 265 mAHD.

4.3 Site History

Historical aerial imagery is available in colour for the study area between 2000 and 2018 (Government of Western Australia, 2019), (Google Inc., 2019). The 2000 imagery shows the area in its current land use with agricultural crops in the valleys between ridges. In 2001 a palaeo-channel appears within the soil surface, which intersects the haul road alignment between Kiaka Road and the westernmost ridge. The stream course is next visible in 2006 and is variably obscured by crop thereafter. Over the span of available imagery, no structures were observed to have been placed within the haul road alignment or earthworks pads.

4.4 Geology

An extract of the 1:250,000 geological map of the site is presented in Figure 2. The site is underlain by Noondine Chert, which outcrops in NNW-SSE trending parallel ridges. Between the ridges are gentle sloping valleys infilled with Alluvium, where valleys are narrow, they may represent preferentially weathered Dolerite Dykes. The map does not differentiate between Colluvium derived from the ridges and Alluvium. However, sufficient site-specific information exists to confirm the presence of Colluvium. A conceptual geological model is presented in Figure 4.

Each geological unit is discussed in the following sub-sections.

4.4.1 Fill

Fill has not been mapped on the 1:250,000 geological map and no placement has been observed in historical aerial imagery. Fill may have been placed locally as part of access works for the 2007 exploratory drilling campaign and is likely to be limited in its lateral and vertical extent. Any Fill is likely to be variable in composition and derived from local sources such as Colluvium or waste rock from the Existing Mine.

4.4.2 Alluvium

The Alluvium is Quaternary (<2.58 Ma) in age and was deposited as a series of floodplain deposits by a large historical river, of which only Kyaka Brook and remnant palaeo-channels remain (Actis Environmental Services, 2011). The 1:250,000 geological map describes the Alluvium generically as “clay, silt, sand” (Geological Survey of Western Australia, 1982).

Site specific sources characterise the Alluvium as “loamy-earths, clays and minor sandy-earths” (Simcoa Operations Pty Ltd, 2018). Sources further suggest the Alluvium to comprise “clay and broken rock” (M.E. Trudgen & Associates, 2018). Agricultural practices, visible in aerial imagery, are likely to have disturbed the upper 300 mm of soil and increased the organic matter content.

No historical boreholes have been undertaken within the Alluvium therefore, the depth is not definitively known. Given that historical boreholes have encountered 2 to 4 m of Colluvium at the margin of ridges, it is possible that the soil – bedrock contact is in excess of 4 m depth. The depth is anticipated to increase towards the centre of the valley.

4.4.3 Colluvium

The Colluvium is Cainozoic (<66 Ma) in age and is currently being deposited by an ongoing combined process of chemical and physical erosion of the bedrock. The deposition is highly incremental and the unit is therefore, likely to vary in composition. Furthermore, the Colluvium’s lateral and vertical extents will vary significantly and may inter-finger with the Alluvium.

Site observations by others note that the soils on the chert ridges vary in depth from skeletal on the blocky outcropping chert, to gravelly, loamy sands lower down the slopes. The surface soil was often “pale grey, silty, fine sand” (M.E. Trudgen & Associates, 2018).

Within the Proposed Mine area, soil depths at the margin of ridges are noted in historical boreholes (MK 023, MK042, MK044 and MK046) to be up to 2 m thick. Elsewhere at the ridge margins, arisings from depths of typically 2 m to 4 m, up to 6 m (MK065, MK075, MK132 and MK153) show chert “chips” with ferruginous content (Simcoa Operations Pty Ltd). This suggests an intermittent presence of ferricrete. At the Existing Mine, boreholes MB02 and MB03 (located at a ridge margin), respectively encountered a 2 m and 4 m thick laterite overlying Noondine Chert. The laterite at MB02 was described as “Laterite/Quartz: Red-brown hard siliceous ferricrete, iron rich and iron stained; 30% light dark brown amorphous quartz, dark impurities, 20% light brown talc rich clay”, and in MB03 as “Laterite/Quartz: Red-brown hard siliceous

ferricrete, iron-rich and iron stained; 20% grey and brown amorphous quartz; 10% light brown talc rich clay" (Saprolite Pty Ltd, 2012).

4.4.4 Noondine Chert

The Noondine Chert (previously Coomberdale Chert) is Middle Proterozoic (1600 – 1000 Ma) in age and is a member of the Coomberdale Sub-group of the Moora Group. The group lays unconformably over Archaean basement rocks at depth and is typically over 700 m thick (Geological Survey of Western Australia, 1982).

The chert was formed by the surface silicification of carbonate rocks (siliceous limestone/dolomite) which has been observed to a depth of 75 m below surface. The date of silicification is uncertain but is considered to be Tertiary (66 – 2.58 Ma) in age. The regional strike is generally between 10° and 20° west of north and dips are westwards at about 20° to 30° (Simcoa Operations Pty Ltd, 1992). The beds exhibit distinct sedimentary banding which has been strongly faulted (Simcoa Operations Pty Ltd, 2018).

The 1:250,000 geological map explanatory note describes the Noondine Chert as consisting of "bedded chert, chert breccia, orthoquartzite, silicified limestone and dolomite and contains significant siliceous siltstone and sandstone beds, and minor claystone" (Geological Survey of Western Australia, 1982). Lithological descriptions from boreholes (MB01, MB02 and MB03) within the Existing Mine typically describe it as light grey to grey amorphous quartz, variably translucent, massive, with occasional iron staining and minor dark impurities. The rock strength is given as moderately hard (Saprolite Pty Ltd, 2012).

Iron oxides, titanium oxides and clays occur in the chert in the near-surface zone, with significant quantities of kaolin at depths of 10 m, up to 40 m thick (MK010, MK018, MK021 and MK048) (Simcoa Operations Pty Ltd). These are thought to have been formed by strong weathering of other rock types. The zone includes clays and ferruginous material, which are concentrated along joints and cavities and contain iron, aluminium and titanium oxides (Parker, 2010).

Cavities occur throughout the deposit, which are sometimes empty and sometimes filled with quartz gravel. The gravel deposits are considered to be collapse breccias, which appear to have been washed and sorted by underground streams. The cavities, which appear to have been formed by faulting and possibly by leaching of carbonate rich chert have presented significant problems for open-hole exploratory drilling at the Proposed Mine (MK051, MK053, MK062 and MK064). The area is referred to as containing physiographic amphitheatres which are probably related to the collapse of limestone/chert into large underground caverns (Simcoa Operations Pty Ltd, 2019).

4.4.5 Dolerite Dykes

Dolerite Dykes of undetermined Precambrian (>541 Ma) age are shown within the bedrock on the 1:250,000 geological map. The dykes are steeply dipping, and generally between 1 m and 10 m thick with the largest up to 50 m thick or more. Some dykes approach 5 km in length, but the majority do not exceed 1 or 2 km (Geological Survey of Western Australia, 1982). The dykes have north and northwest trends, occasionally becoming east-west trending.

Boreholes MK142 to MK146 are arrayed within a narrow valley approximately 170 m to the north of the West Earthwork Pad. The recovered material was classified as "weathered dolerite" with comments that the boreholes recovered "red clay, no quartz" to depths of at least 18 m (Simcoa Operations Pty Ltd). This dyke may further extend south into the West Earthwork Pad.

Between the West and East Earthwork Pads, the haul road follows an alignment along a west-east trending valley. The trend is uncharacteristic for the NNW-SSE trending valleys, and may be the surface expression of a weathered dyke.

4.5 Groundwater

Extensive groundwater abstraction pumping trials have been undertaken at the Existing Mine therefore, a correspondingly large amount of monitoring data exists. No data is available for the Proposed Mine although due to the proximity and geological continuity of the two sites, only minimal changes in level are anticipated. Groundwater level is at approximately 20 m depth (Industrial Mineral Services Pty Ltd, 2001).

Monthly monitoring data for 2018 at the Existing Mine reveals that the groundwater levels vary annually between RL+ 210.94 mAHD to RL+ 214.24 mAHD (approx. 11 to 14 m depth at the West Earthworks Pad and 42 to 45 m depth at the East Earthworks Pad). The trend being for the level to fall between September to April, rising in May to August. This follows a pattern expected for aquifers directly affected by rainfall, with rising water levels over winter and falling water levels in summer (Saprolite Pty Ltd, 2019).

The salinity of groundwater ranges from fresh to brackish and groundwater pH is slightly alkaline (Saprolite Pty Ltd, 2012).

4.6 Acid Sulphate Soils

The Acid Sulfate Soil Risk Map indicates that where the site is located on the Coomberdale Sub-group, it is an area considered to be of “no known occurrence” of encountering Acid Sulphate Soils (ASS) (Australian Soil Resource Information System, 2019).

Areas mapped as Alluvium, are indicated to have a “low probability” of encountering ASS.

4.7 Geotechnical Parameters

No geotechnical parameters are available for any geological units.

4.8 Geotechnical Risks

4.8.1 Karst

The Noondine Chert is prone to karst cavities of varying scale. Many past boreholes at the Existing and Proposed Mines have been terminated at depths of between 10 m and 38 m due to cavities stopping drilling (Simcoa Operations Pty Ltd). Furthermore, these voids have been proven at the site to extend to 4 m in height (BH02, void encountered at 28 m depth, RL+ 188 mAHD) (Saprolite Pty Ltd, 2012). The voids are sometimes filled with quartz gravel which appear to have been washed and sorted by underground streams (Simcoa Operations Pty Ltd, 2019). Larger voids extending to the surface have been recorded in the Noondine Chert, such as at the Jingemia cave system and Devil’s Hole, located 27 km NNW of the site (Department of Parks and Wildlife, 2019). Of note, are references to the general site area being associated with surface depressions or ‘amphitheatres’ linked to the collapse of underground caverns (Simcoa Operations Pty Ltd, 2019).

Karst is most likely to pose a hazard to the bridge over Kiaka Brook, whereby relatively high loads are focussed at the bridge abutments. This may contribute to the collapse of any voids/caverns below the bridge and render the bridge inoperable.

At the East Earthworks Pad, several boreholes (MK050, MK051, MK053, MK062, MK063, MK064 and MK076) located on the ridges bordering the pad were terminated at depths of between 16 to 30 m due to cavities. The risk of karst collapse may be locally higher in this area.

4.8.2 Settlement

The Alluvium and to a lesser extent Colluvium, extend to an unknown depth with a poorly defined contact between soil and bedrock. Structures with foundations spread over areas of deep and shallow soil may experience differential settlement.

The soils may have undergone limited consolidation. The Alluvium is described as consisting predominantly of unsaturated sandy clay and may therefore, undergo a limited amount of settlement during the construction period, with potential for ongoing long-term settlement.

The Colluvium is described as being “gravelly loamy sand” and is therefore, likely to undergo limited amounts of settlement during the construction period, with minimal long-term settlement.

The presence of lateral concretions in the soil may contribute to a reduction in total settlement. Depending on the lateral extent of concretions relative to a structures foundations, differential settlement may occur.

4.8.3 Concrete and Steel Durability

Limited chemical laboratory test results (of unknown site location and strata origin) are available which may aid in assessing the exposure classification for buried concrete and steel components. In accordance with AS 2159-2009, the tests give a preliminary indication that the soil and water are likely to be classed as non-aggressive. No information is available for the Noondine Chert, although it is anticipated to also prove non-aggressive.

4.8.4 Near-surface Concretions

Laterites, as referred to in this report, consist of lateritic duricrusts or zones of iron oxide enrichment and cementation within the soil profile (Anand & Butt, 2003). The term laterite correctly refers to the complete weathering profile (including the weathered rock and in situ residual soils), but for the purpose of this report, laterite refers to ferricrete or the zone of iron oxide enrichment and cementation (Brink, 1985).

There are two recorded occurrences of laterite, both located at the boundary between ridge and valley in the Existing Mine. It is assumed that the lateritic soil identified is within the Colluvium. Boreholes MB02 and MB03, respectively encountered a 2 m and 4 m thick laterite overlying Noondine Chert. The laterite is typically described as a hard siliceous ferricrete with lesser amounts of quartz and clay (Saprolite Pty Ltd, 2012). Exploration boreholes at the margin of ridges in the Proposed Mine recovered chert “chips” with ferruginous content to depths of 6 m (Simcoa Operations Pty Ltd). This indicates that ferricretes may also be present at the Proposed Mine area.

Silcretes and ferricretes are noted on the 1:250,000 geological map to be present within the Phanerozoic soils approximately 4 km northeast of the site. Given the historical alluvial transportation and deposition across the site from east to west, there is potential for silcrete and ferricrete to be present not only in the Colluvium, but also within the Alluvium.

Calcretes are less likely to form as the original sedimentary rocks forming the Noondine Chert have been depleted in Calcium and Magnesium as part of the silicification process (Simcoa Operations Pty Ltd).

Dependant on the lateral extent of the concretions, standard techniques and methodologies (e.g. nominal 20 to 30 tonne capacity excavator) may prove sufficient for excavation. Where laterally extensive, the use of an excavator bucket with tiger teeth or a hydraulic breaker attachment may be necessary.

4.8.5 Pavement Sub-grade

Aerial imagery shows multiple unsealed vehicle tracks crossing the valleys and ridges at the Proposed Mine. It is not known if the tracks have been lined with gravel. The tracks infer that the sub-grade has good light vehicle trafficability and that therefore, subject to confirmatory insitu-density tests, limited treatment may be required for sustained heavy vehicle trafficking.

4.8.6 Rock Excavation & Cutting Stability

If the haul road is to maintain a shallow grade between the Bridge and the West Earthworks Pad, a cut within the Noondine Chert may be required. There is insufficient information available to assess whether blasting, ripping or to a lesser extent, excavation will be appropriate.

Once formed, the stability of the cutting will be highly dependent on a variety of factors, including how much soil cover is present and the presence of any faults, but principally the rock's strength, weathering, joint set orientation and condition (aperture, infilling, saturation, Rock Quality Designation (RQD) etc.). The overall cutting design and support measures (if necessary) will require this data.

5. Recommended Site Investigation

5.1 Scope of Works

A geotechnical ground investigation is recommended to further characterise the site conditions by filling gaps within the existing data. The purpose of the investigation is to enable the refinement of:

- Geological Model, particularly in respect to the Alluvium under the Earthworks Pads;
- Geotechnical design parameters;
- Suitable siting locations for the development structures;
- Suitable foundation types and associated concrete/steel durability;
- Building settlement estimates; and
- Geotechnical risk levels:
    - Haul road sub-grade suitability;
    - Soil excavatability;
    - Rock excavatability and Support measures;
    - Karst collapse risk; and
    - Acid Sulphate Soils.

The recommended scope of the investigation is as follows:

- Four geotechnical boreholes to 30 m depth, minimum HQ size or larger (e.g. PQ size), with:
    - Standard Penetration Tests (SPTs) at 1.5 m centres and where cohesive, alternating with thin wall samplers of minimum diameter 63 mm (U63); and
    - Groundwater monitoring wells installed over the full depth of all boreholes.
- 20 No test pits to 3 m depth, including sub-sampling;
- Geotechnical logging of borehole core and test pit samples;
- 20 No Dynamic Cone Penetrometer (DCP) tests at the location of test pits, to 1.8 m depth;
- Four geophysical transects, including a combination of Multi-Channel Analysis of Surface Waves (MASW) and Seismic Refraction; and

A summary of each investigation location and the targeted development area is provided in

Table 2, overleaf. The locations are shown on Figure 5.

Table 2: Recommended Site Investigation

ID	Methodology	MGA50 Co-ordinates				Depth / Transect Length (m)	Secondary Feature	Investigation Target			
		Easting (m)	Northing (m)	Easting (m)	Northing (m)			Bridge	Haul Road	West Earthworks Pad	East Earthworks Pad
BH01	Borehole	407078	6625051	-	-	30.00	Monitoring Well	X	X		
BH02	Borehole	407094	6625149	-	-	30.00	Monitoring Well	X	X		
BH03	Borehole	408233	6625620	-	-	30.00	Monitoring Well		X	X	
BH04	Borehole	409002	6625950	-	-	30.00	Monitoring Well		X		X
TP01	Test Pit	407052	6624823	-	-	3.00	DCP		X		
TP02	Test Pit	407126	6625291	-	-	3.00	DCP		X		
TP03	Test Pit	407517	6625301	-	-	3.00	DCP		X		
TP04	Test Pit	407687	6625308	-	-	3.00	DCP		X		
TP05	Test Pit	407816	6625307	-	-	3.00	DCP		X		
TP06	Test Pit	407987	6625333	-	-	3.00	DCP		X	X	
TP07	Test Pit	407971	6625602	-	-	3.00	DCP		X	X*	
TP08	Test Pit	408149	6625615	-	-	3.00	DCP		X	X**	
TP09	Test Pit	408162	6625527	-	-	3.00	DCP		X	X	
TP10	Test Pit	408267	6625341	-	-	3.00	DCP		X	X	
TP11	Test Pit	408373	6625449	-	-	3.00	DCP		X	X	

ID	Methodology	MGA50 Co-ordinates				Depth / Transect Length (m)	Secondary Feature	Investigation Target			
		Easting (m)	Northing (m)	Easting (m)	Northing (m)			Bridge	Haul Road	West Earthworks Pad	East Earthworks Pad
TP12	Test Pit	408559	6625345	-	-	3.00	DCP		X	X	
TP13	Test Pit	408476	6625629	-	-	3.00	DCP		X	X	
TP14	Test Pit	408319	6625713	-	-	3.00	DCP		X	X	
TP15	Test Pit	408453	6625873	-	-	3.00	DCP		X		
TP16	Test Pit	408687	6625916	-	-	3.00	DCP		X		
TP17	Test Pit	408929	6625942	-	-	3.00	DCP		X		X
TP18	Test Pit	409013	6626056	-	-	3.00	DCP		X		X
TP19	Test Pit	408987	6625851	-	-	3.00	DCP		X		X
TP20	Test Pit	409057	6625946	-	-	3.00	DCP		X		X
GT01	Geophysical Transect	407072	6625024	407097	6625171	150.00	-	X	X		
GT02	Geophysical Transect	407958	6625305	408335	6625736	575.00	-		X	X	
GT03	Geophysical Transect	407945	6625606	408296	6625623	350.00	-		X	X***	
GT04	Geophysical Transect	408986	6625832	409016	6626081	250.00	-		X		X

Note: DCP = Dynamic Cone Penetrometer. (*) TP07 targeting administration buildings. (**) TP08 targeting weighbridge. (***) GT03 targeting administration buildings and weighbridge. All boreholes are to be placed on geophysical transect alignments to enable refinement of geophysical data. All drilling core will be retained for laboratory sub-sampling. Sub-samples will be taken by a Geotechnical Engineer/Engineering Geologist during the excavation of test pits.

5.2 Laboratory Testing

5.2.1 Geotechnical Laboratory Testing

Laboratory testing is to be undertaken at a NATA endorsed laboratory in accordance with current Australian Standards, or, where no Australian Standard test method exists, MRWA Materials Testing Manual standards may be used.

The following testing must be included as part of the laboratory testing implemented on samples recovered from boreholes and test pits:

- Liquid Limit, Plastic Limit, Plasticity Index – 9 tests;
- Linear Shrinkage – 9 tests;
- Moisture Content Test – 18 tests;
- Organic Matter Content – 6 tests;
- Particle Size Distribution (PSD) – 12 tests;
- Unconsolidated Undrained triaxial compression without measurement of porewater pressure, Set of 3 (AS 1289.6.4.1-2016) – 3 tests;
- One-dimensional consolidation tests (AS 1289.6.6.1-2016) – 3 tests;
- California Bearing Ratio (CBR), 95% Compaction, 4 Ring, 9 kg Surcharge, Soaked – 6 tests;
- Modified Maximum Dry Density (MMDD) – 6 tests;
- Point Load Strength Index tests on rock samples (uniaxial & diametric) – 12 tests;
- Uniaxial Compressive Strength (UCS) on rock samples – 8 tests;
- Durability Suite – Soil (pH, Sulphate (SO_4), Chloride, Electrical Resistivity) – 5 tests; and
- Durability Suite – Water (pH, Sulphate (SO_4), Chloride, Electrical Resistivity) – 4 tests.

5.2.2 Acid Sulphate Soil Laboratory Testing

Laboratory testing is to be undertaken at a NATA endorsed laboratory. Testing may include but not be limited to the following tests:

- pH_F – 20 tests; and
- pH_{FOX} – 20 tests.

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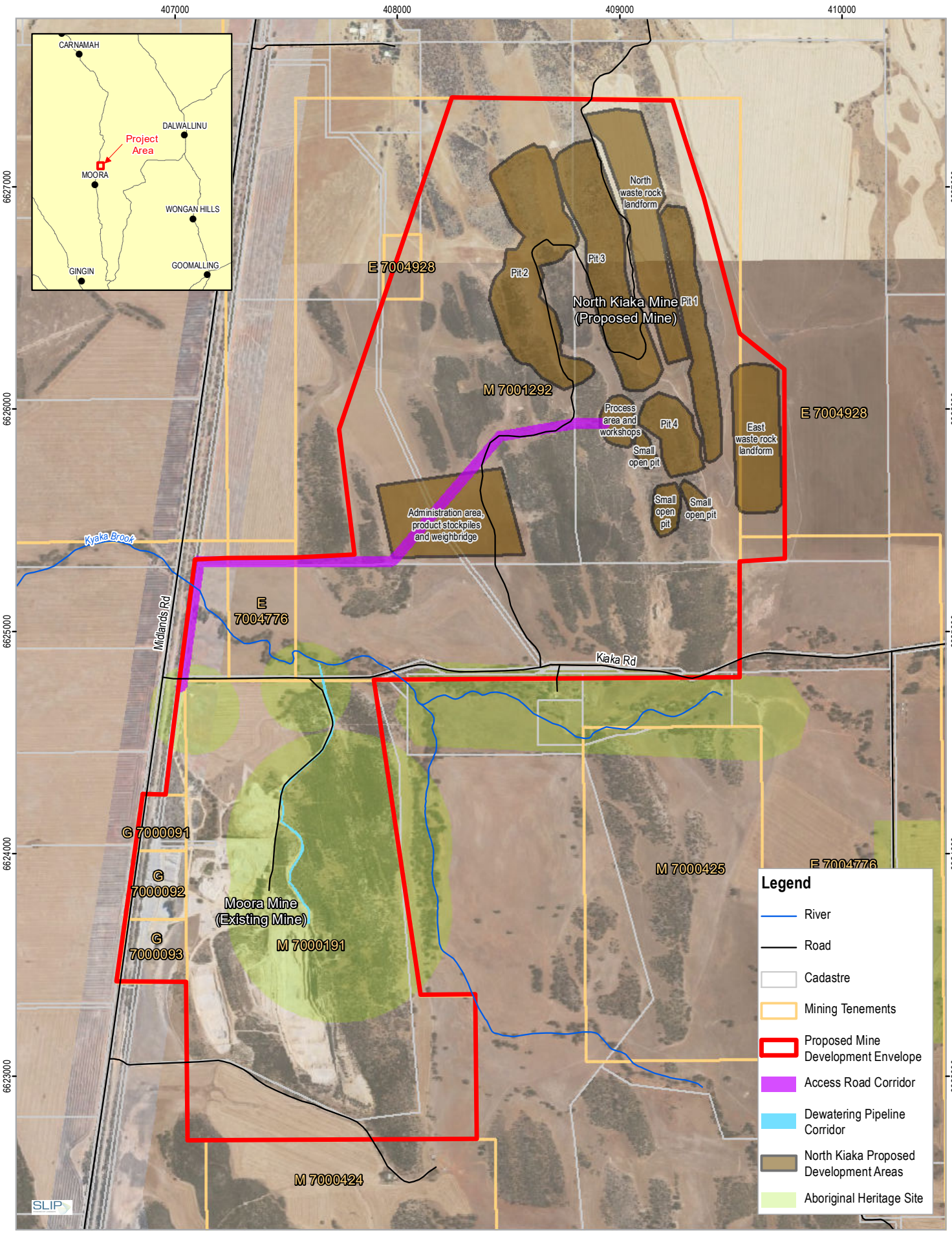
Figures



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Grid: GDA 1994 MGA Zone 50

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Simcoa Operations Pty Ltd
North Kiaka Approvals and Supporting Studies
Geotechnical Desktop Study

Project No. **61-37455**
Revision No. **0**
Date **30 Apr 2019**

Site Locality Plan

FIGURE 1

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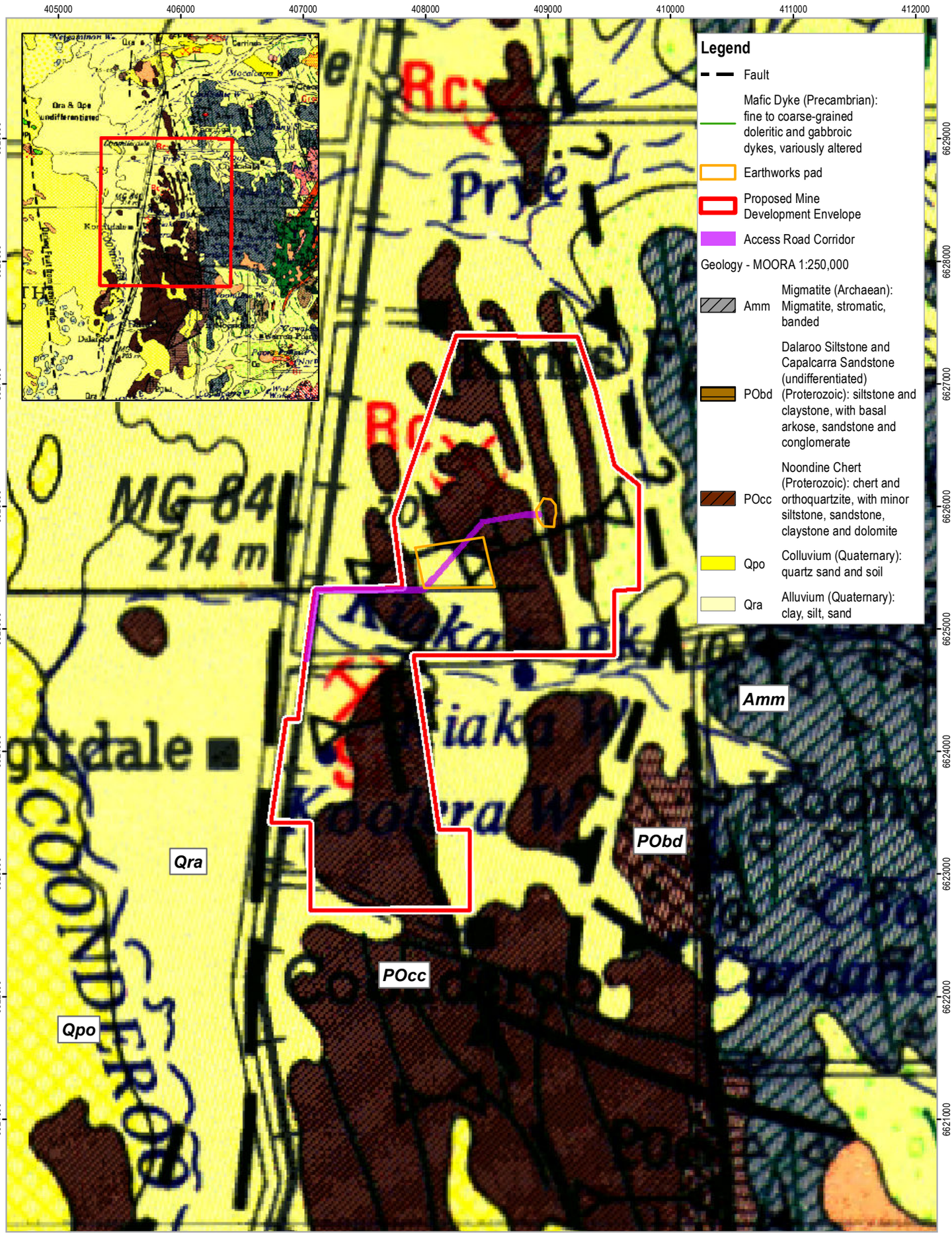
Data source: Simcoa: Mining Development Area - 2018; Landgate: Imagery, Cadastre, Road - 20180601; DMIRS: Mining Tenements - 20180601; Access Road Corridor - 20180601, Dewatering Pipeline Corridor - 20180627; Mine Development Envelope - 20180627; DoW: River - 201108; DIA: Aboriginal Heritage Site - 201806. Created by: afeeney



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Map Projection: Transverse Mercator
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Simcoa Operations Pty Ltd
North Kiaka Approvals and Supporting Studies
Geotechnical Desktop Study

Project No. **61-37455**
Revision No. **0**
Date **30 Apr 2019**

Site Geological Plan

FIGURE 2

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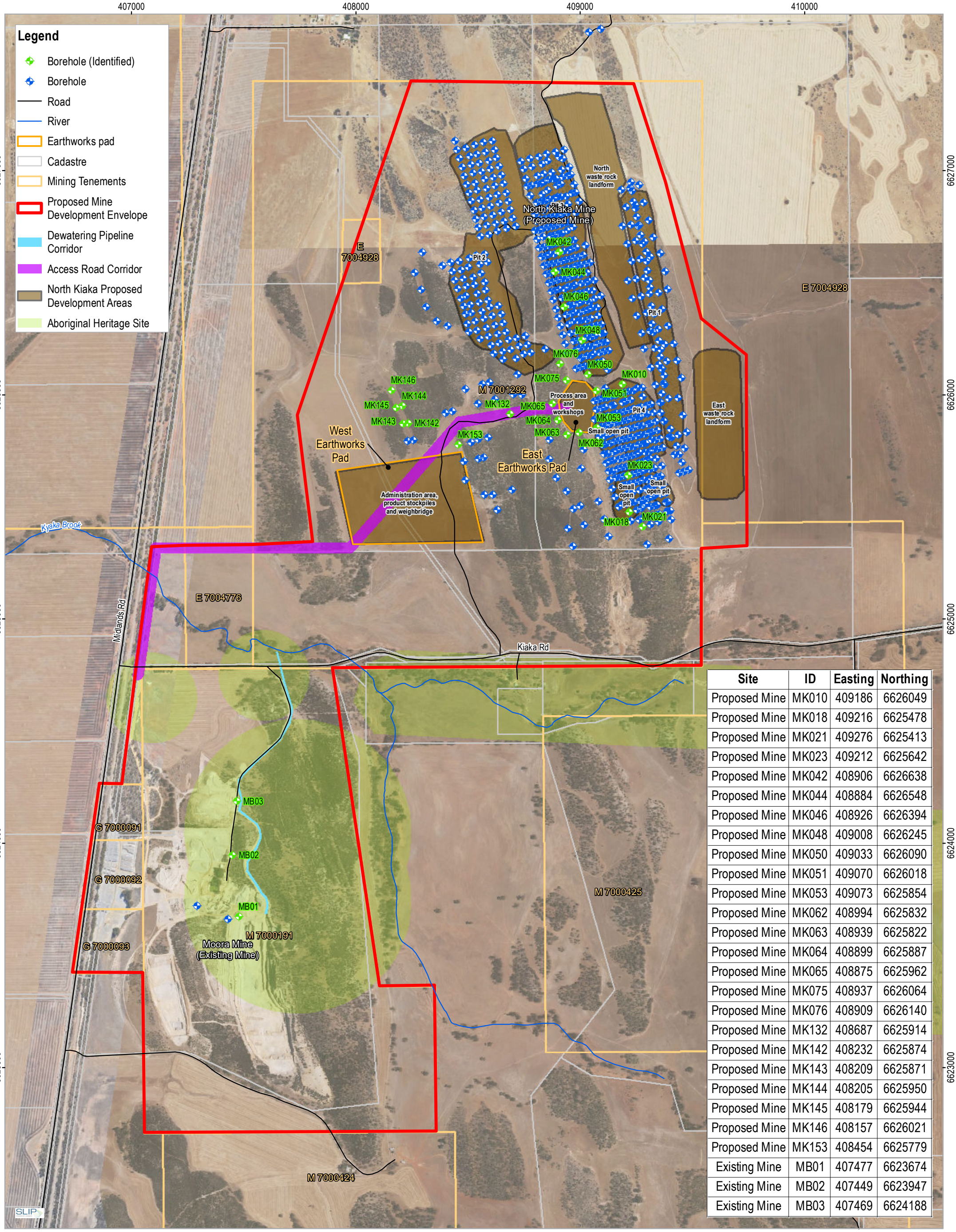
Data source: Simcoa: Mining Development Area - 2018; Geology: 1:250,000 Geological Series - MOORA, SHEET SH50-10, 1st Edition, Geological Survey of Western Australia, 1982. Created by: afeeney



Site	ID	Easting	Northing
Proposed Mine	MK010	409186	6626049
Proposed Mine	MK018	409216	6625478
Proposed Mine	MK021	409276	6625413
Proposed Mine	MK023	409212	6625642
Proposed Mine	MK042	408906	6626638
Proposed Mine	MK044	408884	6626548
Proposed Mine	MK046	408926	6626394
Proposed Mine	MK048	409008	6626245
Proposed Mine	MK050	409033	6626090
Proposed Mine	MK051	409070	6626018
Proposed Mine	MK053	409073	6625854
Proposed Mine	MK062	408994	6625832
Proposed Mine	MK063	408939	6625822
Proposed Mine	MK064	408899	6625887
Proposed Mine	MK065	408875	6625962
Proposed Mine	MK075	408937	6626064
Proposed Mine	MK076	408909	6626140
Proposed Mine	MK132	408687	6625914
Proposed Mine	MK142	408232	6625874
Proposed Mine	MK143	408209	6625871
Proposed Mine	MK144	408205	6625950
Proposed Mine	MK145	408179	6625944
Proposed Mine	MK146	408157	6626021
Proposed Mine	MK153	408454	6625779
Existing Mine	MB01	407477	6623674
Existing Mine	MB02	407449	6623947
Existing Mine	MB03	407469	6624188

Paper Size ISO A3

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Metres

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

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Project No. **61-37455**
Revision No. **0**
Date **01 May 2019**

Existing Information Plan

FIGURE 3

G:\61\37455\GIS\Maps\Working\Geotech\6137455_003_ExistingInformationPlan_RevA.mxd
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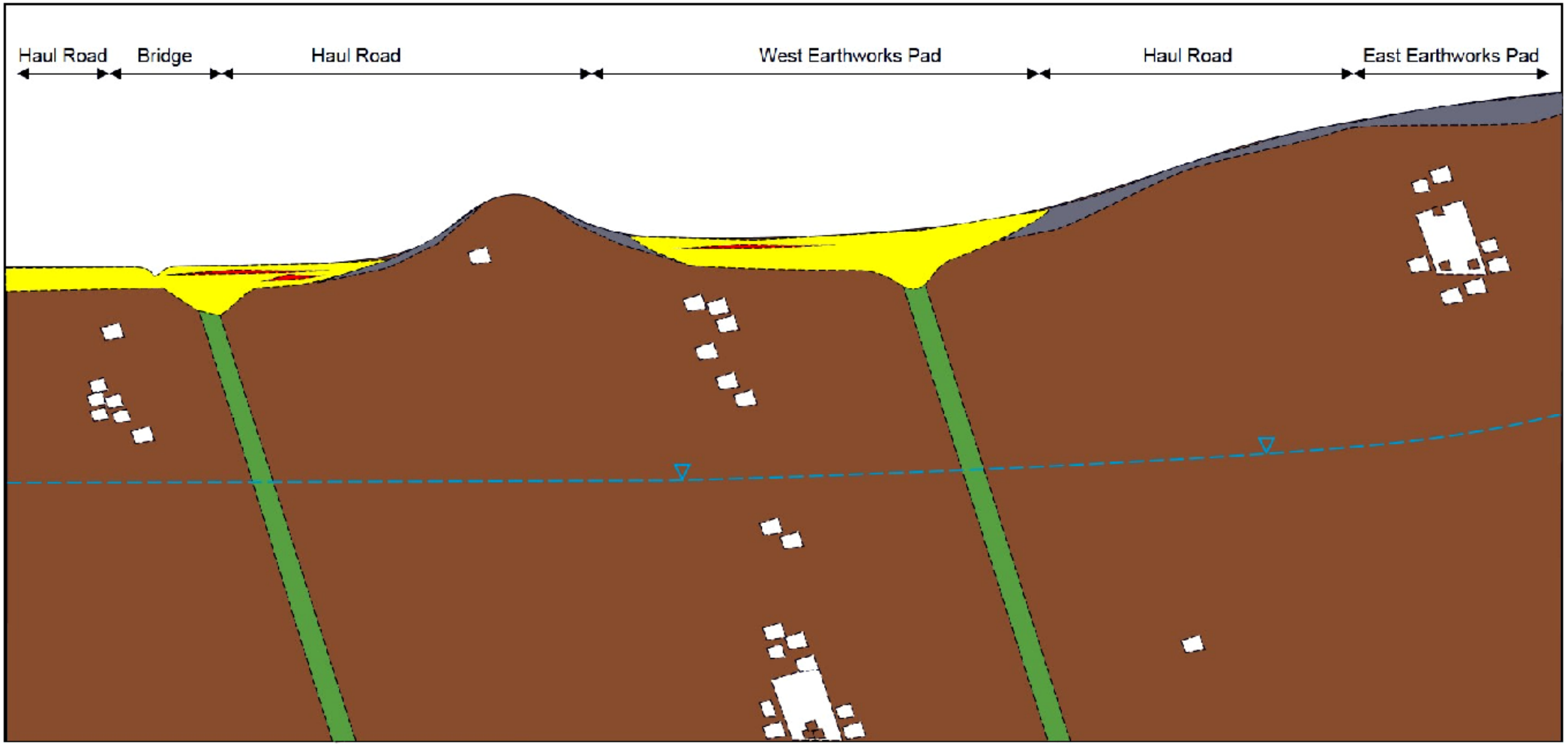
Data source: Simcoa: Mining Development Area - 2018; GHD: Boreholes - 20190430; Landgate: Imagery, Cadastre, Road - 20180601; DMIRS: Mining Tenements - 20180601; Access Road Corridor - 20180601, Dewatering Pipeline Corridor - 20180627; Mine Development Envelope - 20180627; DoW: River - 201108; DIA: Aboriginal Heritage Site - 201806. Created by: afeeney



Legend

- Groundwater table
- Alluvium
- Cementation
- Colluvium
- Dolerite Dyke
- Noondine Chert
- Karst

Geohazards:

1) Karst - Collapse under structure
2) Thick Unconsolidated Soil - Excessive structure settlement with long term creep
3) Cementation - Difficult Excavation / Variable pavement sub-grade suitability
4) Geo-environmental - Ground chemical aggressivity to buried concrete / steel
5) Rock Excavation - Strength and cutting stability

Paper Size ISO A4

Note: Not to scale

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Simcoa Operations Pty Ltd
North Kiaka Approvals and Supporting Studies
Geotechnical Desktop Study

Project No. **61-37455**
Revision No. **0**
Date **30 Apr 2019**

Conceptual Geological Model

FIGURE 4

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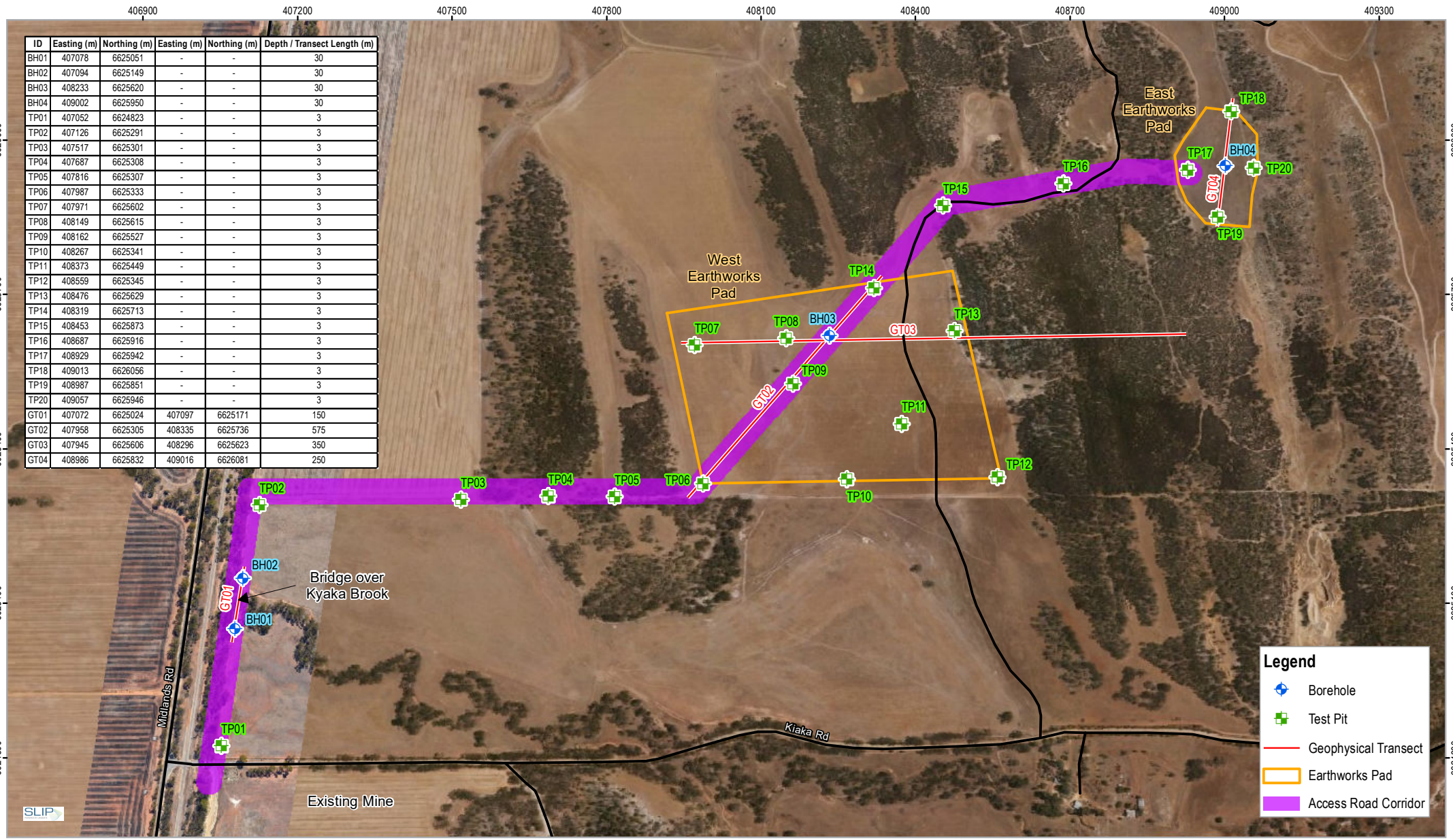
Print date: 30 Apr 2019 - 15:55

Data source: GHD: Conceptual geological model - 20190430. Created by: afeeney

ID	Easting (m)	Northing (m)	Easting (m)	Northing (m)	Depth / Transect Length (m)
BH01	407078	6625051	-	-	30
BH02	407094	6625149	-	-	30
BH03	408233	6625620	-	-	30
BH04	409002	6625950	-	-	30
TP01	407052	6624823	-	-	3
TP02	407126	6625291	-	-	3
TP03	407517	6625301	-	-	3
TP04	407687	6625308	-	-	3
TP05	407816	6625307	-	-	3
TP06	407987	6625333	-	-	3
TP07	407971	6625602	-	-	3
TP08	408149	6625615	-	-	3
TP09	408162	6625527	-	-	3
TP10	408267	6625341	-	-	3
TP11	408373	6625449	-	-	3
TP12	408559	6625345	-	-	3
TP13	408476	6625629	-	-	3
TP14	408319	6625713	-	-	3
TP15	408453	6625873	-	-	3
TP16	408687	6625916	-	-	3
TP17	408929	6625942	-	-	3
TP18	409013	6626056	-	-	3
TP19	408987	6625851	-	-	3
TP20	409057	6625946	-	-	3
GT01	407072	6625024	407097	6625171	150
GT02	407958	6625305	408335	6625736	575
GT03	407945	6625606	408296	6625623	350
GT04	408986	6625832	409016	6626081	250



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

GHD

Simcoa Operations Pty Ltd
North Kiaka Approvals and Supporting Studies
Geotechnical Desktop Study

Project No. **61-37455**
Revision No. **0**
Date **01 May 2019**

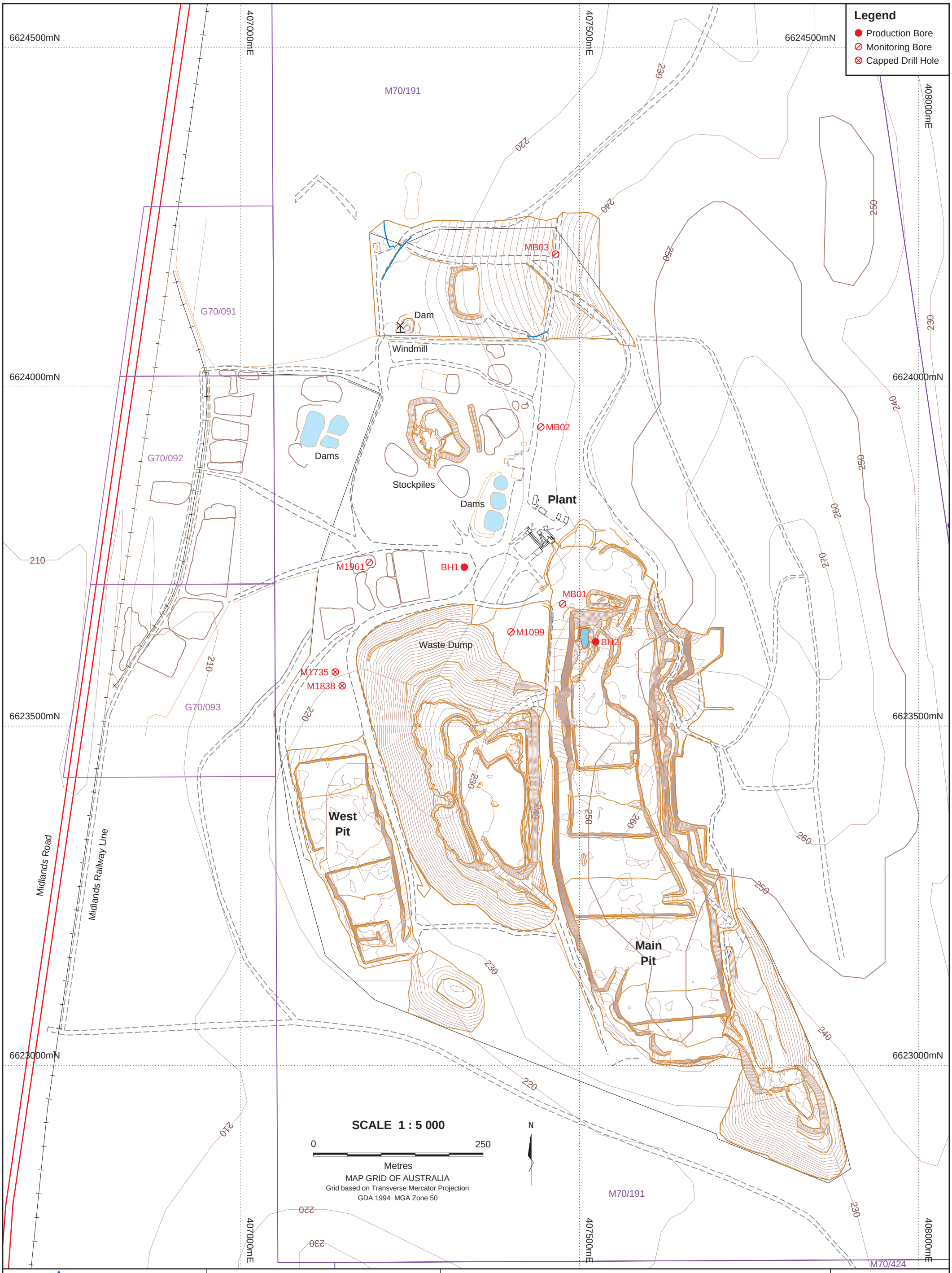
Recommended Investigation Plan

FIGURE 5

Data source: GHD: Boreholes, test pits, geophysical transects, earthworks pads - 20190430; Landgate: Roads - 20190128, Imagery. Created by: afeeney

Appendices

Appendix A – Existing Geotechnical Information



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Author: Z.Scott	Checked: G.Richards	Project: MOORA QUARTZ MINE		Figure No. 4
Drawn: S.Coleman	Approved: G.Richards		A3	Plan No. E0200-006

SAPROLITE ENVIRONMENTAL

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COMPOSITE WELL LOG

Bore No: BH2

Client: Simcoa Operations Pty Ltd

Operation: Phase 2 Hydrogeological Investigations

Commenced: 19/10/11	**Method:** Rotary Air Percussion	**Site:** Moora Quartz Mine
Completed: 21/10/11	**Fluid:** N/A	**East (MGA):** 407526mE
Drilled: Austral Drilling	**Bit Record:** 12" Hammer	**North (MGA):** 66236162mN
Logged By: Z.Scott	**Hole Purpose:** Production Bore	**SRP RL:** 216mAHD

Static Water Level: 3.72mbtoc **Date:** 21/10/11

Elevation (mAHD)	Depth (mbgl)	Geology	Graphic Log	Strati-graphy	Lithological Description	EC Post-Purge (uS/cm)	Well Completion Diagram	Well Completion Notes
215	0	Proterozoic		Quartz	Quartz: Grey amorphous quartz (60%), light grey and light brown amorphous quartz, slight-moderately fractured, minor to slight iron staining; trace impurities on some fragments; minor to trace vuggy light grey quartz.	0 1000 2000		Lockable Steel Wellhead 355mmND (SWDRP) Stickup: 0.73magl Production Casing Stickup: 0.48magl Cement Grouting Interval: 0.0mbgl to 0.91mbgl Surface Casing: 0.73magl to 0.91mbgl, 355mmND ERW Steel
210	5				Quartz: Light grey and light brown amorphous quartz, slightly fractured, minor to trace iron staining, minor banding with dark impurities, translucent.			Water Level: 2.99mbgl Blank Casing: 0.48magl to 4.34mbgl, 200mmND ERW Steel
					Quartz: Grey amorphous quartz, minor light grey amorphous quartz, minor dark impurities.			
					Quartz: Light grey and light brown amorphous quartz, minor impurities, translucent, slightly fractured; 10% yellow-light brown soft friable interstitial clay.			Slotted Interval: 4.34mbgl to 28.34mbgl, 200m ERW Steel - 5mm Vertical Machine Slotted
205	10				Quartz: Grey amorphous quartz, massive; dark impurities, slightly fractured; light grey and light brown amorphous quartz, moderately fractured, slightly translucent, minor-trace dark impurities.	0 1000 2000		Airlift Yield at 8mbgl: 2L/s EC at 8mbgl: 1,006us/cm
					Quartz: Light grey and light brown amorphous quartz, slightly fractured, trace impurities; minor grey amorphous quartz; 10% yellow-light brown soft friable interstitial clay.			
200	15				Quartz: Light grey and light brown amorphous quartz, massive, translucent, trace impurities; 20% grey amorphous quartz, massive.			Airlift Yield at 18mbgl: 10L/s EC at 18mbgl: 1,002us/cm
					Quartz: Light grey and light brown amorphous quartz, slightly fractured, translucent, trace impurities; 10% grey amorphous quartz; <5% yellow-light brown interstitial clay.			
195	20					0 1000 2000		
								Airlift Yield at 30mbgl: 24L/s EC at 30mbgl: 1,028us/cm
190	25							Casing Depth: 28.34mbgl, 200mmND ERW Steel Endcap
				Siliceous Void	Siliceous Void: Light brown-orange brown siliceous micro crystalline flakes, minor to trace impurities, brittle, translucent; 20% light brown amorphous quartz with trace impurities; 10% light yellow-brown insterstitial clay. Quick penetration rate - no resistance.	0 1000 2000		Fallback: 28.34mbgl to 32.0mbgl
185	30							Total Depth Drilled: 32mbgl

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COMPOSITE WELL LOG

Bore No: MB01

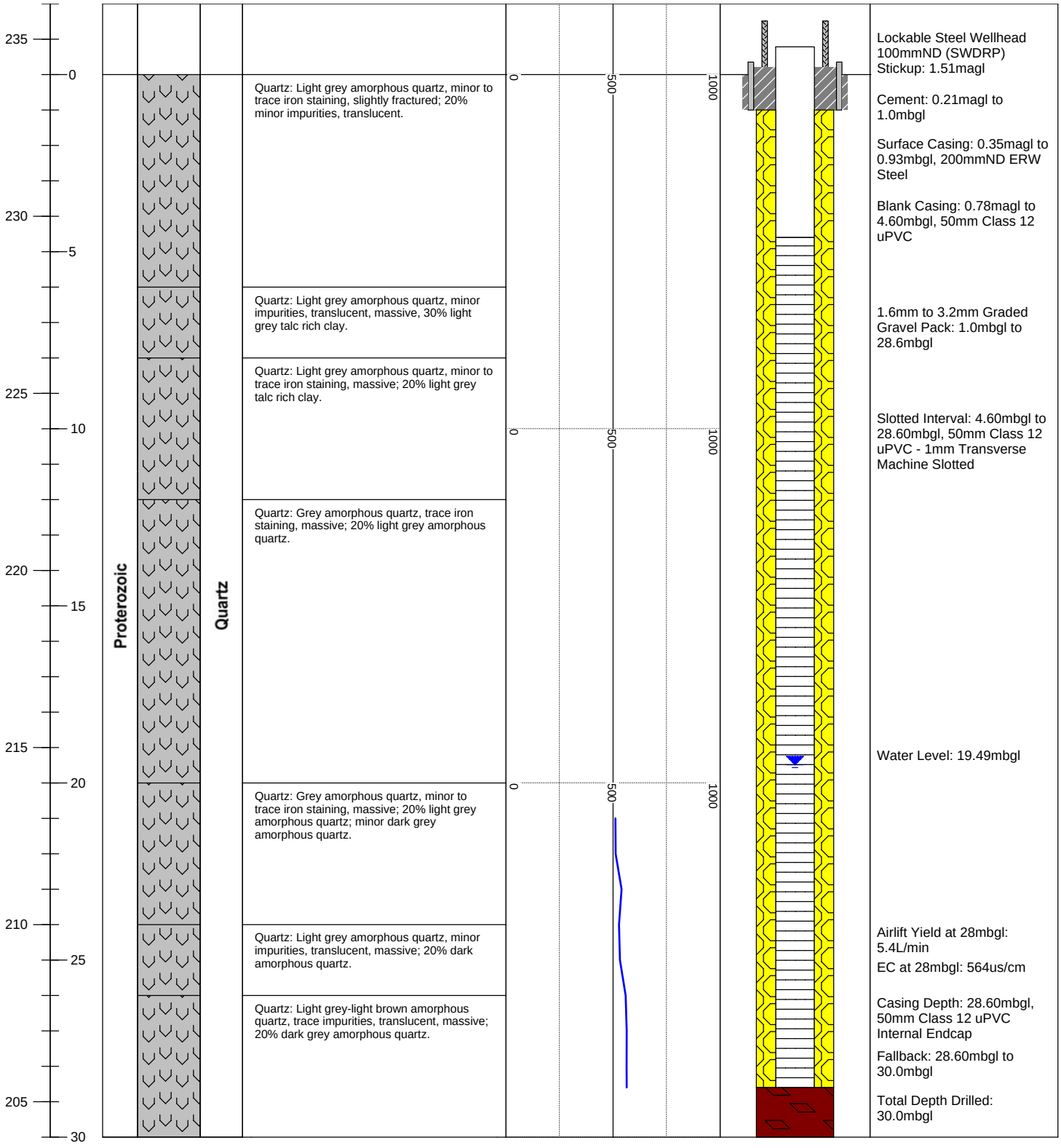
Client: Simcoa Operations Pty Ltd

Operation: Phase 2 Hydrogeological Investigations

Commenced: 12/10/11	**Method:** Rotary Air Percussion	**Site:** Moora Quartz Mine
Completed: 14/10/11	**Fluid:** N/A	**East (MGA):** 407477mE
Drilled: Austral Drilling	**Bit Record:** 6" Hammer	**North (MGA):** 6623674mN
Logged By: Z.Scott	**Hole Purpose:** Monitor Bore	**SRP RL:** 234mAHD

Static Water Level: 21.00mbtoc **Date:** 18/10/11

Elevation (mAHD)	Depth (mbgl)	Geology	Graphic Log	Strati-graphy	Lithological Description	EC Post-Purge (uS/cm)	Well Completion: Diagram	Well Completion: Notes



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COMPOSITE WELL LOG

Bore No: MB02

Client: Simcoa Operations Pty Ltd

Operation: Phase 2 Hydrogeological Investigations

Commenced: 15/10/11	**Method:** Rotary Air Percussion	**Site:** Moora Quartz Mine
Completed: 15/10/11	**Fluid:** N/A	**East (MGA):** 407446mE
Drilled: Austral Drilling	**Bit Record:** 6" Hammer	**North (MGA):** 66239369mN
Logged By: Z.Scott	**Hole Purpose:** Monitor Bore	**SRP RL:** 224mAHD

Static Water Level: 10.15mbtoc **Date:** 18/10/11

Elevation (mAHD)	Depth (mbgl)	Geology	Graphic Log	Strati-graphy	Lithological Description	EC Post-Purge (uS/cm)	Well Completion: Diagram	Well Completion: Notes
225	0	Proterozoic		Laterite	Laterite/Quartz: Red-brown hard siliceous ferricrete, iron rich and iron stained; 30% light-dark brown amorphous quartz, dark impurities, 20% light brown talc rich clay.	0 500 1000		Lockable Steel Wellhead 100mmND (SWDRP) Stickup: 0.87magl
								Cement: 0.25magl to 1.0mbgl
220	5			Quartz	Quartz: Light grey amorphous quartz, minor impurities, translucent, trace to minor iron staining, massive; minor dark grey amorphous quartz.			Surface Casing: 0.40magl to 1.0mbgl, 200mmND ERW Steel
								Blank Casing: 0.74magl to 4.40mbgl, 50mm Class 12 uPVC
215	10				Quartz: Grey amorphous quartz, minor to trace iron staining, minor dark impurities; 20% light grey amorphous quartz.	0 500 1000		1.6mm to 3.2mm Graded Gravel Pack: 1mbgl to 28.40mbgl
								Water Level: 9.28mbgl
210	15				Quartz: Grey amorphous quartz, trace iron staining, massive; minor dark amorphous quartz.			Slotted Interval: 4.40mbgl to 28.40mbgl, 50mm Class 12 uPVC - 1mm Transverse Machine Slotted
205	20				Quartz: Grey amorphous quartz, slightly fractured, minor dark impurities; 20% light grey amorphous quartz.			
					Quartz: Light grey amorphous quartz, minor impurities, translucent, massive.	0 500 1000		
200	25				Quartz: Light grey amorphous quartz, minor impurities, translucent, massive; minor dark grey amorphous quartz, massive.			Airlift Yield at 28mbgl: 4.2L/min
								EC at 28mbgl: 473us/cm
								Casing Depth: 28.40mbgl, 50mm Class 12 uPVC Internal Endcap
								Fallback: 28.4mbgl to 30.0mbgl
195	30							Total Depth Drilled: 30.0mbgl

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COMPOSITE WELL LOG

Bore No: MB03

Client: Simcoa Operations Pty Ltd

Operation: Phase 2 Hydrogeological Investigations

Commenced: 16/10/11	**Method:** Rotary Air Percussion	**Site:** Moora Quartz Mine
Completed: 17/10/11	**Fluid:** N/A	**East (MGA):** 407469mE
Drilled: Austral Drilling	**Bit Record:** 6" Hammer	**North (MGA):** 6624188mN
Logged By: Z.Scott	**Hole Purpose:** Monitor Bore	**SRP RL:** 235mAHD

Static Water Level: 20.63mbtoc **Date:** 21/10/11

Elevation (mAHD)	Depth (mbgl)	Geology	Graphic Log	Strati-graphy	Lithological Description	EC Post-Purge (uS/cm)	Well Completion: Diagram	Well Completion: Notes
235	0	Proterozoic		Laterite	Laterite/Quartz: Red-brown hard siliceous ferricrete, iron rich and iron stained; 20% grey and brown amorphous quartz; 10% light brown talc rich clay.	0 2000 4000		Lockable Steel Wellhead 100mmND (SWDRP) Stickup: 0.78magl
								Cement: 0.25magl to 3.0mbgl
								Surface Casing: 0.22magl to 3.10mbgl, 200mmND ERW Steel
								Backfill: 3.0mbgl to 4.0mbgl
230	5			Quartz	Quartz: Light grey amorphous quartz, minor impurities, translucent, massive; 20% light brown talc rich clay; <5% black moderately hard rock fragments.			
					Quartz: Light grey amorphous quartz, minor impurities, massive; 30% light brown talc rich clay; <5% black moderately hard rock fragments.			Blank Casing: 0.74magl to 10.70mbgl, 50mm Class 12 uPVC
225	10				Quartz: Light grey amorphous quartz, minor impurities, massive; 30% black moderately hard rock fragments; grey-brown interstitial clay.	0 2000 4000		1.6mm to 3.2mm Graded Gravel Pack: 4.0mbgl to 34.7mbgl
					Quartz: Grey amorphous quartz, massive; 20% light grey-green amorphous quartz; <5% black moderately hard rock fragments.			
220	15				Quartz: Dark grey amorphous quartz, massive; minor light grey amorphous quartz; 10% black moderately hard rock fragments.			Slotted Interval: 10.7mbgl to 34.7mbgl, 50mm Class 12 uPVC - 1mm Transverse Machine Slotted
					Quartz: Light grey amorphous quartz, minor impurities, translucent, slightly fractured.			
215	20				Quartz: Dark grey amorphous quartz, massive; 20% light grey amorphous quartz, massive.	0 2000 4000		Water Level: 19.85mbgl
210	25				Quartz: Light grey amorphous quartz, minor impurities, translucent, massive; minor dark grey amorphous quartz; <5% black moderately hard rock fragments.			
205	30					0 2000 4000		Airlift Yield at 34mbgl: 0.9L/min EC at 34mbgl: 1,964us/cm
								Casing Depth: 34.7mbgl, 50mm Class 12 uPVC Internal Encap
								Fallback: 34.7mbgl to 36.0mbgl
200	35				Quartz: Light grey amorphous quartz, minor iron staining, translucent, massive; minor dark grey amrphous quartz; <5% black moderately hard rock fragments.			Total Depth Drilled: 36.0mbgl

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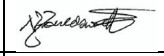
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S Davidson	P Baker		Nick Houldsworth		13/09/2021

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