



Application for Licence Amendment

Part V Division 3 of the *Environmental Protection Act 1986*

Licence Number	L8918/2015/1
Licence Holder	Keysbrook Leucoxene Pty Ltd
ACN	137 091 297
APP Number	APP-0027990
Premises	Keysbrook Mineral Sands Mine 1391 Hopeland Road North Dandalup WA 6207 Legal description – Part of Lots 101, 103, 104 & 105 on Diagram 92169, lot 300 on plan 31012, Lots 31, 32, 33 & 34 on Plan 408493, lots 56, 57, 59, 63 & 64 on Plan 739, Lot 20 on Plan 41621, Lot 201 on Plan 68316, Lots 507 & 508 on Diagram 91207. As defined by the premises maps attached to the revised licence.
Date of Report	22 December 2025
Proposed Decision	Revised licence granted

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1. Decision summary

Licence L8918/2015/1 is held by Keysbrook Leucoxene Pty Ltd (the licence holder), a subsidiary of Doral Mineral Sands Pty Ltd, for the Keysbrook Mineral Sands Mine (the premises). The premises is located on Hopeland Road, approximately 1.7 kilometres (km) north of North Dandalup.

This amendment report documents the assessment of potential risks to the environment and public health from proposed changes to the emissions and discharges during the operation of the premises. As a result of this assessment, revised licence L8918/2015/1 has been granted.

The revised licence issued as a result of this amendment consolidates and supersedes the existing licence previously granted in relation to the premises.

2. Scope of assessment

2.1 Regulatory framework

In completing the assessment documented in this amendment report, the Department of Water and Environmental Regulation (the department; DWER) has considered and given due regard to its Regulatory Framework and relevant policy documents which are available at <https://dwer.wa.gov.au/regulatory-documents>.

2.2 Overview of Premises

The Keysbrook Mineral Sands Mine is located on the Swan Coastal Plain about 1.7 kms north of North Dandalup and 2.5 kms west of Keysbrook. It consists of a shallow, low-grade mineral sands ore deposit, which is mined and refined to leucoxene, ilmenite and zircon products. About 1,740 hectares (ha) of land has previously been approved for mining, with operations commencing in 2015.

Prior to mining, the area was used primarily for agriculture and associated homesteads, but also includes pockets of native vegetation. The land consists of privately owned, freehold, lots granted prior to 1899, with mineral rights owned by the land holder. For this reason, the *Mining Act 1978* does not apply.

2.2.1 Mining activities

The licence holder mines the deposit progressively, through a series of shallow, open cut pits, using dry mining techniques. Mining and earthworks activities are conducted between 7 am and 7 pm, seven days per week, using heavy mobile equipment. This includes dozers, excavators, haul trucks, graders, loaders, and in-pit mobile screening units (referred to as mobile field units (MFU's)). The pits are mined to a maximum depth of about 6 metres below ground level (mbgl). The geology contains monazite, which contains naturally occurring radioactive materials (NORMs). Pockets of potentially acid sulfate soils (ASS) have been identified within the mining area.

During the wet seasons, when the groundwater table is elevated, dewatering is required to access the ore. This water is transferred to the process water ponds or may be discharged to on-site surface water discharge locations, if it meets set water quality standards.

2.2.2 Processing activities

Processing at the premises occurs 24 hours per day, seven days per week. Ore processing starts within the pit, where it is slurried and pumped from the feed preparation plant (FPP) to the wet concentrate plant (WCP) for further processing to a heavy mineral concentrate (HMC) product. Processing at the WCP is a wet process that uses physical separation techniques. The

water is sourced from the process water ponds at the WCP, which holds a mix of dewatering effluent, captured stormwater and returned tailings decant water. Additional water is drawn from the deeper Leederville Aquifer, if required. Excess water from the process water ponds is authorised for disposal to surface watercourse locations, if it meets specified water quality criteria.

HMC is stockpiled at the premises prior to being transported off-site to the Picton Mineral Separation Plant, located about 120km south of the mine, for further refinement to zircon, ilmenite, and leucoxene products.

Waste clay, sand and tailings produced on the premises are backfilled into the mine voids. Tailings material from the Picton Dry Separation Plant is also authorised for return and disposal to the Keysbrook Mineral Sands Mine voids, provided that it meets specified criteria. The backfilled voids are subsequently rehabilitated back to pasture. The licence holder has indicated that several of the eastern Lots have been fully rehabilitated.

2.3 Proposed expansion of the project

The licence holder is close to extracting all of the accessible ore within the approved mining area. For this reason, the licence holder is now seeking an expansion of the mining area to the west of the existing premises (refer to figure 1, below) to access additional ore.

The proposed western expansion of the project includes an additional 513ha of mining area, taking the total mining area for the project to about 2,258ha. The expansion area includes infill areas in cadastral Lots 62 and 63, which are within the existing prescribed premises boundary for L8918/2015/1. The expansion area will also include areas within cadastral Lots 20, 64, 201, 507 and 508 (refer to figure 1, below) which are currently outside the prescribed premises boundary. Cadastral Lot 202 and a portion of Lot 62 will not be mined and will be conserved as a vegetation offset area.

Minor watercourses that cross the mining area, which are shallow, poorly defined and typically dry in summer, will be diverted and mined, then reestablished during the rehabilitation phase of the project. Medium watercourses that cross the mining area, with well-defined creek channels and higher flows, will not be mined within 20m of the banks of those water courses. These include the Dirk Brook Tributary, Nambeelup Brook North Tributary, Balgobin Brook South Tributary and Nambeelup Brook South Tributary.

The processing plant and associated infrastructure will remain in the current locations, and the mining and processing methodology will remain generally consistent with the existing operation.

This proposed expansion requires approvals from a number of regulatory agencies, refer to section 2.5 (below).

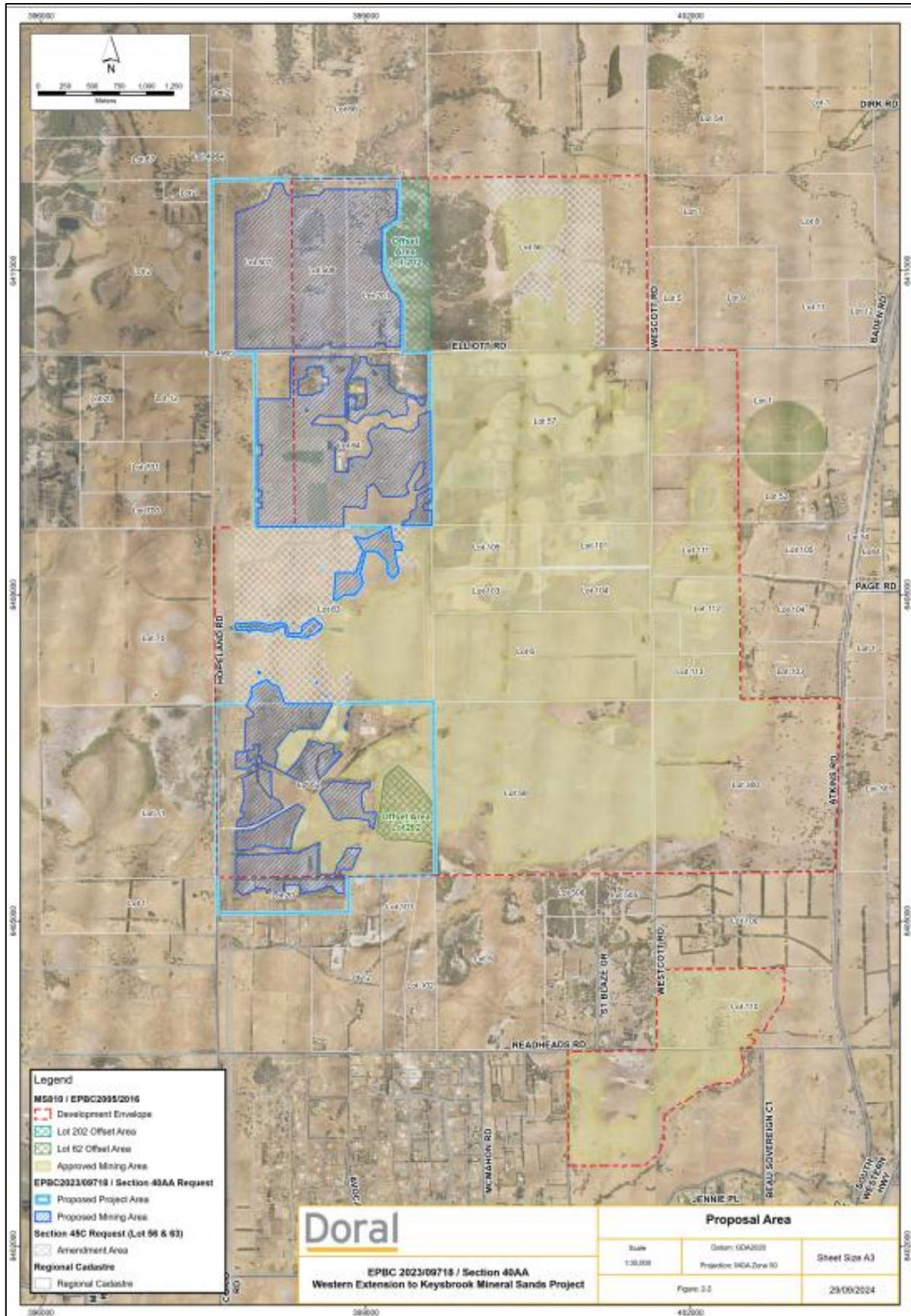


Figure 1: Keysbrook Mineral Sands Mine – existing mining area in yellow and the proposed expansion area in blue.

2.4 Scope of the Part V licence amendment application

On 14 March 2025, the licence holder submitted an application (this amendment) to the department to amend licence L8918/2015/1 under section 59 and 59B of the EP Act. The application is to expand the prescribed premises boundary and mining area in alignment with the proposed western expansion that is currently being assessed under Section 40AA of the EP Act by the EPA. This application was processed in parallel with the Part IV application.

Due to the Minister's decision to reduce the scope of the ministerial statement for the premises, the licence amendment assessment also includes the assessment of acid sulfate soils management, potential dust impacts and a wider range of aspects relating to water management at the premises.

In addition to the expansion of the prescribed premises boundary, specific requests for the amendment of licence conditions included:

- An increase in the authorised volume of water that may be discharged to surface water bodies each year, from 250,000 kilolitres (kL) to 500,000kL (ie category 6 increase);
- Addition of 17 water discharge points to both major and minor surface waterbodies within the expanded disturbance footprint;
- Addition of 4 surface waterbody monitoring points both upstream and downstream of the proposed additional discharge points;
- Addition of 8 groundwater monitoring points around the perimeter of the western expansion area;
- Removal of eastern surface waterbody monitoring point WQ4;
- Removal of eastern groundwater monitoring points KS4, KS6 and KS7;
- Provide an exemption to monitor groundwater bores KS10 to KS13 for up to 12 months at a time for operational reasons;
- Removal of the requirement for the process water pond to be lined;
- Removal of the requirement for continuous pH and electrical conductivity (EC) monitoring of the discharge water; and
- Removal of the limits on the radioactivity of Picton Tailings that may be deposited at the premises.

No increase in category 8 processing throughput is requested as part of this application.

2.5 Legislative context

2.5.1 *Environmental Protection and Biodiversity Conservation Act 1999*

In 2005, the Keysbrook Mineral Sands Mine was determined to be a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to impacts to listed threatened species and communities and wetlands of international importance. Conditional approval under the EPBC Act was granted in 2010 under permit EPBC 2005/2163.

The western expansion of the project has also been determined to be a controlled action due to potential impacts to the Baudin's cockatoo, Carnaby's cockatoo and Forest red-tailed cockatoo species, which are listed as endangered or vulnerable under the EPBC Act. This aspect of the proposal was assessed through the bilateral agreement with the Western Australian (WA) government.

2.5.2 Part IV of the EP Act

The original proposal to develop the Keysbrook Mineral Sands Mine was assessed by the Environmental Protection Agency (EPA) in 2007, with approval granted in 2009. The premises was originally regulated under Part IV of the EP Act through Ministerial Statements (MS) 810, 984 and 1089. The original MS 810 regulated:

- direct impacts to vegetation, including breeding and foraging habitat for endangered cockatoos;
- protection of watercourses and wetlands;
- rehabilitation;
- groundwater and surface water management;
- acid sulfate soils management; and
- noise and dust management.

These aspects were largely regulated through the development and implementation of a series of management plans. MS 1089 modified some of the noise management conditions in MS 810.

Two section 45C amendments to MS810 were granted in 2019 and 2023 to increase the mining area within the approved development envelope.

Proposed western expansion of the project

In September 2023, the licence holder referred the project to the EPA for the expansion of the mining footprint to the west of the existing premises. This required a significant amendment of an approved proposal under Section 40AA of the EP Act. This application was determined on 10 December 2025 and Ministerial Statement 1263 for the project was issued, which has superseded MS 810, MS 984 and MS1089.

The Ministerial Statement for the project has been significantly revised and has a more limited scope than the previous authorisations under Part IV of the EP Act. Some potential impacts to the community and the environment, which were previously regulated through the Part IV Ministerial Statements, were delegated to Part V to assess and regulate. This includes dust impacts, acid sulfate soil management, and certain aspects of surface water and groundwater management, which are therefore now part of this assessment.

The licence holder applied to have the corresponding application to amend licence L8918/2015/1 for the western expansion of the premises processed in parallel under Part V of the EP Act.

2.5.3 Rights in Water and Irrigation Act 1914

The premises overlies three surface water areas that are proclaimed under the *Rights in Water and Irrigation Act 1914* (RiWI Act) – the Serpentine River System, the Murray River System and the Dandalup River System. Surface water bodies on site ultimately discharge into the Peel-Harvey Estuary, a Ramsar wetland system.

The premises is also situated across the proclaimed Serpentine Groundwater Area and the Murray Groundwater Area. Groundwater is found in both the unconfined surficial aquifer and the deeper, Leederville aquifer.

Dewatering of the surficial aquifer, which is required to access the ore, is authorised through several groundwater licences issued under the RiWI Act. Additional water that may be required for processing activities is drawn from the deeper Leederville Aquifer and is regulated through a separate groundwater licence.

2.5.4 *Mining Act 1978*

The premises and the expansion are situated on privately owned, freehold, lots granted prior to 1899, with mineral rights owned by the land holder. For this reason, the *Mining Act 1978* does not apply.

Regulation of mining activities for mineral sands projects is executed through both Part IV and Part V of the EP Act, and rehabilitation and closure are regulated entirely through Part IV of the EP Act.

2.5.5 *Local government planning approvals*

The premises is located on both the Shire of Serpentine Jarrahdale and the Shire of Murray. As the premises is not on a mining lease, the site is regulated through Extractive Industry Licences (EIL's) issued under the *Local Government Act 1995* (LG Act) by each shire. The licence holder has existing EIL's for the current operation and has indicated that EIL applications for the expansion area will be submitted once the relevant approvals under the EP Act are obtained.

2.5.6 *Radiation Safety Act 1972*

The orebody contains monazite, a mineral that naturally contains low levels of thorium and uranium. These naturally occurring radioactive materials (NORMs) are at low levels within the ore but concentrate as the material is processed.

Under the *Radiation Safety Act 1972*, regulated through the Radiological Council of Western Australia, the licence holder has developed a Radiation Management Plan and submits annual monitoring reports to the regulator. The Department of Local Government, Industry Regulation and Safety (DLGIRS) also has a role in regulating radiation safety on mine sites.

2.5.7 *Part V of the EP Act*

In addition to the legislation outlined above, the premises is regulated under Part V, Division 3 of the EP Act and is authorised for category 6 (mine dewatering) and category 8 (mineral sands mining or processing) activities under Schedule 1 of the Environmental Protection Regulations 1987 (EP Regulations).

Licence L8918/2015/1, first issued in 2015 under Part V of the EP Act, focuses on discharges and emissions from the premises that are not directly regulated by the Ministerial Statements, to prevent regulatory duplication. Therefore, the scope of the existing licence primarily focusses on emissions from tailings deposition and discharges of potentially impacted water to surface watercourses. The scope of this amendment application is outlined in section 2.4.

2.5.8 *Compliance with licence L8918/2015/1*

Authorised volume of category 6 discharge to surface water

As part of the Part V assessment process, a review of the premises' compliance with the existing licence conditions was undertaken. It showed that over the past five years, the licence holder has exceeded the authorised category 6 limit of 250,000 tonnes per year of process water that may be discharged to surface water bodies on three occasions (refer to figure 2, below).

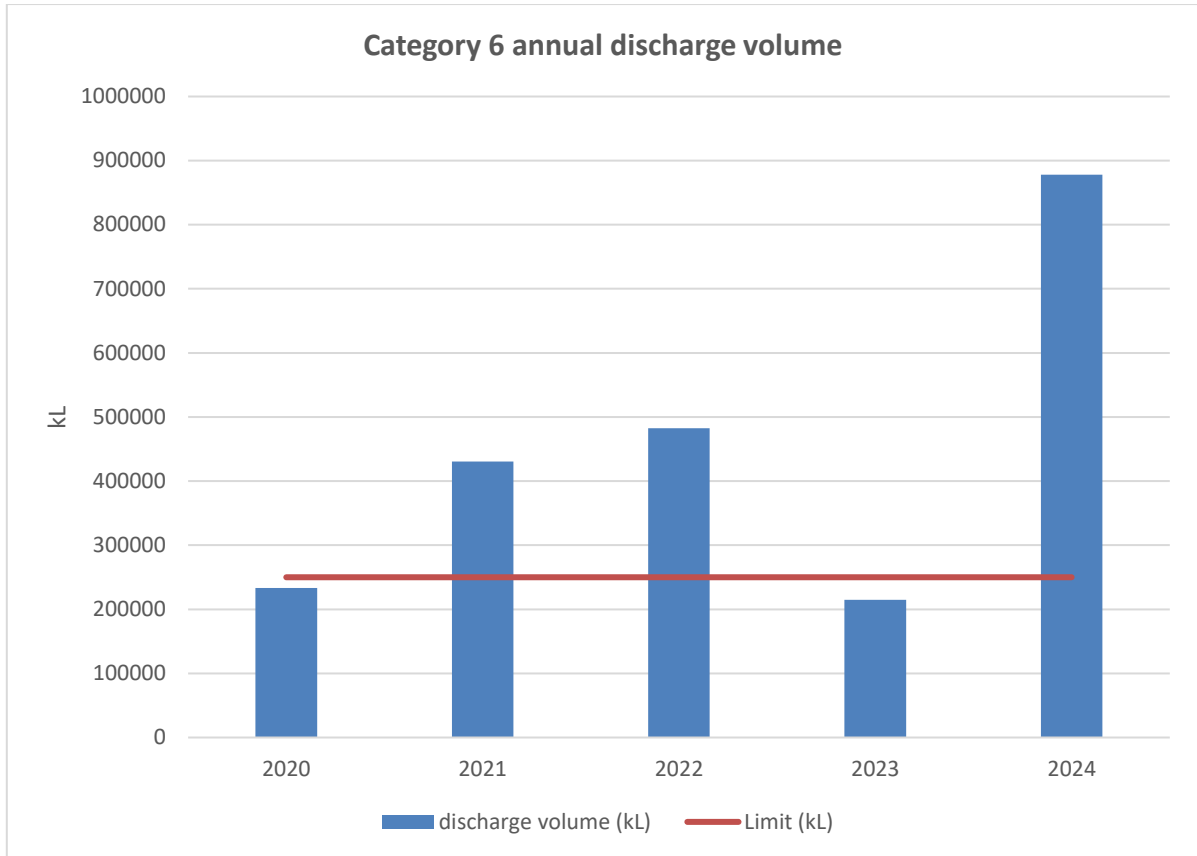


Figure 2: Keysbrook Mineral Sands Mine annual category 6 discharge volume and licence limit

The licence holder undertook a Surface Water Assessment in 2019 (AQ2, 2019) which identified the need for additional discharge of process water from the premises due to a larger than expected disturbance footprint of the operation. The larger footprint has resulted in an increased volume of potentially contaminated stormwater that requires capture and treatment.

The licence holder is therefore seeking an increase in the authorised volume of category 6 process water that may be discharged from the site from 250,000 tonnes per year to 500,000 tonnes per year. For further discussion on this issue, refer to section 2.6.3.

Category 6 discharge water quality

In 2024, L8918/2015/1 was amended to include additional mining areas that had been approved under Part IV of the EP Act via a section 45C amendment. As part of this assessment, aspects of the surface water and groundwater management at the premises were reviewed and amended.

It was identified that more process water was being discharged from the premises than had been originally assessed, and this was occurring throughout almost all months of the year, not only during high rainfall periods. To reduce potential environmental risks from this activity, restrictions on discharges of category 6 water to the high-rainfall May to October period were included on the licence. Discharge water quality criteria limits were also added.

Discharge water quality since this time has generally been compliant with the limits, with the exception of total suspended solids (TSS) limit of 80mg/L. The TSS limit was exceeded on seven occasions between July and December 2024, ranging up to 180mg/L.

Tailings management

The licence holder is authorised to dispose of tailings from the Picton Minerals Separation Plant in the mine voids at the Keysbrook Mineral Sands Mine when it is co-disposed with tailings generated on site at the WCP. While NORMs are found at low levels in the ore, they tend to increase in concentration as the ore is processed. For this reason, limits were placed on the licence to ensure that batches of Picton tailings do not exceed radioactivity limits of 79 parts per million (ppm) for uranium and 244 ppm for thorium. See section 2.6.4 for further detail.

Over the past 5 years, the thorium limits have been exceeded twice – once in 2020 and once in 2024.

Release from in-pit tailings storage facility

In September 2025, during the assessment of this amendment, a significant emission of process water and tailings (estimated at over 100,000kL) was released from an in-pit tailings storage facility onto neighbouring agricultural properties. Preliminary investigations indicate that the embankment surrounding the in-pit tailings may have overtopped and there was not a secondary containment bund around the facility. Although this incident remains under investigation, Assurance Branch has indicated that conditions on the licence relating to the prevention of tailings spills and releases are sufficient and do not require strengthening.

2.6 Siting and environment

2.6.1 Land Tenure

Doral Mineral Sands Pty Ltd owns the majority of the parcels of land within the existing prescribed premises boundary and within the proposed expansion area (see figure 3, below). It is understood that the licence holder has not yet reached mining agreements with all of the owners of the properties that will be within the revised prescribed premises boundary, however, documentation has been provided indicating that those owners agree to having their properties included in the assessment process for environmental approvals. The licence holder will only be able to mine these areas once an agreement is in place, however, it is reasonable for the scope of this assessment to consider the full expanse of the area that may be mined, should agreements be reached.

Originally, the prescribed premises boundary for L8918/2015/1 was in general alignment with the disturbance footprint described in MS 810. During the 2024 licence amendment process, the licence holder requested a number of parcels of land to the east of the premises to be removed from the prescribed premises due to these areas being fully rehabilitated and no longer accessible. The Delegated Officer agreed to remove these areas from the prescribed premises, but noted that it was not a determination on the rehabilitation or closure outcomes, which remain the exclusive authority of the EPA. It also does not remove obligations that the licence holder has under the Ministerial Statement for those areas.

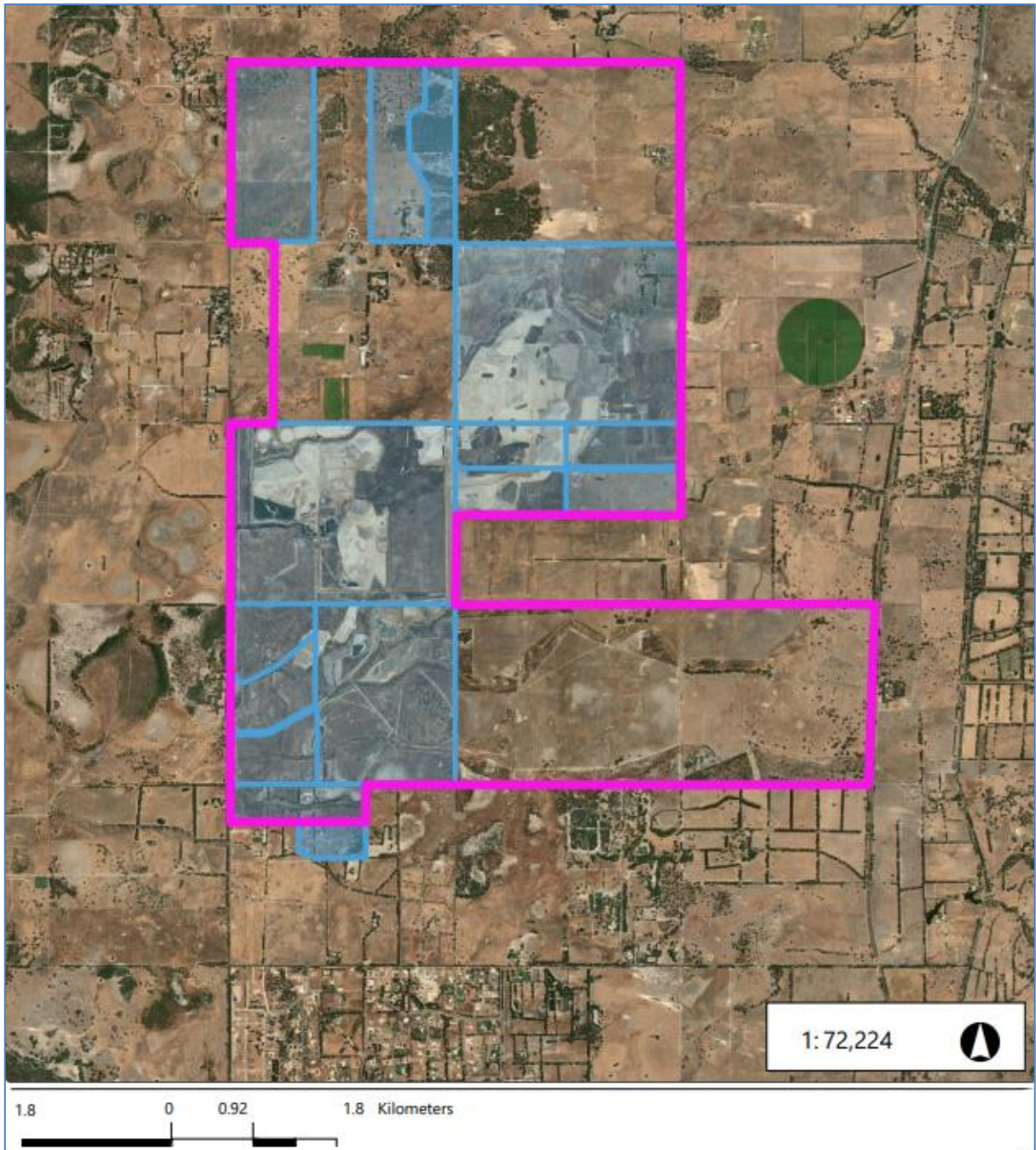


Figure 3: Pink line indicates proposed prescribed premises boundary and blue areas indicate Lots currently owned by the licence holder.

2.6.2 Climate

The premises is located in a Mediterranean climate zone, characterised by warm, dry summers and cool wet winters. The area receives an average of about 1,100mm of rain per year, falling mainly during the winter May to September period (see figure 4, below). The spring and summer months are dominated by strong easterly winds, while the prevailing winds come from the east in autumn and the north in winter.

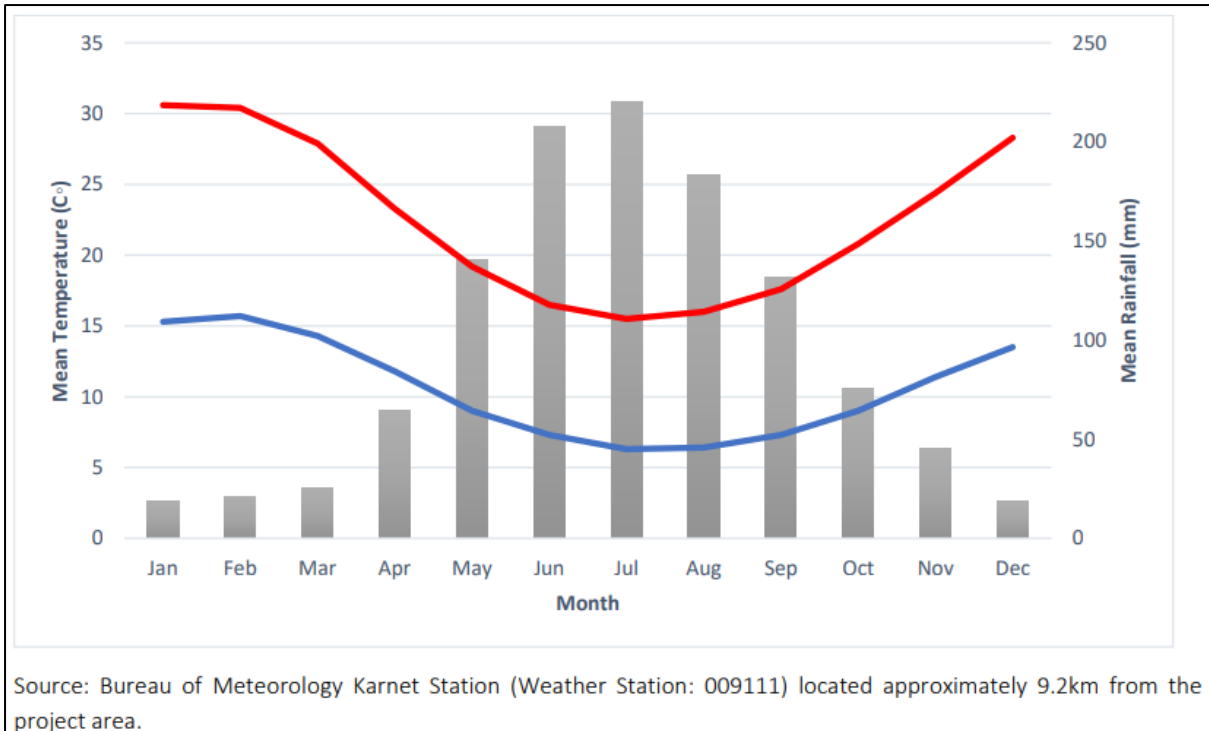


Figure 4: Annual average climate data near the Keysbrook Mineral Sands Mine

2.6.3 Surface hydrology

The premises is located on the Swan Coastal Plain and is predominantly characterised by flat topography or low-relief sandy dunes. Several minor watercourses cross the mining area, which are ephemeral, shallow and poorly defined. Medium watercourses that cross the premises, including the Dirk Brook Tributary, Nambeelup Brook North Tributary, Balgobin Brook South Tributary and Nambeelup Brook South Tributary, have higher flows and more well-defined creek channels. Refer to figure 5 below, with minor watercourses depicted in light blue and medium watercourses in dark blue. Surface water flows westward across the mining area into the Serpentine River System. Water flow ultimately terminates in the Peel-Harvey Estuary, a listed wetland and ecosystem of international significance under the international Ramsar Convention.

This river system has a history of eutrophication, however, it is still considered to have good quality environmental attributes which support the ecological values of the system. There is a routine DWER Healthy Rivers Program monitoring site located downstream of the premises on the Lower Nambeelup Brook. This site is categorised as being in “near optimal” ecological health with good abundance and diversity of aquatic fauna, including providing nursery habitat for the native nightfish, western minnow, western pygmy perch and gilgies (DWER, 2025).

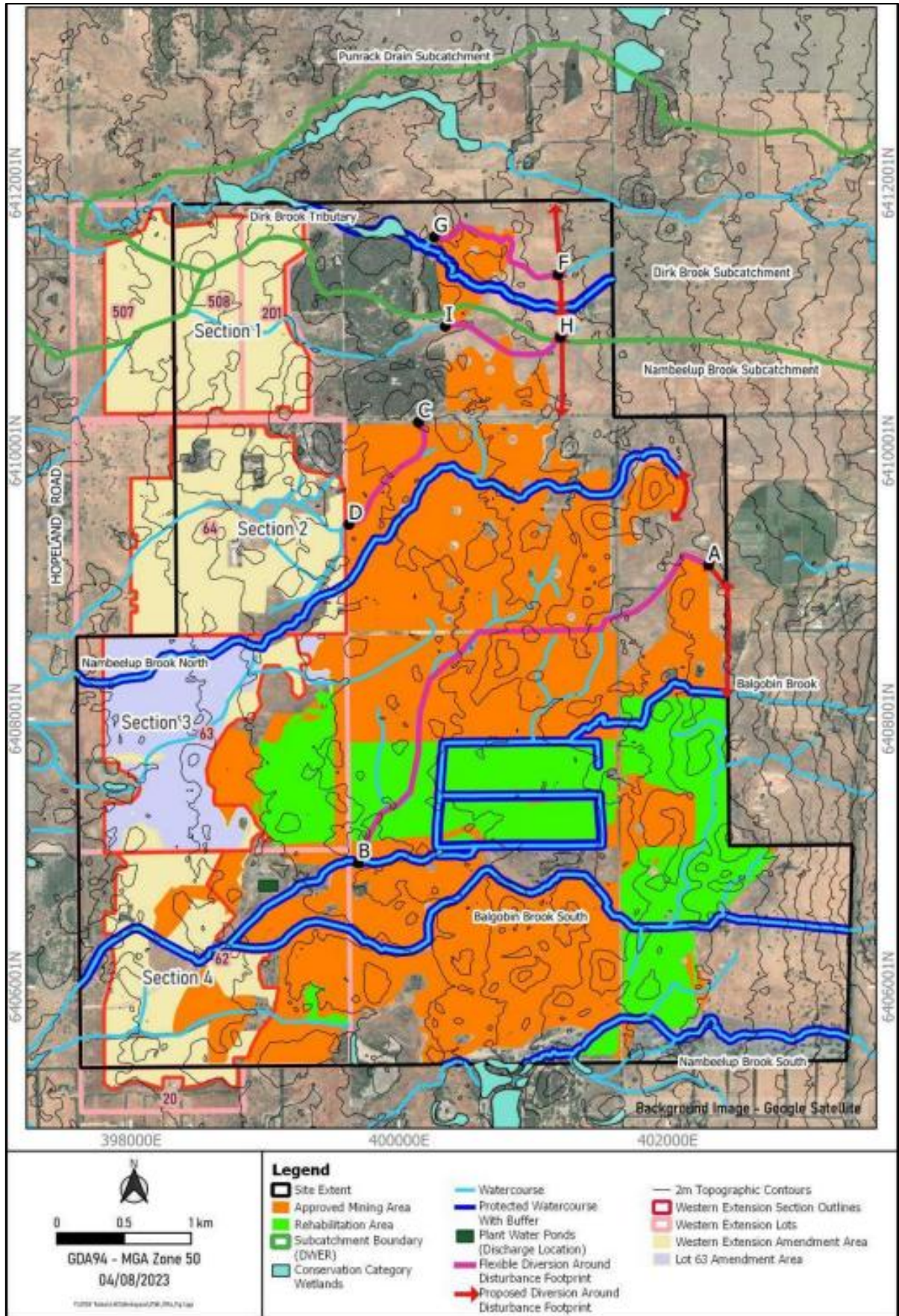


Figure 5: Minor (light blue) and medium (dark blue) watercourses crossing the prescribed premises

Conservation Category Wetlands (CCW) are present along drainage lines within the existing and proposed prescribed premises boundary and immediately surrounding it (see figure 5). The CCWs within and around the mining area are seasonally waterlogged ecosystems that are surface water dependent rather than groundwater dependent.

Direct disturbance to water courses and wetlands

For the western expansion area, the licence holder is proposing to continue with the practice of diverting surface water flows of the minor water courses around the proposed mining area, then reestablishing them during the rehabilitation phase of the project. Minor water courses that can be diverted around the disturbance areas will minimise the volume of potentially contaminated stormwater that the premises will need to capture and manage through the process water circuit. Medium watercourses will not be diverted and will remain undisturbed.

The Ministerial Statement requires there to be no clearing or undertaking of mining activities within 20m of the banks of the medium water courses or within 100m of the boundaries of the CCWs. There are also requirements to ensure that rehabilitated watercourses are stable and support ecological processes.

The RiWI Act also contains provisions to manage direct impacts to the surface waterways, such as vehicle crossings for medium waterways, diversions of minor waterways and rehabilitation of any impacted waterways, through section 17 Bed and Banks permits.

Given that direct impacts to watercourses and the associated wetlands are sufficiently regulated under the Ministerial Statement and the RiWI Act, regulation will not be duplicated on the licence for these activities.

Point source emissions to surface watercourses

Currently, the licence holder is authorised to discharge up to 250,000kL of process water to specified discharge points on Balgobin Brook South, Nambeelup Brook North and the Dirk Brook Tributary during the May to October period. Process water is a mix of mine dewatering effluent, decant return water and stormwater captured from disturbed areas. It is pumped from various areas on site to the process water pond, which has the capacity to contain 74,000kL of water and is designed to allow the settling out of suspended solids prior to discharge. Otherwise, excess process water may be discharged directly from the northern return water settling pond within the active mining area to an approved discharge point.

Since the 2024 licence amendment, discharge from any location must meet the water quality criteria set out in Table 1.

Table 1: Process water discharge limits on L8918/2015/1

Discharge point	Parameter	Limit
Process water pond	pH ¹	5.5 – 8.5
	Electrical conductivity @25C ¹ (EC)	2,500 µS/cm
Northern return water settling pond	Total titratable acidity ¹	40 mg/L (upper)
	Total suspended solids ¹	80 mg/L (upper)

Among other considerations, these limits were considered to be achievable based on historical discharge water monitoring data. On rare occasions, the pH levels in discharge water would drop below 5.5, particularly over the summer months. The most likely source of this acidity is from dewatering effluent (refer to section 2.6.4 for further discussion on this). Historically, EC ranged between 400 and 1800µS/cm and total titratable acidity (TTA) was consistently below 20mg/L. The TSS levels were historically more variable, ranging from below the detection limit to 480mg/L, but averaging just below 50mg/L.

These discharge limits were authorised on the condition that no more than 250,000kL of water would be discharged to the surface water bodies each year, and that discharge would only occur between May 1 and October 31 each year, when rainfall and stream flow are at their peak. These conditions were intended to reduce any potential impacts to the creeks from poor quality water by providing a substantial level of dilution of the discharge water. They also ensured that the receiving creeks are at their highest flows, which would make them better able to tolerate additional water.

Discharge water quality discharge data collected after the amendment went into effect until the end of 2024, indicated that there was a noticeable improvement in discharge water quality, with pH averaging 6.8 and EC averaging 730 μ S/cm. The TSS levels, however, exceeded the discharge limit seven times, although the average TSS value for the period remained around 50mg/L.

Surface water monitoring locations are in place on the medium watercourses in the licence, which require the monitoring of selected chemical parameters. They correspond to upstream and downstream locations in relation to the discharge points. A map showing current emissions discharge locations and surface water monitoring locations is included, below.

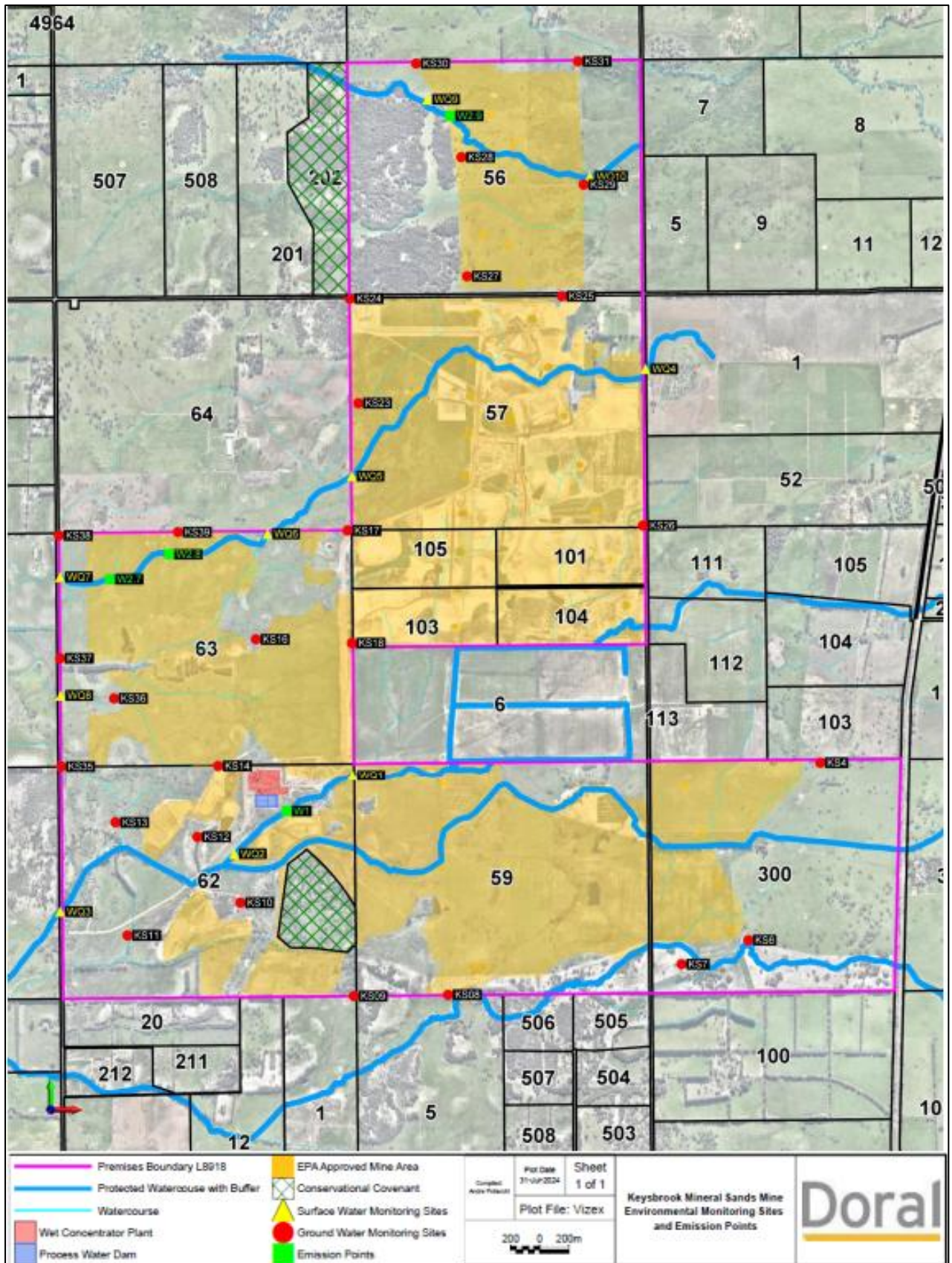


Figure 6: Authorised discharge locations (green), surface water monitoring locations (yellow) and groundwater monitoring locations (red)

Request for an increase in process water discharge volume

The licence holder acknowledges that the authorised volume of process water discharge has been exceeded on several occasions over the past few years due to an increase in the disturbance footprint. The licence holder is therefore seeking an increase to the discharge volume limit as part of this amendment. Prior to mining, there was an assumption that only about 30ha of ground would be disturbed at any point in time, however, over the past few years there has typically been about 150ha of disturbance area, when areas that are undergoing rehabilitation are factored in. This increase in the disturbance footprint means that there is an additional capture of potentially contaminated stormwater which requires management through the process water circuit, which has a fixed capacity to hold 74,000kL of water. The volume of water in excess of this subsequently requires discharge to the environment. A surface water assessment undertaken in 2019 (AQ2, 2019) indicated that about 512,000kL of process water would require discharge in a normal rainfall year based on the ability to hold 74,000kL of water, but recommended an increase to the annual discharge limit to 750,000kL to account for above average rainfall years.

The licence holder is not applying to increase the process water storage capacity at the premises. The licence holder is instead seeking an increase in the authorised volume of process water that may be discharged from the site from 250,000 tonnes per year to 500,000 tonnes per year.

The Delegated Officer has considered the application for an increase in the discharge water volume and is of the view that increasing the volume to only 500,000 tonnes per year would leave the licence holder at high risk of continuing to exceed their authorised discharge volume limit. Should there be an above average level of rainfall, or additional areas of disturbance that are not sufficiently rehabilitated, the licence holder has no alternative strategy to manage any additional process water at the premises. The Delegated Officer considers it prudent to determine a pathway for an increase to the discharge limit to 750,000 tonnes per year, in alignment with the recommendation of the 2019 Surface Water Assessment. Given that there is currently no plan to increase onsite storage capacity and there is no alternative strategy to manage excess process water, assessing additional discharge volume to the highest expected requirement is necessary. Assessing a lesser volume is only likely to result in continued exceedances of the discharge volume limit.

Request for additional discharge point locations and changes to surface monitoring locations

In addition to the increase in discharge volume, the licence holder is also seeking additional discharge points to surface water bodies and corresponding surface water monitoring locations, to account for the westward progression of the mining area. The proposed additional discharge locations and surface water monitoring locations are shown in red below, in figure 7. The licence holder is also seeking the removal of surface monitoring location WQ4 on Nambelup Brook North, on the eastern boundary of Lot 57. They consider the rehabilitation of Lot 57 almost complete and ceased using discharge points on this creek in Lot 57 over a year ago. Instead, the licence holder is seeking to only use WQ5, on the western boundary of the Lot as the upstream monitoring point.

The Delegated Officer notes that the majority of the proposed discharge points would be located on minor streams, which are ephemeral, poorly defined and have peak flows of less than one cubic metre per second. Only locations W2.24 and W2.25, on Balgobin Brook South, are located on a medium watercourse which has peak flows of up to two cubic metres per second.

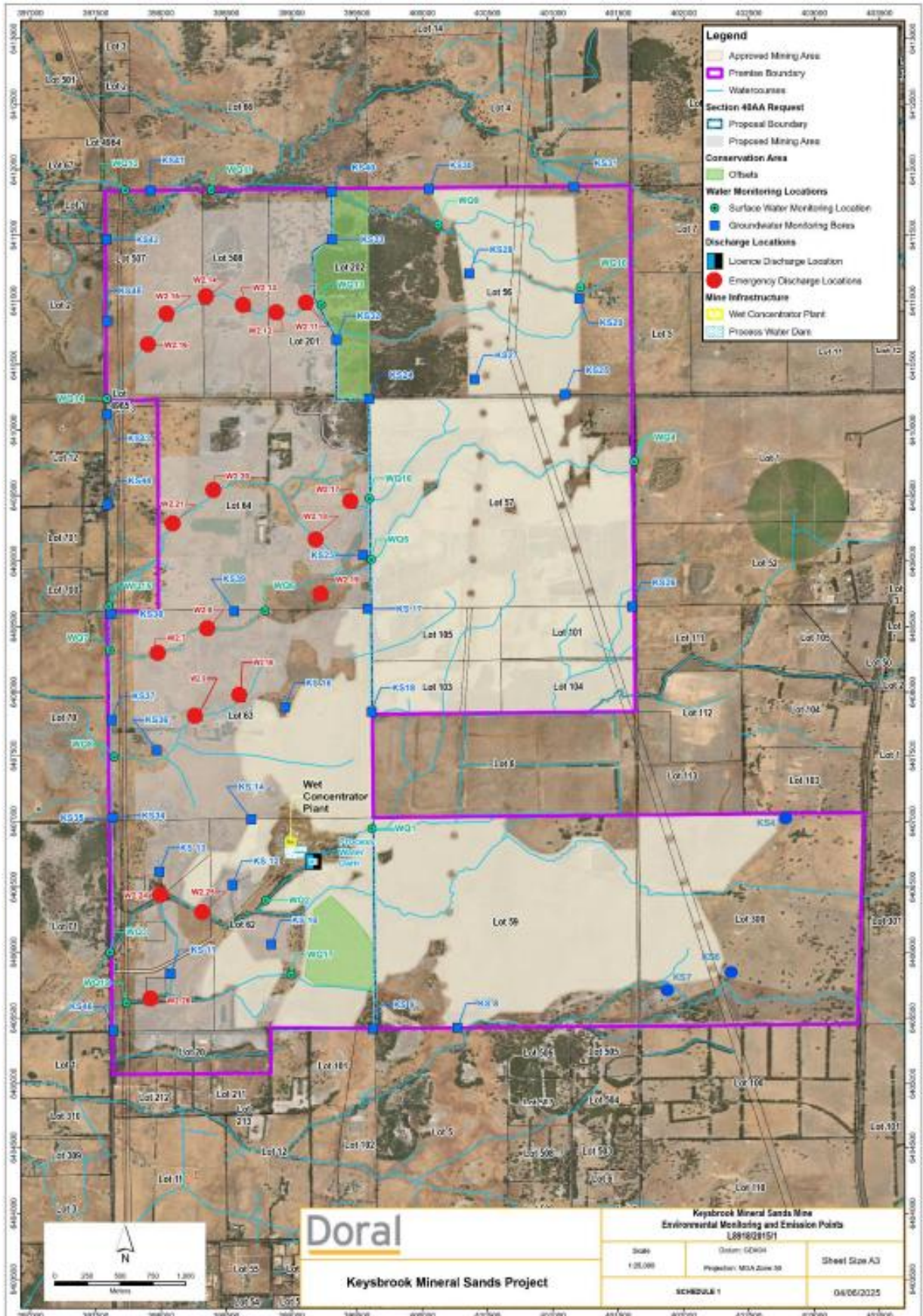


Figure 7: Proposed additional discharge points in red and existing and proposed surface water monitoring locations in light blue.

Request to change process water pond management conditions

The licence holder is also seeking two changes to the process water pond management condition on the licence. Currently, the licence requires the process water pond to be fully lined to prevent seepage and requires continuous pH and electrical conductivity (EC) monitors to be installed to measure the discharge water quality.

The licence holder is requesting the pond liner requirement be removed to increase operational flexibility. Given that the embankments around the process water pond are about 2m above ground level, the Delegated Officer requested the licence holder to initiate a third-party geotechnical review to ensure that the embankments of the pond would remain structurally competent should the liner be removed. A review could not be conducted in the specified time frame, so the assessment of this aspect has been put on hold until further information can be supplied. This issue can be revisited in a future licence amendment when the required technical studies are available.

The licence holder is also requesting the continuous pH and EC monitoring requirements on the process water pond be discontinued given that field monitoring of these parameters was increased from weekly when discharging, to three times per week when discharging, during the last licence amendment. Because there is a requirement for three times per week monitoring to be conducted, which is an equivalent management method, the Delegated Officer is satisfied that the requirement for a continuous monitoring system to be in place constitutes a duplication of controls which can be removed.

2.6.4 Geology

Naturally Occurring Radioactive Materials

Mineral sands ore bodies typically consist of a mixture of a large volume of quartz sand and a small amount of the four ore minerals (ilmenite, rutile, zircon and leucoxene), together with trace amounts of monazite. Monazite is a rare earth mineral that naturally contains a small percentage of thorium and uranium and is therefore classified as a Naturally Occurring Radioactive Material (NORM). After processing at the WCP at the premises, the majority of the monazite reports to the HMC stream and is transported to the Picton Mineral Separation Plant for further refining. This means that the tailings produced from processing at the premises is extremely low in radioactive elements, so is unlikely to pose any radiation risk to people or the environment.

The table below provides a mass-balance of measured concentrations of uranium and thorium in the Keysbrook Mineral Sand Mine HMC, and the subsequent levels that were measured in each product or waste stream for the period February 2022 to January 2023. The 'Final Tails' in the table is returned to the premises (referred to as 'Picton Tails' in L8918/2015/1). Picton Tails are expected to contain comparatively higher levels of radioactive elements than the tailings produced at the Keysbrook premises.

Table 2: Keysbrook Mine Production Data (February 2022 – January 2023) taken from the Doral Annual Radiation Monitoring Report 2023

KLPL Material Type	Dry Tonnes	U (ppm)	Th (ppm)	Total U (tonnes)	Total Th (tonnes)
HMC Feed	84,110	42	253	3.53	21.28
Leucoxene (L88)	27,090	23	271	0.62	7.34
Leucoxene (L70)	19,832	10	199	0.20	3.95
Zircon	9,087	213	153	1.94	1.39

Final Tails	14,643	7	43	0.10	0.63
DR Mids	13,458	50	592	0.67	7.97
Total	84,110	42	253	3.53	21.27

The licence contains a condition that each batch of Picton Tails that is transported to the premises must not exceed a limit of 244ppm thorium and 79ppm uranium. It must also be blended with the tailings produced at the Keysbrook WCP when being disposed of to the mine voids, to further dilute radioactivity levels.

Request to remove Picton Tails limits (condition 7)

The licence holder is seeking the removal of the Picton Tails thorium and uranium limits from the licence, due to radiation management being regulated by DLGIRS and the Radiological Council. The licence holder also states that the required reporting in the Annual Radiation Monitoring Report is in a different format to DWER requirements, making reporting onerous.

The Delegated Officer notes that while there is a requirement for the Annual Radiation Monitoring Report to include radionuclide concentrations and mass balances for the inputs and outputs of the processing streams, L8918/2015/1 is the only instrument that regulates the limits of these emissions at the Keysbrook Mineral Sands Mine premises. The EP Act specifically defines and 'emission' to include emissions of electromagnetic radiation, which should be regulated under Part V of the EP Act.

A review of the 2015 Decision Document for L8918/2015/1 (DER, 2015b) found that the limits were put in place, based on the following rationale, "*This criterion has been suggested by the proponent to ensure radiological levels preclude the potential for post-mining classification of the mine site as "contaminated" under the Contaminated Sites Act 2003.*"

The licence holder was not seeking a reassessment of the limits, only a removal of requirement due to a duplication of regulation. The Delegated Officer finds that there is not a duplication of regulation in this matter, and that the original reasoning for including the limits has not changed. Therefore, the limits and associated annual reporting will remain on the licence.

Acid Sulfate Soils

The project is located on the Swan Coastal Plain and is predominantly characterised geologically by both the Bassendean Dune System and Guildford geological formations. The Bassendean Dune System contains a type of acid sulfate soils (ASS) characterised by reactive pyrite, coupled with a poor buffering capacity, making it prone to acidification when exposed to oxidising conditions. The Guildford Formation is generally present at lower depths and is characterised by sandy clays, gravel and highly reactive coffee rock. Coffee rock is typically iron-rich, often containing inorganic sulfides and potential acidity stored in the form of easily hydrolysable iron and manganese oxides (DER 2015a).

Previous investigations of areas within the premises that have already been mined indicate that the majority of the soils are not acid-forming, but there are small pockets of ASS material. The high-water table at the premises is likely preventing the oxidation of any ASS that may be present. When undisturbed, these soils pose very little environmental risk, however, dewatering and excavation for mining can cause these soils to oxidise and release acid, which will necessitate selective handling and/or neutralisation. Mining in the western extension of the premises is expected to predominantly occur above the water table, but may occur up to a depth of 6mbgl, with some dewatering required.

Prior to this licence amendment, ASS management was regulated entirely through Part IV of the EP Act and Ministerial Statement 810. This was carried out through the implementation of an Acid Sulfate Soils Management Plan (ASSMP), and the requirement to report to the

department on the exceedance of trigger levels. The licence holder is proposing to continue managing ASS in accordance with past practices at the premises and the ASSMP.

As the regulation of ASS management at the premises is now delegated to the Part V licence, this assessment considers the risk of potential ASS impacts from the unmined western extension areas and the unmined Lot 56. The licence holder submitted site specific ASS investigations into Lot 56 and the western extension areas, as part of the application (ABEC 2022 and ABEC 2023). These investigations were carried out in accordance with the DWER guideline *Investigation and identification of acid sulfate soils and acidic landscapes* (DER, 2015a).

Both field testing and laboratory acid-base accounting tests were conducted. The acid-base accounting was conducted using the Chromium Reducible Sulfur (CRS) method to determine the Net Acidity. No samples from any area returned a pH_F result below 4, which would indicate actual acid sulfate soils.

In Lot 56, none of the field test results exceeded the criteria indicating potential acid sulfate soils (PASS). However, further CRS laboratory analysis revealed that 6 of the 12 boreholes drilled exceeded the Net Acidity action criteria of 0.03%S, meaning that PASS (which will generate acid if oxidised) is present. It is not uncommon for field tests to produce both false positive and false negative results. That is why the field tests are only considered screening tests, and only a laboratory analysis to determine the Net Acidity can be used to reliably determine the presence or absence of PASS.

In Lot 56, the CRS acid-base accounting revealed that PASS was present at 2 to 3mbgl in 5 of the 12 boreholes. In addition to this, borehole PASS012 found PASS at 1 to 3mbgl. The planned depth of the pit in Lot 56 is 1.5m, meaning that the PASS observed in the 5 drillholes within the mining area should not be disturbed as it will be below the base of the pit. The report states that drillhole PASS012 is outside the planned mining area, along the northern perimeter of the Lot, and was later converted into a groundwater monitoring bore.

Field testing in the western extension area indicated that 7 boreholes out of the 34 that were drilled, exceeded the criteria indicating PASS. The CRS laboratory analysis confirmed that 11 boreholes exceeded the Net Acidity action criteria of 0.03%S and contained PASS material. The majority of the boreholes with confirmed PASS material were located in Lot 63, but Lots 62, 64 and 201 also contained PASS. Nine of these boreholes showed that the PASS was deeper than the planned base of the pit, meaning that they are unlikely to be directly disturbed. The 2 boreholes that indicated PASS would be at depths within the planned pit were both located in Lot 63. Mining in this area has been completed under the 2023 section 45C amendment to MS 810, and therefore is outside the scope of this assessment.

In addition to the direct disturbance of PASS from mining, there is also a risk of causing PASS to oxidise from dewatering and lowering the water table around PASS that is situated outside the mining pits. The licence holder does not actively dewater for mining using production bores, but when groundwater passively flows into the voids, it is collected in sumps and pumped to the process water circuit. Dewatering water quality is discussed further in section 2.6.5, below.

This information indicates that no actual ASS were identified within the mining area and PASS is present, but is generally at deeper levels than the planned mining disturbance. This means that there is a possible risk of impacts from ASS management in the expanded mining area.

2.6.5 Groundwater

The premises is situated across the proclaimed Serpentine Groundwater Area and the Murray Groundwater Area. Groundwater is found in both the unconfined superficial aquifer and the deeper, Leederville aquifer.

The Leederville aquifer

The Leederville aquifer is a confined system, separated from the superficial aquifer by the confining Guildford Formation. The Leederville aquifer comprises interbedded sandstones and siltstones, which extend to at least 130mbgl and have a modest to high permeability. The Leederville aquifer receives groundwater from the superficial aquifer. The groundwater quality of the Leederville aquifer is fresh to brackish, with a salinity of less than 1,500 mg/L total dissolved solids (TDS) (ABEC 2023). The licence holder has a groundwater licence to draw water from this aquifer under the RiWI Act. Potential impacts from the abstraction of water from this aquifer is managed entirely through the groundwater licence.

The superficial aquifer

The superficial aquifer is present through the Bassendean Sand Dune and Guildford Formations, with the water table sitting at near ground level to about 10mbgl. The water table fluctuates seasonally by about 1m each year in response to rainfall recharge. The groundwater flows to the west, with the salinity ranging from about 200 to about 2,000mg/L TDS and a neutral to slightly acidic pH.

It is in this aquifer that dewatering, mining activities and tailings deposition occurs, and therefore this is the aquifer that is at highest risk of impacts from the mining activities. Since the beginning of the project, the KS series of monitoring bores has been in place to monitor groundwater levels and quality. The licence holder also has a groundwater licence to draw water from this aquifer for the purpose of dewatering to allow for dry mining under the RiWI Act. Potential impacts to nearby environmental receptors and other groundwater users from drawdown of the aquifer is monitored and regulated through groundwater licensing regulation and therefore will not be included in this assessment process.

This assessment is focussed on the risks of potential groundwater deterioration from mining activities, potentially disturbing ASS material or from tailings deposition into this aquifer. Several of these risks were previously regulated through MS 810 and the Water Management Plan that was developed for the premises. All of these risks will need to be reviewed to determine whether additional conditions are required on the licence, to account for the reduced conditions relating to these impacts under the Ministerial Statement.

Groundwater monitoring data

Given that the mine has been in operation since 2015, a review of the groundwater monitoring data collected at the site was undertaken.

In-pit sump monitoring data

Although not currently required to be monitored through the licence for the premises, water quality monitoring for the in-pit sump (which is monitored through the site Water Management Plan, under MS 810) was also reviewed. This data best represents the water quality of the superficial aquifer, as mining and soil disturbance occurs.

In-pit sump data since 2023 was submitted for review, which showed generally neutral pH levels, interspersed with distinct patches of low-pH results (See table 3, below). Discrepancies between field pH measurements and lab pH measurements likely indicate continued reactions occurring between alkaline and acidic chemical species, between when the sample was taken and when it was analysed in the laboratory.

Table 3: Selected water quality monitoring parameters for the in-pit sump water quality

Date	pH Field	Lab pH	Electrical conductivity Field	Lab Total Titratable Acidity	TDS Field	Total acidity	Total alkalinity
16/02/2023	7.07	6.5	410	<5	200		
23/02/2023	6.85	7	380	<5	300	7.6	39
4/03/2023	6.85	6.7	380	6.8	190		
16/03/2023	7.07		410		200		
23/03/2023	6.85		380		190		
3/04/2023	7.48		420		210		
11/03/2023	5.13	5.9	2200	22	1130	27	21
28/03/2023	4.26	5.9	4530	13	2290	19	9.9
5/04/2023	6.38						
6/06/2023	5.04	5	970	16	490		
26/06/2023	6.3	7.3	670	6.3	340	12	9.7
4/07/2023	6.29	7	760	6.1	380		
4/07/2023	6.58	6.8	2080	7.1	1040		
31/07/2023	6.49		1150		570		
4/06/2024	5.63	7.6	400	5.8	200		
18/06/2024	6.08	7.7	920	6.4	460	10	19
8/07/2024	7.12	7.9	620	<5	310		
23/07/2024	6.41	6	440	<5	220	10	8.9
6/08/2024	6.92		500		250		
15/10/2024		7.5					
21/10/2024		7.8		10		<10	25
20/03/2025	6.78	7.3	2290	9.1	1130		
26/03/2025	6.87	7.6	2460	7.3	1230	12	71
1/04/2025	7.15	6.6	2370	6.9	1180	13	64

Groundwater monitoring bore data

A review of the shallow KS series of monitoring bores that are currently in place on L8918/2015/1 was also undertaken. Figure 6 (in section 2.6.3) shows the locations of the KS bores, in red.

Two bores, KS17 and KS23, are showing consistently low pH levels, indicating that the soils are undergoing acidification. The majority of the other monitoring bores are showing neutral or near-neutral pH levels, however, there are some indications that the early stages of acidification are taking place in a small number of additional bores across the premises. It should be noted that groundwater pH measurements on their own can be a poor indicator of the extent to which groundwater acidification is occurring. Acidification is typically a problem that evolves over time, until the groundwater ultimately reaches an equilibrium.

Monitoring of urban dewatering projects in areas underlain by Bassendean Sands has indicated that the following changes in groundwater quality typically occur over time as acidification takes place, prior to a decline in pH levels:

- Concentrations of bicarbonate ions (*i.e.*, the main source of groundwater alkalinity) progressively decline;
- The net acidity of groundwater (*i.e.*, total titratable acidity - alkalinity) progressively increases;
- Sulfate concentrations in groundwater progressively increase due to the oxidation of the sulfide mineral pyrite in aquifer sediments that are exposed to air within the drawdown zone of the water table; and
- Concentrations of some dissolved metals (especially aluminium and iron) increase in groundwater.

The pH level then declines after any buffering capacity of groundwater has been largely depleted. The groundwater monitoring data revealed a zone within the mining area where shallow groundwater appears to be actively undergoing acidification (see figure 8, below). Several groundwater bores within this zone, including KS12, KS18 and KS24, are also showing recent progressive increases in sulfate concentrations, a trend that is consistent with the effects of pyrite oxidation within aquifer sediments.

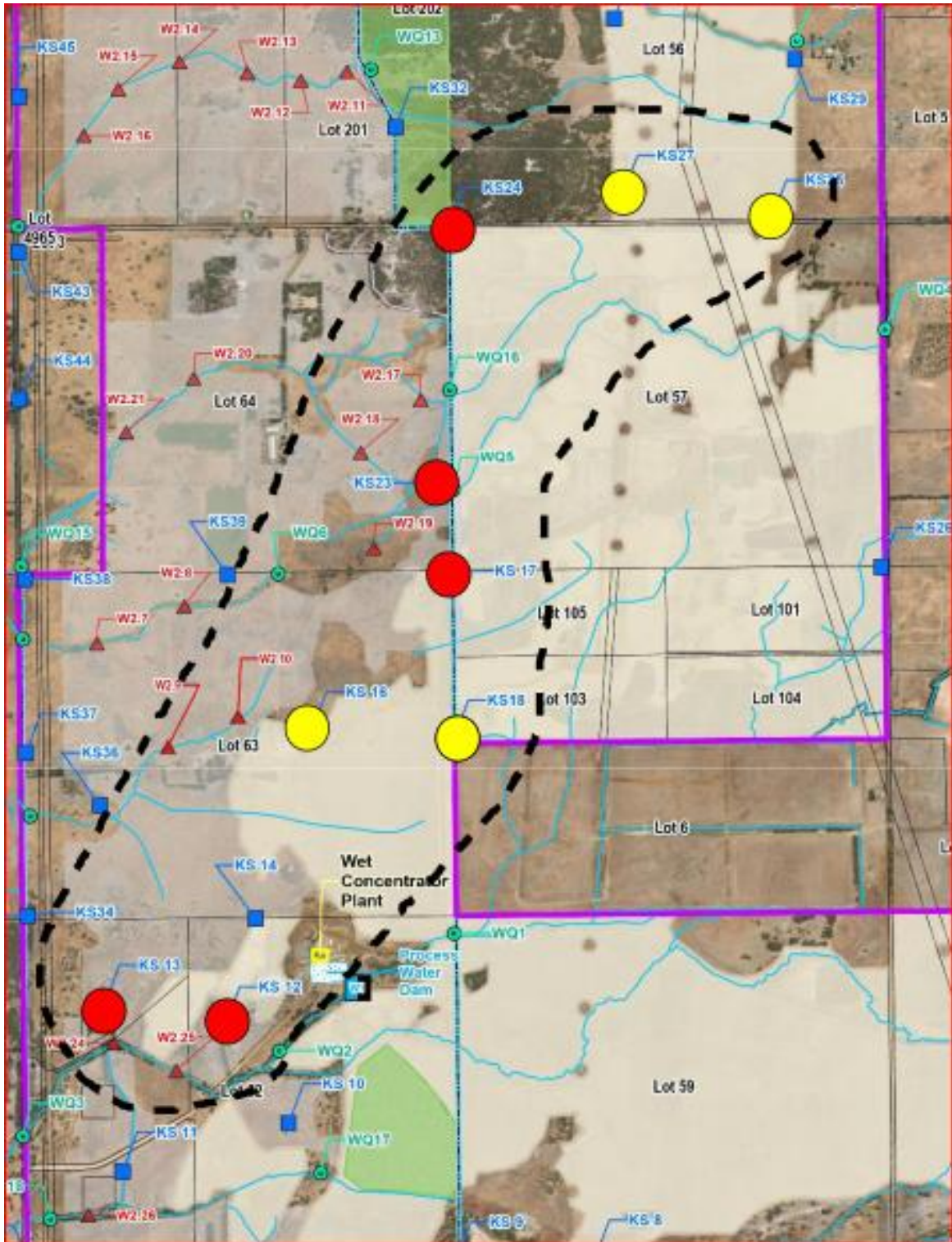


Figure 8: Yellow depicts bores where the alkalinity of the groundwater is approximately the same as total titratable acidity and red depicts locations where the total titratable acidity exceeds alkalinity.

A second issue was observed in the water quality monitoring data, with five groundwater samples reporting elevated levels of gross alpha and/or gross beta activity. Licence L8918/2015/1 currently requires an annual measurement of gross alpha and gross beta activity for any bore where total titratable acidity levels exceed 40mg/L.

Request to amend groundwater monitoring network

As part of this amendment, the licence holder is seeking to expand the groundwater monitoring network to accommodate the western extension of the premises with the addition of 8 groundwater monitoring bores targeting the superficial aquifer. These bores have already been established under the groundwater licensing system. The Delegated Officer finds the placement of the bores suitable to also monitor the western extension areas and will amend the licence accordingly.

The licence holder is also seeking to remove eastern bores KS4, KS6 and KS7 from the monitoring schedule. The licence holder has stated that this eastern area was rehabilitated some time ago. The Delegated Officer notes that rehabilitation and closure outcomes for this premises are regulated through the Ministerial Statement. This area still forms part of the project footprint for the Ministerial Statement, and the EPA has not indicated that this area is to be released from the development envelope. While a review of the groundwater monitoring data for these bores did not identify any obvious issues, there was not sufficient data to definitively conclude that there has been no impact to the groundwater in this area. The Delegated Officer has declined to remove these bores from the monitoring schedule until further data can be provided.

Additionally, the licence holder would like a caveat on the licence to allow bores KS10 – 13 a monitoring exemption for up to 12 months at a time for operational reasons, as they appear to be in the new mining areas in Lot 62. The licence holder has stated that they do not intend to relocate the bores outside the proposed mining areas. These bores are required to be monitored either quarterly, six-monthly or annually for various parameters. Two of these bores have been identified as showing early signs of acidification. The Delegated Officer is prepared to allow one exemption for each bore from the quarterly monitoring requirements for operational reasons, but considers a full year without monitoring data to be excessive amount of data to forgo. This accommodation allows each monitoring bore to be non-operational for up to six months for operational reasons. The Delegated Officer considers it reasonable for the licence holder to adapt the mining schedule to facilitate monitoring requirements to this extent.

2.6.6 Dust impacts

The premises is located in an agricultural region about 2.5kms west of the town of Keysbrook and about 1.7kms north of North Dandalup. The properties within the planned expansion area, and the properties immediately surrounding it, are primarily active farmland, some of which contain homesteads. Four of the Lots that are included within the expansion area and one Lot which has previously been approved for mining (although, it has not been mined yet), currently have residential properties on them. This includes Lots 20, 56, 64, 201 and 508. There are a further 10 residential properties within 1km of the expanded premises boundary, making them at elevated risk of being impacted by dust emissions from the premises (refer to figure 9, below). The highest risk of impacts from dust occurs during dry soil conditions which typically occur in late summer and autumn and coincide with strong easterly winds.

Prior to this licence amendment, dust management was regulated entirely through Part IV of the EP Act and Ministerial Statement 810. This was carried out through the implementation of an Air Quality Dust Management Plan (AQDMP), and the requirement to report to the department on the exceedance of trigger levels. The licence holder is proposing to continue managing dust in accordance with past practices at the premises and the AQDMP.

As the regulation of dust management at the premises is now delegated to the Part V licence, this assessment considers the risk of potential dust impacts from the unmined western extension areas and the unmined Lot 56.

A review of past air quality monitoring data notes that there were 14 events of elevated dust reported since 2021 which the premises may have caused or been a contributor to. All events occurred during the summer and autumn, between November and April, and all events were

associated with strong easterly winds. Investigations indicate that dust generated from open areas, including rehabilitation areas, was a significant contributor to dust levels.

The AQDMP lists a series of management actions to minimise dust generation from the premises. It also outlines a real-time monitoring program of both total suspended particulate (TSP) matter and particulate matter particles smaller than 10µm in diameter (PM₁₀) using boundary monitors, wind measurements, triggers and real-time alerts. This information is used to guide dust management decisions at the premises, such as increasing dust suppression or reducing dust generating activities. The proposed triggers and limits in the AQDMP are outlined below, in Table 4.

Table 4: Air quality triggers and limits from the AQDMP

PARAMETER	TRIGGER CRITERIA	THRESHOLD CRITERIA/LIMIT
Total Suspended Particles (TSP)	600 µg/m ³ 15-minute average	1,000 µg/m ³ 15-minute average
Particulate Matter (PM ₁₀)	40 µg/m ³ 6-hour rolling average	50 µg/m ³ 24-hour average*

The locations of the boundary monitors are moved depending on the areas in which mining and rehabilitation are occurring. The monitors are generally placed between dust generating activities on the premises and sensitive human receptors (downwind) and at an upwind location. Community feedback may also be taken into account when siting the monitors.

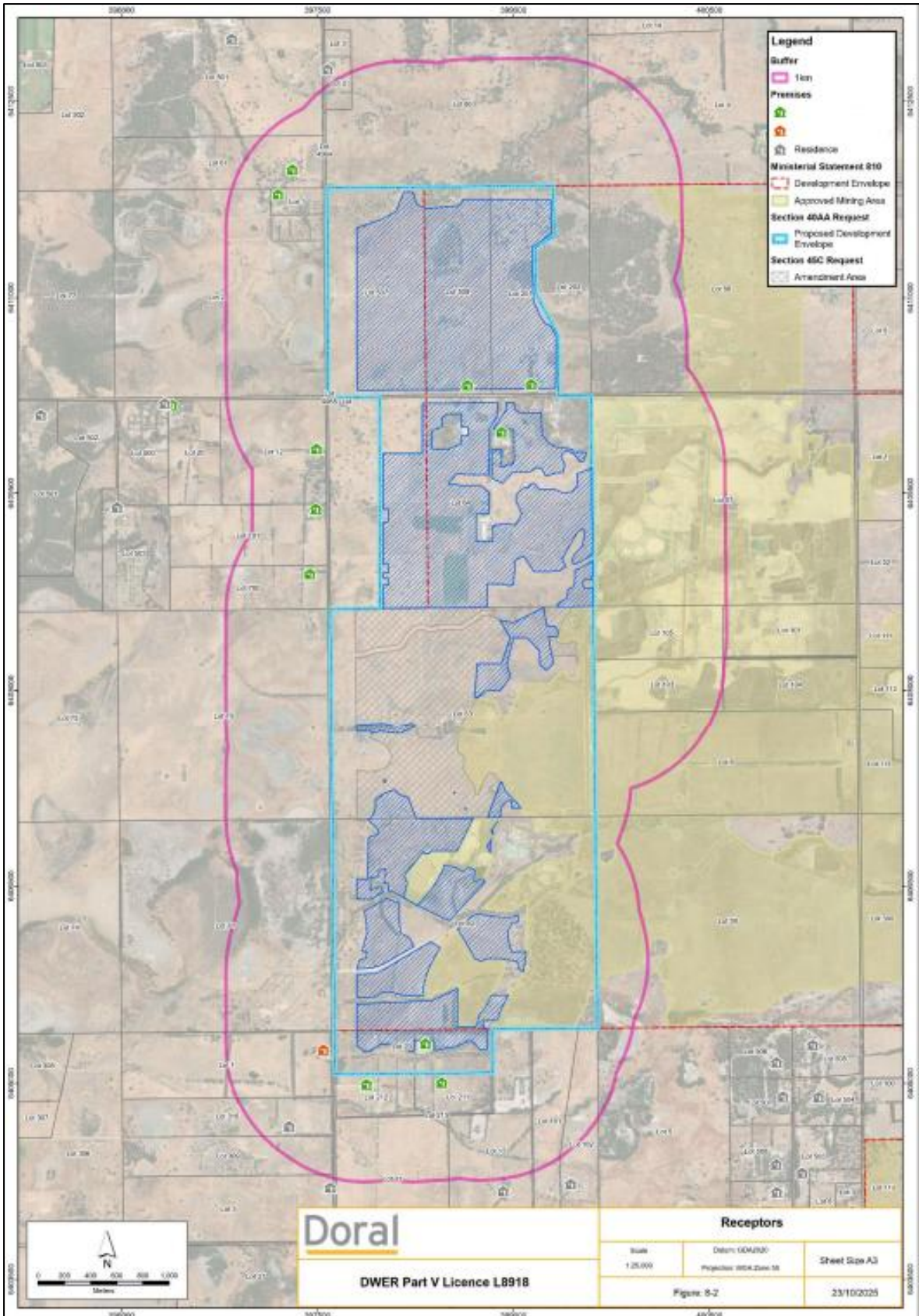


Figure 9: Distance of proposed mining expansion areas to human sensitive receptors

3. Risk assessment

The department assesses the risks of emissions from prescribed premises and identifies the potential source, pathway and impact to receptors in accordance with the *Guideline: Risk assessments* (DWER 2020).

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.

3.1 Source-pathways and receptors

3.1.1 Emissions and controls

The key emissions and associated actual or likely pathway during premises operation which have been considered in this amendment report are detailed in Table 5 below.

Table 5 also details the existing controls on the licence and the control measures the licence holder has proposed to assist in controlling these emissions, where necessary.

Table 5: Licence Holder controls

Emission	Sources	Potential pathways	Proposed / existing controls on the licence
Dust	Erosion of cleared areas and stockpiles during high winds Mining and earthworks Wheel generated dust Materials handling Rehabilitation activities	Air / windborne pathway	<u>Controls in the AQDMP for the premises:</u> Use of slime carts (use of clay slimes for dust suppression). Sowing of a dust crop (fast-growing grasses) on exposed areas such as dry tailings, prior to final rehabilitation. Progressive rehabilitation. Monitoring of meteorological conditions and weather forecasts. Limiting vehicle speeds on the premises. No mining within 300m of an occupied residence without an agreement in place and additional dust controls. Use of dust monitoring at boundary locations, with trigger action criteria and real-time alarms. Covering of HMC loads. Additional restrictions on mine vehicle speeds and increased dust suppression when winds in excess of 23km/hr. Cessation of mining activities, if required.
Tailings	In-pit tailings dams Pipelines	Spills Overtopping of voids Failure of embankments around in-pit	<u>Existing conditions on the licence:</u> Pipeline containment and leak detection requirements. Embankment and bunding requirements around pits being tailed into.

Emission	Sources	Potential pathways	Proposed / existing controls on the licence
		facilities	Inspection requirements
Seepage from tailings or process water facilities	Tailings deposition to mine voids Picton mineral separation plant tailings deposition Process water ponds	Seepage to groundwater	<u>Existing conditions on the licence:</u> Process water ponds are fully lined Limits on Picton Tails disposal Blending of tailings prior to disposal Groundwater monitoring network
Process water and dewatering effluent	Process water ponds and northern return water settling pond Spills	Authorised discharge to surface waterbodies Overtopping process water ponds Spills	<u>Existing conditions on the licence:</u> Discharge water volume limits Discharge water quality limits Surface water quality monitoring Process water pond spillway Discharge point inspections
Sediment laden stormwater	High rainfall events on disturbance areas	Stormwater runoff to surface water and vegetation	<u>Existing conditions on the licence:</u> Stormwater containment infrastructure requirements <u>Ministerial Statement requirements:</u> 20m buffer around major water courses 100m buffer around conservation category wetlands
Acidification of groundwater or soils	Disturbance or dewatering of potentially acid sulfate soils	Disturbance causing oxidation	<u>Controls in the ASSMP for the premises:</u> Field screening of soils. Acid-base accounting of selected soils. Dewatering effluent monitoring. Capture and treatment of dewatering effluent. Treatment of PASS soils with alkaline material, if required.

3.1.2 Receptors

In accordance with the *Guideline: Risk assessments* (DWER 2020), the Delegated Officer has excluded employees, visitors and contractors of the licence holder's from its assessment. Protection of these parties often involves different exposure risks and prevention strategies, and is provided for under other state legislation.

Table 6 below provides a summary of potential human and environmental receptors that may be impacted as a result of activities upon or emission and discharges from the prescribed premises (*Guideline: Environmental siting* (DWER 2020)).

Table 6: Sensitive human and environmental receptors and distance from prescribed activity

Human receptors	Distance from prescribed activity
Five residential premises within the proposed prescribed premises boundary (Lots 56, 508, 201, 64 and 20)	Within the prescribed premises boundary
Lot 67	Property adjacent to prescribed premises House 265m to prescribed premises boundary About 650m from proposed mining area
Lot 1 (north)	Property adjacent to prescribed premises House 350m to prescribed premises boundary About 620m from proposed mining area
Lot 12 (2 houses)	Property adjacent to prescribed premises House 490m to prescribed premises boundary and proposed mining area
Lot 701	Property adjacent to prescribed premises House 460m to prescribed premises boundary and proposed mining area
Lot 700	Property adjacent to prescribed premises House 550m to prescribed premises boundary and proposed mining area
Lot 1 (south)	Property adjacent to prescribed premises House 105m to prescribed premises boundary About 240m from proposed mining area
Lot 212	Property adjacent to prescribed premises House 85m to prescribed premises boundary About 250m from proposed mining area
Lot 211	Property adjacent to prescribed premises House 90m to prescribed premises boundary About 270m from proposed mining area
Lot 310	Property adjacent to prescribed premises House 560m to prescribed premises boundary About 770m from proposed mining area
Pastoral land	Within the prescribed premises boundary, underlying land use is pastoral

Environmental receptors	Distance from prescribed activity
<p>Surface water bodies – RiWI Act surface water areas and irrigation districts:</p> <ul style="list-style-type: none"> • Serpentine River System • Murray River System <p>Onsite water bodies:</p> <ul style="list-style-type: none"> • Dirk Brook Tributary • Nambeelup Brook North • Balgobin Brook South 	<p>Cross east to west through the prescribed premises and will not be directly disturbed, with a 20 m mining exclusion buffer in accordance with Ministerial Statement approvals.</p> <p>Locations within the prescribed premises boundary are authorised process water discharge points.</p>
<p>Several, smaller, unnamed water courses</p>	<p>Crossing through the prescribed premises flowing west</p>
<p>Underlying groundwater – RiWI Act groundwater areas:</p> <p>Serpentine Groundwater Area</p> <p>Murray Groundwater Area</p>	<p>Directly underlying the premises.</p> <p>The superficial water table sits at 0 to 10 mbgl.</p> <p>The Leederville aquifer is a deeper, confined aquifer.</p>
<p>Peel-Yalgorup RAMSAR wetlands</p> <p>Peel-Harvey Estuary (important WA wetlands)</p>	<p>16 kms to the southwest of the premises, with all onsite watercourses terminating in this wetland system</p>
<p>Peel Inlet management area (Waterways Conservation Act Management Area)</p>	<p>4.8 kms to the west of the premises</p>
<p>Conservation Category Wetlands</p>	<p>3 within the expanded prescribed premises boundary and 2-3 potentially downstream outside the prescribed premises.</p> <p>The Ministerial Statement contains a condition requiring a 100m buffer where no clearing or mining may occur around the wetlands.</p>
<p>Conservation vegetation offset area required by the EPA</p>	<p>2 conservation offset areas within the prescribed premises boundary which will be immediately adjacent to the new mining areas in Lot 201 and Lot 62</p>
<p>Ethnographic survey identified one potential cultural site (no artifacts)</p>	<p>Within Lot 64</p> <p><i>Regulated by the Ministerial Statement</i></p>

3.2 Risk ratings

Risk ratings have been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020) for those emission sources which are proposed to change and takes into account potential source-pathway and receptor linkages as identified in Section 3.1. Where linkages are in-complete they have not been considered further in the risk assessment.

Where the licence holder has proposed mitigation measures/controls (as detailed in Section 3.1), these have been considered when determining the final risk rating. Where the Delegated Officer considers the licence holder's proposed controls to be critical to maintaining an acceptable level of risk, these will be incorporated into the licence as regulatory controls.

Additional regulatory controls may be imposed where the licence holder's controls are not deemed sufficient. Where this is the case the need for additional controls will be documented and justified in Table 7.

The revised licence L8918/2015/1 that accompanies this amendment report authorises emissions associated with the operation of the premises i.e. mineral sands mining and processing activities and dewatering activities.

The conditions in the Revised Licence have been determined in accordance with *Guidance Statement: Setting Conditions* (DER 2015).

Table 7. Risk assessment of potential emissions and discharges from the premises during operation

Risk Event					Risk rating ¹ C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions ² of licence	Justification for additional regulatory controls
Source/Activities	Potential emissions	Potential pathways and impact	Receptors	Licence Holder's controls				
Operation								
Expansion of the mining footprint, mining activity including soil disturbance, use of heavy mobile equipment, dewatering.	Dust	Pathway: Air/windborne pathway Impact: Health and amenity	About 13 residential homes within and immediately around the prescribed premises. Wider community including North Dandalup, 1.7kms to the south.	Refer to section 3.1	C = Moderate L = Possible Medium Risk	N	Condition 2, 7, 21 and 22 <u>Condition 5, 6, 23 and 24.</u>	Previously regulated under Part IV of the EP Act. Additional controls have been added to the licence, largely in accordance with controls and monitoring outlined in the AQDMP. The limits from the AQDMP have been transferred to the licence. The AQDMP lists a series of management actions to minimise dust generation from the premises. The Delegated Officer considers them appropriate, and they have been added as conditions on the licence. Expert review of the AQDMP finds that the use of boundary monitors to guide operational dust management is sound and should the nominated limits for TSP and PM10 be met at the boundary, it is considered likely that amenity and human health impacts to the surrounding residents will be maintained at an acceptable level. However, it is noted that the trigger criteria for PM10, averaged over 6 hours, is unlikely to be sensitive enough because once this level is reached, it is unlikely to offer the licence holder sufficient time to reduce dust emissions to maintain compliance with the 24-hour average limit. Experience at other sites indicates that a trigger criterion of 200 µg/m ³ averaged over 1 hour would provide the licence holder a better opportunity to avoid exceedances of the limit. As a result, this trigger has been conditioned on the licence instead. Specific, fixed, locations for boundary dust monitoring will be conditioned on the licence depending on the locations that mining and rehabilitation are occurring. One upwind monitoring location will be required for each area. It is unclear if or when sensitive receptors that are within the boundary of the prescribed premises, will be occupying their residences. For this reason, additional, receptor dust monitoring will be required unless the residence is not occupied.
	Disturbance of PASS material causing acidification of groundwater or potentially metalliferous drainage	Pathway: Seepage Impact: Deterioration of groundwater quality	Groundwater below farmland within the footprint of the prescribed premises	Refer to section 3.1	C = Major L = Unlikely Medium Risk	N	<u>Condition 8, 9, 21, 27, 28 and 29</u>	Previously regulated under Part IV of the EP Act. The Delegated Officer has reviewed the ASS management practices currently in place at the premises and finds that they are not in line with current industry standards. For this reason, additional controls have been added to the licence for the identification and management of acid sulfate soils that meet current industry standards. There is a risk that historical practices may be resulting in some early stage acidification of soils at the premises. A specified action condition has also been added to the licence to conduct an investigation to understand potential groundwater impacts. Refer to detailed risk assessment for further information.
	Sediment laden stormwater	Pathway: Overland runoff Impact: Ecosystem disturbance or impact to surface water quality	Creeks within the prescribed premises boundary Downstream flows into the Peel-Harvey Estuary (EPP area and Ramsar wetland)	Refer to section 3.1	C = Moderate L = Possible Medium Risk	Y	Condition 2 and 12	Previously regulated under Part IV of the EP Act. Standard stormwater conditions have been transferred to the licence.
Expansion of the footprint, disposal of tailings material	Tailings	Pathway: Overtopping, spills or embankment failure	Neighbouring farmland Local surface water bodies Aquatic organisms in	Refer to section 3.1	C = Major L = Rare Medium Risk	Y	Condition 1, 2, 3, 4 and 10	Existing conditions on the licence are considered sufficient to manage this risk event for the expansion of the premises.

Risk Event					Risk rating ¹ C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions ² of licence	Justification for additional regulatory controls
Source/Activities	Potential emissions	Potential pathways and impact	Receptors	Licence Holder's controls				
		Impact: Possible impact to farmland around premises, deterioration of surface water quality and possible aquatic ecosystem disturbance	the water ways					
	Seepage	Pathway: Seepage Impact: Deterioration of groundwater quality	Groundwater below farmland within the footprint of the prescribed premises	Refer to section 3.1	C = Moderate L = Unlikely Medium Risk	Y	Condition 10, 11, 20 and 27.	Existing conditions on the licence are considered sufficient to manage this risk event for the expansion of the premises. The licence holder also sought the removal of Picton Tails thorium and uranium limits from the licence, due to radiation management being regulated by DLGIRS and the Radiological Council. The Delegated Officer finds that there is no duplication of regulation in this matter, and therefore, the limits and associated annual reporting will remain on the licence.
Transport of ore, process water and tailings through pipelines	Tailings or process water	Pathway: Spills Impact: Possible impact to farmland around premises, deterioration of surface water quality and possible aquatic ecosystem disturbance	Neighbouring farmland Local surface water bodies Aquatic organisms in the water ways	Refer to section 3.1	C = Minor L = Unlikely Medium Risk	Y	Condition 1, 2, 3, 4	Existing conditions on the licence are considered sufficient to manage this risk event for the expansion of the premises.
Discharge of process water to additional surface water locations	Process water	Pathway: Direct discharge Impact: Deterioration of surface water quality and possible aquatic ecosystem disturbance	Minor waterways Aquatic organisms in the water ways	Refer to section 3.1	C = Major L = Likely High Risk	N	N/A	It is the department's view that minor watercourses, both within the premises and further downstream, will have an increased risk of being disproportionately impacted by discharges of water from the premises. The volume of water discharged, compared to the natural flows of the creeks, would disrupt the flow regimes; increase the risk of erosion of the creek channel from the additional flow; and potential contaminant loading of the waterways from poor quality discharge water would have an outsized impact due to the lack of dilution. For these reasons, only the two additional discharge points on Balgobin Brook South will be authorised. The additional, proposed surface water monitoring locations on the minor streams have not been approved. The request to remove the requirement for surface water monitoring at location WQ4 on Nambelup Brook North, and instead rely on WQ5 as the upstream site for this waterbody will not be approved at this time. As seen in Figure 6, WQ5 is in the middle of the disturbance area, with rehabilitation of Lot 57 upstream of this location still ongoing. When implementing stream monitoring programs, it is preferable for the upstream surface monitoring locations to be as far upstream as practical, and as far out of any potential impact zone as possible. WQ4 is considered likely to be a better representation of upstream conditions than WQ5 while rehabilitation in Lot 57 fully establishes itself. Once the rehabilitation is established, and surface water quality monitoring data demonstrates that the two sites are analogous, this may be reconsidered.
			Medium waterways flowing into the Peel-Harvey Estuary (EPP area and Ramsar wetland) Aquatic organisms in the water ways	Refer to section 3.1	C = Moderate L = Possible Medium Risk	Y	Condition 12, 13, 14, 15, 19 and 25.	
Increased volume of process water discharged to surface water bodies	Process water	Pathway: Direct discharge Impact: Deterioration of surface water quality and possible aquatic ecosystem disturbance	Surface water bodies and tributaries The Peel-Harvey Estuary (EPP area and Ramsar wetland) Aquatic organisms in the water ways	Refer to section 3.1	C = Moderate L = Unlikely Medium Risk	N	Condition 12, 13, 14, 19 and 25. <u>Condition 15, 26 and 30.</u>	The Delegated Officer has determined that currently, the discharge water does not meet acceptable water quality criteria for an increase of discharge volume to this river system without additional controls to ameliorate potential impacts. This will require the discharge water quality to be significantly improved before the increase in volume can be authorised. A condition specifying the revised discharge water quality limits has been included on the licence, paired with the requirement for the licence holder to investigate and determine a pathway forward to ensure that the limits will be met. It is considered likely that additional infrastructure may be required to achieve this. When it is demonstrated that the revised water quality limits will be met, the licence holder can apply to have the increase in discharge volume authorised on the licence. The Delegated Officer has also included a condition for biological monitoring of the discharge water surface bodies to better understand the impacts of the discharges on the aquatic ecosystems. Selected discharge water and surface water monitoring parameters that are in place under the Water Management Plan but not captured on the licence have been transferred to the licence. Refer to detailed risk assessment for further information.

Note 1: Consequence ratings, likelihood ratings and risk descriptions are detailed in the *Guideline: Risk assessments* (DWER 2020).

Note 2: Proposed licence holder's controls are depicted by standard text. **Bold and underlined text** depicts additional regulatory controls imposed by department.

3.3 Detailed risk assessment for additional volume of process water discharges to surface watercourses

3.3.1 Background and description of risk event

When the licence was first issued, it was anticipated that only small volumes of process water (less than 150,000 tonnes per year) would be required to be discharged from the premises, and that would largely be during winter, in response to high rainfall events. With low volumes of water intended to be discharged during high rainfall periods, the risks of impacts to the local surface water systems were assessed as being 'Low' (DER, 2015b).

As the project has progressed, greater volumes of process water have been captured and require management prior to discharge to the local surface water bodies.

The water quality limits on the licence were set under the condition that discharge would be limited to 250,000kL per year, which would allow for a substantial amount of dilution within the river system. However, as the volume of water is substantially increased, dilution factors will no longer be effective to minimise impacts.

Aquatic Science experts within the department have advised that increasing the discharge volume to 750,000kL per year, with the current water quality limits, would be likely to cause a significant impact to the river water quality, which would be likely to result in ecosystem disturbance. Increases in turbidity reducing light penetration and the smothering of the river substrates with fine particles were considered to be the most problematic, and likely, impacts. It is also noted that the licence holder is generally not meeting the current TSS limits set on the licence, further increasing the risk of impacts.

3.3.2 Description of potential adverse impacts

Discharge of poor-quality process water to the surface waterbodies could cause a deterioration in water quality, causing ecosystem disturbance of the riverine system and compromising ecological functionality. Adverse impacts to species composition and abundance are known to occur in Australian aquatic ecosystems when EC increases by around 1,500 $\mu\text{S}/\text{cm}$. Decreases in pH can lead to direct adverse effects to aquatic organisms, but can also cause the toxicity of other pollutants in the water ways to increase (ANZECC, 2000).

Excess TSS is particularly problematic in riverine aquatic ecosystems because it reduces light penetration, with adverse effects on algae, macrophytes and seagrasses, which then results in a reduction in food supply. It is also known to smother benthic organisms and their habitats and can physically abrade the gills of fish, crustaceans and molluscs (ANZECC, 2000). Locations downstream of the premises, on the Serpentine river system have pebbly, rocky substrates that are important for the breeding cycles of the local fish, which will be negatively impacted by smothering with small particle sediments.

This would be likely to cause high level impacts to the water bodies on site, with the potential to cause medium to long term impacts to the local ecosystem outside the premises.

However, the department's aquatic science experts have also advised that if the discharge water quality were to be significantly improved, it would likely result in minimal ecosystem disturbance, or possibly even have a positive impact. It is recommended that at a minimum, water quality parameters should be set with regard to the default guideline values for freshwater ecosystems in the south-west of Australia outlined in ANZECC (2000). This includes a pH range of 6.5 to 8.0 and an EC of no more than 1,500 $\mu\text{S}/\text{cm}$.

There is no default guideline value for TSS levels, but the existing limit of 80mg/L is considered to be too high for the medium flow streams to accommodate. With an authorised discharge volume of 250,000kL per year, this equates to 20 tonnes of suspended solids being authorised for discharge into the river system each year.

3.3.3 Existing Controls

The licence holder monitors the discharge volume and water quality and has upstream and downstream monitoring of chemical water parameters in place. Process water is collected in the process water circuit and used on site for processing when possible. The process water ponds are designed to reduce sediment loads from the water prior to discharge. Different flocculants have been tried to further lower TSS levels in the discharge stream, however, these have not been particularly effective to date.

Conditions in place on the licence restricting discharge to the winter May to October period, and to only the medium sized surface waterbodies, optimises dilution and therefore reduces some of the potential water quality impacts.

The licence holder has acknowledged that the TSS levels in the discharge water are too high and is currently considering different options to reduce the levels. No commitment has been made to a particular set of additional controls at this stage.

3.3.4 Risk Assessment

The Delegated Officer has considered this risk assessment in two parts.

Firstly, the consequence of discharging up to 750,000 kL of the current, poor-quality, process water to the surface waterbodies deteriorating the water quality, causing ecosystem disturbance of the riverine system and compromising ecological functionality is considered to be major, with potential mid-level impacts to the local ecosystem outside the premises.

The likelihood of impacts occurring is considered possible, given the historic water quality results. This provides an overall rating for this risk as **high**.

However, if the quality of the discharge water were to be improved to a point where the ANZECC southwest Australian lowland freshwater ecosystem water quality guidelines were met for pH and EC, and the total suspended particulate levels were significantly reduced, the risk rating would change.

In this circumstance, the consequence of discharging up to 750,000 kL of good quality process water to the surface waterbodies deteriorating the water quality, causing ecosystem disturbance of the riverine system and compromising ecological functionality would be considered to be moderate, with the potential for low-level impacts to the local ecosystem outside the premises.

The likelihood of impacts occurring would be considered unlikely, with incidents of poor-quality discharge unlikely to occur in most circumstances. The revised risk rating would result in a ranking of **medium**.

3.3.5 Regulatory Controls

The Delegated Officer has determined that currently, the discharge water does not meet acceptable water quality criteria for an increase of discharges to this river system and therefore additional controls to ameliorate potential impacts will be required before an increase in discharge volume can be considered.

To reduce potential impacts to the river systems, the discharge limits are required to be revised lower to be closer to the guideline values for freshwater ecosystems in the south-west of Australia. The Delegated Officer has therefore revised the discharge limits as follows:

Table 8: Revised process water discharge limits

Parameter	Current Limit	Revised Limit
pH	5.5 – 8.5	6.5 – 8.5
Electrical conductivity @25C	2,500 µS/cm	1,500 µS/cm

Total titratable acidity	40 mg/L	40 mg/L
Total suspended solids	80 mg/L	40 mg/L

However, it is acknowledged that these limits, particularly the TSS level, is unlikely to be achievable with the current process water circuit infrastructure at the premises. While achieving the pH and titratable acidity levels would require a simple intervention such as the addition of lime to the process water ponds, complying with the TSS limit is likely to be more difficult.

Reducing TSS levels will probably require the modification of the processing circuit or installation of new infrastructure. Additional, sequential settling ponds may require construction, or the separation of the clay slimes fraction of the waste stream for deposition to evaporation ponds may need to be considered. The Delegated Officer regards the licence holder to be best placed to determine a way forward to achieving the required water quality outcomes.

For this reason, these water quality limits will not take effect until August 2026, and a specified action will be added to the licence for the investigation of options to achieve the required improvement in water quality. A report on the investigation will be required to be submitted to the department by May 2026. This will allow time for the licence to be amended, if required, to accommodate additional infrastructure. During this process, the licence can be amended to increase the discharge water volume if the department is satisfied that the revised discharge water quality limits are likely to be met.

In addition to this, the Delegated Officer has also determined that biological monitoring of the local surface water bodies is warranted, to better quantify the impacts of the water discharges on the local aquatic ecosystems. As the risk profile of discharging process water to the surface water locations has changed, it is appropriate to condition upstream and downstream monitoring to confirm that impacts are minimal.

Instead of requiring a full ecological evaluation, the Delegated Officer considers an annual benthic macroinvertebrate survey in the waterways that may receive process water discharges to be an appropriate level of assessment. Macroinvertebrates are a good indicator of ecosystem health, as healthy waterbodies typically support a diversity of species, whereas impacted locations tend to have fewer species, and consist of only those that are tolerant to pollutants. These surveys can be conducted comparatively quickly and easily and will provide a quantitative indication against which to measure whether the aquatic ecosystem is being impacted (Chessman B, 2003).

3.4 Detailed risk assessment for the disturbance of potentially acid sulfate soils causing impacts to groundwater

3.4.1 Background and description of risk event

Acid sulfate soil identification

The site-specific investigations completed by ABEC (2022 and 2023) were completed generally in accordance with the relevant guidelines, giving sound results. However, it was noted that the pH potassium chloride (pH_{KCl}) value used to evaluate the required Net Acidity calculation was slightly lower than the 6.5 cut-off value outlined in *National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual* (Sullivan et al., 2018). Nonetheless, these investigations were considered to be of a high standard, giving a good indication of where PASS is likely to be found, going forward.

The investigations showed that PASS is widespread throughout Lot 56 but it will likely be below the lowest mine pit floor. They also showed that high levels of PASS were discovered in Lot 63, but the majority were below the anticipated mine floor or are likely to have been mined already, as mining is nearly complete in this Lot. PASS was detected in Lots 62, 64 and 201, below the pit floor level, but in relatively few samples. The PASS found in Lot 62 is likely to be in close

proximity to the floor of the pit and it is recommended that particular attention is given to PASS management practices in this location.

The licence holder has stated that routine sampling of soils in accordance with the ASSMP has found no PASS material that exceeded the Net Acidity action level for treatment, for several years. There is a question, however, about the methodology used to determine whether Net Acidity in soil samples has exceeded action levels. Refer to the Applicant Controls, below.

Groundwater monitoring

Groundwater monitoring data has revealed two bores with consistently low pH levels, and several more that are displaying signs of early-stage acidification, including increasing Net Acidity levels and progressive increases in sulfate. These patterns are consistent with the effects of pyrite oxidation within aquifer sediments caused by the oxidation acid sulfate soils.

The assessment of the groundwater data appears to indicate that there is a zone within the mining area where shallow groundwater appears to be actively undergoing acidification.

Furthermore, dewatering effluent water quality monitoring has returned pH levels as low as 4.2, demonstrating highly localised groundwater acidity compared to typical pH levels recorded at the premises. Some of the pH values in the dewatering effluent are well below the pH levels seen in the groundwater monitoring bores across the premises, suggesting localised oxidation in the groundwater chemistry occurring in or near the pit. The Bassendean Dune Sands, which have a combination of highly reactive pyrite and low pH buffering capacity, are prone to acidification even after only short exposure (less than a week) to air during temporary excavation or dewatering (DER, 2015a).

When these data are considered in combination, it suggests that naturally occurring PASS at the premises is undergoing oxidation, but how much the mining activity is contributing to the issue is unclear. It cannot be determined from the data whether PASS was directly disturbed, or whether the acidification indicators may be a result of dewatering neighbouring PASS material.

In addition to potential acidification issues, it was noted that that gross alpha and gross beta levels in excess of the ANZECC national drinking water guideline value of 0.5 Bq/L (ANZECC, 2000) have been recorded in bores KS11, KS13, KS17 and KS23. The source of the radioactivity detected is likely to be from the naturally occurring, radioactive mineral monazite. Although the thorium and uranium that occurs in monazite is typically stable in the crystal lattice of the mineral, environmental factors, such as low pH can affect their leachability and migration into the groundwater. It is unclear if the acidification of soils that may be occurring at the premises could potentially be contributing to the liberation of radionuclides to the groundwater.

It is noted that the number of groundwater samples returning elevated levels of radioactivity is very low, but it is also noted that many of the groundwater bores at the premises are not analysed for this parameter. The licence currently only requires annual testing for gross alpha and gross beta activity for any bore where total titratable acidity levels exceed 40mg/L. This restriction on the monitoring requirements was initially put in place to reduce the monitoring burden related to the lowest risk groundwater bores, where acidification of the groundwater was not expected to occur (DER, 2015b). This makes it difficult to assess the extent of this potential issue at the premises.

3.4.2 Description of potential adverse impacts

It should be noted that a minor lowering of the pH of the groundwater, or a mild increase in sulfate levels alone, would not be considered a serious environmental impact. However, the more significant risk is that pH levels may continue to drop over time, to a point where the water is unsuitable for other beneficial uses. Acidification is a process that may not be immediately evident and can happen over an extended period of time. The future expected land uses in this area are pastoral and agricultural uses. If the acidity increases sufficiently, it may result in the

liberation of more problematic metals, which are typically stable in the soil but are susceptible to leaching at lower pH levels. Occasionally, this may occur before the pH level drops to a point that is unsuitable for agricultural use, but pre-emptively looking for early signs of acidification can allow the licence holder to undertake interventions that may avert the lowering of the pH and prevent this outcome. Should elevated levels of some metals leach into the groundwater, this could potentially compromise future agricultural use of the groundwater.

There are indications that there is an area within the premises that has started actively undergoing acidification, increasing the risk of groundwater quality deterioration and the mobilisation of metals into the groundwater in the future.

3.4.3 Applicant Controls

A review of the ASSMP for the Keysbrook Mineral Sands Mine (issued in 2015), which was created to fulfill the requirements of MS 810, found that it does not meet current industry standards. The management plan states that it was prepared in accordance with a 2003 series of guidance documents, which have since been superseded. The triggers and limits in the ASSMP do not appear to be in accordance with current industry standards and guidelines and would therefore be likely to result in an underestimation of the presence of PASS material at the premises.

Issues were found with both the field screening tests and the laboratory acid-base accounting protocols, when compared with the requirements described in *Sullivan et al., 2018*. A review of the soil monitoring data sheets for the premises indicated that when the field pH_{FOX} level was below 3, the sample was not identified as likely to be PASS. Furthermore, the acid-base accounting, which utilised the Chromium Reducible Sulfur (CRS) method, used a potential acidity (or S_{CR} value) criterion of 0.03%S to classify a soil sample as PASS or non-PASS material. This is only the correct criterion to use when the pH_{KCl} value for a sample is greater than 6.5 (i.e. in alkaline soils). In neutral soils, the potential acidity result must also be added to actual acidity (s-TAA), and for acidic soils, retained acidity (S_{NAS}) must also be included.

The field data sheets indicate that the licence holder was not determining the pH_{KCl} values for each sample. The ASS site specific investigations conducted by ABEC typically found that soils at the premises had a pH between 4.5 and 6.5, which means that the calculation of Net Acidity for these soils requires adding the actual acidity of the soil (which is easily released into the environment) to the potential acidity of the soil. If the Net Acidity, as determined by summing both of these values, exceed 0.03%S then the material should have been classified as PASS.

This deviation from the benchmarks of the *Sullivan et al., 2018* guidelines has possibly resulted in PASS material at the premises being misclassified as non-acid sulfate soils.

3.4.4 Risk Assessment

The Delegated Officer considers that the consequence of the groundwater at the premises becoming acidified to the extent that groundwater quality deteriorates to the point where future beneficial uses are compromised to be major, with potential high-level onsite impacts.

The likelihood of impacts occurring is considered unlikely, given the low levels of PASS material at the premises and when the additional conditions that have been added to the licence are taken into consideration. This provides an overall rating for this risk as **medium**.

3.4.5 Regulatory Controls

Acid sulfate soils

Due to the flaws that were noted relating to the correct characterisation of PASS material, a prescriptive condition detailing minimum requirements for PASS management has been added to the licence. It includes a detailed description of how to correctly determine the Net Acidity of PASS and outlines how to manage any PASS that is encountered. Trigger levels for the

treatment of soils have been included that reflect current industry standards. It should be noted that these are minimum requirements, and the licence holder may decide that a higher level of testing or management is required in higher risk areas.

The Delegated Officer has also transferred dewatering effluent monitoring requirements from the ASSMP to the licence. It is noted that mine dewatering effluent that may have a low pH is captured in the process water circuit and will be treated to a suitable water quality before discharge. For this reason, no specific triggers or management conditions for dewatering effluent are required on the licence.

Monitoring the dewatering effluent is considered a very useful indicator of whether PASS is being encountered, which the licence holder can use to guide decisions around PASS management. For example, should the pH of the dewatering effluent drop below 6, the licence holder may consider increasing the number of soil samples submitted for acid-base accounting.

Groundwater monitoring results indicate that there is a zone within the mining footprint that is actively undergoing acidification. While the underlying issue stems from the naturally occurring acid sulfate soils, there is a risk that it is being exacerbated by the mining activity.

Should it be determined that mining activity is causing or exacerbating soil acidification, it is understood that active remediation of acidified groundwater post-mining is difficult and often requires the managed aquifer recharge of lime-treated water into the affected area (refer to Shand *et al.*, 2018 for more information). During active mining operations, the department generally recommends a strategy of lime addition directly to the aquifer during mining (i.e. to the in-pit sump, which will allow for flow back to the aquifer when the pit is backfilled and the water table recovers) or lime addition to the tailings backfill in these areas. Buffering in this manner would then be expected to limit potential future groundwater acidification. The department does not deem it necessary at this stage to prescribe a course of action such as this for the licence holder, but it is recommended that the licence holder consider whether these types of remediation actions are warranted, either now or in the future.

Elevated radioactivity levels

The Delegated Officer finds that there is currently insufficient information available to reliably determine if secondary impacts from acid sulfate soil management, such as the mobilisation of metals and radionuclides, is occurring at the premises, and if so, to what extent. However, there are some data points that indicate potential issues, which the Delegated Officer has determined require further investigation by the licence holder. For this reason, a one-off comprehensive groundwater quality investigation will be included as a specified action on the licence.

It is noted that when gross alpha levels and/or gross beta levels exceed the 0.5 becquerels per litre (Bq/L) screening value outlined in the national drinking water guidelines (ANZECC, 2000), it is recommended that the radium isotopes Ra-226 and Ra-228 are added to the groundwater monitoring suite. They will not be added to the routine monitoring suite at this stage, but monitoring for these parameters will be required at all monitoring bores as part of the investigation.

The groundwater investigation will include all the existing monitoring bores on the licence and will target indicators of pyrite oxidation and metals that may be released from weathered monazite, in addition to parameters already included in the routine monitoring.

The current acidity trigger-level of 40 mg/L for monitoring of gross alpha and gross beta activity will be left on the routine groundwater monitoring conditions for the project but may be considered for removal in the future. This caveat was originally included on the licence to reduce the monitoring burden for a parameter that was not expected to be easily leached from the soils, and was therefore considered to be of low-risk of occurring. However, now that a few elevated levels have been recorded at the premises, the risk of elevated uranium and thorium leachate is considered more likely to occur, and may pose an increased risk of impacts. Testing all bores annually would allow for a better understanding of whether these impacts are actually occurring

across the site or in isolated pockets. This issue will be re-examined once the groundwater investigation has been completed and a better understanding of radioactivity levels at the premises is provided.

The Delegated Officer anticipates that the additional groundwater monitoring will provide valuable information to better understand if groundwater at the premises is being impacted. It will help to determine if current management measures are successful in preventing impacts or whether additional measures should be considered. It may also assist the licence holder to build a case for the relinquishment of areas where mining and rehabilitation has been completed.

4. Consultation

Table provides a summary of the consultation undertaken by the department.

Table 9: Consultation

Consultation method	Comments received	Department response
Two owners of Lots within the proposed expansion area advised of proposal on 1 July 2025	None received.	N/A
Shire of Murray advised of proposal on 1 July 2025	None received.	N/A
Shire of Serpentine Jarrahdale advised of proposal on 1 July 2025	None received.	N/A
Radiological Council of Western Australia advised of proposal on 7 August 2025	None received.	N/A
Licence holder was provided with draft amendment on 16 December 2025.	Response received 19 and 22 December 2025. Refer to Appendix 1	Refer to Appendix 1

5. Conclusion

Based on the assessment in this amendment report, the Delegated Officer has determined that a revised licence will be granted, subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

5.1 Summary of amendments

Table 108 provides a summary of the proposed amendments and will act as a record of implemented changes. All proposed changes have been incorporated into the revised licence as part of the amendment process.

Table 108: Summary of licence amendments

Existing Condition no.	Proposed amendments
Cover page	Changed registered business address from premises address to ASIC business address. Added the Lots for the expansion into the premises details.
1 and 2	Condition 1 and 2 consolidated and updated to standardised department wording.
2	Corrected HMC to ore. Removal of continuous pH and EC monitoring equipment requirement. Added standard stormwater requirement condition.
4	Corrected HMC to ore.
Added condition 5	New general condition for dust management.
Added condition 6	New condition for dust management to restrict mining within 300m of an occupied residential premises.
Added condition 7	Licence holder's proposed dust management actions conditioned on the licence.
Added condition 8	New general condition for potential acid sulfate soils management.
Added condition 9	New condition for the screening, identification and management of potential acid sulfate soils management.
Added condition 12	New condition specifying process water management requirements.
8	Two discharge points on Balgobin Brook South added. Clarified wording about discharge period.
9	Timeframe added for the application of the current discharge limits. Corrected condition number to reference discharge monitoring condition. Additional discharge points added.
Added condition 15	Added revised discharge water quality limits that will be applied from 1 August 2026.
13	Selected parameters that are currently monitored under the Water Management Plan, transferred to the monitoring schedule.
14	Added selected dewatering effluent monitoring requirements that are currently monitored under the Water Management Plan. Added requirement to report on ore and potential acid sulfate soils volumes.
Added condition 21	New condition requiring onsite meteorological monitoring for dust management purposes.
Added condition 22	New condition for ambient dust monitoring requirements.
Added condition 23	New condition for ambient dust monitoring requirements when there are receptors within the prescribed premises.
Added condition 24	New condition outlining triggers and limits for ambient dust monitoring.
15	Selected parameters that are currently monitored under the Water Management Plan, transferred to the monitoring schedule.
Added condition 26	New condition for biological monitoring of surface water locations.

16	<p>Additional monitoring bores added to the monitoring schedule.</p> <p>Removal of footnote relating to KS18. Added an exemption for one quarterly monitoring event for bores KS10-13 when mining in Lot 62.</p> <p>Corrected wording for alkalinity parameter.</p> <p>Transferred parameters to the schedule that are currently monitored under the Water Management Plan.</p>
Added condition 28 and 29	Specified actions added, requiring an investigation into the groundwater quality at the premises, and a report to be compiled and submitted to the CEO.
Added condition 30	Specified action added, requiring an investigation into upgrading the process water circuit infrastructure to improve water quality or prevent discharge, and submit a report to the CEO.
17	Updated monitoring data condition numbers
21	Updated monitoring data condition numbers
23	Changed notification requirement to apply to any non-compliance with the conditions of the licence.

References

1. ABEC Environmental Consulting, 2023, *Acid Sulphate Soil Investigation, Western Extension of Keysbrook Mineral Sands Project*.
2. ABEC Environmental Consulting, 2022, *Acid Sulphate Soil Investigation, Lot 56 Proposed Amendment Area, Keysbrook Mineral Sands Project*.
3. ANZECC & ARMCANZ 2000, [Australian and New Zealand Guidelines for Fresh and Marine Water Quality](#), Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
4. AQ2 Pty Ltd, October 2019, *Surface Water Assessment for the proposed Keysbrook Heavy Mineral Sands Project*.
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Appendix 1: Summary of Licence Holder's comments on risk assessment and draft conditions

Condition	Summary of Licence Holder's comment	Department's response
Cover	Correct address to 1424 Hopeland Rd	Corrected
2	Add definition of 'supernatant' to definition table. Add 'embankment' to dot point 2	Definition of 'supernatant' and 'decant water' added to the definitions table. 'Embankment' added to condition.
7	Add definition of 'mining activities' to definition table, similar to the one in the Ministerial Statement.	Definition added.
13	Remove the label 'northern' from the return water settling pond, as the location changes with mining.	Name of pond amended.
13	<p>Due to several of the proposed surface water discharge points not being approved, the Licence holder instead, requests:</p> <ul style="list-style-type: none"> • 2 additional discharge points to Dirk Brook (in the north of Lot 507 and 201). • 1 discharge point in Lot 508 to the minor, unnamed stream. • 1 additional discharge point to Nambeelup Brook (in Lot 63). 	<p>The Delegated Officer considers the discharge to the minor stream in Lot 508 to be high risk, due to the small flows in the stream which makes it more susceptible to impacts than higher flow watercourses. Therefore, the discharge to the minor stream will not be authorised. (Refer to section 3.2 for further detail)</p> <p>However, the Delegated Officer considers additional discharge points on Dirk Brook and Nambeelup Brook to be of similar, medium risk, as the existing discharge points, for the reasons outlined in section 3.2 of this report. It is noted that discharge to both of these watercourses has previously been approved. Therefore, the three additional discharge points on the medium watercourses will be authorised in this amendment.</p> <p>As a consequence, an additional downstream surface monitoring point will be established on Dirk Brook, in relation to the new discharge points. A downstream monitoring point WQ11 was proposed by the licence holder, which the Delegated Officer finds suitable.</p> <p>The licence holder is reminded that while discharges to these locations have been authorised by this instrument, the installation of the discharge infrastructure may also require a Bed and Banks permit under the RiWI Act.</p>

Condition	Summary of Licence Holder's comment	Department's response
15	Request that the new limits for discharge water quality pH be in the range 6.0-8.5 instead of 6.5-8.5.	<p>The new pH limits are in line with the guideline values for freshwater ecosystems in the south-west of Australia, which the Delegated Officer views as a minimum standard to apply given the volume of water that is likely to require discharge from the premises each year, going forward. The limit will remain at 6.0 to 8.5.</p> <p>It is noted that the only source of low-pH water that is likely to enter the process water circuit is mine dewatering effluent and it is only likely to occur on occasion, when acidity is released from mining areas interacting with ASS. At some other premises, the department requires dewatering effluent that falls in the pH range 4 to 6 with high TTA to be treated with lime prior to discharge. Given that dewatering effluent at the premises is sent to the process water circuit, it was not deemed necessary to add specific requirements for effluent treatment to this licence.</p> <p>However, the Delegated Officer strongly recommends that the licence holder consider adding a neutralisation agent to acidic mine dewatering effluent to manage pH levels prior to sending it to the process water circuit, should the dewatering effluent monitoring return low pH levels.</p>
15	Request that the new limit for discharge water quality for TSS to be revised to 60mg/L instead of 40mg/L, with the possibility of revising the limit down further in the future, instead.	<p>The Delegated Officer acknowledges that this is a significant change from the current 80mg/L limit, however, considers that the 40 mg/L limit is appropriate and justified based on the risk to local waterways. The requirement reflects the large volume of water being discharged to local waterways and subsequent increase in suspended solid loading to the receiving environment.</p> <p>As process water is not being diluted to the same factor as when discharge was first authorised, a lower limit is required to ensure there are no impacts to local waterways.</p> <p>The Delegated Officer notes that if the licence holder wishes the value to be revised, site-specific criteria can be developed using the methodology outlined in the ANZG. The onus remains on the licence holder to provide multiple lines of evidence that a higher TSS concentration limit would not result in unacceptable impacts to the environment.</p>
22	Request for dust monitoring requirements to only apply from October to May to allow for equipment calibration and repair during the low-risk, wet, winter period.	<p>The Delegated Officer finds this a reasonable request, given that the higher rainfall during the winter months provides a natural level of protection to the community. It is noted that historically, elevated dust levels have only been recorded between November to April.</p> <p>However, it should be noted that this reduction in monitoring does not apply to condition 23, which requires monitoring at receptors when mining is occurring in close proximity, if the residence is occupied. Similarly, the meteorological monitoring will be required all year round, so that information will be available should there be community complaints and for dust management purposes.</p>
26	Given that this is a highly disturbed agricultural environment, request to only require biological sampling of particular rivers	The Delegated Officer acknowledges that the premises operate within a disturbed agricultural environment; however, downstream waterways retain moderate to high ecological value and

Condition	Summary of Licence Holder's comment	Department's response
	<p>based on a trigger system, such as if water discharged was outside of water quality for a period in excess of 5 days (or similar).</p> <p>Alternatively, could the condition be modified to require a one-off baseline assessment of each waterway and only require additional assessment if they have received discharge water in the past 12 months.</p>	<p>ultimately drain into an internationally listed Ramsar wetland.</p> <p>Biological monitoring is considered necessary to provide quantifiable data on potential environmental impacts. Previous assessments of discharge events where water quality limits were exceeded have often concluded minimal impact without supporting quantitative evidence. Collecting biological data will enable more informed evaluations of environmental risk and support sound regulatory decision-making.</p> <p>The Delegated Officer has considered the licence holder's alternative proposal for a baseline assessment, with additional monitoring only if discharge occurs within the preceding 12 months and considers this approach acceptable. The condition has been modified accordingly.</p>
27	<p>Request to maintain the restriction on sampling of gross alpha and gross beta to those bores that exceed the 40mg/L TTA trigger criteria, based on the likelihood that other bores that do not exceed this threshold are low risk.</p>	<p>The Delegated Officer notes that due to a lack of data, there is a high degree of uncertainty regarding the concentrations of gross alpha and gross beta across the entirety of the premises. While TTA exceeding 40mg/L in a monitoring bore increases the likelihood of leaching of radioactive elements into the groundwater, TTA levels below this threshold does not eliminate the risk of this occurring.</p> <p>The Delegated Officer acknowledges however, that the forthcoming groundwater investigation, due within the next few months, will provide a clearer understanding of site-specific risks. Accordingly, the trigger criterion of 40 mg/L will remain in place as requested. Following review of the investigation results, the Delegated Officer may consider whether the routine groundwater monitoring suite requires amendment.</p>
28	<p>Request to only undertake analysis of radium isotopes on bores which are showing indicators of acidification and undertake gross alpha and gross beta screening only on bores which trigger the 40mg/L TTA. The licence holder considers this to be a suitable risk-based approach to testing.</p>	<p>The Delegated Officer considers the elevated gross alpha and gross beta levels detected in some monitoring bores to indicate a sufficient level of risk that all bores should be tested for radium isotopes at least once. National drinking water guidelines recommend including Ra-226 and Ra-228 in the monitoring suite when gross alpha and gross beta concentrations are elevated.</p> <p>Given that future land use is likely to revert to agriculture, a more sensitive land use, and indicators of potential contamination have been identified, the onus is on the licence holder to ensure that contamination has not / is not occurring. This information will also assist the licence holder in demonstrating site suitability under the <i>Contaminated Sites Act 2003</i> should land use change.</p> <p>If radium concentrations fall within acceptable parameters for agricultural purposes, these results will support any future investigations and provide assurance of environmental protection.</p>