Decision Report

Licensed premises

Division 3, Part V *Environmental Protection Act 1986*

Licence number	L9176/2018/1
Licence holder	Iluka Resources Limited
ACN	008 675 018
File number	DER2018/001555
Premises	Cataby Mineral Sands Mine 10437 Brand Highway CATABY WA 6507 Legal description – Mining tenements M70/194, M70/195, M70/196, M70/517, M70/518, M70/696, M70/760, M70/867, M70/868, M70/869, M70/1018 and M70/1086
Date of report	15 April 2020
Status of report	Final

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1. Definitions of terms and acronyms

In this Decision Report, the terms in Table 1 have the meanings defined.

Table 1: Definitions

Term	Definition
ACN	Australian Company Number
AEP	Annual Exceedance Probability – refers to the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year
AHD	Australian Height Datum
application	refers to the original works approval application made by the licence holder under section 54(1) of the EP Act on 24 October 2018
ARI	Average Recurrence Interval
ASS	Acid Sulfate Soils
category/ categories	categories of prescribed premises as set out in Schedule 1 of the EP Regulations
CWD	Clean water dam
delegated officer	an officer under section 20 of the EP Act
DMIRS	Department of Mines, Industry Regulation and Safety
DOD	Drop-out dam
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
EP Regulations	*Environmental Protection Regulations 1987* (WA)
GDE	Groundwater Dependent Ecosystem
GL	gigalitre
GOS	Groundwater Operating Strategy
HMC	Heavy Mineral Concentrate
Implementation Agreement or Decision	has the same meaning given to that term under the EP Act
L/s	Litres per second
m^3	cubic metres
mbgl	metres below ground level
MCP	Mine Closure Plan
Minister	the Minister responsible for the EP Act and associated regulations
ModCod	Modified Co-disposal – refers to a proprietary modification to the historical methods for co-disposal of sand/clay tailings, which involves the addition of flocculant at the point of deposition to provide for more efficient water recovery and faster tails consolidation times
Mtpa	million tonnes per annum
MS	Ministerial Statement
MSP	Mineral Separation Plant
MUP	Mining Unit Plant
Noise Regulations	*Environmental Protection (Noise) Regulations 1997* (WA)
NORM	Naturally Occurring Radioactive Material

PASS	Potential Acid Sulfate Soils
pH_F	field pH
pH_{FOX}	field peroxide pH
pH_{INC}	pH chip tray incubation test (16-week)
PM	means total particulate matter including both solid fragments of material and miniscule droplets of liquid
PM_{10}	means particles with an aerodynamic diameter of less or equal to 10 microns (µm)
prescribed premises	has the same meaning given to that term under the EP Act
Premises	refers to the premises to which this report applies, as specified at the front of this report
primary activities	as defined in Table 1 of the amended licence
PWD	Process water dam
RCWA	Radiological Council of Western Australia
report	refers to this document
risk event	as described in *Guidance Statement: Risk Assessment*
ROM	Run of Mine
SSP	Surface Screening Plant
SPOCAS	Suspended Peroxide Oxidation Combined Acidity and Sulfur
TDS	Total Dissolved Solids
TSP	Total Suspended Particulates
UCC	Up Current Classifier
$\mu g/m^3$	micrograms per cubic metre
UTL	upper threshold limit
WCP	Wet Concentrator Plant
WHIMS	Wet High Intensity Magnetic Separation

2. Background

Cataby is a large scale heavy mineral sands mine located on the foot slopes of the Gingin Scarp, around 150 km north of Perth, in the Shire of Dandaragan. It is currently the only active mining operation for Iluka Resources in Western Australia.

The original mining proposal was formally assessed in 2005 by the Environmental Protection Authority (EPA) via an Environmental Protection Statement (EPS) level of assessment. The proposal was approved in 2006 through Ministerial Statement 720, however the project did not immediately proceed due to market conditions. Amendments to MS 720 were subsequently approved in October 2015 through the issue of MS 1017 (refer to section 4.1).

Site construction works commenced in January 2018 following the issue of works approval W5935/2015/1 in March 2016, with full mining operations commencing in May 2019.

Table 2 describes the categories of prescribed premises the licence is subject, as defined in Schedule 1 of the EP Regulations.

Table 2: Prescribed premises categories

Classification of Premises	Description	Premises throughput
Category 8	Mineral sands mining or processing: premises on which mineral sands ore is mined, screened, separated or otherwise processed.	12,000,000 tonnes per annual period
Category 6	Mine dewatering: premises on which water is extracted and discharged into the environment to allow the mining of ore.	2.2 gigalitres per annual period

3. Overview of the Cataby Mineral Sands Project

The project involves the mining and processing of heavy mineral sands and mine dewatering. A summary of the project is provided in Table 3.

Table 3: Summary of the project

Element	Description
Premises name	Cataby Mineral Sands Mine
Mine status	Operational
Commodity mined	Mineral sands
Life of mine	Approximately 9 years
Land tenure	All mining tenements are held exclusively by the licence holder All land within the Premises boundary comprises private freehold lots and individual agreements are in place to allow land access for mining
Ore quantity	80.4 million tonnes, to be mined at a rate of 9.8 Mtpa
Overburden removed	160.4 million tonnes, to be removed at a rate of 19.5 Mtpa
Topsoil and subsoil	11.3 million tonnes, to be handled at a rate of 1.4 Mtpa
Total material disturbed	284.5 million tonnes
HMC recovered	5.3 million tonnes
Pit depth	60 m below ground level
Area of disturbance	Up to 1,942.0 hectares
Clearing	156.0 hectares of native vegetation
Dewatering	Abstraction of groundwater for dewatering purposes (from the

	superficial aquifer), to be used in processing. Excess to be returned to the aquifer via infiltration and reinjection
Ore processing	Mining trommel, wet separation plant, flocculant thickener and associated infrastructure to be used to produce a heavy mineral concentrate
Secondary processing	To be conducted off-site at existing mineral separation plants, with sand and clay tailings to be returned to the Premises for backfill to mine voids

The Premises is located across several mining leases, which are approximately 6,173 ha in total area and comprise several third party freehold lots. The Brand Hwy straddles several tenements, and the Cooljarloo Mineral Sands Mine abuts the northern boundary (Figure 1).

The Cataby orebody covers an area approximately 18 km long and up to 3 km wide, with a total disturbance area of approximately 1,942 ha. Table 4 provides a summary of the indicative disturbance area by type.

Table 4: Area of disturbance

Disturbance type	Mine activity reference	Total
Mine pits	Pits 1 – 16	1,048.7
Soil stockpiles	Topsoil, subsoil, overburden stockpiles	518.1
Ore/ROM stockpiles	Above ground ROM stockpiles	74.2
Mining and processing infrastructure	MUPs, SSPs, WCP/WHIMS, offices, workshops, laydown yards, HMC stockpiles, process water dams, fuel storage	67.0
Infrastructure corridor	Haul roads, power, telecommunications, freshwater pipelines	227.3
Diversion channel or drain	Surface water runoff channels around mining and processing infrastructure	6.7
Total disturbance area		**1,942.0**

3.1 Construction and site development

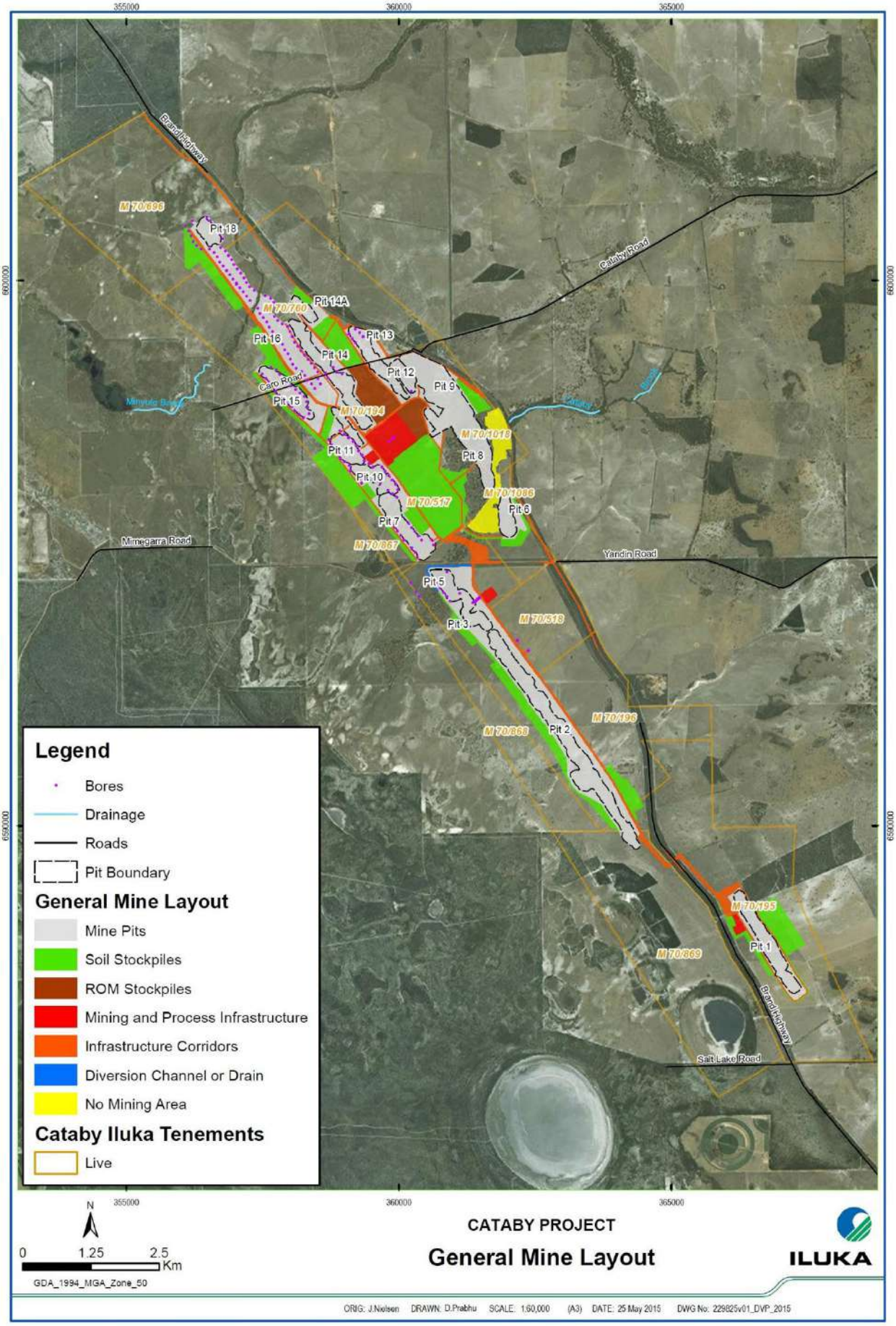
Construction works commenced in January 2018 and were largely completed by December 2018. Initial site development works involved road upgrades to the intersection of Mimegarra Rd and the Brand Hwy, installation of water supply and management infrastructure, installation of power supply infrastructure and development of the process plant area, including the Wet Concentrator Plant (WCP), thickeners and associated infrastructure.

3.1.1 Pre-production mining and stockpiling

Starter pits within Pit 2 and Pit 9 were excavated using an excavator and haul truck fleet, with ore stockpiled at the commissioning run-of-mine (ROM) pad. Pit 12 was also excavated to the full perimeter of the pit design, to create an initial 'ModCod' disposal cell for sand tailings and clay fines (refer to section 0).

Two Mining Unit Plants (MUPs) were installed within the starter pits, in addition to two Surface Screening Plants (SSPs), slurry pipelines, pumps and stackers, in preparation for start-up, commissioning and full mining operations.

Topsoil and subsoil from starter pits have been stockpiled adjacent to clearing / construction areas. Overburden from starter pits have been stockpiled at the central overburden stockpile, and used to create the sand tailings stacker pad.



▲ Figure 1: Location and features of the Premises

3.1.2 Commissioning

Commissioning commenced on 23 November 2018 and was completed on 10 May 2019, upon which the mine became fully operational. Commissioning generally included:

- Hydro-testing of pipelines and pump systems function testing;
- Commissioning of the raw water system;
- Dry commissioning of the MUPs, SSPs, WCP/WHIMS circuit and thickeners;
- Wet commissioning of the MUPs, SSPs, WCP/WHIMS circuit and thickeners;
- Testing the sand and ModCod tailings system; and
- Commissioning of the process control system.

A total of 450,000 tonnes or ore was used to commission the MUPs, SSPs and WCP/WHIMS circuits and associated equipment, with the heavy mineral concentrate (HMC) produced being stored at the HMC stockpile pads. The sand tailings and clay fines produced during commissioning were disposed within the initial 'ModCod' cell (refer to section 3.2.3) in Pit 12.

3.2 Operational aspects

The mining and processing operations incorporate conventional dry mining, followed by wet screening and gravity separation.

Many of the pits will be mined to a basement level that is below the natural groundwater table and dewatering will be required to facilitate dry mining conditions. Where the dewatering rate exceeds the project's water demand, excess water is returned to the aquifer via infiltration basins, and reinjection bores where required.

Mine voids are being backfilled progressively throughout the life-of-mine by tailings and overburden.

3.2.1 Mining operations

The Cataby deposit is predominantly a large undeveloped high strip, low grade ilmenite deposit. Topsoil and subsoil is pre-stripped and stockpiled separately, or placed on areas undergoing rehabilitation. Overburden is removed using a combination of scrapers, excavators and trucks, and stockpiled or placed directly into the mine void, or used for the construction of earthen bunds, infrastructure pads and internal roads.

Mining operations occur on a 24-hour, 7 days per week basis to an approximate depth of 60 m below ground level (mbgl). There are a total of 16 pit areas, with some pits being contiguous with each other. At least 2 pits will be mined concurrently, with one MUP/SSP combination dedicated to mining in the northern part of the Premises and the second MUP/SSP combination initially dedicated to the southern part.

Table 5 provides a general overview of the proposed mining sequence for each MUP/SSP combination.

Table 5: General mining sequence

Mining Unit	Mine pit	Timing	Comment
MU20	13	Sep 2018 – Dec 2019	to ROM – used in commissioning and later in mine life
	9	Apr 2019 – Nov 2023	Starter pit – essentially 1 pit, however split into Pit 8 for cockatoo exclusion times
	8		
	14	Nov 2023 – Jan 2025	Mined after Pit 8/9
	16	Jan 2025 – Sep 2026	Mined after Pit 14
	Stockpile	Sep 2026 – May 2027	Ore sourced from ROM stockpile
MU21	12	Sep 2018 – Feb 2019	to ROM for commissioning and initial ModCod disposal
	2	May 2019 – Jun 2021	Starter pit

	11	May 2019 – Jun 2020	to ROM – mined simultaneous to Pit 2
	10	Jan 2021 – Jan 2022	
	1	Jun 2021 – Jan 2022	Mined after Pit 2
	15	Jan 2022 – Jan 2023	Mined after Pit 1
	7	Jan 2023 – Dec 2023	Mined after Pit 15
	Stockpile	Dec 2023 – Sep 2025	Ore sourced from ROM stockpile
	6	Sep 2025 – Oct 2025	Mined after ROM stockpile exhausted
	3	Oct 2025 – Aug 2026	Mined after Pit 6
	14A	Aug 2026 – Sep 2027	Mined after Pit 3
	11	Sep 2026 – Dec 2026	Mined after Pit 14A

The general sequence of mining operations is outlined below:

- vegetation clearing and topsoil / subsoil stripping;
- overburden removal, followed by extraction of mineral sands ore using dozers, or excavators and trucks;
- progressive backfilling of mine voids by a combination of sand tailings, blended co-disposal of the sand and clay streams, and overburden; and
- progressive rehabilitation behind the advancing mining operation.

3.2.2 Ore processing

Processing also occurs on a 24-hour, 7 days per week basis and involves the two MUPs feeding the two SSPs, prior to an ore slurry being delivered to the WCP. The MUPs are fed ore from the pit basement by dozer-push method or direct excavation and incorporate a sizer/screening unit to reduce the ore to a pumpable slurry. The SSPs utilise trommel and scrubbers to remove oversize and re-slurry the ore for pumping to the WCP.

The WCP uses a combination of wet gravity and magnetic techniques to separate magnetic and non-magnetic HMC from the screened ore (Figure 2).

Wet Concentration Plant

Ore initially passes through a series of hydro-cyclones to separate out clay fines (nominally less than 53 microns), followed by banks of gravity spirals where the heavy minerals with specific gravities >3.5 flow to the inside of the spirals and separate from the principal waste mineral quartz, which has a specific gravity <3 and travels towards the outside of the spirals. This process recovers the majority of the heavy mineral as HMC, which typically comprises about 90 – 95% valuable heavy minerals (principally ilmenite, leucoxene, zircon and lesser amounts of monazite) on a dry weight basis.

Magnetic separation

A secondary concentrator then further separates the HMC into the magnetic and non-magnetic fractions. A low intensity magnetic separator initially removes the high magnetic susceptibility material (predominantly magnetite, which would otherwise build up in the wet high intensity magnetic separation (WHIMS) circuit) using vibrating and static screening.

A rotating drum with a permanent magnet positioned and fixed internally ‘holds’ the highly magnetic material on the drum surface, until it rotates past the magnets’ field of influence and is removed to a tailings stream. The remaining material is fed to the WHIMS, where magnets are arranged in pairs so that the strength of the magnetic field will vary, resulting in pre-determined zones of high and low magnetic force. Water keeps the magnets cool and also wash the matrix, to assist with the separation.

The WHIMS circuit produces two products: a magnetic stream (predominantly ilmenite), and a non-magnetic stream (zircon and rutile).

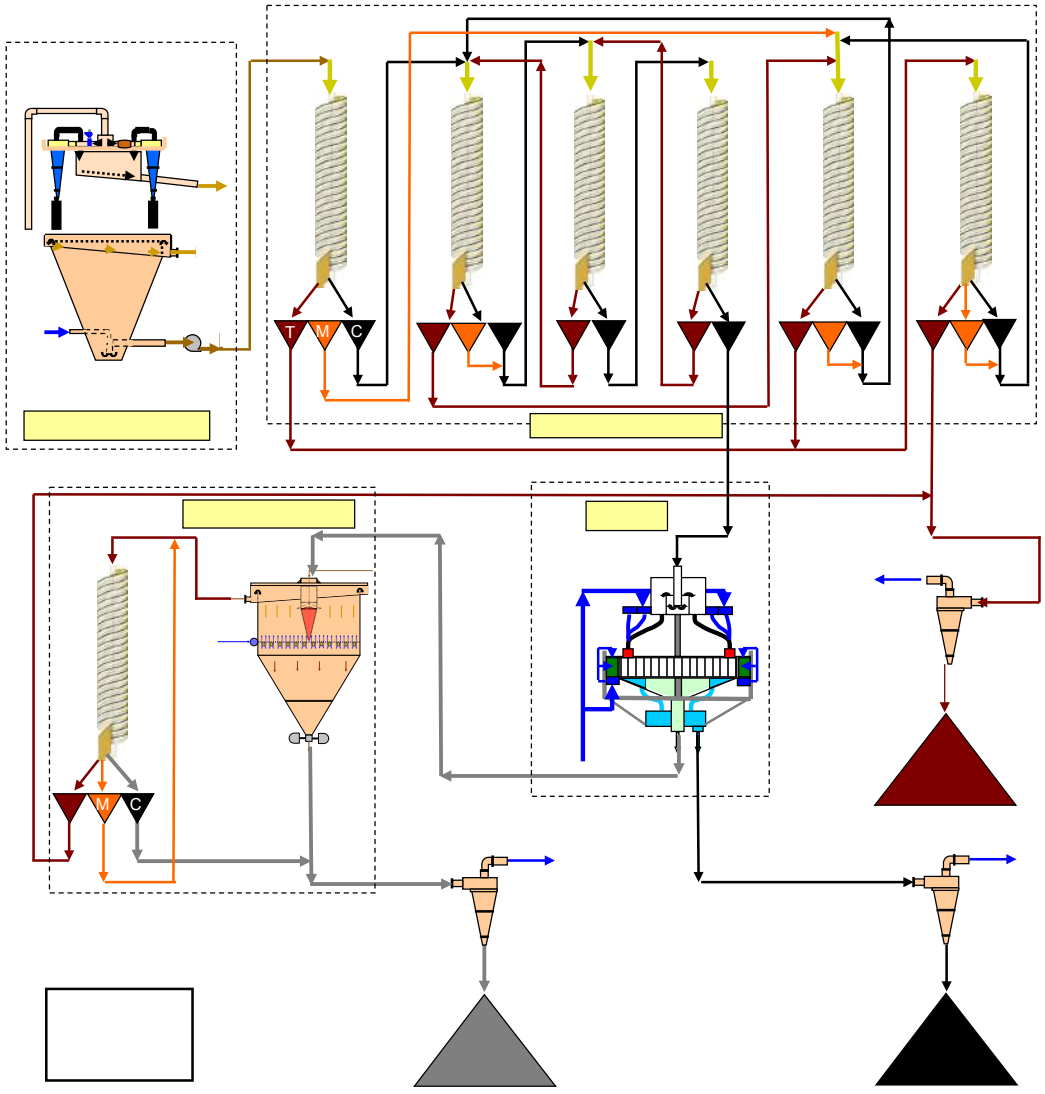
Non-magnetic separation

The non-magnetic stream is subjected to further separation via an up-current classifier (UCC), which removes the fine quartz material and other gangue fines and improves the HMC grade of the product to 95%, for secondary downstream separation.

The UCC is a vertical hydraulic sizing device that uses an upward flow of water to produce an overflow of fine light material and an underflow of coarser, heavier material.

HMC management

Both HMC product streams are pumped to separate stockpile areas adjacent to the WCP via dewatering hydro-cyclones, where the cyclone overflow is returned to the process water circuit. A subsurface drainage system captures stockpile seepage and returns it to the process water circuit.



▲ Figure 2: Process flow – separation circuits

The magnetic HMC fraction is transported south to the North Capel Mineral Separation Plant (MSP) and the non-magnetic fraction is transported north to the Narngulu MSP, for further separation into various grades of zircon concentrates, leucoxene, rutile and primary and secondary ilmenite products.

3.2.3 Tailings disposal

The tailings streams produced from the WCP comprise benign sands, clays and heavy minerals (quartz, kaolinite, goethite and ilmenite). A combination of co-disposal of clay fines/sand (including proprietary systems, such as modified co-disposal ('ModCod')) and sand stacking is used to dispose of these streams.

Co-disposal (ModCod)

Clay fines are separated from the ore using hydro-cyclones at the WCP. The clay fines component, which is generally at a low slurry density of <4% solids, is pumped to the thickeners, where small amounts of flocculant is added using automated dosing equipment. The thickened clay fines is then mixed with a pre-determined amount of sand tailings and pumped to pre-mined pits for disposal. Additional flocculant is added to the mix at the point of deposition.

ModCod storage cells will generally be filled to the original ground level and will be allowed to consolidate. Decanted water from the ModCod is pumped back to the process water dam for reuse in the concentration process. The ModCod cells will be progressively rehabilitated during operations and the closure phase of the project.

Sand stacking

Sand tailings form the majority of the residues from the WCP and are pumped to sand-stacking locations either in-pit or adjacent to the WCP overburden stockpile. For in-pit disposal, sand tailings are pumped via polyethylene pipes and stage pumps to the in-pit disposal area, dewatered at the pit edge and dry-stacked directly back into the mining void.

In-pit embankment designs and stability analysis

As a contingency measure, the licence holder may construct in-pit embankment walls to retain tailings in active mining pits to allow in-pit storage of tailings, if required. Table 6 provides the minimum design parameters for such embankments, which will incorporate a minimum crest width of 10 m. Embankments would be constructed in maximum 500 mm horizontal layers and roller compacted to at least 95% of the standard maximum dry density.

Table 6: Minimum design guideline for in-pit embankments

Phreatic surface	Height		
	<20m	20m – 40m	40m – 50m
Pond away from embankment (normal conditions)	2H:1V	2.5H:1V	2.5H:1V
Pond near embankment (worse-case)	2.5H:1V	3H:1V	3.5H:1V

Pipeline network

Slurried materials are transferred around the Premises using high density polyethylene pipelines. The pipelines, which are constructed with either welded joins or butt-flange connections, are used to transfer the following:

- Sand/clay tailings to ModCod cells;
- Sand tailings to mine pit voids; and
- Return water from the ModCod cells and sand tails areas back to the process water circuit.

Pipelines have designated pipeline corridors with secondary containment, through the use of minimum 1 m high earthen bunds.

Secondary tailings management

Tailings produced from off-site processing at the North Capel and Narngulu MSPs are not returned to the Premises for disposal.

The rare earth mineral monazite is contained within the HMC fraction during separation in the

WCP, predominantly in the non-magnetic HMC fraction which is processed at the Narngulu MSP. Some monazite is also contained within the magnetic HMC fraction, which is processed at the North Capel MSP. The disposal of monazite from both MSPs is managed in accordance with the approved Radiation Management Plans for these sites, and is not returned to the Premises for disposal.

3.2.4 Mine water management

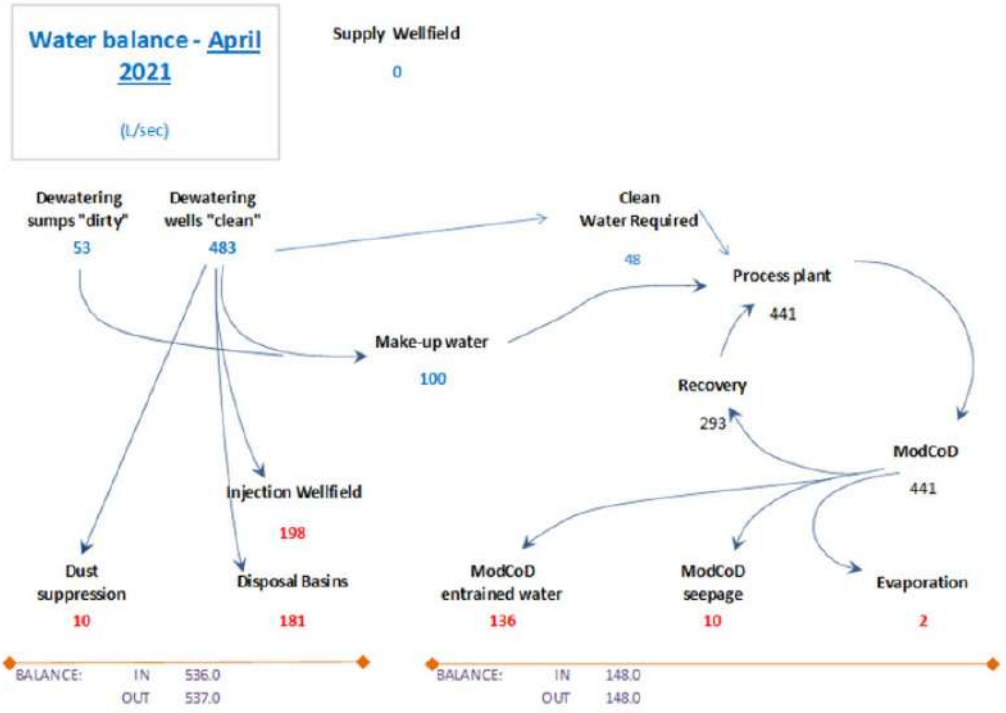
Many of the mine pits will be excavated to below water table level, where dewatering will be required to enable dry mining to occur. Dewatering bores located immediately behind the pit crests will operate during overburden stripping and mining and are intended to minimise the groundwater inflows to the excavation. It is anticipated that groundwater inflows will not be completely eliminated by the bore pumping – groundwater discharging into the pits will be collected in drains and sumps constructed in the mine floor and will be pumped out of the pits.

Process water is expected to be lost at a rate of approximately 148 litres per second (L/s) through seepage from and entrainment in tailings, evaporation and dust suppression. This water will be replaced with 'clean' groundwater from production bores and 'dirty' water from in-pit sump pumping. Processing requires a continuous supply of at least 48 L/s of clean water, with the remaining 100 L/s makeup supplied as either clean or dirty water.

At times the volume of water from the dewatering bores and in-pit sump pumping will exceed the water demand for processing, and will require discharge (see section 3.2.6). There will also be periods when there will be a shortfall of water, where idle dewatering bores will be used to provide additional processing water. The water balance for the mine after initial start-up is shown in Figure 3.

▲ Figure 3: Project water balance for the life-of-mine.

Figure 4 illustrates the water balance conditions predicted to arise in April 2021 at the peak of dewatering pumping, which is estimated at 536 L/s (53 L/s from in-pit sump pumping and 483 L/s from dewatering bores (Jacobs, 2014b)). The volume of water lost from the process circuit is 148 L/s, consisting of 136 L/s of ModCod entrained water, 10 L/s seepage from tailings and 2 L/s from evaporation – this loss is made up for by water sourced from the dewatering system, at least 48 L/s of which is clean water from production bores. At this time there is a surplus of 378 L/s, which requires disposal into infiltrations basins and through aquifer re-injection bores.



▲ ***Figure 4: Estimated water balance at the peak of mine dewatering (April 2021)***

3.2.5 Water distribution network

A schematic of the mine water distribution network is illustrated in Figure 5.

The distribution network begins by transferring water abstracted from the Superficial aquifer via production bores to a clean water dam (CWD). The CWD overflows into a process water dam (PWD), from where it is distributed to processing facilities and associated activities.

A drop-out dam (DOD), which is engineered to promote sedimentation prior to overflowing to the PWD, receives 'dirty' water from an interceptor pit, return water from ModCod cells and sand tailings, a sedimentation pond, and water from in-pit sump pumping.

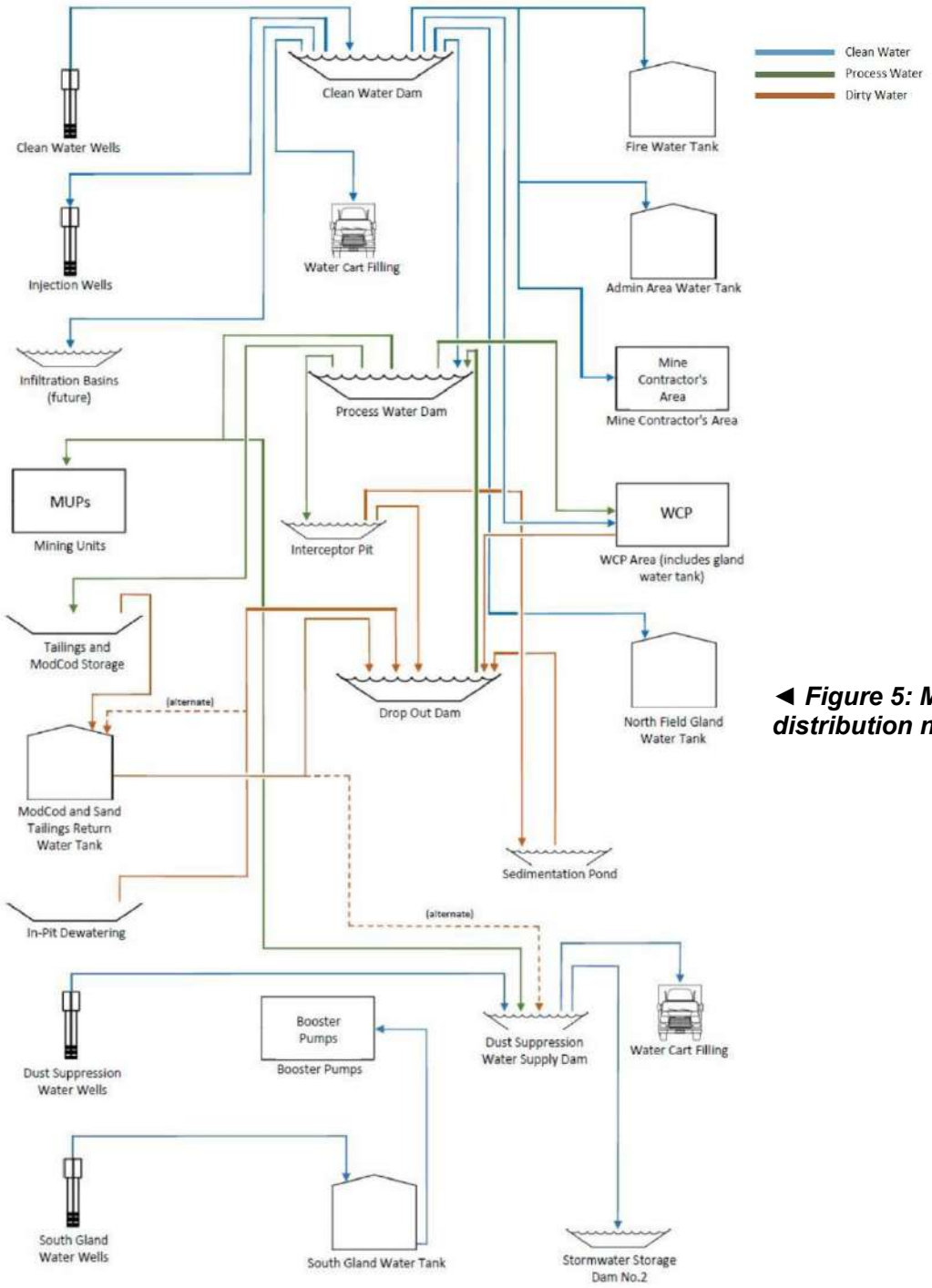
Water storages

The PWD (approx. 44,000 kL capacity) is located between the CWD (approx. 22,000 kL) and the DOD (approx. 16,000 kL) and supplies the WCP, the tailings storages and the MUPs/SSPs by ground-mounted pumps. The PWD and DOD are clay-lined to prevent infiltration and to maintain water quality. An emergency spillway into the drainage channel to the north of the dam is in place, to allow excess water to flow to the sedimentation pond (see below).

Stormwater management

Runoff from undisturbed catchments upstream of, and within, the mine site is diverted away from mine pits, infrastructure and other operational areas, into existing drainage lines through bunding and local drains on the upstream side of the haul road.

Surface water runoff generated in active pits and non-rehabilitated pits is collected via sumps and pumped to the process water management system. In disturbed sub-catchments, surface water runoff is diverted to stormwater management infrastructure (i.e. dams, ponds and drains), which are sized to contain a 1:10 AEP 6-hour storm event. In larger storm events, overflow from the sedimentation pond will be directed to mine pits where it will infiltrate and/or be used in the mine water management system.



◄ Figure 5: Mine water distribution network

Key mine stormwater infrastructure consists of a sedimentation pond, that will operate over the life-of-mine, in addition to temporary sumps/basins that will be constructed alongside infrastructure as the mine progresses.

The sedimentation pond captures runoff from the mine infrastructure area and the two ROM pads and central overburden stockpile, with overflow to the adjacent Pit 11 which will also collect runoff from the adjacent road infrastructure. The sedimentation pond is not being used as part of the normal process water circuit – its primary function is to provide a containment for site stormwater runoff under high rainfall events that exceed site drainage infrastructure capacity. It is intended the pond will remain empty under normal operations.

The mine includes the progressive mining and rehabilitation of mine pits, such that the total disturbance area is significantly less than the total mine footprint. Some pits will remain open to provide emergency stormwater capacity, if required, which will minimise runoff from the disturbed area contributing to the sedimentation basins and the sediment load within the catchment.

3.2.6 Dewatering discharge

When water produced from the dewatering system (i.e. the combination of groundwater pumping from production bores, dewatering bores and the water pumped from in-pit sumps) exceeds the mine water demand, the excess water requires disposal. The maximum rate of dewatering disposal in any 12 month period is predicted to be 2.2 GL/yr (Jacobs, 2018).

The rate of dewatering disposal will be variable and is influenced by:

- the dewatering rate required to achieve dry mining condition;
- the rate of water consumption relative to the dewatering rate; and
- changes to the mine plan as may occur during the life-of-mine.

The water disposal strategy involves discharge of the water into infiltration basins located in the final pit void of Pit 1 and Pit 2, with direct injection into the aquifer to provide additional contingency to accommodate disposal volume and/or control mounding at disposal sites. Water is sourced from the CWD that only receives 'clean' water sourced directly from dewatering bores, therefore water quality is similar to regional groundwater quality.

Infiltration basins

The use of Pit 1 is the long-term strategy for infiltration over the life-of-mine. It has a capacity of approximately 7 million cubic metres and is anticipated to receive approximately 2.2 million cubic metres of excess water between February 2022 and January 2026, as illustrated in Figure 4. At maximum dewatering, approximately 31% of the capacity will hold standing water.

A contingency infiltration basin has also been considered in the final pit void of Pit 2, which may be used prior to Pit 1 being mined and available for discharge. It has a capacity of 530,000 cubic metres and may receive up to 300,000 cubic metres of excess water over a 2 month period between December 2021 and January 2022. At maximum dewatering, approximately 56% of its capacity will hold standing water. Disposal of excess water may be augmented by simultaneous discharge to aquifer re-injection bores, if required (see below).

Aquifer re-injection

Up to 16 mine dewatering bores that have dual capacity to be used as re-injection bores are being used to dispose of excess mine water. The primary purpose of discharge via the re-injection bores is to mitigate the impacts of groundwater drawdown within the mine path dewatering zone (excluding GDE mitigation – see below).

Nominal re-injection rates will be managed by the licence holder to ensure GDE mounding thresholds determined through groundwater modelling (Jacobs, 2014b), and as provided in the Groundwater Operating Strategy (GOS) (Iluka, 2017c), are not exceeded.

Groundwater Dependent Ecosystems mitigation system

As a requirement of MS 1017, the licence holder has prepared a Groundwater Dependent Ecosystem (GDE) management plan that identifies GDEs potentially at risk from drawdown impacts caused by mine dewatering, and establishes a monitoring program with early-warning trigger values and a tiered management response to exceedances of those trigger values. If a monitoring trigger is exceeded, this will initiate detailed investigations to determine the significance of the threatening process and devise the most appropriate management actions required, such as the release of excess water to recharge and maintain the hydrological regime of GDEs.

3.3 Infrastructure

The infrastructure at the Premises, as it relates to category 6 & 8 activities, is detailed in Table 7 and with reference to the Premises map (attached in the amended licence).

The list of mobile equipment in Table 7 is based on the scenarios modelled in the noise impact assessment submitted with the original works approval application (SVT, 2015). The licence holder has indicated different types and combinations of equipment than that modelled may be used throughout the life-of-mine.

Table 7: Cataby mine infrastructure

Infrastructure	
Prescribed activity category 8	
Mineral sands ore will be mined using dry mining methods, and primary processing using wet separation to produce a heavy mineral concentrate	
Fixed operations	
1	WCP, WHIMS plant and UCC, including thickener(s) and associated pumps
2	Skid-mounted MUPs (MU20 & MU21)
3	SSPs (MU02 & MU23 SSP), including slurry pipelines, pumps and conveyors
4	HMC product stockpile pads (Mags & Non-Mags)
5	ROM stockpile pads (ROM North & ROM South)
6	Sand tailings and clay fines system, including pipelines, booster pumps and stackers
7	Clean Water Dam (CWD), Process Water Dam (PWD), Drop Out Dam (DOD)
8	Sedimentation Pond / stormwater storage dam
9	Return water pipeline network
10	Soil stockpiles – Overburden, topsoil, subsoil
Mobile equipment	
1	8 x Bulldozers (2 x CAT DL9, 4 x CAT D11R carry dozers)
2	3 x Excavators (1 x CAT330, 1 x CAT375, 1 x CAT5130)
3	5 x Scrapers (CAT 657E)
4	8 x Haul Trucks (3 x CAT 773, 5 x CAT 777)
5	3 x Water Carts (CAT631C)
6	5 x Carry Graders (pulled by 9530 John Deere tractor)
Prescribed activity category 6	
Groundwater abstraction (dewatering) of the superficial aquifer to allow dry mining conditions, with mine water used to supplement mine water demand and excess discharged to the environment via infiltration basins and reinjection bores	
1	Dewatering bores
2	In-pit sumps and pumps, including water pipelines
3	Infiltration basins (Pits 1 & 2)
4	Reinjection bores
Other activities	
1	Groundwater abstraction (superficial aquifer) for processing

3.4 Exclusions to the Premises

The following matters are out of the scope of this assessment and have not been considered within the technical risk assessment detailed in this report:

- contractors' laydown yards, mechanical workshops, equipment storage areas, wash down bay(s), etc.;
- fuel storage and re-fuelling area(s);
- bioremediation area(s); and
- rehabilitation.

The licence is related to category 6 & 8 activities only and does not offer the defence to offence provisions in the EP Act (see s.74, 74A and 74B) relating to emissions or environmental impacts arising from non-prescribed activities, including those referenced above.

4. Legislative context

Table 8: Relevant approvals and tenure

Legislation	Number	Approval
Part IV of the EP Act	MS 1017	Ministerial approval for implementation of the proposal (to construct and operate the Cataby mine)
Mining Act 1978 (WA)	Registration ID: 55412	Mining Proposal and Mine Closure Plan (updated) for the Cataby Mineral Sands Project
Rights in Water and Irrigation Act 1914 (WA)	GWL175697(1)	Licensed allocation 14,000,000 kL/a from the Gingin Groundwater Area, Perth – Superficial Swan aquifer, for the purpose of dewatering for mining purposes, dust suppression for mining purposes, and mineral ore processing and other mining purposes
Environment Protection and Biodiversity Conservation Act 1999 (Cth)	Decision Notice EPBC 2005/2001	The proposed action (to construct and operate a mineral sands mine along the Brand Hwy, Cataby) is not a controlled action

4.1 Part IV of the EP Act

4.1.1 Background

The original mine proposal was referred to the EPA in March 2003 under section 38 of the EP Act, who set an EPS level of assessment in April 2003.

The proponent submitted its final EPS document to the EPA in November 2005, with the EPA providing its report and recommendations to the Minister for Environment (Minister) in December 2005 (EPA Bulletin 1212). The Minister subsequently approved the project through the publishing of MS 720 on 18 April 2006.

In October 2015, MS 720 was replaced by MS 1017, following changes to the implementation conditions and proponent commitments.

4.1.2 Ministerial Statement 720

EPA Bulletin 1212 (December 2005) provides the EPA's assessment of the original mine proposal. The relevant environmental factors identified were generally related to the impacts of mining on flora and fauna of conservation significance from vegetation clearing and groundwater drawdown, and noise impacts. The EPA recommended the project could be managed in an environmentally acceptable manner, providing there is satisfactory implementation of proponent commitments, which addressed acid sulfate soils (ASS), dust, noise and fauna (Carnaby's Black Cockatoo).

MS 720 contained a number of conditions that related to ensuring there would be no significant impacts on Carnaby's Black Cockatoo and its breeding and feeding habitats, in addition to significant vegetation and flora communities from clearing, and groundwater-dependent ecosystems from dewatering of the Superficial aquifer. Conditions were also included to ensure noise levels from the project would be acceptable.

MS 720 also referenced a number of proponent commitments relating to the preparation of management plans for ASS and dust, in addition to implementing offsets to promote the recovery of the local Carnaby's Cockatoo population, and fencing off a 'no mining' area due to significant vegetation values (i.e. Oliver Remnants).

4.1.3 Ministerial Statement 1017

In March 2015, the proponent requested changes to implementation conditions within MS 720 under section 46 of the EP Act. The changes included an extension of the timeframe for substantial commencement of the project, and to contemporise and consolidate several of the implementation conditions and proponent commitments.

EPA Report 1555 (August 2015) provides the EPA's report into the proposed changes. As part of the assessment the key environmental factors identified in Bulletin 1212 were revised in accordance with updated EPA environmental assessment guidelines, to reflect terrestrial fauna, flora and vegetation, amenity and offsets.

MS 1017 contains a revised set of conditions, however still retains the intent and environmental requirements of the original conditions of MS 720. The original proponent commitments were deleted as it was considered more appropriate to manage these aspects under Part V, Division 3 of the EP Act or through Ministerial Conditions. These commitments predominantly related to the management of dust and landform/soils (ASS).

Key findings:

The delegated officer notes that:

1. MS 1017 requires the proponent to conduct monitoring of the following themes:
   a) the health of significant vegetation within adjacent nature reserves and wetlands; and
   b) groundwater levels and quality;

   with respect to potential impacts from dewatering drawdown.

   Consistent with section 57 of the EP Act:

   (4) *If an application for a licence made under subsection (1) is related to a proposal which has been referred to the Authority under section 38, the CEO shall not perform any duty imposed on him by subsection (3) –*

   (b) contrary to, or otherwise that in accordance with, an implementation agreement or decision.

   conditions have been imposed in the Part V licence for the targeted monitoring of groundwater quality in areas where tailings will be deposited and where mining has the potential to cause increasing salinity and acidity.
2. Noise has been identified as a key environmental factor by the EPA in its assessment of the project, as full compliance with the Noise Regulations cannot be demonstrated. The EPA recognised the proponent's commitments and considered if private agreements or other arrangements can be made with nearby sensitive receivers, the risk of noise impacts from project could be considered acceptable.
3. Ministerial Conditions have been imposed through MS 1017 to address the risk of noise impacts during mining operations, including the implementation of a Noise Management Plan (in consultation with DWER). Consistent with section 57 of the EP Act (see point 1 above), conditions have not be imposed in the Part V licence to regulate noise emissions from the project.
4. Proponent commitments made under the original proposal have been deleted from MS 1017. Dust and ASS are now to be managed under Part V of the EP Act.

4.2 Other relevant approvals

4.2.1 *Mining Act 1978* (WA)

With the exception of land alienated before 1 January 1899, all minerals[1] are the property of the Crown, and a mining title must be obtained from the Department of Mines, Industry Regulation and Safety (DMIRS) before ground disturbing exploration activities or any mining operations may be undertaken (DMP, 2015b).

DMIRS has approved a mining proposal (Registration ID: 55412) to develop the mineral sands deposit on tenements M70/194, M70/195, M70/196, M70/517, M70/518, M70/696, M70/760, M70/791, M70/867, M70/868, M70/869, M70/1017, M70/1018 and M70/1086, all of which is over private land.

DMIRS also administer the *Mines Safety and Inspection Act 1994*, with respect to the standards of occupational safety and health. The Resources Safety Division administers occupational health (OSH) legislation for mining operations, and safety legislation and the licensing regime for dangerous goods, including regulation of the State's major hazard facilities. This includes the requirement to lodge and have approved a Project Management Plan, reviewing structural designs and specifications of tailings storage facilities and other engineered mine-related infrastructure, etc.

Mine Closure Plan

All tenements that have an approved mining proposal on them must also have an approved mine closure plan (MCP) that has been prepared in accordance with the "Guidelines for Preparing Mine Closure Plans" (DMP, 2015a).

DMIRS has approved a MCP for the project (Iluka, 2015a), which pre-dated the current closure guidelines. A number of minor issues were identified that required addressing in the 2018 revision regarding closure obligations, stakeholder consultation and refinement of completion criteria. The licence holder submitted a revised MCP in 2018, which is currently being reviewed by DMIRS.

4.2.2 *Rights in Water and Irrigation Act 1914* (WA)

Groundwater is a key component of the mining operation and will be used in various mining and processing facilities across the site, including potable water supply.

The Premises lies within the Gingin Groundwater Area, Wedge Island sub-area, which is less than 50% allocated when considering the Superficial aquifer system.

Groundwater abstraction in gazetted areas is regulated by DWER under section 5C of the *Rights in Water and Irrigation Act 1914*. A section 5C Licence to Take Water has been issued from the Superficial aquifer (14,000,000 kL/yr) for the purposes of mine dewatering, mineral ore processing, and dust suppression.

4.2.3 *Radiation Safety Act 1975* (WA)

Deposits of mineral sands contain levels of naturally occurring radioactive materials (NORM). The radioactive constituents are mostly thorium with smaller amounts of uranium, and their respective decay products. Monazite is the most common radioactive mineral and typically constitutes less than 0.5% of the mined ore; however any operation in which radioactive containing material is extracted from the ground and processed can potentially concentrate NORM in product, by-product or waste streams.

The management of radiological risk (to human health and the environment) from NORM is undertaken jointly by DMIRS and the Radiological Council of WA (RCWA). Prior to the

[1] When occurring on private land, the following are not considered minerals for the purposes of the Mining Act: limestone, rock, gravel, shale, sand and clay (excluding oil shale, mineral sands, silica or garnet sand, kaolin, bentonite, attapulgite and montmorillonite).

commencement of any stage of mining to which radiation regulations apply, the licence holder is required to obtain approval for a Radiation Management Plan (RMP) and a Radiation Waste Management Plan (RWMP) for the proposed activities at that stage. Both plans are reviewed by DMIRS and RCWA against defined requirements before the grant of approval to operate.

4.2.4 Planning approvals

The Shire of Dandaragan has advised that planning approval is not required for the proposal.

4.3 Part V of the EP Act

4.3.1 Applicable regulations, standards and guidelines

The overarching legislative framework of this assessment is the EP Act and EP Regulations.

The guidance statements which inform this assessment are listed in Appendix 1.

4.3.2 Works Approvals

Works Approval W5935/2015/1 was issued on 10 March 2016 to authorise the initial mine construction works. An administrative amendment was subsequently conducted in June 2016 relating to changes to the ambient air monitoring requirements and ASS controls for mine pits above the water table.

4.3.3 Licence amendment – April 2020

The licence holder submitted an amendment application for the following:

- inclusion of additional aquifer reinjection wells around proposed pits 15 and 16;
- inclusion of a cell within pit 9 for future deposition of ModCod (Pit 9a), as a contingency in the event pit 11 is not available in time; and
- change the pH limit for dewatering water in Table 10 to match the pH management trigger in Table 11.

4.3.4 Clearing of Native Vegetation

Clearing of native vegetation in Western Australia requires a clearing permit, unless exemptions apply. Under Schedule 6 of the EP Act, clearing assessed under section 40 of the EP Act as part of a proposal referred under section 38 of Part IV of the EP Act does not require a clearing permit, providing the clearing is done in accordance with the Implementation Agreement or Decision.

The EPA has assessed the clearing of remnant vegetation within the areas to be mined and clearing for access. The authorised extent of clearing has been limited to a maximum of 156 ha, as described and spatially defined in MS 1017.

5. Modelling and monitoring data

5.1 Acid sulfate soils investigations

Previous ASS studies

Several ASS studies have been conducted at the Cataby deposit over the years.

In 2004, Environmental Geochemistry International conducted a preliminary acid rock drainage survey for a portion of the deposit, which identified several potential acid-forming (PAF) materials in the eastern strandline, north of Cataby Brook.

In 2006, Soilwater Consultants conducted a detailed ASS survey on the area where PAF materials were identified in the 2004 study, as at the time, mining was to commence in the eastern strandline, north of Cataby Brook. The results indicated that no ASS or PASS were likely to be present, with 98% of samples tested having pH_F values > 5, most samples tested having pH_{FOX} > 4, and black or black/grey soils being observed in the area.

In 2010, Soilwater Consultants conducted a desktop ASS study using all geological drilling data,

previous ASS study results and pedogenic relationships identified at other Iluka minesites on the coastal plain. This review indicated that the site was generally not conducive to ASS formation and hosting, with only small, isolated regions identified as areas where ASS may occur, occurring as localised zones of black to dark grey clays, both above and below the current watertable.

Recent ASS study

The most recent ASS investigation was conducted in 2012 by Soilwater Consultants (SWC, 2012). A total of 5,359 soil samples from 136 drill holes were collected across the proposed mine pits, with sampling frequency increased in areas where black soils were expected.

The depth of drilling varied from 27 – 59 m (average hole depth 40 m), intersecting all surficial geological formations (Bassendean, Guildford and Yoganup), and with all drill holes extended at least 2 m below the base of the proposed mine pit. Selected holes were extended to depths > 60 m to intersect the basal Leederville and Yarragadee Formations.

5.1.1 Results

The key results from the 2012 soil sampling and associated analytical testing include:

- in-situ pH (pH_F) values for all samples tested varied from 4.2 to 8.9, which is typical of soils on the Swan Coastal Plain and reflects their poor buffering capacity. Approximately 2% of samples tested had a pH_F between 4 and 5, indicating that oxidation may have previously occurred within these soils;
- oxidised field pH (pH_{FOX}) values for all samples tested varied from 1.4 to 8.3. Approximately 2.6% of samples had a pH_{FOX} value < 4, indicative of potential ASS (PASS). Less than 1% of all samples tested had a pH_{FOX} value < 3.5;
- a comparison of the results of screen testing (pH_F and pH_{FOX}) with soil colour showed the majority of samples (> 95%) that experienced a large drop in pH following oxidation (i.e. pH_{FOX} value < 3) were black or dark grey in colour. This result indicates that soil colour can be a useful management tool for the field identification of PASS;
- the results of acid-base account analyses, using the Suspension Peroxide Oxidation-Combined Acidity and Sulfate (SPOCAS) testing suite, showed the majority of samples tested (94%) had a S_{CR} value below the Limit of Reporting (0.005 %S). Nine samples (1.8%) were above the DWER Assessment Criterion of 0.03% S (DER, 2015b), with the remainder between 0.005% S and 0.03% S; and
- chip-tray incubation tests found that for the majority of soils, the pH values after the 16-week incubation (pH_{INC}) showed little change from the original pH values, indicating that negligible oxidation had taken place. In contrast, samples associated with black clays had a pH_{INC} that was at least 1 pH unit lower than the original pH, but had not dropped to as low as the pH_{FOX}, indicating that oxidation of the black clays was incomplete over the 16-week incubation period.

Table 9: Pit mining volumes and predicted ASS

Pit No.	Total mined volume (m^3)	Mined ASS volume (m^3)	Mined ASS (%)
2	22,478,000	24,000	0.1
8	15,314,000	600,000	3.9
13	1,933,000	6,000	0.3
14	5,026,000	153,000	3.0
15	4,322,000	4,500	0.1
16	8,078,000	252,000	3.1
Total of all pits[1]	***130,280,000***	***1,039,500***	***0.8***

Note 1: Includes volumes to be mined from pits where no ASS has been detected.

The findings of all the ASS studies were incorporated into a geological block model for the mine to quantify the volumes of ASS present and their spatial distribution in relation to mining and groundwater drawdown from mine dewatering. The estimated volume of ASS predicted to occur within the mine pit shells is 1,039,500 m3 (Table 9), which is less than 0.8% of the total volume of material to be excavated during mining.

The volume of ASS outside of the pits but within the modelled drawdown zone was estimated to be 3,339,000 m^3, which is considered to be conservative as the drawdown contours were based on worst-case responses and did not consider the impacts on the surrounding watertable of aquifer re-injection and other measures that will be used to minimise impacts to ecosystems that are ground and water dependent.

5.1.2 DWER technical review

DWER's review of the *Cataby Deposit Acid Sulfate Soil Survey – RevC1* (SWC, 2012) and the updated *ASS Management Plan* (Iluka, 2018) identified that:

- The investigations conducted were carried out in an appropriate staged manner, and the conceptual site model developed for determining the distribution of sulfide minerals in the deposit is also considered to be sound and should form a suitable basis for managing the disturbance of sediments during mining;
- The proposed management of excavated black/dark grey clays and sandy clay in pits where the overburden is disturbed above the water table is considered to be technically sound and is supported;
- It is recommended that Total Acidity be included in the monthly groundwater monitoring suite carried out on-site, as it is a more sensitive indicator of groundwater acidification than changed in pH on their own. Trigger values for acidity should also be developed based on the upper threshold limit (UTL) value of background levels in groundwater in the area. Additional sampling should be undertaken where the UTL is triggered, following by full chemical analysis;
- It is recommended that field tests of pH, acidity and electrical conductivity be undertaken at least weekly on the mine dewatering water, to enable a rapid response to any changes in pH and acidity that may occur during active dewatering. If trigger levels for these field parameters are exceeded, the dewatering water should be resampled and chemically analysed for the full suite of chemical parameters;
- Contingency measures listed for managing the risk of sulfide oxidation in sediments that contain sulfide minerals are suitable. However, only limited information has been provided about how groundwater might be managed in the event that drawdown leads to contamination of groundwater by metals.

Key Findings:

1. Given the relatively low percentage of PASS materials identified at the site, the disturbance of ASS should be manageable.
2. The proposed management measures for all black/dark grey clays and sandy clays are considered to be technically sound and should ensure that all PASS at the site will be treated and disposed of in a timely manner, which will mitigate the risks of adverse environmental impacts being caused by these materials.
3. Weekly field tests for pH, acidity and electrical conductivity should be conducted on the mine dewatering water, to enable a rapid response to changes in pH and acidity.

5.2 Noise model

The licence holder has undertaken a noise impact assessment for the project using the noise modelling software *SoundPLAN 7.3*, to predict noise levels at each nearby receiver under five scenarios that are considered to represent the different phases of mining throughout the life-

of-mine. The CONCAWE algorithms were selected for the model, as it includes the influence of wind and atmospheric stability (SVT, 2015).

5.2.1 Results

The model predicts exceedances of the assigned noise levels at 18 of the 23 identified neighbouring receivers, with the most significant exceedances (up to 18 dB(A)) predicted during evening and night time mining scenarios.

The highest noise levels are predicted at NSR1 (Liberty, Glassy's Hat Hotel & Roadhouse), NSR2 (Caltex Truck Stop) and NSR3, which are located within the Premises boundary. NSR1 is an operating licensed hotel owned by the licence holder, and has on-site residential accommodation. SVT (2015) notes it will be challenging to manage noise at these receivers due to the high noise and close proximity.

Noise levels are predicted to exceed the assigned levels at NSR13, NSR14, NSR15 and NSR16, particularly during the evening and night time in scenarios 2, 3 and 4, and exceedances will be highest during calm or southerly wind conditions. However, the 'Stop Sequence' analysis indicates that noise compliance can be achieved at these receivers with significant levels of equipment relocation during night time mining.

Night time noise exceedances (up to 6.5 dB(A)) are predicted at NSR4, NSR6, NSR8, NSR12, NSR17 and NSR18. The 'Stop Sequence' analysis indicates that noise compliance will be difficult to achieve, and will require substantial reductions in mining activities under certain meteorological conditions.

SVT has recommended replacement of the CAT 651B watercarts in the mine design, which are a lower noise alternative. This has been shown to be effective at reducing noise at all receptors, and also reducing the instances of predicted tonality.

SVT considers Iluka's 'What-If' noise management tool is critical in managing noise levels, and the licence holder should continue to seek amenity agreements or other arrangements with NSR13, NSR14, NSR15 and NSR16 if the mine noise emissions or operating times cannot be reduced.

5.2.2 DWER technical review

DWER's review of the *Cataby Minesite Noise Environmental Impact Assessment* (SVT, 2015) identified that:

- The methodology of the noise modelling and selection of the operational scenarios seem acceptable, and the predicted noise impacts are considered to be reliable;
- Based on the information provided, the project appears to be a noise non-compliance project. The noise emission levels from the mining operations are predicted to exceed the assigned levels by up to 18 dB(A) at nearby sensitive receivers, depending on the operational scenario, meteorological conditions, time of day and presence of tonality.
- Although the licence holder has proposed a number of noise mitigation and management measures, it is unlikely that even if fully implemented, these measures would be able to bring the project into noise compliance, due the proximity of neighbouring receivers; and
- The EPA has noted the high risk of noise non-compliance and has recognised the licence holder's commitments to provide alternative arrangements, such as noise attenuation of residential properties, and pursuing amenity agreements with the closest receivers.

Key Findings:

1. The noise model predicts the project is unable to comply with the Noise Regulations, particularly during evening and night time mining scenarios, due to the proximity of nearby sensitive receivers.
2. A number of noise mitigation and management measures have been proposed by the licence holder, such as bunding, noise monitoring, using a real-time noise management model to plan and manage mobile and fixed plant activities with regards to actual and predicted

meteorological conditions, and relocating mobile equipment or modifying operations. Despite these measures and considering the abovementioned finding, the acceptability of noise to nearby receptors will be heavily reliant upon amenity agreements being in place between the licence holder and the receptors.

6. Location and siting

6.1 Siting context

The Premises is located in the State's coastal Wheatbelt region, approximately 20 km from the coast and 150 km north of Perth.

The site is located along the foot-slopes of the Gingin Scarp, which is the prominent landform feature of the area. The Brand Highway, a major infrastructure route between the Mid West region and Perth, runs along the eastern flank of the proposed mine pits, and partly within the Premises boundary.

The surrounding area is predominantly agricultural and includes a number of public reserves that have been vested for conservation and recreational purposes. Immediately north of the Premises is the Cooljarloo Mineral Sands Mine (operated by Tronox).

6.2 Residential and sensitive premises

Farm residences make up most of the identified residential and sensitive receptors in the vicinity of the Premises. Two roadhouses are located along the Brand Hwy and within the Premises boundary, with each of these including motel-style accommodation. The Liberty Roadhouse, which is located immediately adjacent to Pit 9/12, includes a licensed hotel and is owned by the licence holder.

A total of 23 receptors have been identified in proximity to the Premises (Figure 6). It is noted the former-Tronox worker's accommodation camp, which is located on the mine path and will soon be decommissioned, is currently being used by mine construction workers. However, in accordance with DWER's *Guidance Statement: Risk Assessment*, it has not been considered a receptor location for the purposes of this assessment.

6.3 Physiography

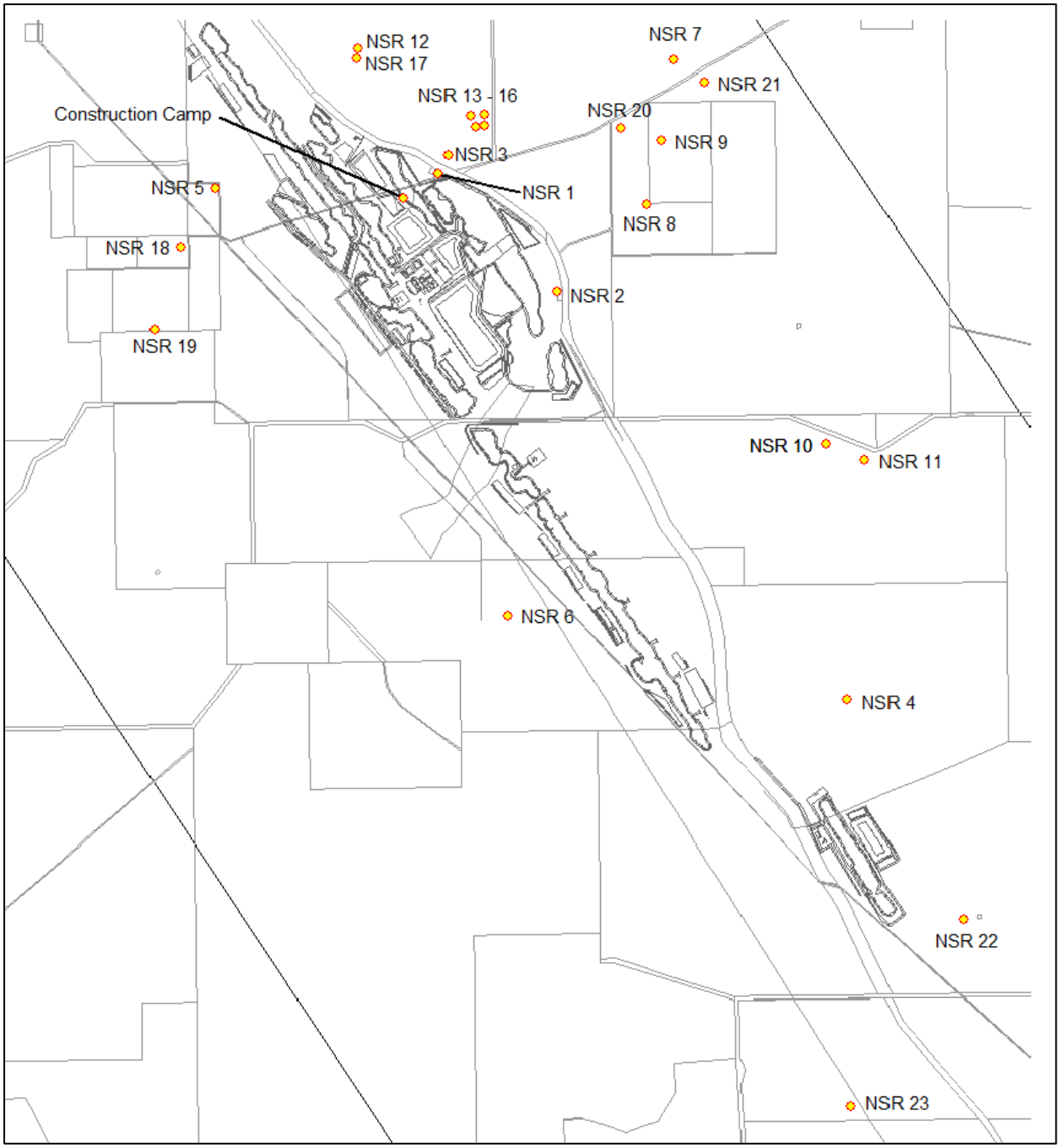
The Premises is defined by the Swan Coastal Plain physiographic unit, which is bounded to the east by the Gingin Scarp and the Indian Ocean to the west. It consists predominantly of cleared farmland.

The landscape mostly slopes westward and is drained by south-westerly-flowing watercourses. The general features of the area are typical of the Bassendean Sand complex, which covers most of the Swan Coastal Plain.

6.3.1 Geology

The Premises is located within the central part of the northern Perth Basin, a deep linear trough of sedimentary rocks that is bounded to the east by the Darling Fault and composed of up to 12 km of Permian to Quaternary sediments. The regional stratigraphy (Table 10) indicates three distinct depositional cycles in the sedimentary succession, with each cycle separated by a major unconformity in the form of an erosional surface.

The mineralised ore that comprises the Cataby deposit is hosted in the Late Tertiary Yoganup Formation. In the southern portion of the Premises, south of Mimegarra Rd, the mineralised deposits are underlain by the Leederville Formation, whilst in the north are underlain by Yarragadee sediments. A small portion of the south-eastern section of the deposit is likely to be underlain by the Mesozoic sediments of the Parmelia Formation.



▲ ***Figure 6: Location of sensitive receptors within proximity to the proposed mine***

Table 10: Regional stratigraphy

Age	Series	Stratigraphic successions
Quaternary	Holcene (recent)	Alluvium, Colluvium, Safety Bay Sand
	Late Pleistocene	Bassendean Sand, Tamala Limestone
	Pleistocene	Guildford Formation
Tertiary	Pliocence	Yoganup Formation, Ascot Formation
Unconformity		
Cretaceous		Leederville Formation
Unconformity		
Jurassic	Middle-Late	Yarragadee Formation
	Middle	Cadda Formation

	Early	Cockleshell Gully Formation
Triassic	Middle-Late	Lesuer Sandstone
	Early	Kockatea Shale

Basement materials

The Leederville, Parmelia and Yarragadee Formations consist of interbedded, weakly to well consolidated sandstone, siltstone, shale and claystone that, in the upper portions, have been deposited in a non-marine, primarily fluvial setting. The Leederville Formation sediments conformably overlie the Yarragadee and the Parmerlia Formations, and as such are considered to be in hydraulic continuity.

On the eastern margin of the deposit, the basement materials outcrop along the Gingin and Dandaragan Scarps.

Yoganup Formation

The mineralised sands of the Yoganup Formation unconformably overlie the Cretaceous Formations, resulting in an abrupt contact. The Yoganup Formation consists primarily of friable 'beach' sands which were deposited and developed during successive marine transgression and regression events. Given its predominantly sandy texture, it hosts the regional aquifer in a semi-confined system.

Guildford Formation

Following the last regression of sea levels in the Pliocene (Late Tertiary), alluvial, fluvial and colluvial conditions were favoured resulting in the deposition of the Guildford Formation. These conditions continued throughout the Pleistocene resulting in the development of thick (up to 30m) beds of primarily sandy clay to clay sediments directly overlying the sandy Yoganup Formation. Isolated zones of sand exist within the clayey Guildford sediments, in response to heterogeneous parent materials. These sandy zones are currently saturated resulting in isolated regions of groundwater within the predominately unsaturated clays.

Bassendean Sands

Unconformably overlying the Guildford Formation are a series of aeolian sand dunes corresponding to the Bassendean Dunal System. These dunes represent an eastern extension of the more widespread dunal system on the Swan Coastal Plain and often attain thicknesses of up to 10 m, playing an important role in controlling surface water movement throughout the region.

6.3.2 Landform and soils

The landform and soils of the Cataby area exhibit a diverse array of materials ranging from sands to sandy clays, with varying quantities of ironstone gravels. On the western side of the Premises, the soils are generally associated with the Bassendean Soil – Landscape System, which consists primarily of shallow to deep, pale grey, aeolian dunal sand overlying the alluvial/colluvial Guildford Formation clays.

In the central part of the Premises, the soils correspond to the Nyalgarda and Boothendarra Soil –Landscape System, consisting primarily of shallow sandy duplex soils. On the eastern and far northern and southern extensions of the deposit, the soils belong primarily to the Rowes and Yeeramullah Soil – Landscape Systems, consisting of deep colluvial yellow sands and residual sandy gravels, often overlying a lateritic duricrust or sandy clays.

6.4 Surface hydrology

The Swan Coastal Plain has numerous lakes and wetlands that are hydraulically connected to groundwater and are potentially important Groundwater Dependent Ecosystems (GDEs). There are a number of small lakes located near the Premises, including Lake Guraga, Namming Lake and a number of un-named lakes, many of which appear to be dry and some are salt encrusted. Most of these features are expected to be sites of local groundwater

discharge. Minty's Lake, located immediately south of the Premises, is understood to have formed in recent times as a result of land clearing and subsequent watertable rise.

A number of ephemeral streams or brooks flow across the scarp and form important wetlands and GDEs near the Premises:

- Minyulo Brook, which flows westwards through the northern part of the Premises to a series of permanent wetlands (Caro Swamp, Emu Lakes and Dog Hole). Emu Lakes is the largest, permanent freshwater lake in the Jurien-Dandaragan-Lancelin region and is of regional and local significance as providing habitat for native fauna, including several migratory bird species. The southern branch flows south-west into the seasonal Douaraba Swamp and semi-permanent Walyengarra Lake;
- Cataby Brook, which flows westwards through the centre of the Premises and into the Eneminga Nature Reserve, where it joins the Eneminga Swamp system; and
- Caren Caren Brook, which lies to the south of, and outside of, the Premises. This brook feeds into Namming Lake, before terminating at Lake Guraga.

These brooks are generally understood to be surface water features fed by rainfall runoff and overland flow crossing the scarp and are perched above the watertable on low permeability clay lenses and more extensive laterite horizons. They are not permanent watercourses and are dry at times.

6.5 Hydrogeology

The region features unconsolidated sediments of marine origin (Superficial Formations) located along the coast fringe and overlying the formations of the northern Perth Basin.

The Gingin Scarp represents the eastern limit of the Superficial Formations. The Dandaragan Scarp represents an impermeable barrier to horizontal groundwater flow that isolates the Premises from groundwater to the east of the scarp. The principal hydrogeological units present at the site are characterised by three major aquifer systems that are regionally extensive, being found throughout the coastal plain (Figure 7).

6.5.1 Superficial

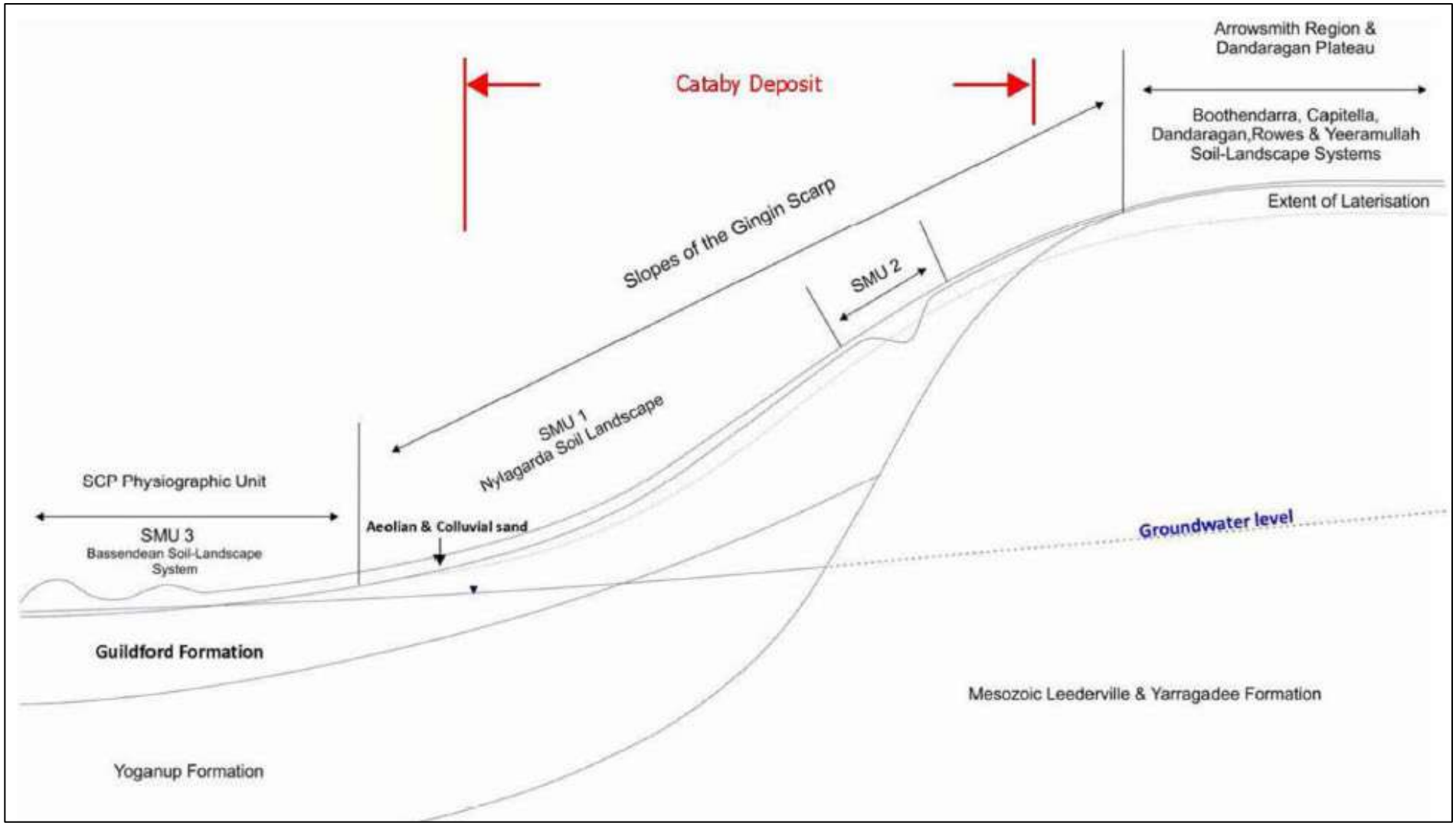
A water table aquifer system (Superficial Aquifer) occurs within the superficial formations beneath the Swan Coastal Plain. Locally, the aquifer system comprises the Guildford Formation (mostly above the water table) overlying the Yoganup Formation. The Guildford Formation is a clayey sand deposit that varies from 10 m deep (below the Swan Coastal Plain) to 30 m deep (along the Gingin Scarp) and forms the upper confining layer to the Yoganup Formation.

The Yoganup Formation hosts the heavy mineral deposits of the project. These sediments are predominantly sandy in texture, however clay-rich zones do occur having formed in an estuarine setting. The thickness of the Yoganup Formation varies from less than 10 m on the eastern side of the Gingin Scarp to over 30 m below the mid- and foot-slopes.

6.5.2 Leederville

The Leederville Aquifer is a significant regional multi-layered groundwater flow system spanning much of the Perth Basin and directly underlies the Superficial Aquifer. It consists of discontinuous interbedded sandstones, siltstones and shales. The Leederville Aquifer is not found continuously across the Premises and is absent in the northern part of the Cataby region, where the Yarragadee Formation outcrops of directly underlies the Superficial Formation.

Although there is no clearly defined aquitard overlying the Leederville, the lower elevations of this unit act as a confined aquifer reflecting the influence of poorly permeable clay and silt lenses present within the Leederville Formation that hinder the vertical movement of groundwater. While the Leederville Aquifer has a reported maximum thickness of about 550 m, it is thinner than this at the Premises.



▲ Figure 7: Conceptual local hydrogeology cross-section

6.5.3 Yarragadee

The Yarragadee Aquifer is a regional confined multi-layered groundwater flow system aquifer formed by the Yarragadee Formation and Gage Formation. Locally, the Yarragadee Aquifer successions have a thickness greater than 2,800 m, comprised of interbedded sandstones, siltstones and shales. It is overlain by the Leederville Aquifer in the southern part of the Cataby region and either outcrops or is in direct connection with the sediments of the Superficial Aquifer (the Yoganup and Guildford Formations) in the northern parts of the region.

6.5.4 Laterite deposits

Cemented sands (laterite deposits) are commonly observed in mineral sands deposits where the current and historical water table fluctuations and/or hiatus to deposition have resulted in the accretion of hard, cemented sands of low permeability. They have been noted and, in places, mapped across the Premises, where they play a role in restricting vertical groundwater movement within otherwise permeable strata. This effect is important in providing hydraulic separation at some locations between the sands that host the mineral deposits and a) the underlying Leederville and Yarragadee Aquifers of substantial thickness and in some circumstances b) the overlying shallower, often clay-rich units.

6.5.5 Groundwater occurrence and flow

The hydrogeology of the local area comprises a throughflow system, with groundwater flowing in a west to south-west direction towards the coast. Groundwater generally has total dissolved solids (TDS) of less than 2,000 mg/L, with higher concentrations known to occur along some drainage lines and wetland bodies where evaporation is active, and also near streams (e.g. Minyulo Brook) which receive saline runoff from farming areas.

Groundwater levels vary in relation to topography. To the east of the Gingin Scarp levels can be quite deep (20 – 45 mbgl), where to the west groundwater is significantly shallower and in the order of 10 – 15 mbgl.

6.5.6 Groundwater quality

Groundwater in the Superficial aquifer is generally of the sodium-chloride type, with magnesium exceeding calcium concentrations (in a ratio consistent with magnesium being derived from seawater).

Monitoring to date has shown pH ranging from 4.66 (very strongly acidic) to 9.36 (very strongly alkaline), with an average 6.18 (slightly acidic). Local alkalinity at several sites is possibly associated with local environments. The acidic nature has been interpreted to be rain-derived due to the dissolution of carbon dioxide to form carbonic acid with little to no buffering capacity in the groundwater.

Generally groundwater in the Superficial aquifer is less than 1,000 mg/L TDS, with some localised brackish groundwater (up to 3,000 mg/L TDS) occurring near swamps, lakes and drainage lines where evaporation of shallow waters is evident.

6.5.7 Groundwater dependent ecosystems

GDEs are found on the coastal plain to the west of the Premises where the water table is shallow, particularly at the foot of the scarp where there is enhanced recharge and a change of topographic slope.

Wetlands and lakes generally occur in topographic lows where the ground surface dips below the water table. Some wetlands including a number of brooks, occur above the water table and are formed as perched systems on low permeability clay-rich sediments and lateritic deposits that hinder the vertical movement of water in the unsaturated zone. Many of these features are rainfall and runoff dependent and recede with dry weather.

Based predominantly on depth to groundwater, a total of 33 terrestrial and wetland remnants within the Cataby project area have been identified as being potential GDEs that are at risk of

mining impacts, with sites to the west of the Premises likely to have a greater dependence on groundwater, given the shallower depth to the watertable in this area.

Several wetlands identified as GDEs occurring to the west of the Premises are also dependent on surface water inflows and therefore maybe impacted by changes to surface water flow regimes.

The location of potential GDEs in relation to the Premises is shown in Figure 8.

6.6 Native vegetation

The Premises is characterised by cleared pasturelands that are used to graze cattle and sheep. Remaining native vegetation is fragmented across the landscape and often completely degraded as a result of grazing. The Premises is adjacent to a number of regionally significant conservation reserves.

A total of 18 blocks of remnant vegetation have been identified in and around the Premises – the majority of which has been rated as being 'completely degraded', with only selected sections along with Brand Hwy road reserve as being in 'very good' to 'excellent' condition.

6.6.1 Vegetation types and conservation significance

Remnant vegetation in and around the Premises has not been recorded as threatened or priority ecological communities.

One area identified as the 'Oliver Remnant' has been recognised as having high conservation value, despite its degraded condition, due to its floristic features (presence of threatened and priority species) and as a breeding area for the endangered Carnaby's Black Cockatoo. The 'Oliver Remnant' contains both flora and fauna of the mixed Wandoo/Marri woodland complex that follows the channel of the Cataby Brook.

6.7 Physical environment

6.7.1 Climate

The Cataby area has a Mediterranean climate that is characterised by warm to hot, dry summers and cool, wet winters.

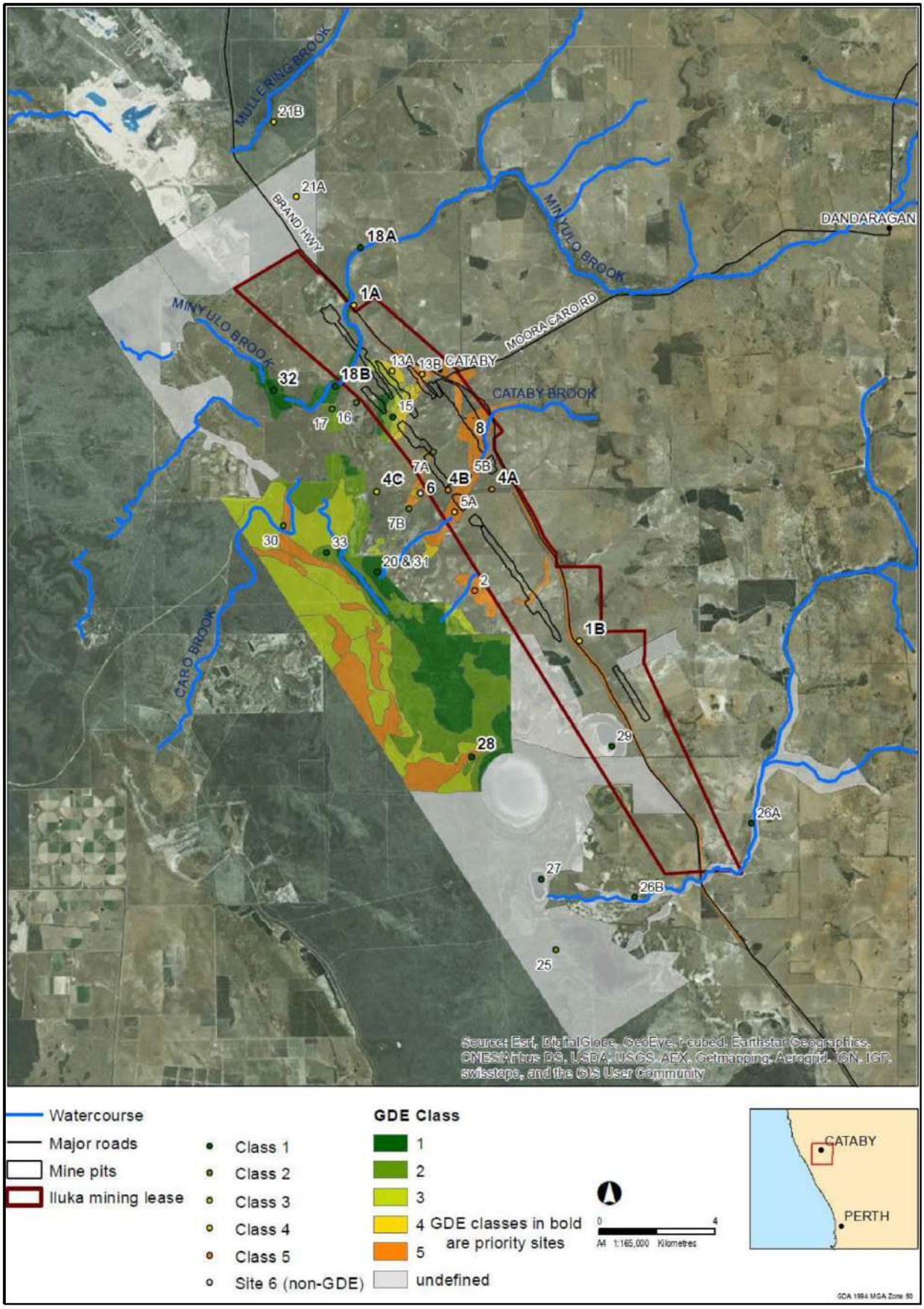
Weather patterns are dominated by the regular passage of rain-bearing cold fronts from the Indian Ocean in winter, and dry easterly air flows from inland areas in summer. Rainfall progressively declines in northerly and easterly directions (i.e. as distance from the coast increases).

6.7.2 Wind direction and strength

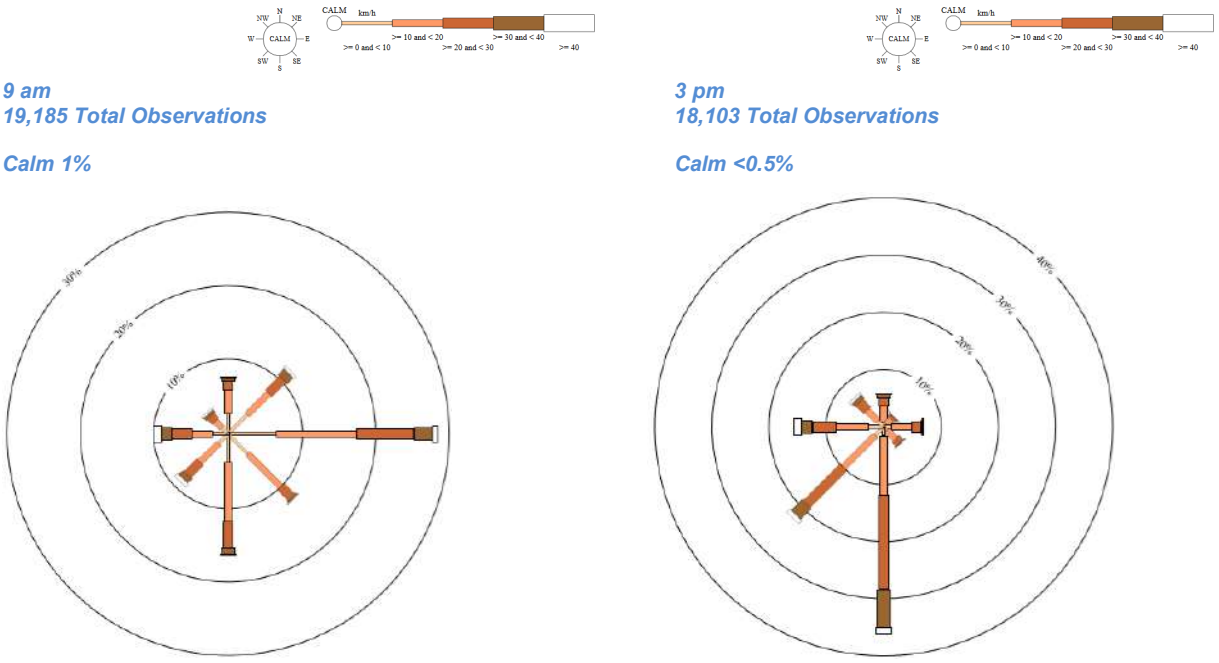
The nearest Bureau of Meteorology weather station is located at Lancelin (Site number 009114), approximately 35 km south-west of the Premises.

The average wind direction at 9 AM and 3 PM is presented in Figure 9▲ *Figure 9*. The following wind roses represent the various percentage of wind occurrences recorded during the period 1965 – 2018 (BoM, 2018).

On-site observations by the licence holder indicate winds can vary seasonally in the area, with the majority of winds between 10 and 30 kph, and gusts of up to 40 kph. Winter winds are from the north-east in the mornings, changing to westerlies in the afternoon. Spring and summer winds are from the east in the morning, shifting to south-westerlies in the afternoon. Autumn winds are from the north-east in the morning, changing to south-westerlies in the afternoon.



▲ ***Figure 8: Potential Groundwater and Surface Water Dependent Ecosystems***

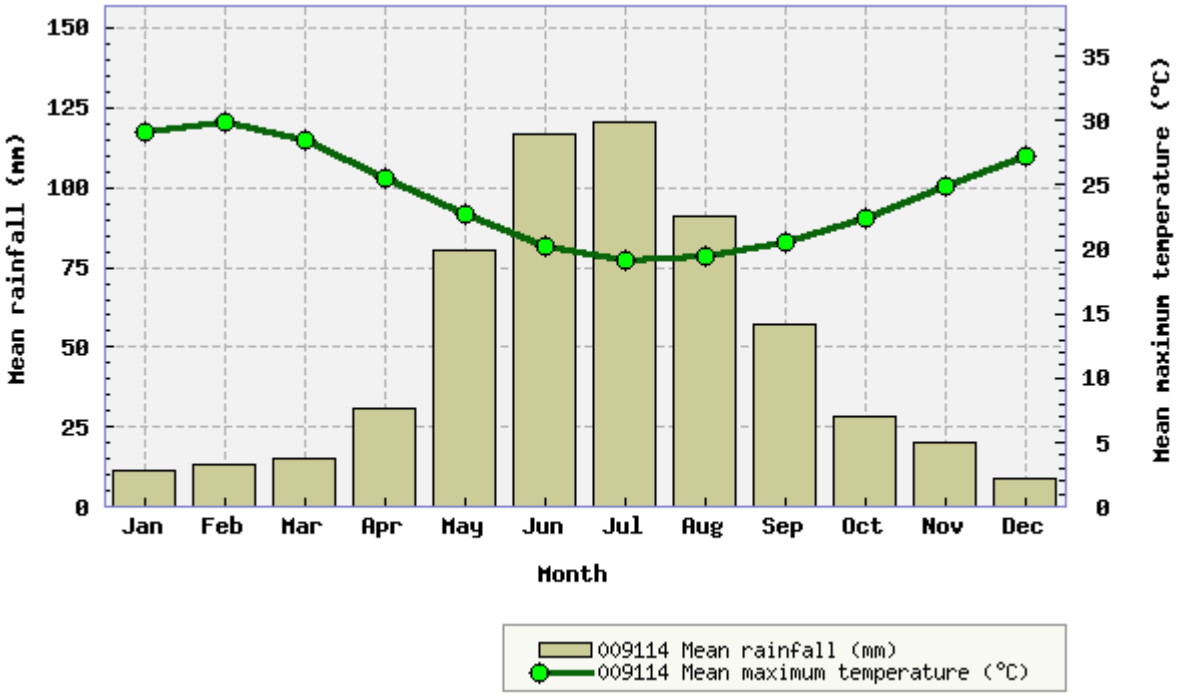


▲ ***Figure 9: Wind roses, Lancelin 1965 – 2018 annual average at 09:00 am and 3:00 pm***

6.7.3 Rainfall and temperature

According to the Köppen-Geiger climate classification system, Cataby is considered a hot-summer Mediterranean climate, where there is at least 3 times as much precipitation in the wettest month of winter as in the driest month in summer, and the driest month in summer receives less than 30 mm. The average temperature is 18.4 °C and annual average rainfall over the past 60 years is approximately 660 mm.

Over an average year both average monthly rainfall and evaporation rates are highly seasonal (Figure 10). Evaporation exceeds rainfall in all but the wettest months and annual evaporation is three times higher than annual rainfall.



▲ ***Figure 10: Average rainfall and maximum temperature for Lancelin 1965 – 2018***

7. Risk assessment

7.1 Determination of emission, pathway and receptor

In undertaking its risk assessment, DWER will identify all potential emissions pathways and potential receptors to establish whether there is a risk event which requires detailed risk assessment.

To establish a risk event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission. Where there is no actual or likely pathway and/or no receptor, the emission will be screened out and will not be considered as a risk event. In addition, where an emission has an actual or likely pathway and a receptor which may be adversely impacted, but that emission is regulated through other mechanisms such as Part IV of the EP Act, that emission will not be risk assessed further and will be screened out through Table 11.

The identification of the sources, pathways and receptors to determine risk events are set out in Table 11 below.

Table 11: Identification of emissions, pathway and receptors during mining operations

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Pre-mining works	Clearing of native vegetation	Noise, dust	23 residences within 2 km radius (4 receptors within the Premises) Users of the Brand Hwy	Air / wind dispersion	Amenity and human health impacts	No	Clearing of native vegetation is regulated through MS 1017.
	Topsoil stripping and O/B removal	Oxidation of ASS	Groundwater, groundwater dependent vegetation	Leaching from in situ material	Groundwater contamination (acidification)	Yes – refer to section 9.6	Potential impacts on groundwater quality and environmental values.
		Noise	23 residences, users of the Brand Hwy (see above)	Air / wind dispersion	Amenity impacts	Yes – refer to section 9.4	Potential impacts on amenity to nearby receptors.
		Fugitive emissions (dust)			Amenity and human health impacts	Yes – refer to section 9.5	Potential impacts on amenity to nearby receptors.
Category 8: Mineral sands mining or processing: premises on which mineral sands ore is mined, screened, separated or otherwise processed	Mining and processing of ore	Oxidation of ASS	Groundwater, groundwater dependent vegetation	Leaching from in situ material	Groundwater contamination (acidification)	Yes – refer to section 9.6	Potential impacts on groundwater quality and environmental values.
		Noise	23 residences, users of the Brand Hwy (see above)	Air / wind dispersion	Amenity impacts	Yes – refer to section 9.4	Potential impacts on amenity to nearby receptors.
		Fugitive emissions (dust)			Amenity and human health impacts	Yes – refer to section 9.5	Potential impacts on amenity to nearby receptors.
			Vegetation, including riparian vegetation adjacent to mine voids		Soil contamination, etc. (see above)	No	Dust loading on vegetation from mining and processing of ore has not been further risk assessed due to the temporary nature of the mining operation (7 years). Any actual dust impacts can be regulated under the provisions of Section 49 of the EP Act.
		Contaminated stormwater	Surface waters, wetlands, ecosystems adjacent to stockpiles	Direct discharge	Contamination of surface waters, etc. (see above)	Yes – refer to section 9.7	Potential impacts to off-site environmental values; erosion and sedimentation.
	Return water pipelines	Rupture of pipeline causing return water discharge to land or waters	Vegetation, including riparian vegetation adjacent to pipeline alignment	Direct discharge	Soil and surface water contamination, etc. (see above)	Yes – refer to section 9.8	Potential impacts to surface waters, wetland, ecosystems adjacent to the pipeline alignment.
	Stockpiling of HMC	Seepage of water entrained within the HMC to groundwater	Groundwater, groundwater dependent vegetation	Through base of HMC pad	Groundwater contamination	No	The HMC stockpile pads are constructed with compacted clay/gravel hardstand with underdrainage. Pads are also sloped to direct surface water runoff to collection sumps, which drain to the dirty water pond for reuse in the mining operation. The risk of adverse impacts is considered to be Low, based on engineering controls implemented by the licence holder as part of the works approval.
					Groundwater mounding	No	
		Contaminated stormwater	Surface waters, wetlands, ecosystems adjacent to stockpiles	Direct discharge	Contamination of surface waters, etc. (see above)	No	
		Dust lift-off	21 residences, users of the Brand Hwy (see above)	Air / wind dispersion	Amenity and human health impacts	No	The risk of impacts from dust-lift off of HMC stockpiles is considered to be Low, given the location of the HMC stockpiles relative to sensitive receptors, including native vegetation and other off-site receptors.
			Vegetation, including riparian vegetation adjacent to stockpile		Soil contamination, etc. (see above)	No	
	Disposal of sand tailings (mine void)	Seepage of water entrained within the sand tailings to groundwater	Groundwater, groundwater dependent vegetation	Through base of mine void	Groundwater contamination	No	Sand tailings (consisting principally of silica sand) to be returned to the mine void will have undergone wet separation only and are unlikely to contain contaminants that might otherwise be present in sand tailings that have undergone secondary processing (i.e. mostly clean sand). As the HMC will be transported off-site for secondary processing, no tailings will be returned for disposal. The material risk of groundwater contamination from sand tailings is therefore considered to be Low.
					Groundwater mounding	No	See comment for mine dewatering below.
		Rupture of pipeline causing mine tailings discharge to land or waters	Vegetation, including riparian vegetation adjacent to pipeline alignment	Direct discharge	Soil and surface water contamination, etc. (see above)	Yes – refer to section 9.6	Potential impacts to surface waters, wetland, ecosystems adjacent to the pipeline alignment.
	'ModCod' cells	Seepage of water entrained within the tailings to groundwater	Groundwater, groundwater dependent vegetation	Through base of pond	Groundwater contamination	No	See comment for mine dewatering below.
					Groundwater mounding	No	

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
		Rupture of pipeline causing tailings discharge to land or waters	Vegetation, including riparian vegetation adjacent to pipeline alignment	Direct discharge	Soil and surface water contamination, etc. (see above)	Yes – refer to section 9.8	Potential impacts to surface waters, wetland, ecosystems adjacent to the pipeline alignment.
		Dust lift-off	23 residences, users of the Brand Hwy (see above)	Air / wind dispersion	Amenity and human health impacts	Yes – refer to section 9.5	Potential impacts on amenity to nearby receptors.
			Vegetation, including riparian vegetation adjacent to cells		Soil contamination, etc. (see above)	No	Dust loading on vegetation from mining and tailings operations has not been further risk assessed for the reasons stated above.
		Overtopping/breach of containment causing discharge to land or waters	Vegetation, including riparian vegetation adjacent to pond	Direct discharge	Soil and surface water contamination, etc. (see above)	No	'ModCod' cells are to be constructed within active or completed mine voids, therefore there is no risk of overtopping or breaching of the containment.
	Naturally Occurring Radioactive Materials (NORM)	Seepage to groundwater	Groundwater, groundwater dependent vegetation	Lateral or vertical seepage through base of mine void	Groundwater contamination	No	Radiation management is regulated by DMIRS.
Category 6: Mine dewatering: premises on which water is extracted and discharged into the environment to allow mining of ore	Dewatering	Excess mine water	Groundwater, groundwater dependent vegetation	Direct discharge (aquifer reinjection)	Groundwater mounding	No	The Delegated Officer notes there has been a significant emphasis on potential impacts from dewatering drawdown on the shallow groundwater resource and nearby environmental values, and that this aspect has been subject to rigorous assessment under Part IV (regarding protection of GDEs) and the RIWI Act. In order to offset drawdown impacts, re-infiltration and re-injection of mine water is proposed as key mitigation strategies. Groundwater modelling (Jacobs, 2014) has considered all potential sources of recharge (including seepage from ModCod cells), and a detailed tiered trigger response management framework has been developed through the GDE Management Plan and the GOS, to ensure that only acceptable water quality is discharged and that unacceptable mounding does not occur from recharge activities. The Delegated Officer is therefore satisfied the potential for groundwater mounding and contamination from discharge/recharge activities has been risk assessed as part of the operating strategies for managing the potential impacts of mine dewatering and excess water disposal on GDEs, and that these issues can be adequately managed under the existing provisions of the GOS. Controls will be imposed on the licence to specify the authorised discharge locations (infiltration basins and re-injection bores), in addition to discharge quality criteria based on background data. Groundwater monitoring conditions will also be imposed to enable oversight of potential mounding and contamination issues, and additional conditions may be imposed, should the provisions of the GOS become ineffective.
					Groundwater contamination	No	
					Groundwater drawdown	No	Managed under Part IV and the RIWI Act.

7.2 Consequence and likelihood of risk events

A risk rating will be determined for risk events in accordance with the risk rating matrix set out in Table 12 below.

Table 12: Risk rating matrix

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Medium	Medium	High

DWER will undertake an assessment of the consequence and likelihood of the Risk Event in accordance with Table 13 below.

Table 13: Risk criteria table

Likelihood		Consequence		
The following criteria has been used to determine the likelihood of the Risk Event occurring.		The following criteria has been used to determine the consequences of a Risk Event occurring:		
			Environment	Public health* and amenity (such as air and water quality, noise, and odour)
Almost Certain	The risk event is expected to occur in most circumstances	Severe	• **onsite impacts**: catastrophic • **offsite impacts local scale**: high level or above • **offsite impacts wider scale:** mid-level or above • Mid to long-term or permanent impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are significantly exceeded	• Loss of life • **Adverse health effects:** high level or ongoing medical treatment • Specific Consequence Criteria (for public health) are significantly exceeded • **Local scale impacts:** permanent loss of amenity
Likely	The risk event will probably occur in most circumstances	Major	• **onsite impacts**: high level • **offsite impacts local scale**: mid-level • **offsite impacts wider scale**: low level • Short-term impact to an area of high conservation value or special significance^ • Specific Consequence Criteria (for environment) are exceeded	• **Adverse health effects:** mid-level or frequent medical treatment • Specific Consequence Criteria (for public health) are exceeded • **Local scale impacts**: high level impact to amenity
Possible	The risk event could occur at some time	Moderate	• **onsite impacts**: mid-level • **offsite impacts local scale**: low level • **offsite impacts wider scale**: minimal • Specific Consequence Criteria (for environment) are at risk of not being met	• **Adverse health effects:** low level or occasional medical treatment • Specific Consequence Criteria (for public health) are at risk of not being met • **Local scale impacts:** mid-level impact to amenity
Unlikely	The risk event will probably not occur in most circumstances	Minor	• **onsite impacts**: low level • **offsite impacts local scale**: minimal • **offsite impacts wider scale**: not detectable • Specific Consequence Criteria (for environment) likely to be met	• Specific Consequence Criteria (for public health) are likely to be met • **Local scale impacts:** low level impact to amenity
Rare	The risk event may only occur in exceptional circumstances	Slight	• **onsite impact**: minimal • Specific Consequence Criteria (for environment) met	• **Local scale**: minimal to amenity • Specific Consequence Criteria (for public health) met

^ Determination of areas of high conservation value or special significance should be informed by the *Guidance Statement: Environmental Siting.*

* In applying public health criteria, DWER may have regard to the Department of Health's *Health Risk Assessment (Scoping) Guidelines.*

"onsite" means within the Prescribed Premises boundary.

7.3 Acceptability and treatment of Risk Event

DWER will determine the acceptability and treatment of Risk Events in accordance with the Risk treatment in Table 14 below:

Table 14: Risk treatment table

Rating of Risk Event	Acceptability	Treatment
Extreme	Unacceptable.	Risk Event will not be tolerated. DWER may refuse application.
High	May be acceptable. Subject to multiple regulatory controls.	Risk Event may be tolerated and may be subject to multiple regulatory controls. This may include both outcome-based and management conditions.
Medium	Acceptable, generally subject to regulatory controls.	Risk Event is tolerable and is likely to be subject to some regulatory controls. A preference for outcome-based conditions where practical and appropriate will be applied.
Low	Acceptable, generally not controlled.	Risk Event is acceptable and will generally not be subject to regulatory controls.

7.4 Risk Assessment – Impact to off-site receptors from noise emissions

7.4.1 Description of risk event

Noise from operating heavy earthmoving equipment and fixed plant, impacting on the amenity of nearby off-site receptors.

7.4.2 Identification and general characterisation of emission

Noise will be generated from the operation of mobile earthmoving equipment and fixed plant as part of mining and processing activities. Mining, screening and processing of ore will occur continuously (24 hours per day).

A Noise Impact Assessment carried out by SVT (2015) predicted exceedances of the assigned noise levels at 18 of the 23 identified neighbouring receivers, depending on the mining scenario, meteorological conditions, time of day and presence of tonality. The most significant exceedances (up to 18 dB(A)) were predicted during evening and night time mining scenarios (refer to section 5.2).

DWER notes that monitoring and interpreting noise from the mining operation is likely to be complex due to the underlying environmental setting, described as follows:

- Wind generated noise – the site is located on the footslopes of the Gingin Scarp, which is considered to influence local wind conditions due to high-speed winds blowing west from the landform towards the scarp. These wind conditions are likely to enhance the propagation of sound, causing noise emissions to travel increased distances;
- Ambient rural noise – the site is located within a rural setting that exhibits low ambient noise levels, especially at night time, which is likely to provide an amenity value for residents who have chosen a rural lifestyle. Noise generated from the mining operation will be a new noise source within a low ambient environmental setting, and will likely be intrusive to residents in proximity to the mine;
- Wildlife noise – noise emitting wildlife such as birds, insects and cattle may significantly contribute to the overall noise levels when measured, which may complicate data analysis and cause difficulties in attributing tonal emissions to the operations;
- Other anthropogenic noise – the Brand Hwy runs parallel to the eastern boundary of the

Premises, which is a major infrastructure route used frequently by freight trucks and other vehicles. The passing trucks are likely to exhibit tonal frequencies that are similar to, and occasionally in excess of, the tonal characteristics emitted from the mining operation.

The underlying environmental setting therefore adds a level of complexity in attributing noise emissions and tonal characteristics to the mining operation, as the mine is not the exclusive source of noise in this location.

7.4.3 Description of potential adverse impact from the emission

Noise can cause nuisance and a reduced quality of life and health for human populations, particularly when the source is located near sensitive receptors. Noise can affect the psychological status of human populations nearby in terms of emotional stress, anger and physical symptoms. Frequency, intensity, duration, meteorological conditions and distance to receptor are all factors which may affect the impact of noise emissions on sensitive receptors.

7.4.4 Criteria for assessment

Noise Regulations

The *Environmental Protection (Noise) Regulations 1997* (Noise Regulations) operate as a prescribed standard under the EP Act in Western Australia. DWER is responsible for administering the Noise Regulations.

Assigned levels

The Noise Regulations (part two) deal with noise passing from one premise to another, and outlines the allowable noise emissions that may be received at different types of receivers on specific days and times (regulation eight). A summary of the assigned levels applicable to the Application is set out in Table 15.

Table 15: Assigned noise levels applicable to the Application

Type of premises receiving noise	Time of day	Assigned level (dB(A))		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80

The $L_{A\ 10}$ noise level is the most significant for the Premises, as this is representative of the continuous noise emissions expected during mining operations, and is the level which is not to be exceeded for more than 10% of the Representative Assessment Period.

The Noise Regulations note that an emission of noise found in breach of regulation seven (if applicable) is a prescribed alteration of the environment and is likely to be unreasonable, and may be defined as pollution (as per s.3A of the EP Act).

Penalties

In addition to noise levels, penalties may also apply if noise is emitted with annoying characteristics, i.e. noise that is tonal (contains a definite note or pitch, e.g. whining, droning), impulsive (is brief and abrupt, e.g. banging, thumping) or modulated (has a repeated cyclic pattern, e.g. like a siren). The provision for tonal emissions is +5 dB(A).

Construction sites

Under Regulation 13, noise from construction work on construction sites need not comply with the assigned noise levels when the work is carried out between 0700 and 1900 hours (excluding Sundays and public holidays), is conducted in accordance with AS 2436, and the equipment used is the quietest reasonably available.

For noise to be exempted under Regulation 13 the site must meet the definition of a *construction site* and the work must meet the definition of *construction work*. DWER considers that although some activities during operation of a mineral sands mine may be considered to be construction, they do not meet the definition of construction work under Regulation 13, as they are considered to be part of the actual mining activity, i.e. overburden removal and stockpiling of ore for commissioning.

Must take reasonable measures

Section 51(b) of the EP Act requires occupiers of premises to take all reasonable and practicable measures to prevent or control emissions. The onus is therefore on the mine operator to ensure that impacts to amenity are as low as reasonably practicable, even if noise levels comply with the Noise Regulations.

7.4.5 Licence holder controls

The licence holder has prepared a noise management plan, which provides a range of mitigation and management measures to reduce the impact of noise on the surrounding environment, as described in Table 16 below.

Table 16: Licence holder's proposed controls for noise emissions

Management control	Details
Model verification and review	Review and verify noise model during first 12 months of operation: - verifying predicted noise data at selected receptors; - updating noise source data used in the model; and - review data from reference locations.
Pre-shift planning	Undertake noisiest activities during day time hours
	Use of predictive tool such as a 'What-If' model or similar, to predict noise levels at receptors and allow proactive management of the mining fleet
'Buy Quiet' policy	Ensure mining contractor has equipment rated as having the lowest noise emissions practicable
Site design and planning	Placement of ROM and HMC stockpiles around the fixed processing plant to provide some noise attenuation
	Placement of overburden stockpiles at active mining areas to act as noise bunding
	Placement of MUPs in pits at least 5 m below the natural ground level

	where practicable and safe to do so
	Installing pumps within enclosures and behind stockpiles
	Installing hard-wired dewatering pumps instead of generators in close proximity to receptors
Control at source	Noise suppression modifications to mobile equipment may include: - affixing noise bafflers to radiators; - installing sound enclosures lined with absorbent material around the engine bay; - installation of noise curtains behind engines; - installation of rubber seals to noise suppression equipment; - installation of special mufflers and redirection of exhaust to maximise ground absorption; and - modification to engines - use of broadband reversing alarms instead of beepers
	Equipment noise levels will be checked annually to ensure it meets the required noise levels
Amenity agreements	In place with owners and occupiers of properties in proximity to the project
Stakeholder relations	Mine Manager to meet regularly with surrounding landholders, to keep them informed of site activities and discussions of any issues
Training and induction	Workers to be trained on noise management strategies with individual responsibilities highlighted
	Mine planners, supervisors and operators to undergo specific environmental noise training, to ensure mining fleet is managed in compliance with the Noise Regulations
Adaptive management	Continuous real-time monitoring of noise emissions at two permanent locations, and use of a mobile noise monitoring station
	Real-time data to assist in management of the fleet during operations, and allow real-time assessment of noise emissions to help verify the materiality of any noise complaints
	Setting internal alert and action levels, to initiate plant and equipment management measures, e.g. relocation of equipment

7.4.6 Key findings

The Delegated Officer has reviewed the information regarding the risk of noise emissions and has found:

1. The noise model predicts the project will be unable to comply with the Noise Regulations at all times, particularly during evening and night time mining scenarios, due to the proximity of nearby sensitive receivers.
2. A number of noise mitigation and management measures have been proposed by the licence holder, such as bunding, noise monitoring, using a real-time noise management model to plan and manage mobile and fixed plant activities with regards to actual and predicted meteorological conditions, and relocating mobile equipment or modifying operations. Despite these measures and considering the abovementioned finding, the acceptability of noise to nearby receptors will be heavily reliant upon amenity agreements being in place between the licence holder and the receptors.
3. Due to the complex and largely unpredictable environmental setting, in addition to the high risk of noise non-compliance, the EPA formed the view that it is appropriate for noise to be regulated under Part IV of the EP Act. The monitoring, management and control of noise emissions at the Premises will therefore be regulated by DWER under MS1017.

7.4.7 Consequence

The Noise Regulations prescribe the allowable levels of noise that can be received at a receptor. Noise received above the allowable levels is considered unacceptable; however noise may also be considered unacceptable if emitted in a manner that is not as low as reasonable practicable, even if the received levels are below the allowable level.

The consequence of noise emissions exceeding the allowable levels at nearby receptors, or emitted in a manner that is not as low as reasonable practicable, may result in impacts to amenity, causing concern and complaints – particularly if it disturbs sleep at night. The level of impact to amenity can be influenced by many factors, including the amplitude of the exceedance (e.g. 1 dB is barely noticeable, compared to 10 dB which is usually twice as loud), the length of the exceedance, the time of day of the exceedance (night vs. day), or if it contains annoying characteristics (i.e. tonality, impulsiveness or modulation).

The Delegated Officer therefore considers the consequence of noise emissions from operations causing impacts to the amenity of nearby receptors to be **Moderate**.

7.4.8 Likelihood of Risk Event

The Delegated Officer notes that mineral sands mines are complex sites involving many different activities that produce different types of noise, that vary depending on the time of day and type and location of the mining activities. In addition the mining of mineral sands, in general, is a progressive process whereby new pits are opened and as the mine progresses old pits are backfilled. Given the temporary nature of the mining process, the impact of noise on any one particular receptor is unlikely to be constant and/or consistent throughout the life of mine, as the mine path progresses.

In DWER's experience of previous and existing mineral sands mines, noise emissions can become a significant issue for sensitive receptors in close proximity to mines that have continuous (24 hours per day) operations. This is particularly common for mines located in quiet, rural areas where background noise levels are very low, i.e. < 20 dB(A), and therefore any increase in noise levels is likely to be considered intrusive to nearby receptors.

In considering the noise modelling for the Project, the Delegated Officer considers it **Almost Certain** that noise emissions from mining operations will cause impacts to the amenity of nearby receptors (at one point in time or another, most likely under worst case meteorological conditions and during specific mining scenarios).

7.4.9 Overall rating of noise emissions

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 12) and determined that the overall rating for the risk of noise emissions causing impacts to the amenity of nearby receptors is **High**.

7.5 Risk Assessment – Impact to off-site receptors from fugitive emissions (dust)

7.5.1 Description of risk event

Dust generated from mining operations, causing adverse impacts on the health or amenity of nearby receptors and users of the Brand Hwy.

7.5.2 Identification and general characterisation of emission

Dust, or total suspended particulate matter (TSP), is comprised of coarse particulate matter (CPM), which is generally comprised of particles greater than 10 micron (µm) in diameter, and the respirable fraction comprised of particles less than 10 µm in diameter (PM_{10}). The majority of dust generated during the operation of a mineral sands mine is CPM, being comprised of unprocessed mineral oxide particles.

Sources of dust from mining operations may include fugitive dust from exposed mining areas, open areas or rehabilitated surfaces, overburden/topsoil/product/waste stockpiles, movement of vehicles along haul roads and access tracks, and the mining, screening, processing and transporting of ore.

7.5.3 Description of potential adverse impact from the emission

Potential impacts from dust emissions are:

- Visibility for highway traffic;
- Inhalation risk to human health; and
- Nuisance dust/visual amenity.

The Mid West region experiences a mild Mediterranean climate with hot/dry summers and mild/wet winters. The climate is strongly influenced by seasonal wind patterns, with the local area known for its strong off and on-shore winds (summer sea breezes frequently reach 40 kph or more).

The licence holder has identified 23 receptors in the vicinity of the Premises, which includes both Iluka-owned and private residences as well as commercial properties. Six receptors have been identified by the licence holder as being at high risk of being impacted from nuisance dust during strong prevailing winds from the south to south-west, and one farm house when the strong prevailing winds come from the north to westerly direction. However receptors most at risk are those located adjacent to mine pits 6, 8, 9, 12 and 13, with the northern Cataby roadhouse being at greatest risk due to the strong prevailing southerly wind conditions.

In addition the Brand Hwy, being a primary road and major transport route, runs immediately adjacent to the western boundary of the Premises (the Brand Hwy is considered to be a sensitive land use).

Dust emissions can be harmful to human health and the environment. Human health effects of dust tend to be associated with PM_{10} and $PM_{2.5}$, which remain suspended in the air for longer periods and can penetrate into the lungs. Elevated TSP levels may cause nuisance impacts, however the finer particle fraction (< PM_{10}) may pose a health risk as indicated above.

In DWER's experience of regulating mineral sands mines, fugitive dust during adverse weather conditions can also cause concern or complaints from residents within proximity to the mine, particularly those who suffer from asthma or hayfever. Other common complaints include impacts on amenity (hanging out washing, entertaining outdoors, etc.), and the response time of the mine to resolve excessive dust when the receptor is being/has already been impacted.

7.5.4 Criteria for assessment

Separation distance

DWER considers a minimum separation distance of 1,000 – 2,000 m is required between mineral sands mining operations and sensitive land uses, to minimise the risk of impacts from light overspill, dust and noise.

Air quality standards

There are no directly applicable ambient air quality standards for the Premises.

The Ambient Air Quality NEPM provides a benchmark against which the risk of adverse health effects arising from exposure to PM_{10} (from any source) can be assessed (but is not considered a regulatory standard), and is shown in Table 17.

Table 17: Ambient Air Quality NEPM – Standards for pollutants

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances
Particulates as PM_{10}	24 hours	50 µg/m^3	None
	Annual	25 µg/m^3	

The Kwinana EPP also provides an equivalent ambient air quality standard and limit with respect to TSP emissions from industry. Given the siting context and distances to residential and sensitive receptors, the standard and limit set for Policy Area B (industrial premises not considered heavy industry) is considered to be the most relevant and is shown in Table 18.

Table 18: Kwinana EPP ambient air quality standards and limits for TSP

Policy Area	Averaging period	TSP standard	TSP limit
Area B	24 hours	90 µg/m^3	260 µg/m^3

7.5.5 Licence holder controls

The licence holder has prepared a dust management plan to outline its approach to managing fugitive dust emissions arising during mine operations. A summary of the proposed controls are set out in Table 19 below.

Table 19: Licence holder's proposed controls for dust emissions

Activity	Mitigation/management action
Dust Management Working Group	Consists of the site manager, mine superintendent, mining contractor, rehabilitation superintendent, environmental superintendent, dust control officer and environmental specialist
	Group to meet on a monthly basis when mining in Pits 6, 8, 9, 12 and 13, to review the effectiveness of on-site dust management
Operational controls	Short-term weather forecasting
	Internal monitoring of works areas to ensure boundary exceedances are avoided
	Competency testing of operators undertaking dust suppression
	Maintenance log books to be used and audited for dust control equipment
	Adaptive management through proactive dust mitigation strategies
	Dedicated water/slimes carts being operated at each operational area identified as being at risk to elevated dust emissions in the vicinity of sensitive receptors
Weather forecasting	Short-term (72 hour) local forecasting of wind speed, direction, inversion potential and rainfall, coupled with specific dust control work programs, to provide early warning and preparation for potential high dust conditions
Source and engineering controls	Wind erodible areas – planned incremental topsoil clearing; perimeter bunding as additional dust entrapment devices; open areas to be stabilised with suppressant (other than water); large stockpiles to be stabilised; wind barriers, etc.
	Overburden handling and haulage – clay fines sprayed to non-working areas; dedicated water trucks for in-pit suppression; haul roads graded and watered when necessary; synthetic stabilisers trialled if water ineffective; water cannon or misters trialled on working pit faces; on-site vehicle speed limits enforced
	Light vehicle and other traffic – additional pre-emptive water cart use in response to local weather reports; application of chemical dust suppressants in dust-prone areas; minimising area open to road infrastructure; stabilising/rehabilitating closed vehicle tracks; reducing vehicle activity during high dust conditions
	Dozer and grader activity – additional water carts, water cannons and stabilising

	agents used when necessary
	Front end loader activity – operator control of dump height and feed rate
	Mining units – conveyor and sizing activity mitigated through side curtains and low drop heights; misting spray bars to be used to target specific areas
Monitoring	Monitoring of TSP and PM_{10} at fixed locations using real-time monitoring - one monitor located at the northern roadhouse (high risk receptor); - one monitor located near the AWS (background monitoring); - data monitored 24 hours at the WCP control room;
	Alarm triggers to be integrated into the WCP monitoring system;
	Mobile monitoring to be conducted at nearest receptors during seasonally high winds, in addition to on-site monitoring in proximity to work areas;
Contingency actions	Trigger: visual assessment identifies dusty conditions on-site Initial response: determine cause of dust; determine if potential for impacts – if so, implement appropriate management actions; Follow-up actions: report through internal system; determine whether change in management procedures is required to prevent reoccurrence; implement changes
	Trigger: on-site monitoring identifies high dust levels at source Initial response: verify by visual inspection; determine cause; inform activity manager(s); activity manager(s) implement dust control procedures; Follow-up actions: monitoring dust levels to confirm controls effective; if not, report to area manager and review alternative actions; report through internal system; implement changes
	Trigger: visual assessment identifies dust crossing Brand Hwy Initial response: determine cause of dust; if persistent, and activity-specific, cease activities until conditions improve; implement appropriate management actions Follow-up actions: communicate to neighbouring stakeholders; determine whether change in management procedures is required to prevent recurrence; implement changes; report to DWER as required
	Trigger: dust complaint received Initial response: discuss with complainant to aid determining dust source; implement appropriate management actions; monitor dust levels to confirm controls effective Follow-up actions: report through internal system; determine whether change in management procedures is required to prevent recurrence; implement changes; follow up with complainant
	Trigger: monitoring indicates licence criteria exceeded Response: determine cause; cease activities as required; identify change to management practice to prevent reoccurrence; implement changes; report through internal system; report to DWER

7.5.6 Key findings

The Delegated Officer has reviewed the information regarding the risk of fugitive dust impacting on sensitive receptors and has found:

1. The local area is strongly influenced by seasonal wind patterns, and is known for strong off- and on-shore winds.
2. There are a number of sensitive receptors within proximity to the Premises, located to the east, that are considered at high risk of being impacted by fugitive dust.
3. A high level of regulatory control is required through the Licence to ensure fugitive dust does not impact on off-site receptors.

7.5.7 Consequence

The consequence of TSP impacting on sensitive receptors located off-site or on the Brand Hwy is likely to be of nuisance value, causing amenity impacts by settling on surfaces and causing soiling and/or discolouration (**Minor**).

The consequence of PM_{10} impacting on sensitive receptors is likely to constitute exposure to a hazard with short-term adverse health effects (requiring treatment) and impact to amenity for short periods (**Moderate**).

7.5.8 Likelihood of Risk Event

Given the proximity of sensitive receptors and their location in the landscape, in addition to the prevailing local weather conditions, and the inadequate level of dust controls proposed by the licence holder, the Delegated Officer considers it **Likely** that TSP and PM_{10} generated from the Premises will impact on sensitive receptors (at one point in time or another, most likely under worst case meteorological conditions and during specific mining scenarios).

7.5.9 Overall rating of fugitive emissions (dust)

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 12) and determined that the overall risk rating for fugitive emissions (dust) causing impacts to the health and/or amenity of nearby receptors is **High**.

7.6 Risk Assessment – Sulfide oxidation (Acid Sulfate Soils)

7.6.1 Description of risk event

Direct disturbance (i.e. physical movement) or indirect disturbance (e.g. lowering of the water table) of ASS, causing acidification of groundwater and degradation of water quality and other environmental values.

7.6.2 Identification and general characterisation of emission

ASS occur naturally in soils and sediments that contain iron sulfide minerals (principally as the mineral pyrite) and/or their precursors. These minerals are typically found at shallow depth (less than 3 m deep) in low-lying areas near the coast and are harmless when left in a waterlogged, undisturbed environment, but have the potential to cause environmental problems due to the generation and release of sulfuric acid when exposed to air through drainage, dewatering or excavation (DER, 2015c).

Sulfidic sediments may also occur at depths greater than 3 metres on the coastal plains, which can be disturbed by large-scale sand mining operations. Although the general principles for managing these deeper sulfidic sediments are similar to that of managing shallow acid sulfate soils, the scale of mining operations and the characteristics of these deeper sediments can cause additional hazards on disturbance that require careful management to prevent environmental problems taking place.

ASS investigations at the site have identified pyritic sediments (Potential ASS, PASS) are likely to occur within small localised regions within the project area, and generally associated with lenses of black to dark grey/black lagoonal clays and sandy clays (refer to Section 5.1). These lenses are unevenly distributed across the Premises, predominantly in the Guildford Formation (sometimes above the groundwater table) and Yoganup Formation.

Approximately 1 million cubic metres of ASS material is estimated to be directly disturbed by mining, which constitutes ~1% of the total material proposed to be mined, and a further 3 million cubic metres within the soil profile surrounding the mine pits that might be affected by groundwater drawdown during mine dewatering.

7.6.3 Description of potential adverse impact from the emission

ASS pose a number of significant environmental risks such as:

- Deoxygenation – the oxidation process consumes oxygen, and in extreme cases can remove all of the oxygen from the water column, resulting in the death of aquatic organisms;
- Release of metals and metalloids – many heavy metals (such as cadmium and lead) and metalloids (such as arsenic) form sulfidic minerals, which if oxidised, are released into the pore water or into the overlying water column, where they may be incorporated into animal or plant tissue and potentially into the food chain; and
- Impacts on public health – loss of amenity (preventing aquatic ecosystems being used for recreation), the generation of four odours (including toxic hydrogen sulfide), and impaired drinking water.

7.6.4 Criteria for assessment

The DWER guideline *Identification and investigation of acid sulfate soils and acidic landscapes* (DER, 2015c) is the accepted framework in Western Australia for assessing and managing environmental risks associated with ASS.

The framework underpins the management of ASS and water resources to avoid unacceptable impacts and involves:

- developing a sound conceptual model for the site, including an understanding of local hydrogeological conditions, of the distribution of sulfide minerals, and of the presence of sensitive environmental receptors;
- identifying risk mitigation measures on the basis of the conceptual model, and making firm commitments that these measures will be implemented; and
- developing a long-term contingency plan, incorporating a commitment to undertake appropriate monitoring accepted by regulatory agencies.

The assessment is undertaken in an iterative manner where the suitability of site-specific data for making reliable management decisions is repeatedly questioned until a consensus is reached between the licence holder, DWER and other regulatory agencies (i.e. DMIRS).

7.6.5 Licence holder controls

The licence holder has developed a conceptual model for the site, including a description of local hydrogeological conditions, the spatial distribution of sulfide minerals and the presence of environmental receptors (SWC, 2012). A risk management strategy has been developed on the basis of the conceptual model (Iluka, 2018), and is based on:

- reliable identification and mapping of ASS materials;
- understanding the potential environmental effects of exposure to ASS;
- disposing of non-mineralised ASS material below the watertable with minimal delay; and
- ensuring the processing of mineralised ASS is conducted in a manner that does not create current or future environmental issues.

A summary of management and contingency strategies is provided in Table 20 below.

Table 20: Licence holder's proposed controls for managing ASS

Type	Proposed controls
Soil management	
Action criteria	Any material with pH_{FOX} less than 3.5 and/or S_{CR} more than 0.03% S will be considered ASS

Overburden – Bassendean Sand/ Guildford Clay	All black/dark-grey clays and sandy clays will be presumed to be ASS (unless verified not to be ASS) and managed depending on whether the pit is being mined above or below the water table: - where pits are being mined below the water table, ASS material will be disposed below the watertable without delay; - where pits are being mined above the water table, ASS material will be buried within-pit under clean non-ASS material as soon as practicable (no later than 70 hours after exposure); or blended within-pit with suitable neutralising agent in accordance with DWER guidelines (DER, 2013)
Oversize	Will be routinely disposed below the watertable, unless verified to not be ASS
Ore/ROM	Ore will be processed through the WCP as soon as possible to minimise the risk of stockpiled materials oxidising and producing contaminated leachates
	Stockpiling of ore will be avoided, however if required, will only be done in areas where seepage and runoff can be collected
HMC	Will be stockpiled on compacted limestone facilities that have been designed and constructed to minimise losses to groundwater by collecting seepage and runoff for monitoring and treatment, prior to reuse or disposal
Backfill	Backfill material (including tailings) confirmed to be ASS material will be treated with lime or other neutralising agent at rates determined by the net acid generating potential of the material (in accordance with DWER guidelines (DER, 2013)), prior to disposal in mined voids
Contingency treatment	If ASS materials are not able to be managed using the above methods, they may be blended with lime or other neutralising agent at rates determined by the net acid generating potential of the material (in accordance with DWER guidelines (DER, 2013))
Water management	
Dewatering	Mine pit dewatering will be managed in accordance with the GOS
	Dewatering bores will only be operated as necessary to dry mine and backfill active pits
Process water	In the event monitoring of process water quality detects an issue (e.g. acidification, liberation of metals), additional water quality control units will be integrated into the circuit (e.g. lime dosing to manage pH)
Excess water disposal system	Water quality will be monitored in dewatering sumps, infiltration basins and in the process water dams, to ensure water not meeting quality specified in the GOS is discharged via re-injection bores or infiltration
	Non-conforming water will be treated with lime or other neutralising agents or mixing with other water, if required, prior to disposal
Monitoring and response	
In situ overburden and ore	Soil tests when in areas of predicted ASS overburden or ore – soil tested to have pH_F < 4.0, or pH_{FOX} <3.5 will be treated as ASS
HMC stockpiles	Daily operational sampling (XRF TS%) when processing known ASS ore – if TS% > 0.03 then focus on leachate monitoring (3 x weekly for pH, field acidity and monthly groundwater quality underlying stockpiles)
Oversize (rock)	When processing known ASS ore, all oversize to be considered ASS and disposed below the watertable
Process tailings	Daily analysis of clay fines (S_{CR}) and sand tails (pH_{FOX} > 6.5 and SPOCAS method) when processing known ASS ore – ASS affected tailings to be identified and treated as required

Process water	When processing known ASS ore – 3 x weekly sampling of pH and field acidity, weekly sampling of TAlk, TDS, Cl, SO_4, Al, Fe (dissolved) – if pH < 4 and Cl:SO_4 < 2.0, analyse for major ion suite, water treatment initiated
Groundwater[1]	Monthly sampling of pH, Total Acidity, TAlk, TDS, Cl, SO_4, Al, Fe (dissolved) – if pH < 4 and Cl:SO_4 < 2.0, analyse for major ion suite, commence weekly monitoring and review long term trends
Surface water bodies	Monthly sampling when flowing of pH, Total Acidity, TAlk, TDS, Cl, SO_4, Al, Fe (dissolved) – if pH < 4 and Cl:SO_4 < 2.0, analyse for major ion suite, investigate potential cause

Note 1: Mine pit dewatering will be managed in accordance with the Groundwater Operating Strategy. The groundwater monitoring program will be undertaken to detect changes in groundwater quality that could be attributed to dewatering and off-site impacts. Monitoring will provide an early indication of adverse effects of ASS on local groundwater, both during operations and mine closure.

7.6.6 Key findings

The Delegated Officer has reviewed the information regarding the risk of sulfide oxidation and has found:

1. The low number of samples that tested positive for pyrite minerals suggests that ASS is manageable at the site.
2. Management and contingency measures proposed by the licence holder for managing the risk of sulfide oxidation in sediments that contain significant amounts of sulfide minerals appear suitable; however the risk of groundwater contamination by metals due to drawdown has not been addressed.
3. Trigger values for acidity should be developed based on the upper threshold limit value of background levels in groundwater in the area (likely to be ~100 mg/L $CaCO_3$). Where acidity levels are triggered, additional sampling should be undertaken, including full chemical analysis.

7.6.7 Consequence

If not detected or managed early, the consequence of direct and/or indirect disturbance of ASS can lead to long-term environmental impacts at a local level (**Moderate**).

7.6.8 Likelihood of Risk Event

The likelihood ASS disturbance causing long-term environmental impacts at the site is medium (**Possible**), if a regular screening and groundwater monitoring program is in place.

7.6.9 Overall rating of sulfide oxidation

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 12) and determined that the overall rating for sulfide oxidation is **Medium**.

7.7 Risk Assessment – Impacts from surface water runoff

7.7.1 Description of risk event

Discharge of surface water runoff, causing erosion and adverse impacts to watercourses and wetlands.

7.7.2 Identification and general characterisation of emission

Contaminants conveyed in stormwater discharges from active haul roads, access roads, heavy vehicle operating areas (e.g. ROM pad), hardstand areas (e.g. plant site), will vary. The activities, contaminant sources, and contaminants detailed in Table 21 are commonly found at mineral sands mine and related facilities.

Table 21: Stormwater contaminant sources and contaminants at mineral sands mines

Activity	Contaminant source	Contaminants
Heavy earthmoving equipment movements – active haul roads, access roads	Surface grading and exposure of soils	Dust, total suspended solids (TSS), total dissolved solids (TDS), turbidity, pH and oil and grease
Mining and processing activities	HMC storage	Dust, TSS, TDS, turbidity, sulfates, iron
	Overburden/topsoil storage	
	Mine voids	
	Materials handling and loading/unloading	
Equipment/vehicle maintenance	Fuelling activities	Diesel fuel, petrol, oil, chemical oxygen demand (COD)
	Parts cleaning	Solvents, oil, heavy metals, acid/alkaline wastes
	Disposal of oily rags, oil filters, batteries, coolants, degreasers	Oil, heavy metals, solvents, acids, COD
Rehabilitation	Site preparation for rehab	Dust, TSS, TDS, turbidity, pH

7.7.3 Description of potential adverse impact from the emission

Potential environmental impacts include:

- Changes to the flood regime (levels and velocities) through encroachment of specific mine pits on the Minyulo Brook floodplain, which may result in changes to the creek profile through erosion and impacts on vegetation communities; and
- Impacts to water quality as a result of the creek's proximity to the mining operations.

7.7.4 Licence holder controls

The licence holder has prepared a Surface Water Management Plan to outline its approach to managing stormwater runoff during mine operations. A summary of the proposed controls include:

- Runoff from undisturbed catchments upstream of and within the Premises will be diverted away from mine pits, infrastructure and other operational areas. The flow will be directed away from the mine infrastructure into existing drainage lines through bunding and local drains on the upstream side of the haul road. In particular, flood bunding around Pit 16 – Minyulo Brook and Pit 8, Pit 6 and Pit 5 – Cataby Brook will allow the majority of flows from the upstream catchments to flow through existing natural drainage pathways;
- Surface water runoff generated in active pits and non-rehabilitated areas (i.e. pits closed for less than or equal to 2 years) will be collected via sumps within the respective pits and pumped to the process water management system;
- Surface water runoff generated in disturbed sub-catchments (e.g. stockpiles, roads and rehabilitated areas, sub-catchments containing pits that area active or have been closed less than or equal to 2 years) will be diverted to stormwater management infrastructure (i.e. dams, ponds and drains), which has been sized to contain a 1:10 AEP 6-hour storm event;
- In large flood events overflow from the sedimentation ponds will be directed to mine pits where it will infiltrate or be used in the mine water management system.

7.7.5 Key findings

The Delegated Officer has reviewed the information regarding the risk of surface water runoff and has found:

1. Due to the size of the operation and there being two watercourses traversing the Premises, the licence holder has proposed a significant stormwater drainage system that would divert all stormwater runoff from disturbed sub-catchments to stormwater management infrastructure.
2. The risk of impacts is mitigated through the conceptual design of the stormwater drainage system, which is based on providing containment of a 1:10 AEP 6-hour event, after which flows report to adjacent mine pits and not off-site.

7.7.6 Consequence

The consequence of contaminated surface water runoff entering local drainage lines could lead to long-term environmental impacts at a local level (**Moderate**).

7.7.7 Likelihood of Risk Event

The likelihood contaminated surface water runoff causing long-term environmental impacts at the site is low (**Unlikely**), if an appropriate stormwater drainage plan is implemented.

7.7.8 Overall rating of impacts from surface water runoff

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 12) and determined that the overall rating of impacts from surface water runoff is **Medium**.

7.8 Risk Assessment – Slurry pipeline failure

7.8.1 Description of risk event

Failure of slurry pipelines, releasing mine tailings (sand tailings, silts and clay slimes,) into the environment and causing adverse impacts on surface waters, wetlands, native vegetation or soil over a localised area.

7.8.2 Identification and general characterisation of emission

Sand tailings, silts and clay slimes comprise the coarse-grained (typically quartz sand) and fine-grained (typically silt sized clay material) solid material remaining after the heavy mineral concentrate has been separated from the mined ore, and are slurried with process water to facilitate transfer.

Clay minerals have a great affinity for water, with the ability to soak up ions from a solution and release them when conditions change, which can result in the transportation/dispersion of contaminants from one area to another (USGS, 1999).

7.8.3 Description of potential adverse impact from the emission

A number of important wetlands and groundwater dependent vegetation occur down hydraulic gradient of the Premises (e.g. Caro Swamp, Emu Lakes, Dog Hole, Eneminga Swamp system, etc.). If spills or leaks of mine tailings reach these systems, it may cause contamination through sedimentation (increased concentration of suspended sediments (i.e. turbidity) and an increased accumulation of fine sediments) and potentially a number of other adverse effects on ecosystem health.

7.8.4 Licence holder controls

Pipelines from the WCP to the 'ModCod' cells will run parallel with mining haul roads. Once installed, secondary containment in the form of a 1m high earthen bunds will be created (Figure 11).

Pumps and slurry flow will be monitored with flow meters at designated pumping stations. The operator in the control room will monitor flow readings, and pressure gauges throughout the pipeline system will alert the operator of issues.

The licence holder considers that any spills or leaks from pipelines will be localised and contained on the Premises.

▲ ***Figure 11: Example of secondary containment to be constructed for all pipelines.***

7.8.5 Key findings

The Delegated Officer has reviewed the information regarding the risk of pipeline failure/overtopping of mine tailings infrastructure and has found:

1. There is a possibility that important wetlands and groundwater dependent vegetation may be impacted from a spill or leak of mine tailings.
2. The risk of impacts is mitigated for low velocity leaks by running pipelines adjacent to the mining haul road and below the natural ground surface.
3. Flow meters and pressure gauges on the pipelines should enable early detection of spills and/or leaks.

7.8.6 Consequence

The consequence of spills or leaks of clay slimes and/or sand tailings from pipeline failure would constitute a potential or actual alteration of the environment, with the potential for off-site impacts at a local scale (**Minor**).

7.8.7 Likelihood of Risk Event

The Delegated Officer considers that any spills or leaks of clay slimes or sand tailings will be localised and contained on the Premises, and is **Unlikely** to cause off-site impacts to environmental values.

7.8.8 Overall rating of pipeline failure

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 12) and determined that the overall rating for a pipeline failure causing impacts to environmental values is **Medium**.

7.9 Summary of acceptability and treatment of Risk Events

A summary of the risk assessment and the acceptability or unacceptability of the risk events set out above, with the appropriate treatment and control, are set out in Table 22 below. Controls are described further in section 1.

Table 22: Risk assessment summary

	Description of Risk Event			Licence holder controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting regulatory controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
1.	Noise	Heavy earthmoving equipment and fixed plant	Causing amenity impacts to off-site receptors	Equipment and operational controls Routine noise monitoring Setting noise trigger levels and contingency actions	Moderate consequence Almost certain likelihood **High Risk**	N/A	Regulated under MS 1017
2.	Fugitive dust	Exposed mining areas, stockpiles, vehicle movements, mining and processing activities	Causing health and/or amenity impacts to off-site receptors	Operational controls Routine dust monitoring Visible dust inspections	Moderate consequence Likely likelihood **High risk**	Acceptable subject to proponent controls conditioned and additional regulatory controls	Licence to specify: - Timing of dust generating activities - Must use dust suppression, both water and other than water - Dust monitoring during summer works - Limits apply for TSP and PM_{10} at monitoring sites - Must conduct an investigation into exceedances
3.	Acid Sulfate Soils	In situ soils with sulfide minerals	Groundwater contamination (acidification)	Neutralisation Strategic reburial Stockpiling Routine screening Groundwater monitoring	Moderate consequence Possible likelihood **Medium Risk**	Acceptable subject to proponent controls conditioned	Licence to specify: - Must monitor and manage dewatering effluent - Dewatering effluent trigger values – to trigger management actions - Field surveys of overburden - Treatment of PASS in overburden and ore - Groundwater monitoring of ASS parameters - Setting of ASS triggers based on UTC

	Description of Risk Event			Licence holder controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting regulatory controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
4.	Contaminated stormwater	Mine site runoff	Erosion, sedimentation and other effects on health of surface water ecosystems	Temporary diversion of drainage lines Bunding installed to divert sheet runoff around laydown/storage areas	Moderate consequence Unlikely likelihood **Medium Risk**	Acceptable subject to proponent controls conditioned	Licence to specify: - Design of hardstand areas, ROM pads, etc. to divert stormwater runoff to a constructed drainage depression or sedimentation basin
5.	Slurry pipeline failure	Direct discharge of clay slimes/ sand tailings	Sedimentation and other effects on health of surface water ecosystems	Routing of pipeline along haul roads Bunding (1 m high) Pressure/flow sensors Daily inspections	Minor consequence Unlikely likelihood **Medium Risk**	Acceptable subject to proponent controls conditioned and additional regulatory controls	Licence to specify: - Automatic cut-outs/secondary containment/pressure sensors to be maintained on pipelines - Inspections of infrastructure

8. Regulatory controls

A summary of regulatory controls determined to be appropriate for the risk event is set out in Table 22. The risks are set out in the assessment in section 7 and the controls are detailed in this section. DWER will determine controls having regard to the adequacy of the licence holder's controls. The conditions of the licence will be set to give effect to the determined regulatory controls.

8.1 Licence controls

8.1.1 Authorised emissions

A requirement had previously been imposed (formerly condition 1 on the original licence) to specify the authorised location(s) for disposal of mine tailings (waste sand and clay), fugitive dust emissions, noise emissions, indirect emissions to groundwater (i.e. seepage) and disposal of excess mine water via infiltration and aquifer re-injection.

Note: *The requirements specified in Table 2 of the original licence generally replicated the details provided in the mining proposal for the project.*

Table 2 of the original licence was linked to Schedule 2, which provided a list of the primary activities and primary infrastructure and equipment considered by the delegated officer in DWER's risk assessment of the original works approval application.

Grounds: *DWER's risk assessment is based on emissions and discharges as per the modelled scenarios provided in the original works approval application. The defence provisions of s.74, 74A and 74B may not apply to emissions and discharges that have not been modelled and therefore have not been risk assessed by DWER.*

The licence holder has advised that adaptive management of dust at the Premises may require the use of mobile equipment that differs from the number and type used in the modelling scenarios and as listed in Schedule 2 of the licence. Where this occurs, noise and dust must be managed to ensure compliance with the Noise Regulations and dust limits in the licence. If the number and type of equipment regularly differs from the equipment used in the modelling, it is recommended the licence holder apply for an amendment.

April 2020 amendment: *the format of the amended licence has been updated to the most recent DWER format, whereby condition 1 and the authorised emissions table has been replaced by a note that indicates the licence 'does not provide any implied authorisation for emissions, discharges or activities not specified in the licence'. The list of primary activities in Schedule 2 has been relocated to the front page of the amended licence.*

8.1.2 Construction works

The following infrastructure is authorised for construction during mining operations as per the design criteria and specifications outlined in the original works approval application:

Infrastructure	***Requirements (design and construction)***
'ModCod' storage cells	• *Must be constructed within active or completed mine voids;* • *Pond floors must sloped to allow the collection of supernatant water;*
Pipelines carrying clay slimes, sand tailings and return water	*Must be constructed with:* • *Automatic cut-outs in the event of a pipe failure; OR* • *Secondary containment sufficient to contain any spill for a period equal to the time between routine inspections; OR* • *Telemetry systems and pressure sensors along pipelines to allow detection of leaks and failures;*
ROM pads	• *Constructed with compacted overburden material or similar;* • *Drainage designed to divert stormwater runoff to a constructed drainage*

Infrastructure	Requirements (design and construction)
	depression or sedimentation basin.

Note: *The requirements specified in Table 1 of the amended licence generally replicate the design and specifications outlined in the original works approval application and have been determined as being required to mitigate potential risks identified in this report.*

Grounds: *DWER acknowledges the continuous nature of mineral sands mining and the need to incrementally construct/deconstruct temporary containment infrastructure, such as 'ModCod' storage cells, as the mine path advances. In order to avoid triggering s. 53 of the EP Act whenever a new pond is required, the licence provides an ongoing authorisation for construction, providing the construction is in accordance with specified design criteria, with compliance certification of as-constructed ponds to be provided within the next relevant annual environmental report.*

8.1.3 Infrastructure and equipment

The following environmental controls, infrastructure and equipment should be maintained and operated to manage the risk of impacts to environmental receptors (conditions 3, 4 & 5):

- Design capacity of all mining and processing infrastructure to be specified;
- HMC stockpile pads to be impervious, and designed to drain surface water runoff to a lined collection sump with sufficient holding capacity;
- Operational freeboard of 0.5 m vertical distance on 'ModCod' cells to be maintained at all times (whilst operating);
- Daily inspections of freeboard capacity and pipelines for visual integrity and leak assessment to be conducted, to enable early detection and proactive management; and
- Installation of industry standard safeguards for all pipelines carrying tailings and HMC, such as the use of automatic cut-outs, secondary containment, or telemetry and pressure sensors to allow detection of leaks and failures.

Note: *The requirements specified above generally replicate the licence holder's controls, and were considered in determining the risk of impacts to environmental receptors from operation of specified infrastructure and equipment.*

Additional controls have been determined as being required to mitigate potential risks identified in this report.

Grounds: *All major mining infrastructure and their current design capacities have been specified in the licence to reflect the current maximum production capacity of the Premises (as provided by the licence holder). Any proposed alterations that would increase the design capacity of this infrastructure will require reassessment in accordance with s. 53 of the EP Act.*

Operational freeboard requirements on 'ModCod' cells, the use of safeguards for pipelines containing materials that could otherwise pose a risk to the environment, and conducting daily inspections of pipelines and containment infrastructure have been considered necessary to minimise the risk of accidental releases, spills or leaks of mine tailings.

Given the potential quality of water contained within the HMC that will be allowed to drain from the stockpile (i.e. low pH, high salinity), the minimum design specifications for the pads, including surface water runoff and seepage controls, has been specified commensurate to this risk.

8.1.4 Disposal of mine tailings

A control has been imposed (Condition 6) to specify the nominated location(s) as the authorised disposal area(s) for mine tailings.

Note: *The requirements specified in Table 4 of the amended licence are generally consistent with the mine closure plan for the Premises.*

Grounds: *DWER's risk assessment is based on the disposal of mine tailings in the locations specified in the approved mine closure plan (Iluka, 2015a). Disposal of mine tailings in locations other than those specified has not been risk assessed, and the defence provisions of s.74, 74A and 74B would therefore not apply.*

Sand tailings must be disposed within any of the completed mine voids, or stockpiled separately at the WCP for later placement into mine voids. Clay slimes must be thickened and blended with sand tailings and disposed within 'ModCod' storage cells as a wet slurry. Provision for the use of clay slimes as dust suppressant on the Premises has also been included within Table 4.

April 2020 amendment: *Pit 9 on the map of emission points in Schedule 1 has been amended to include a new ModCod disposal location, delineated 'Pit 9a' (Pit 9 was previously denoted as a pit for sand tails only). This is a contingency measure in the event Pit 11 is not available in time for the disposal of ModCod.*

8.1.5 Emissions to groundwater

Controls have been imposed (Conditions 7 & 8) to specify the nominated location(s) as the authorised disposal points for excess mine water.

Note: *The requirements specified in Table 5 of the amended licence are generally consistent with the groundwater operating strategy for the Premises.*

Grounds: *DWER's risk assessment is based on the disposal of excess mine water in the locations specified in the approved groundwater operating strategy (Iluka, 2017c). Disposal of excess mine water in locations other than those specified has not been risk assessed, and the defence provisions of s.74, 74A and 74B would therefore not apply.*

This disposal of excess mine water for the purposes of recharging and maintaining the hydrological regime of GDEs is exempted from this condition, if conducted in accordance with the GDE management plan (Iluka, 2017a) and the groundwater operating strategy (Iluka, 2017c).

April 2020 amendment: *an additional 22 injection wells will be constructed in proximity to Pits 15 & 16 as part of planned adaptive management strategies to manage surplus dewatering water and mitigate the impacts of groundwater drawdown within the mine path dewatering zone. The additional wells are required to manage realised aquifer response to re-injection and technical capacity of existing injection wells.*

The delegated officer has determined the construction of additional wells will not result in a change to the material risk of the aquifer reinjection activities at the site, providing the disposal of excess mine water is conducted in accordance with the GDE management plan (Iluka, 2017a) and the groundwater operating strategy (Iluka, 2017c).

8.1.6 Fugitive dust controls

A number of fugitive dust controls have been specified in condition 9 (Table 7) of the amended licence, including:

- Controls during topsoil stripping;
- Use of water carts and sprays;
- Use of dust suppressants (other than water);
- Conditions under which activities must cease; and
- Monitoring and setting trigger levels.

Note: *The requirements specified in Table 7 generally replicate the management measures outlined in the licence holder's dust management plan (Iluka, 2015c), however more detail has been added.*

Grounds: *In considering the strong prevailing winds in the locality, a high level of regulatory control is required through the licence to mitigate the risk of fugitive dust impacting on off-site*

receptors during mining operations.

The dust controls specified in Table 7 are consistent with the operation of similar mineral sands mines on the Swan Coastal Plain, and are not considered to be overly onerous. The key control relates to the suspension of specific operations during high wind conditions, where there is a risk of causing off-site impacts. The onus is therefore on the licence holder to use available tools (e.g. monitoring) and experience to mitigate the risk.

Continuous dust monitoring during the drier months (Oct – May) is considered necessary to determine regulatory compliance with the specified limits, and to provide assurance over the effectiveness of the dust controls specified in Table 7.

8.1.7 Acid sulfate soils controls

The following controls have been specified in the licence (condition 10) to mitigate potential impacts on groundwater quality from the disturbance of ASS:

- Monitoring of dewatering effluent, including trigger values and subsequent management actions;
- Specified treatment of identified reactive overburden and ore; and
- Actions to be taken in response to exceedances of groundwater trigger values.

Note: *The requirements specified in Table 8 of the amended licence generally replicate the management measures in the licence holder's soil management plan (Iluka, 2018), however more detail has been added.*

Grounds: *A review of the ASS Investigation Report (SWC, 2012) for the project indicates the presence of PASS within the mine pit boundary, predominantly associated with black/dark-grey clays and sandy clays.*

The ASS controls specified in Table 8 are generally consistent with the operation of similar mineral sands mines on the Swan Coastal Plain, with some site-specific controls included, and are not considered to be overly onerous. The key controls relate to early intervention and treatment of identified PASS. The onus is therefore on the licence holder to use available tools (e.g. monitoring) and experience to mitigate the risk.

April 2020 amendment: *the licence holder requested the pH 'trigger limit' in Table 11 to be changed from 6.0 to 5.5 to match the actions/requirements in Table 10.*

It was explained to the licence holder the pH criteria of ≤ 5.5 in the ASS controls table (Table 10) is an absolute limit that is not to be exceeded, whereas the pH criteria listed in Table 11 is designed to trigger a management response, to ensure the absolute limit is not exceeded. No changes have been made to the licence with this regard.

8.1.8 Monitoring general

A number of conditions have been applied to the licence (conditions 11 – 14) to prescribe the minimum monitoring requirements. They relate to the minimum requirements for sampling and analysis of samples, minimum timeframes for sampling frequency, and calibration requirements for instruments used by the licence holder.

Grounds: *The requirements specified above are to ensure sampling is conducted in a manner that is consistent with accepted standards, procedures and processes.*

8.1.9 Ambient environmental monitoring

Monitoring of ambient air quality (dust) and groundwater quality have been specified in the Licence (conditions 16 – 18), requiring:

- Monitoring of ambient air quality at high risk receptors and a background location;
- Actions to be taken in response to exceedances of limits for air quality; and
- Monitoring of groundwater quality in the vicinity of mine pits.

Note: *The licence holder has proposed to conduct monitoring of dust – the requirements specified above expand on the scope relative to the risk of off-site impacts. Groundwater monitoring is proposed to continue throughout mining, in parallel with the existing programme under the groundwater operating strategy.*

Grounds: *In consideration of the nearest BoM weather station, being 35 km south-west at Lancelin, more accurate, site specific wind data should be used to develop a reliable weather forecasting tool (for managing dust), and for use in investigations into potential exceedances.*

Ambient air quality

In consideration of the potential for off-site impacts from fugitive dust, monitoring of dust during mining operations is critical for providing assurance over the effectiveness of management controls at the Premises. This includes regular monitoring of TSP (at least once every 6 days) and PM_{10} levels (at least 2 samples of continuous logging (15 minute averages) over a minimum 14 days) at the northern Cataby roadhouse and a background location.

Given the proximity to sensitive receptors (including the Brand Hwy), ambient air quality criteria have been deemed necessary for the protection of human health and amenity. As such, limits for TSP (nuisance value) and PM_{10} (human health) have been imposed at the northern Cataby roadhouse, as this is considered to be the highest risk receptor for dust emissions and an appropriate location for representing the level of impact to receptors from mining operations during the prevailing easterly and southerly wind conditions.

The limit for TSP has been determined using reference to the Kwinana EPP, which is considered by DWER to be an equivalent standard for ambient air quality at all sand mining and related operations where an environmental standard does not exist for the subject area. Given the location and distance to receptors, the Area B standard (260 µg/m^3, 24 hour average) is considered to be the most relevant.

The limit for PM_{10} has been determined using reference to the Air NEPM for particles as PM_{10} (50 µg/m^3, 24 hour average). Although DWER does not consider the Air NEPM to be an appropriate regulatory standard, it is considered to be an equivalent standard in the absence of an environmental standard for the subject area.

The provision for an exceedance of the specified limits has also been included in the licence, if in the event of an exceedance an appropriate investigation if undertaken and it can be demonstrated the exceedance is not attributed to operation on the Premises.

Groundwater quality

Monitoring of shallow groundwater in the vicinity of each mine pit will enable early detection and proactive management of changes in groundwater quality that may be attributed to mining activities. Monthly monitoring of standard physical parameters (SWL, pH, EC, redox potential, total acidity and alkalinity) will be conducted as part of the Groundwater Operating Strategy. Additional parameters include major ions (quarterly) and metals and metalloids to be measured on a six-monthly basis.

8.1.10 Record keeping

A number of conditions have been applied to the licence (conditions 19 – 23) to prescribe the minimum record keeping requirements. They relate to the records that need to be kept throughout the duration of the licence, and the standards for record-keeping.

In addition, the licence holder is required to submit an annual environmental report, containing a summary of all monitoring conducted during the previous annual period.

Grounds: *The requirements specified above are necessary to demonstrate compliance with other requirements of the licence.*

8.1.11 Complaints

The recording of complaints has been specified in the licence (condition 20), to ensure the licence holder implements a suitable complaints management procedure.

Grounds: *The requirements specified above are necessary to document all complaints received by the licence holder, and to demonstrate that each complaint has been sufficiently addressed.*

9. Determination of licence conditions

The conditions in the issued licence in Attachment 1 have been determined in accordance with the *Guidance Statement: Setting Conditions*.

The *Guidance Statement: Licence Duration* has been applied and the issued licence expiry has been set to align with expiry of tenement M70/194 (09/04/2027), being the primary tenement upon which the main processing infrastructure is located.

10. Conclusion

This assessment of the risks of activities on the Premises has been undertaken with due consideration of a number of factors, including the key documents and policies specified in this report (summarised in Appendix 1).

Based on this assessment, it has been determined that the amended licence will be granted subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

Alana Kidd
MANAGER, RESOURCE INDUSTRIES
Delegated Officer
under section 20 of the *Environmental Protection Act 1986* (WA)

Appendix 1: Key documents

	Document title	In text ref	Availability
1.	Bureau of Meteorology, 2018. Climate Data Online – Climate Statistics: Lancelin (009114)	BOM, 2018	accessed at:
2.	Cataby Mineral Sands Project – Application for Licence under Part V of the EP Act – Supporting document. Iluka Resources Ltd, October 2018	Application form and supporting document	DWER records (A1732290)
3.	DER, June 2015. *Identification and investigation of acid sulfate soils and acidic landscapes*. Department of Environment Regulation, Perth.	DER, 2015a	accessed at: www.dwer.wa.gov.au
4.	DER, June 2015. *Treatment and management of soils and water in acid sulfate soil landscapes*. Department of Environment Regulation, Perth.	DER, 2015b	
5.	DER, July 2015. *Guidance Statement: Regulatory principles.* Department of Environment Regulation, Perth.	DER, 2015c	
6.	DER, October 2015. *Guidance Statement: Setting Conditions.* Department of Environment Regulation, Perth.	DER, 2015d	
7.	DER, November 2016. *Guidance Statement: Environmental Siting*. Department of Environment Regulation, Perth.	DER, 2016	
8.	DER, February 2017. *Guidance Statement: Risk Assessments*. Department of Environment Regulation, Perth.	DER, 2017a	
9.	DER, February 2017. *Guidance Statement: Decision Making*. Department of Environment Regulation, Perth.	DER, 2017b	
10.	DMP, May 2015. *Guidelines for Preparing Mine Closure Plans*. Department of Mines and Petroleum, Perth.	DMP, 2015a	accessed at: www.dmp.wa.gov.au
11.	DMP, October 2015. *Mining Act Guidelines – Basic Provisions*. Department of Mines and Petroleum, Perth.	DMP, 2015b	
12.	Iluka Resources Ltd, June 2015. Mining Proposal – Cataby Mineral Sands Project. Rev0	Iluka, 2015a	accessed at: minedexext.dmp.wa.gov.au
13.	Iluka Resources Ltd, September 2015. Noise Management Plan – Operations – Cataby Mineral Sands Project. Rev2	Iluka, 2015b	DWER records (A1754559)
14.	Iluka Resources Ltd, October 2015. Dust Management Plan – Cataby Mineral Sands Project. Rev2	Iluka, 2015c	DWER records (A1754558)
15.	Iluka Resources Ltd, January 2017. Groundwater-dependent Ecosystem Management Plan – Cataby Mineral Sands Project. Rev2	Iluka, 2017a	DWER records (A1754557)

16.	Iluka Resources Ltd, March 2017. Surface Water Management Plan – Cataby Mineral Sands Project. Rev1	Iluka, 2017b	DWER records (A1754556)
17.	Iluka Resources Ltd, June 2017. Groundwater Operating Strategy – Cataby Mineral Sands Project. Rev2	Iluka, 2017c	DWER records (A1754555)
18.	Iluka Resources Ltd, October 2018. Soil Management Plan – Cataby Mineral Sands Project. Rev2	Iluka, 2018	DWER records (A1754554)
19.	Jacobs, November 2014. *Cataby Detailed Feasibility Study – Groundwater Modelling – Final Report.* Prepared for Iluka Resources Ltd by Jacobs Group (Australia) Pty Ltd.	Jacobs, 2014a	DWER records (A1754552)
20.	Jacobs, November 2014. *Cataby Mineral Sands Project – GDE Impact Assessment.* Prepared for Iluka Resources Ltd by Jacobs Group (Australia) Pty Ltd.	Jacobs, 2014b	DWER records (A1754553)
21.	Jacobs, July 2015. *Cataby Mineral Sands Mine – Surface Water Assessment*. Prepared for Iluka Resources Ltd by Jacobs Group (Australia) Pty Ltd.	Jacobs, 2015	DWER records (A1754551)
22.	Jacobs, May 2018. *Cataby Mineral Sands Mine – Groundwater Modelling Report*. Prepared for Iluka Resources Ltd by Jacobs Group (Australia) Pty Ltd.	Jacobs, 2018	DWER records (A1754549)
23.	Ministerial Statement 720	MS 720	accessed at www.epa.wa.gov.au
24.	Ministerial Statement 1017	MS 1017	
25.	Report and recommendations of the Environmental Protection Authority – Cataby Mineral Sands Project, Iluka Resources Limited (December 2005).	EPA Bulletin 1212	
26.	Report and recommendations of the Environmental Protection Authority – Cataby Mineral Sands Project, Cataby, Shire of Dandaragan – inquiry under s46 of the *Environmental Protection Act 1986* to amend Ministerial Statement 720, Iluka Resources Limited (August 2015).	EPA Report 1555	
27.	SVT, February 2015. *Cataby Minesite Noise Environmental Impact Assessment*. Prepared for Iluka Resources Ltd by SVT Engineering Consultants.	SVT, 2015	DWER records (A1754548)
28.	SWC, July 2012. *Cataby Deposit – Acid Sulfate Soil Survey (ASS)*. Prepared for Iluka Resources Limited by Soilwater Consultants Pty Ltd.	SWC, 2012	DWER records (A1754547)
29.	Works Approval W5935/2015/1 – Cataby Mineral Sands Mine	W5935/2012/1	accessed at: www.dwer.wa.gov.au

Attachment 1: Amended licence L9176