Government of Western Australia
Department of Water and Environmental Regulation

Amendment Report

Application for Licence Amendment

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

Licence Number	L8306/2008/3
Licence Holder	Newmont Boddington Gold Pty Ltd
ACN	101 199 731
File Number	APP-0026065
Premises	Newmont Boddington Gold Gold Mine Road, BODDINGTON WA 6390 Legal description – As defined by the Premises maps and tenements in Schedule 1 of the Revised Licence.
Date of Report	13 August 2025
Decision	Revised licence granted

Table of Contents

1. Decision summary

Licence L8306/2008/3 is held by Newmont Boddington Gold Pty Ltd (Licence Holder) for the Newmont Boddington Gold Mine (the premises), located along Gold Mine Road, Boddington 6390, Western Australia.

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 construction and operation of the Premises. As a result of this assessment, revised licence L8306/2008/3 has been granted.

2. Scope of assessment

2.1 Regulatory framework

In completing the assessment documented in this Amendment Report, the department 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 Newmont Boddington Gold Mine (the premises) is a gold mining and processing operation. The premises boundary encompasses both privately-owned land and State Forest areas within the Shire of Boddington, located approximately 3.7 kilometres (km) north-west of the Boddington township.

Oxide mining was initially mined at the premises in 1987, with the basement copper and gold-bearing ore taking place from 1994. The premises entered a period of care and maintenance from 2001 before recommencing operations in late 2009. Licence L8306/2008/1 was granted to authorise recommencement of activities at the premises, which has been renewed in 2015 (L8306/2008/2) and 2023 (L8306/2008/3).

2.2.1 F1 RDA

Facility and embankment design

Currently, the primary containment infrastructure for gold tailings slurry is the F1 residue disposal area (RDA). The F1 RDA is a single-cell valley facility with a catchment area of 12.44 km^2. The facility was commissioned in 2009, comprising of nine operating embankments (referred to as 'saddle dams'). The facility was constructed over natural ground (i.e., the F1 area), existing tailings (i.e., the F3 RA, which operated prior to care and maintenance), and the O2 water storage reservoir.

Historically, the raising of the saddle dams has been undertaken using a combination of downstream, centreline, and upstream construction methods to achieve optimal geotechnical stability[1]. Buttressing of several saddle dams have been required since the Stage 10 embankment raise to achieve adequate level of stability and factor of safety. Currently, the facility is authorised under existing licence L8306/2008/3 to be raised to a maximum embankment height of 361.0 mRL (Stage 18). Currently, the facility has been constructed up to Stage 17 and is anticipated to reach maximum storage capacity by 2026 (Knight Piesold 2021).

[1] A record of the construction methods utilised for each embankment raise at each saddle dam is maintained in the Licence Holder's *RDA Operating Manual* (NBG 2023).

Tailings delivery

Tailings slurry is pumped from the premises gold processing plant to the residue booster station before being pumped to the F1 RDA. The tailings delivery pipelines are designed to pump tailings slurry at a rate between 1,407 m^3/hour and 2,853 m^3/hour[2].

Tailings delivery pipelines are fitted with automated, magnetic flow meter rupture detection, which sounds and alarms the control room when it detects a difference in flow rate of 10% or higher. The pump is set to automatically shut down if the alarm is not responded to within 20 minutes. Leak detection valves are also included on the HDPE-lined steel pipes to indicate HDPE liner failure.

Additionally, four emergency catchpits are located along the pipeline route to contain tailings slurry during power outages, pump failure, or pipe failure, as well as wastewater from routine flushing of tailings pipeline. Each catchpit is two-staged, with the first being concrete-lined to allow solids cleanout via a loader, while the second stage is clay-lined for capturing the water component of discharged tailings slurry, which can be pumped out. Recovered tailings material are sent through the residue booster station for treatment prior to discharge at either the F1 RDA or R4 RDA tailings beach.

Cyanide management

At the residue booster station, Caro's acid[3] is added to convert cyanide in the tailings slurry to the less toxic cyanate species through a redox reaction (Figure 1e). Lime is also added to control the pH of the tailings slurry. The residue booster station is equipped with four treatment units, one duty and one standby for both the tailings delivery stream and the decant return water stream. Lime is also added to control the pH of the tailings slurry.

Weak acid dissociable (WAD) cyanide is monitored every 15 minutes at the residue booster station to determine appropriate Caro's acid treatment dosages and to ensure tailings WAD CN concentrations are compliant with internal targets as it is pumped through to F1 RDA for discharge. The current internal target for WAD CN output to the F1 RDA is 42.5 mg/L. The Licence Holder is also certified under the International Cyanide Code since 2012, which requires the WAD CN to remain below 50 mg/L for wildlife protection. Existing licence L8306/2008/3 requires the Licence Holder to notify the department when WAD CN concentrations have been detected at over 50 mg/L for over a one-hour period. Cyanide concentrations in the tailings slurry and return water are managed under an internal Cyanide Management Plan.

Tailings deposition

Following Caro's acid treatment, tailings slurry is deposited into F1 RDA by the eastern, southern, and northern distribution lines[4] that extend from the residue booster station. Tailings slurry is deposited sub-aerially at densities between 50% to 65% solids (by weight) via spigots spaced approximately 60 m apart. The spigotting approach supports the use of an upstream construction method for the embankment raises, as it requires the tailings beach underlying the raise to have sufficient shear strength with minimal potential for ongoing consolidation.

Sub-aerial deposition allows the slurry to be discharged onto the tailings beach, which slopes

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[2] The system manages slurry weight between 1,577 tonnes per hour and 2,419 tonnes per hour, or between 50% to 65% solids.

[3] Peroxomonosulfuric acid, which is produced by mixing hydrogen peroxide and sulfuric acid.

[4] The eastern pipeline services saddle dams 5, 7, and 8. The southern pipeline services saddle dams 1, 9, and 10. The northern pipeline services saddle dams 3, 4, and 5. Tailings distribution pipelines consist of 710 mm HDPE pipeline with spigot offtakes that are 300 mm pipelines with holes.

gently (around 1V in 300H) along the beach, allowing solids to settle due to the low flow velocity. Coarse, heavier particles will be the first to settle, with finer particles flowing on towards the decant pond. Tailings deposition will continue at any one location for at least 24 hours but no longer than 48 hours, or until a layer of residue about 400 mm thick is formed. Tailings deposition will then rotate along the facility, generally at two or three spigot increments. The newly deposited layer is then left to consolidate, drain, and shed water. The rotation of tailings deposition around the F1 RDA aims to manage the size and location of the decant pond, as well as the rate of rise of the tailing beach, and allow sufficient wetting of the tailings beach to minimise fugitive dust emissions.

Decant pond

The F1 RDA decant pond is typically located along the western portion of the facility, adjacent to natural ground and away from the saddle dams. The decant pond has a maximum design volume of 2.4 Mm^3 and a minimum operating freeboard of 500 mm. Due to the varying embankment heights across the saddle dams, an operating freeboard of 1,000 mm is applied to saddle dams 1, 2, and 10 due to these having the lowest crests within the facility.

Four electrical turret decant pumps are used to abstract decant water from the decant pond at up to 2,400 m^3/hour (Figure 1b). The decant water is pumped to the CN destruction tank at the residue booster station, where the return water undergoes further treatment with Caro's acid to achieve WAD CN concentration of <1 mg/L, before being pumped to the processing circuit for reuse. This operational strategy reduces reliance on raw water and maintains a water deficit at the F1 RDA, which reduces the risk of potential seepage and embankment failure.

An emergency spillway has been designed at saddle dam 2 western abutment to channel overflow into the D1 Dam. Currently, the spillway has not been constructed, with construction triggered by a number of scenarios, where there is a likelihood that decant pond overtopping may occur.

Seepage management

To manage tailings supernatant and potential seepage from tailings slurry deposition, a 1.5 mm HDPE liner was installed on the southern portion of the F1 RDA, overlying 300 mm of compacted clay (Figure 1a). The liner encompasses the entire extent of the decant pond[5], with the intent of controlling the phreatic surface within the embankments and minimise seepage into the environment. The northern portion of the facility was not lined because the underlying oxide unit was determined to be adequate for managing seepage (Knight Piesold 2008). Nevertheless, a recent hydrogeological review has determined that most seepage from the RDA likely occurred from the unlined parts of the facility (BDH 2019).

In addition to the HDPE liner, a number of infrastructure have been constructed or installed to manage seepage at the F1 RDA, as shown in Figure 1 and summarised in Table 1.

Table 1: Seepage management infrastructure at F1 RDA

Infrastructure	Design	Infrastructure location	Purpose
Underdrainage collection system	100 mm perforated drainage pipes spaced at 50 m intervals and connected to main drains. Underdrainage drains into three	Laid directly above the HDPE liner, and within *in situ* gravels in	To reduce hydraulic head acting on the base of the F1 RDA and reduce potential

[5] The liner extent was designed to be sufficient to encompass the decant pond with an operational volume of 2.4 Mm^3, as well as rainfall from a 25-year annual recurrence interval (ARI) storm event for up to 24 hours (i.e., 1.2 Mm^3).

Infrastructure	Design	Infrastructure location	Purpose
	underdrainage sumps at saddle dam 1 upstream toe. Average total abstraction rate from the sumps is approximately 140 m^3/hour. Refer to Figure 1c.	areas north of the liner.	seepage.
Leak collection and recovery system (LCRS)	Installed within a gravel layer where water drains towards two sumps at the saddle dam 1 upstream toe. The LCRS sumps are installed deeper than the underdrainage sumps. Average abstraction rate from the LCRS is approximately 25 m^3/hour.	Installed in a gravel layer under the HDPE or soil liner during early construction stages.	To capture potential seepage that have bypassed the liner and/or groundwater that has entered the facility from belowground.
Beach drains	V-shaped structure comprising an inner drain and outer drain running in parallel, approximately six meters wide, 500 mm deep and lined with textile. Three 160 mm perforated drainage pipes installed within a sandy gravel drainage medium. Intercepted seepage is gravity drained towards a common beach drain sump.	Installed approximately 150 m upstream of the saddle dams 1, 3, 4, 5, 7, 8, 9, and 10, between 335 mRL and 345 mRL (i.e., Stage 10 to Stage 13).	To intercept seepage within the upper part of the settled tailings and control phreatic surface near the saddle dams.
Toe drains	160 mm slotted drainage pipe, surrounded by sandy gravel drainage medium, followed by geotextile for erosion protection. Toe drains report to toe wells, which were constructed on topographical low points along the downstream saddle dams. Collected water is pumped to the perimeter sumps via submersible pump or air pumps. Flow rates vary between toe wells, with an average total flow rate of 389 m^3/day. Refer to Figure 1d.	Upstream zone of saddle dams 3, 4, 5, 7, 8, and 9, installed during starter embankment construction.	To reduce hydraulic head and phreatic surface within the saddle dams.
Perimeter sumps	A series of 11 sumps surrounding the northern half of the F1 RDA. The sumps intercept rainfall, catchment runoff, toe drain water, groundwater, as well as seepage flowing out of the F1 RDA. Sumps are connected via a pipeline, which pumps the collected water towards the R4 RDA for discharge. Pumping rates vary by sumps and the volume of inflow received, estimated to be greatest at SD3SU-B, SD5-SUA and SD8-SUA1 (BDH 2019). Monthly volume pumped averaged at approximately 275,214 m^3. Refer to Figure 2.	On the outer perimeter of saddle dams 3, 4, 5, 7, and 8.	To intercept and capture potential seepage from F1 RDA, preventing it from migrating into the wider environment, as well as control groundwater mounding around F1 RDA.

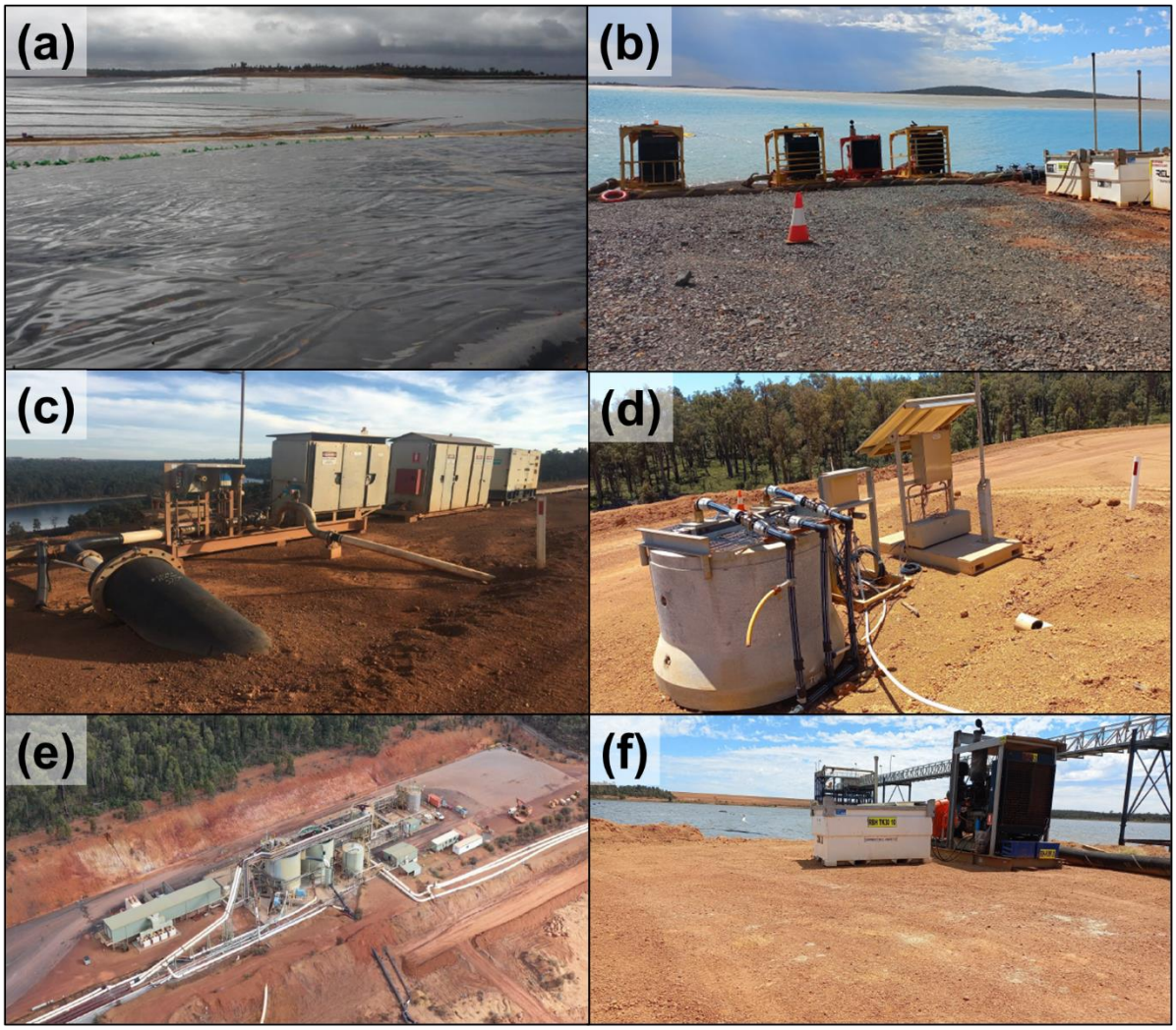


Figure 1: F1 RDA – (a) HDPE liner overlooking the tailings beach and decant pond; (b) decant pump setup; (c) sump collected seepage from underdrainage system and associated pumps; (d) toe drain sump and pump; (e) booster pump station and cyanide destruction plant; (f) R4 RDA decant pump setup.

Intercepted seepage from the underdrainage system, LCRS, and beach drain are redirected to the F1 RDA tailings beach as they may be impacted by contaminants associated with tailings and cannot be appropriately discharged into the environment (without further treatment).

Intercepted seepage from the toe drains and perimeter sumps are pumped to the neighbouring R4 RDA[6]. The water quality from these sources is less likely to be impacted due to either geochemical attenuation or mixing with ambient groundwater.

2.2.2 R4 RDA

The R4 RDA is an inactive, unlined valley facility that was historically used to contain oxide tailings between 1988 and 1993. Following that, the facility received tailings periodically (i.e., when the F3 RDA was being raised or during pipeline maintenance). Currently, the R4 RDA holds approximately 40 megatonnes of historical tailings and is used as a water storage facility.

[6] The exception to this is existing perimeter sump SD9, which receives water collected from the northern and eastern beach drain. Water from perimeter sump SD8SU-A1 is returned to the F1 RDA tailings beach. Due to the water source and quality, it is not appropriate to discharge it into the R4 RDA.

The R4 RDA is authorised to accept water from the F1 RDA toe drains and perimeter sumps. Existing licence L8306/2008/3 also permits the temporary discharge of water from the F1 RDA underdrainage, and beach drains in situations where the F1 RDA decant pond size is anticipated to exceed its target area (i.e., outside the extent of the HDPE liner). Historically, this discharge typically occurs in winter months, where increased rainfall has resulted in an enlarged decant pond area. The F1 RDA is susceptible to large runoff volumes from rainfall events due to its large catchment area.

Furthermore, the R4 RDA also accepts water from catch pits 3 and 4 during the cleaning out and draining of the tailings delivery pipelines, as well as treated wastewater from the Plant and Village Sewage Treatment Plants (STP) during upset conditions or shut-downs (via Storm Water Pond Number 1).

The R4 RDA is equipped with diesel turret decant pumps at the southern boundary of the facility, which returns water to the processing circuit (Figure 1f). The pump is operated manually. The area surrounding R4 RDA is used for stockpiling bauxite, rehabilitation and construction materials, as well as a location for residue/tailings rehabilitation trials.

2.3 Application summary

On 31 May 2024, the Licence Holder submitted an application to the department to amend licence L8306/2008/3 under section 59 and 59B of the *Environmental Protection Act 1986* (EP Act). The following amendments are being sought:

- Construction and operation of four additional embankment raises (Stage 19 to Stage 22) to all ten saddle dams at the F1 RDA, from a maximum embankment height to RL 363.2 m to RL 369.9 m (varying between each saddle dam);
- Installation of 10 groundwater monitoring bores to replace 11 existing licensed monitoring bores that will be decommissioned as a result of the F1 RDA expansion;
- Amendment of the prescribed premises boundary to include general purpose lease G70/272, granted by the Department of Mines, Petroleum and Exploration (DMPE) on 29 May 2025.

This amendment is limited only to changes to Category 5 activities from the existing licence. No changes to the aspects of the existing licence relating to Category 6, 33, 54, 57, 63, and 73 have been requested by the Licence Holder. Table 2 below outlines the proposed changes to the existing licence.

Table 2: Proposed throughput capacity changes

Category	Current production capacity	Proposed production capacity	Description of proposed amendment
5 – Processing or beneficiation of metallic or non-metallic ore	45,000,000 tonnes per annual period	No proposed changes to production capacity.	• Four embankment raises to the existing F1 RDA to increase tailings storage capacity from 600 megatonnes to 750 megatonnes. • Construction of additional groundwater monitoring bores to replace existing bores that will be decommissioned as a result of the F1 RDA expansion.
6 – Mine dewatering	4,000,000 tonnes per annual period		No proposed change.
33 – Chemical blending or	35,000 tonnes per annual period		No proposed change.

Category	Current production capacity	Proposed production capacity	Description of proposed amendment
mixing			
54 – Sewage facility	270 m^3/day		No proposed change.
57 – Used tyre storage (general)	100 tyres		No proposed change.
63 – Class I inert landfill site	2,000 tonnes per annual period		No proposed change.
73 – Bulk storage of chemicals etc.	6,000 m^3 in aggregate		No proposed change.

2.3.1 F1 RDA expansion

The proposed expansion to the F1 RDA will increase the maximum tailings storage capacity of the facility from 600 megatonnes to 750 megatonnes. The expansion will be undertaken through four stages of embankment raises to the ten saddle dams, from Stage 18 to Stage 22. At the current ore processing capacity, the expanded F1 RDA will provide sufficient tailings storage capacity up until 2029 (Table 3).

Table 3: Projected scheduling and storage capacity for F1 RDA expansion

Stage	Planned construction period	Year staged capacity reached	Additional tailings storage capacity per stage (megatonnes)
Stage 19	2025/2026	2026	41.8
Stage 20	2026/2027	2027	41.8
Stage 21	2027/2028	2028	42.0
Stage 22	2028/2029	2029	25.3
TOTAL			150.9

Due to the scale and design of the facility, the proposed embankment height will vary between each saddle dam (Table 4). All saddle dams will be raised via upstream construction method, except Saddle Dam 2 (raised via centreline construction) and the Wattle Pit embankment (raised via downstream construction). Embankment construction material will consist of low permeability fill and gravel, sourced from onsite borrow areas, as well as mine waste rock, oxide, and dried tailings. The upstream zone of the raised embankments will primarily utilise dried tailings (for upstream construction) and low permeability fill (for centreline construction).

Table 4: Saddle dam and HDPE liner staged construction height

Infrastructure	Construction method	Stage 19 (mRL)	Stage 20 (mRL)	Stage 21 (mRL)	Stage 22 (mRL)
Saddle Dam 1	Upstream	361.4	363.9	366.4	368.1
Saddle Dam 2	Centreline	361.4	363.9	366.4	368.1

Infrastructure	Construction method	Stage 19 (mRL)	Stage 20 (mRL)	Stage 21 (mRL)	Stage 22 (mRL)
Saddle Dam 3	Upstream	361.5	364.0	366.5	368.2
Saddle Dam 4	Upstream	361.5	364.0	366.5	368.2
Saddle Dam 5	Upstream	361.5	364.0	366.5	368.2
Saddle Dam 7	Upstream	363.2	365.7	368.2	369.9
Saddle Dam 8	Upstream	363.2	365.7	368.2	369.9
Saddle Dam 9	Upstream	361.4 to 363.2[1]	363.9 to 365.7[1]	366.4 to 368.2[1]	368.1 to 369.9[1]
Saddle Dam 10	Upstream	361.4	363.9	366.4	368.1
Wattle Pit embankment	Downstream	361.4	363.9	366.4	368.1
HDPE liner	---	363.9	363.9	368.1	368.1
Increase in saddle dam height	---	+2.5 m	+2.5 m	+2.5 m	+1.7 m

Note 1: The Saddle Dam 9 embankment crest slopes from Saddle Dam 8 in the east to the Saddle Dam 10 in the west.

During the embankment raises, a HDPE liner will be installed at the Wattle Pit embankment upstream face and the F1 RDA western perimeter (north of the Wattle Pit embankment), where a 300 mm-thick layer of low permeability fill is compared and overlain with a 1.5 mm-thick HDPE liner.

Buttressing will be constructed at all saddle dams, comprising structural fill underlain by a 500 mm-thick layer of filter sand and gravel (250 mm each). The buttress foundation will be cleared, scarified, moisture conditioned, and compacted prior to buttress construction. Most notably, the construction of additional buttressing will:

- Require the existing premises boundary to be expanded to accommodate the larger F1 RDA footprint due to buttress extensions, through the inclusion of general purpose lease G70/272;
- Require the decommissioning of up to 38 existing groundwater monitoring bores, of which 11 are specified in existing licence L8306/2008/3; and
- Require modification to the extent of existing perimeter sumps to accommodate the larger F1 RDA footprint due to buttress extensions.
- Require some of the toe wells to be raised, where the pumps will be removed and the well brought offline during the raising.

2.3.2 Perimeter sump modifications

At the time of the submission of this application, the Licence Holder had predicted that works associated with buttress extensions may impact existing perimeter sumps around the F1 RDA. As a result, the Licence Holder had proposed to decommission the existing perimeter sumps and construct replacement sumps in similar locations. The construction of new perimeter sumps was highlighted as an opportunity to improve their efficacy and function (BDH 2023b, 2023c, 2024b), by, for example, increasing the depth of the sump.

However, the Licence Holder later indicated (in a letter dated 27 May 2025; refer to Appendix 1) that the existing perimeter sumps would not be impacted by the proposed activities and that

replacement sumps would not be required. Nevertheless, the perimeter sumps may be subject to modifications to accommodate buttressing works. It was requested that the amended licence provide flexibility to accommodate the necessary operational modifications.

In reviewing the existing perimeter sump network, the department identified several modifications that had been undertaken over the years (Figure 2):

- Perimeter sump SD3SU-B (as shown on the existing licence L8306/2008/3) was not a proper perimeter sump. It was simply a known seepage location, where the seepage was collected and monitored. In 2023, a seepage drainage blanket was constructed to intercept the seepage and drain it to perimeter sump SD3SU-C nearby to the west.
- Perimeter sump SD8SU-D (as shown on the existing licence L8306/2008/3) was decommissioned in 2025 to enable buttress extension at Saddle Dam 8. Water from the sump is connected and drains to perimeter sump SD8SU-D1 through a drainage network underlying the buttressing.
- Perimeter sump SD8SU-D1 (authorised under a licence amendment, dated 11 February 2022) was constructed in April 2025 to replace the decommissioned perimeter sump SD8SU-D. This perimeter sump was constructed further south of the proposed location due to the Saddle Dam 8 buttress footprint.
- Perimeter sump SD8SU-A1 (as shown on the existing licence L8306/2008/3) was modified in May 2025, with its footprint and storage capacity reduced due to the Saddle Dam 8 buttress extension. The perimeter sump was subsequently renamed SD8SU-C1.

The department will consider the past modifications to the existing perimeter sumps and assess whether their capabilities for managing potential impacts remain adequate for the proposed activities.

Additionally, the Licence Holder has also proposed the construction of a new perimeter sump between existing perimeter sumps SD3SU-A and SD3SU-C. The proposed location is currently a topographical low point that collects water. The Licence Holder has proposed to properly construct perimeter sump SD3SU-B at this location. To address potential groundwater mounding issues around Saddle Dam 3, the Licence Holder has proposed to construct the sump to a deeper depth[7].

[7] The Licence Holder has expressed concern that the deepening of existing perimeter sumps may cause localised stability issues due to their close proximity to the F1 RDA embankment toes (refer to Appendix A).

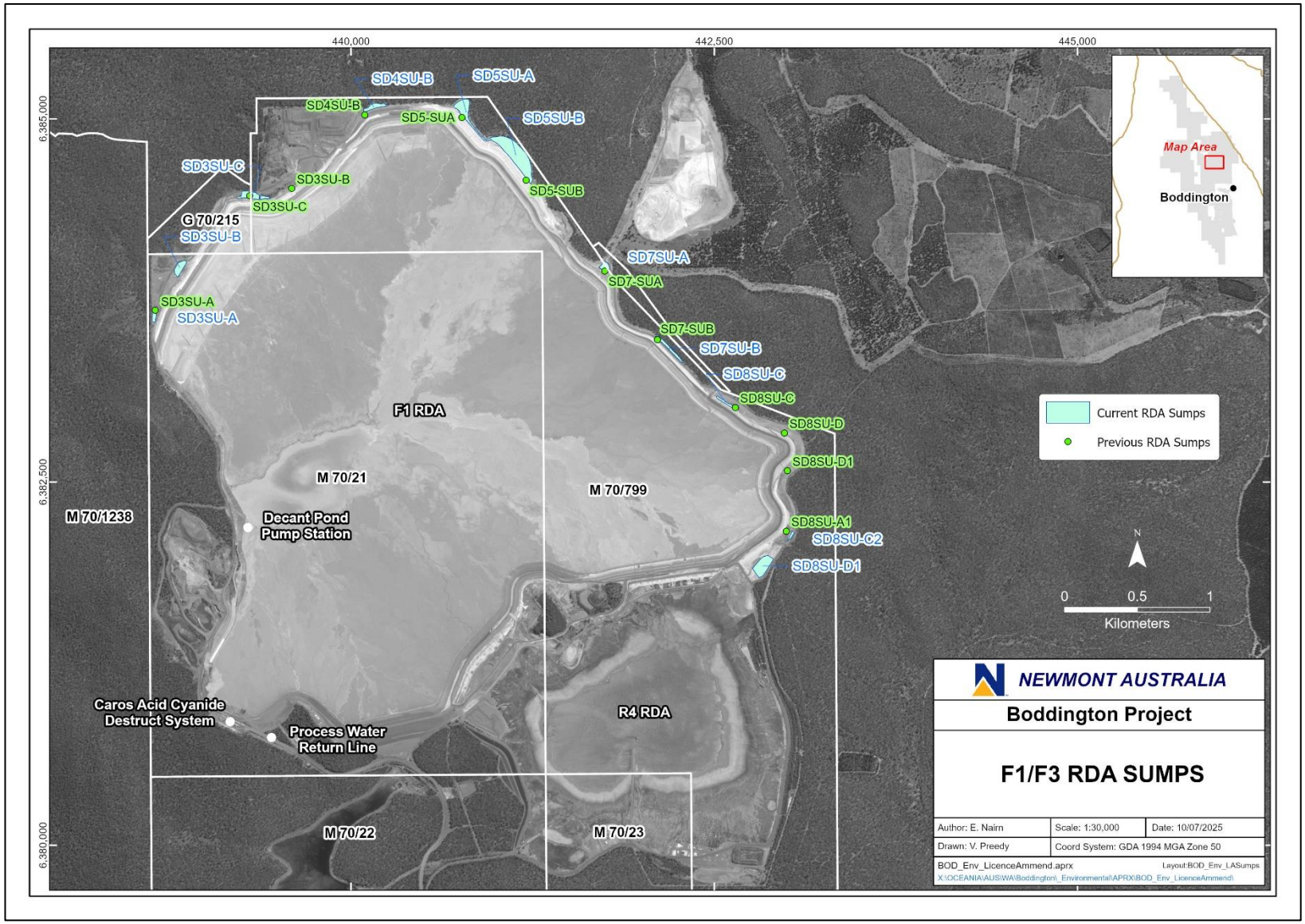


Figure 2: Location of previous (green) and current existing (blue) perimeter sumps

2.3.3 Monitoring bore replacement

The Licence Holder manages and monitors an extensive network of groundwater monitoring bores at the premises. At present, there are approximately 110 groundwater monitoring bores surrounding the F1 RDA and R4 RDA (Figure 3), where 33 of these bores are required to be monitored under existing licence L8306/2008/3.

The proposed expansion to F1 RDA will result in up to 38 monitoring bores being impacted, of which 11 are listed on the existing licence (Table 5). A monitoring bore review undertaken by BDH (2023c) recommended that 22 monitoring bores be replaced[8]. Replacement bores were not deemed necessary by BDH (2023c) for the other 16 monitoring bores that will be impacted due to redundancy provided by nearby existing monitoring bores.

All monitoring bores that are currently specified in existing licence L8306/2008/3 will be replaced, except for monitoring bore F1BR16D. While groundwater at this monitoring location has shown increasing concentrations of sulfate, evidence of groundwater mounding has been limited. There are limited options for a replacement bore as the expanded F1 RDA footprint is encroaching on the adjacent D1 Dam, with seepage likely being captured by the D1 Dam. Furthermore, existing monitoring bore O234BR3 is located slightly downgradient of monitoring bore F1BR16D and can be monitored for evidence of seepage from the D1 Dam (BDH 2023c).

The installation of these bores will provide opportunity to collect additional lithological data, as well as better target key hydrogeological units of interest. Further, the replacement monitoring bores can be sited away from the existing perimeter sumps, thus reducing the influence of sump water quality on the groundwater collected at these monitoring bores, which may be masking more subtle seepage migrating through these areas.

The replacement monitoring bores will be installed prior to the decommissioning of the existing impacted bores to ensure adequate monitoring coverage and continuity during the expansion activities.

Table 5: Summary of impacted groundwater monitoring bores

Monitoring bore ID	Specified in licence L8306/2008/3	Replacement recommended	Rationale for no replacement	Approximate bore depth
F1BR16D	Yes	No	Nearby bore (O234BR3). Limited space for replacement bore.	N/A
F1BR16S-2	No	No	Limited space for replacement bore.	N/A
F1BR18D	No	No	Nearby bore (F1BR17D)	N/A
F1BR18S	No	No	Nearby bore (F1BR17S)	N/A
F1BR20D	No	No	Nearby bore (F1BR17D)	N/A
F1BR20S	No	No	Nearby bore (F1BR17S)	N/A
F1BR21D	No	Yes	N/A	25
F1BR21S-2	No	Yes	N/A	10
F1BR22D	Yes	Yes	N/A	30
F1BR22S-2	No	Yes	N/A	10
F1BR23D	Yes	Yes	N/A	30
F1BR23S	No	Yes	N/A	10

[8] In determining whether replacement monitoring bores were required, the review considered the hydrogeological setting of the impacted monitoring bores, their monitoring purpose (in relation to F1 RDA), as well as the uniqueness and quality of monitoring data from these bores (i.e., whether there are other unimpacted monitoring bores nearby and whether monitoring bore can yield reliably monitoring information, respectively).

Monitoring bore ID	Specified in licence L8306/2008/3	Replacement recommended	Rationale for no replacement	Approximate bore depth
F1BR24D-2	Yes	Yes	N/A	40
F1BR24S	No	Yes	N/A	10
F1BR25D-2	Yes	Yes	N/A	40
F1BR25S	No	Yes	N/A	10
F1BR26D	Yes	Yes	N/A	35
F1BR26S-2	Yes	Yes	N/A	10
F1BR27D	No	No	Nearby replacement bore (F1BR26D)	N/A
F1BR27S	No	No	Nearby replacement bore (F1BR26S)	N/A
F1BR28D	No	No	Nearby replacement bore (F1BR26D)	N/A
F1BR28S	No	No	Nearby replacement bore (F1BR26S)	N/A
F1BR29D	Yes	Yes	N/A	40
F1BR29S	Yes	Yes	N/A	10
F1BR30D	No	No	Nearby bore (F1BR31D)	N/A
F1BR30S	No	No	Nearby bore (F1BR31S)	N/A
F1BR32D	No	No	Nearby bore (F1BR31D)	N/A
F1BR32S	No	No	Nearby bore (F1BR31S)	N/A
F1BR35D	Yes	Yes	N/A	25
F1BR35S	No	Yes	N/A	5
F1BR37D	No	No	Nearby bore (F1BR36D)	N/A
F1BR37S	No	No	Nearby bore (F1BR36S)	N/A
F1BR38D	Yes	Yes	N/A	30
F1BR38S-2	No	Yes	N/A	8
F1BR41D	No	Yes	N/A	40
F1BR41S	No	Yes	N/A	8
F1BR15D	No	Yes	N/A	45
F1BR15S-2	No	Yes	N/A	5

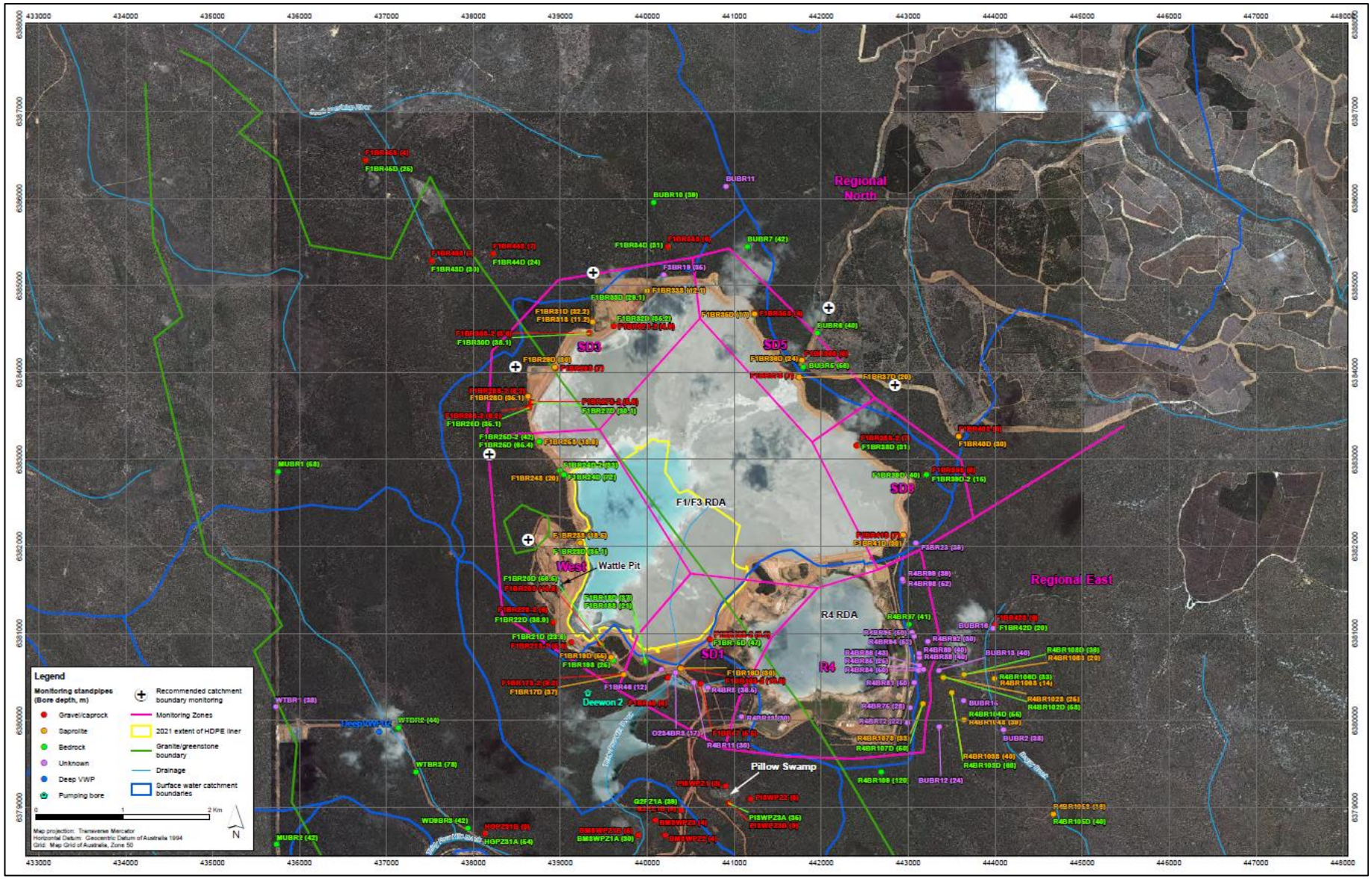


Figure 3: Groundwater monitoring bores surrounding F1 RDA and R4 RDA

Licence: L8306/2008/3

2.4 CEO-initiated licence review

Following the renewal of licence L8306/2008/3 on 2 April 2023, the department initiated a licence review under Section 59(2) of the EP Act. The review was intended to ensure that potential risks of emissions and discharges arising from continued operation of the premises (including the F1 RDA) was accurately and adequately managed under licence L8306/2008/3. The review also aims at refining and, where possible, streamlining conditions in licence L8306/2008/3 to improve their clarity and enforceability.

While the licence review is currently ongoing, the department has decided to undertake the review in a staged approach. The review of activities and controls relating to tailings deposition, management, and seepage, as well as matters relating to the F1 RDA and the R4 RDA, will be completed in conjunction with this assessment for the proposed expansion to the F1 RDA.

At this stage, emissions and discharges relating to other infrastructure and activities at the premises have not been reassessed.

2.4.1 RDA Groundwater Management Plan

During the site visit to the F1 RDA in March 2023, the department observed degraded vegetation condition near the vegetation fringe adjacent to Saddle Dam 3. Further investigation undertaken by the Licence Holder found that the observed impacts to vegetation correlated with the shallowing of the local water table, likely a result of groundwater mounding localised around the F1 RDA (detailed further in Section 3.5.3). As a result, the department required the Licence Holder to prepare a Groundwater Management Plan (GMP; BDH 2024b) to specify controls for managing and minimising the risk of continued tailings deposition at the F1 RDA from impacting nearby sensitive receptors. The GMP was submitted to the department in May 2024.

While the GMP was not submitted as part of this application to amend licence L8306/2008/3, the department has considered the controls proposed in the GMP as it is relevant to the scope of the application, as well as the CEO-initiated licence review.

2.4.2 Water quality management at R4 RDA

In addition to the continued expansion and operation of the F1 RDA, the department will also consider potential risk events associated with the continued operation of the R4 RDA as a water storage reservoir that receives sump water (and other seepage-impacted water) from the F1 RDA. Historical observations of fauna using the R4 RDA as a habitat has prompted a series of investigations into the potential risk to fauna due to the exposure to water at this facility.

Over the past years, the Licence Holder has undertaken a number of investigations to better understand and assess the risk associated with fauna ingesting water from the R4 RDA. As part of this amendment, the department has undertaken an updated risk assessment, based on findings presented by the Licence Holder. This issue is discussed further in a detailed risk assessment under Section 3.6.

2.5 Part IV of the EP Act

The proposal for the Newmont Boddington Gold Mine was referred to and approved by the Environmental Protection Authority (EPA) in 1988 under Part IV of the EP Act. Since then, the premises have undergone a number of changes, which are reflected in multiple ministerial statements (MS).

In 2002, MS 591 was published following a review under section 46 of the EP Act, which superseded previous existing ministerial statements and their conditions for the premises. The MS 591 was implemented when the premises recommenced operation in 2009.

Subsequently, a revised proposal was referred to the EPA for assessment in 2012. The revised proposal was to further extend the life of mine by up to 24 years, by:

- Widening and deepening the existing Wandoo North and Wandoo South mine pits;
- Increasing ore processing capacity;
- Increasing the size of existing stockpiles and constructing ancillary infrastructure; and
- Constructing new water storage areas, waste rock dumps, and a new RDA.

The EPA report 1506 identified five key environmental factors for the revised proposal, including flora and vegetation, terrestrial fauna, hydrological processes, amenity, and offsets (integrating factor). The MS 971 was published on 12 June 2014, which set out conditions to manage impacts to these key environmental factors.

EPA report 1506 specified that impacts from (i) surface water runoff or discharge from the RDA, waste rock dumps and other infrastructure, (ii) seepage from RDAs on groundwater, and (iii) point source emissions from mining and processing activities could be adequately managed under Part V of the EP Act.

On 7 September 2023, an application was submitted under section 45C of the EP Act to amend the disturbance footprint approved under MS 971, to support the proposed F1 RDA expansion. The amendment 'traded' a previously approved disturbance footprint at the waste rock dump area to clear areas required for borrow pits and buttressing the expanded F1 RDA. The application was approved by the EPA on 26 April 2024.

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 2020c).

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 Location and siting

The premises boundary encompasses both privately-owned land and State Forest areas within the Shire of Boddington. The premises is located on the eastern fringe of the Darling Plateau. The F1 RDA is located on the northmost portion of the prescribed premises, abutting State Forest area to the west and privately-owned land to the east.

Natural topography slopes from approximately 340 m Australian Height Datum (mAHD) to the north of the RDA area (comprising both the F1 RDA and the R4 RDA) down to around 200 mAHD at the Hotham River in the south and is dominated by a prominent ridge to the west of the RDA area which reaches up to 540 mAHD.

The premises is located within the northern jarrah forest biogeographic subregion, on a duricrusted plateau characterised by open forests of *Eucalyptus marginata* (jarrah) and *Corymbia calophylla* (marri). Other dominant tree species include *E. wandoo* (wandoo), with wandoo-marri woodlands becoming more predominant to the east of the premises. The western portion of the premises and beyond is located within the Dwellingup State Forest.

3.1.1 Human activities

The nearest town is the Boddington Township, located approximately 11.2 km south-east of the RDA area at the premises (comprising both the F1 RDA and the R4 RDA) (Figure 4).

In addition to the township, a number of rural residential and commercial premises are located to the east and south of the premises, typically isolated on agricultural land between remnant patches of native vegetation. From the RDA area, the nearest residential dwellings are located

approximately 6.5 km east of the F1 RDA, along Chalk Brook Road. Several dwellings are also present further east, along Bannister-Marradong Road (i.e., >10 km) (Figure 4).

Activities undertaken at some of the commercial premises typically relate to agriculture or natural resource management, including pine or blue gum plantations, grazing and cropping. In terms of industrial activities, the Boddington Wastewater Treatment Plant (BWTP) is a prescribed premises operated by the Water Corporation (regulated under licence L6792/1991/12), located approximately 9.1 km south-east of the RDA area, and directly adjacent to the premises' accommodation village. Further south-east of the RDA area is the Boddington Bauxite Mine, which is a prescribed premises operated by South32 Worsley Alumina Pty Ltd (regulated under licence L5960/1983/11).

To the north-west of the premises, the Bibbulman Track intersects part of the premises boundary, running along the western perimeter of the F1 RDA (Figure 5). The track is a nationally significant recreational walking trail within the Dwellingup Sate Forest. The closest portion of the track is approximately 500 m away from the F1 RDA footprint. Track users generally experience an enclosed and canopied view, with the exception of some high points along the track where canopy vegetation is reduced, and the view extends across the landscape.

3.1.2 Climate and meteorology

The south-west region of Western Australia experiences a Mediterranean-type climate, characterised by hot dry summers and cold wet winters. Winter rainfall is typically associated with westerly frontal systems that move across the region between May and September, which contributes an average of 542 mm in rainfall, comprising approximately 86% average annual rainfall. Conversely, evaporation is most pronounced between October and April, estimated at 1,126 mm, which comprises 83% of average annual evaporation.

Prevailing winds are east-southeasterly in the summer, with an average wind velocity of 10 km/h to 22 km/h. Wind directions become west-northwesterly in winter months, with comparable wind velocities (CDM Smith 2024). Wind roses from the Bureau of Meteorology's Wandering monitoring station (ID: 95640) indicated wind directions were generally from the northerly and southeasterly during the morning, and then northwesterly and southeasterly during the afternoon (Ramboll 2022).

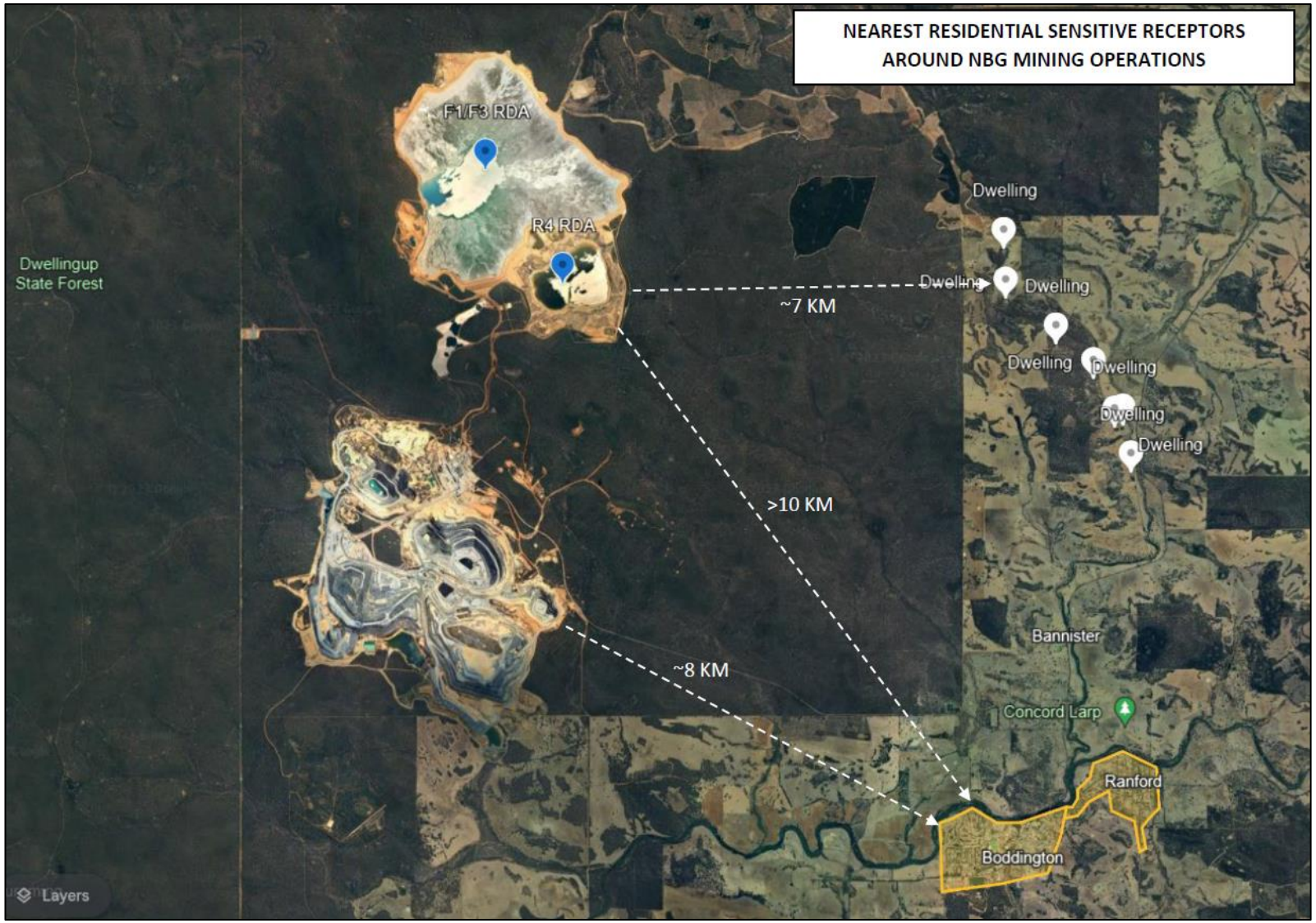


Figure 4: Distance of RDA area to nearby human dwellings and towns

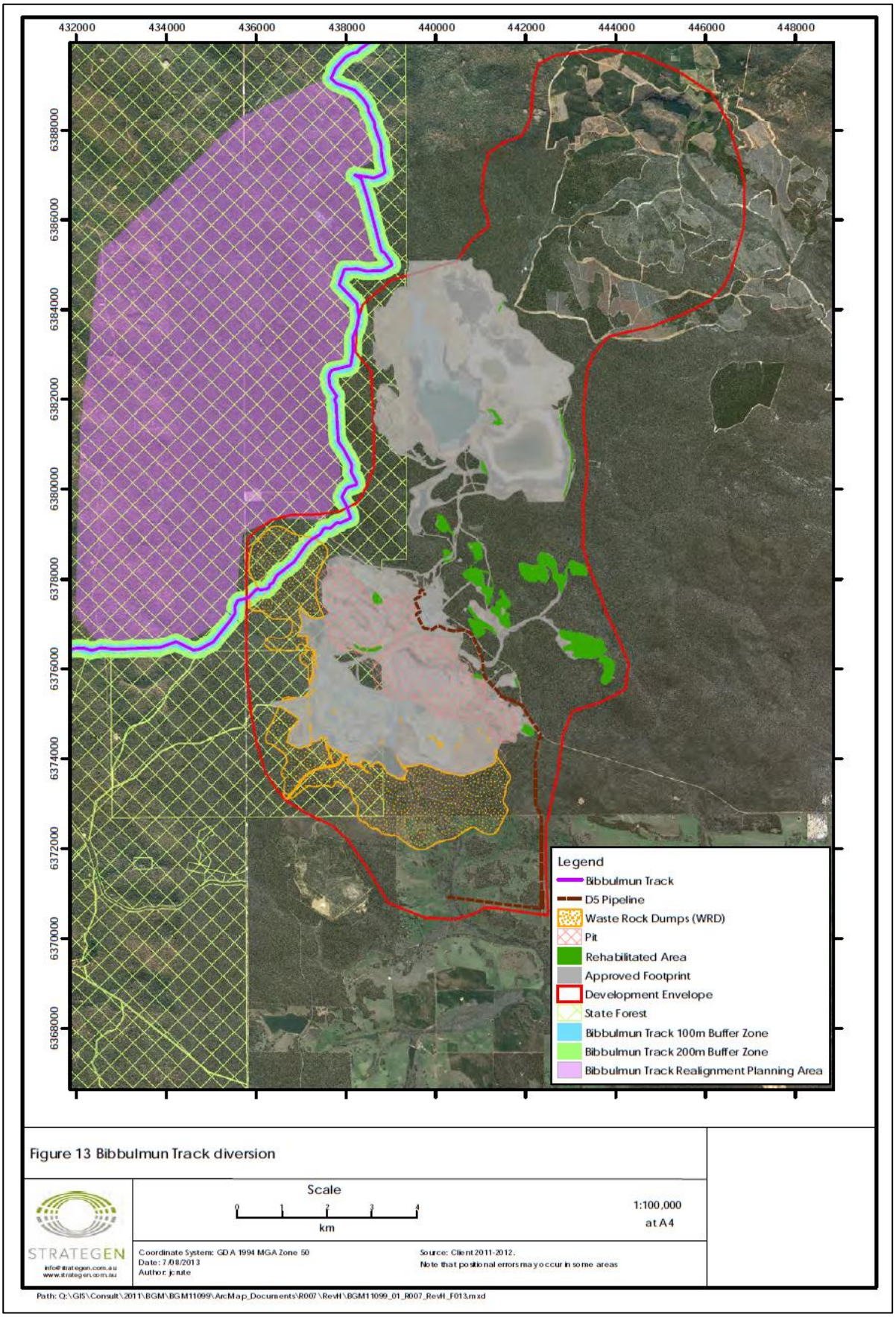


Figure 5: Bibbulmun Track location relative to the premises

3.1.3 Hydrology

The premises is located within the Thirty-Four Mile Brook catchment, a seasonal tributary of the Hotham River. The catchment is approximately 78 km^2 and includes several minor tributaries and creeks (e.g., Wattle Hollow Brook, Thirty-Four Mile Brook) and swamps (e.g., Pillow Swamp, Boomerang Swamp, and Round Swamp, located between the RDA area and the open mine pits further south of the RDAs) (Figure 6). The original flow path for the Thirty-Four Mile Brook has been modified by the construction of water storage dams, waste rock dumps, and the RDAs, as well as mining of at the Wandoo North Pit. Further east, other tributaries, such as Boggy Brook and House Brook, flow southwards into the Hotham River.

The Hotham River is located south of the RDA area, flowing from east to west through the Boddington township before joining up with the Thirty-Four Mile Brook (which now flows from south of the mining area) and bending southwards near the eastern premises boundary (Figure 6). The Hotham River eventually joins the Murray River to continue flowing southwards through the Williams River. At its closest point, the Hotham River is approximately 9.5 km south of the RDA area.

All surface water bodies within the premises experience ephemeral flow primarily during winter months. The Hotham River retains pools during the summer period, which is supported by groundwater flow.

The premises is also located within the Dandalup River System and Murray River System Proclaimed Surface Water Area under the *Rights in Water and Irrigation Act 1914*. The Licence Holder currently holds surface water licence SWL60668(7), which permits the taking of up to 15,000,000 kL of water from the Hotham River annually, subject to licence conditions.

Directly north of the premises and the RDA area is the Serpentine River catchment. The northern catchment is also classified as a Public Drinking Water Source Areas (PDWSA), namely the South Dandalup Dam Catchment Area to the north-west and the Serpentine Dam Catchment Area to the north (Figure 6). Both PDWSAs are classified as Priority 1, with small parcels of land classified as Priority 2, and are strategic sources of public drinking water to the Perth, Mandurah, Pinjarra, Harvey, as well as the Goldfields and agricultural regions.

The premises' northern boundary current intersects with portions of the South Dandalup Dam Catchment Area, most notably, the northern perimeter of the F1 RDA abuts the Priority 2 area boundary. The Priority 2 area is currently privately owned by the Licence Holder.

3.1.4 Hydrogeology

The premises is located on the north-eastern region of the Archean Saddleback Greenstone Belt and Boddington Terrane in the south-western region of the Yilgarn Craton. In general, the Saddleback Greenstone Belt is comprised of three main geological formations, the Marradong Formation to the east, Wells Formation to the west, and the Hotham Formation occupying a relatively limited area on the south-western region (Klohn Crippen Berger 2023). The south-western portion of the F1 RDA is located on mainly basaltic/mafic rocks with Proterozoic dolerite dykes of the Marradong Formation, while other portions of the facility overlie granitic rocks.

Locally, the F1 RDA footprint overlies relatively thick overburden within a valley environment that was formerly drained by the Thirty-Four Mile Brook and its tributaries (Klohn Crippen Berger 2023). The overburden underlying the facility consists of surficial and residual alluvium, and/or colluvium, and saprolite.

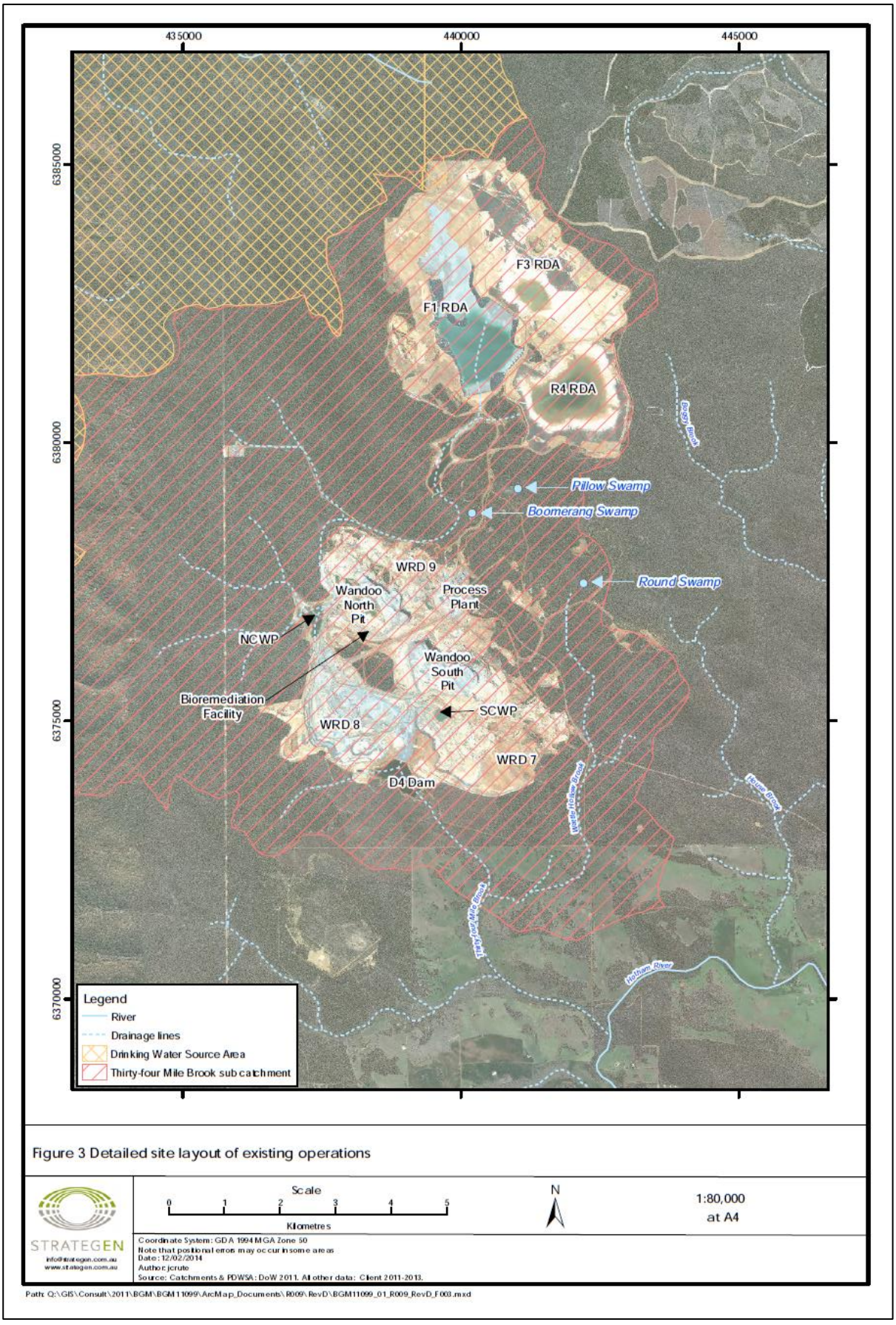


Figure 6: Catchment areas, surface water bodies, and drainage lines at the premises

Previous groundwater investigations have consistently identified four primary hydrogeological units that are relevant for the RDA area (BDH 2019), comprising (Figure 7):

1. A seasonal shallow hydrogeological unit, consisting of hardcap and laterite gravels occurring close to the surface (i.e., <5 mbgl to 10 mbgl). Groundwater in this unit is thought to be perched but may be hydraulically connected to the underlying units in some locations. This hydrogeological unit is likely the most relevant in terms of supporting vegetation and groundwater dependent ecosystems (GDE).
2. An oxide unit which underlies the seasonal shallow hydrogeological unit, comprising highly weathered clayey bedrock at depths from 5 mbgl to 50 mbgl, potentially reaching as deep as 60 mbgl. The oxide unit is indicated to be present throughout the RDA area, though it is absent in a few locations nearer to the Hotham River to the south. While the unit is not expected to laterally transmit significant amounts of groundwater, there are some locations where vertical migration of groundwater may occur through this unit when saturated. The oxide unit is unsaturated below the Pillow Swamp, Round Swamp, and Boomerang Swamp, which acts as a seal below the seasonal shallow hydrogeological unit at these locations. At the RDA area, the oxide unit is likely saturated and allows for the transmission of pressure from the RDA into the underlying weathered and fractured upper bedrock hydrogeological unit.
3. A weathered and fractured upper bedrock hydrogeological unit, including the interface at the base of the oxide unit. This hydrogeological unit is considered to be the primary groundwater and seepage transmitting zone, occurring almost throughout the RDA area at depths ranging between 10 mbgl and 60 mbgl. This unit is also the primary target unit for screening monitoring bores around the RDA area.
4. A deep fractured bedrock hydrogeological unit, which comprises discrete and isolated zones of fracturing that are associated with structural features in the unweathered greenstone bedrock. This unit has been intercepted in the open mine pits, as well as deep groundwater abstraction bores. While there is potential for highly permeable fracture zones to exist within this unit, it is unlikely to interact with or be significantly influenced by activities at the RDAs.

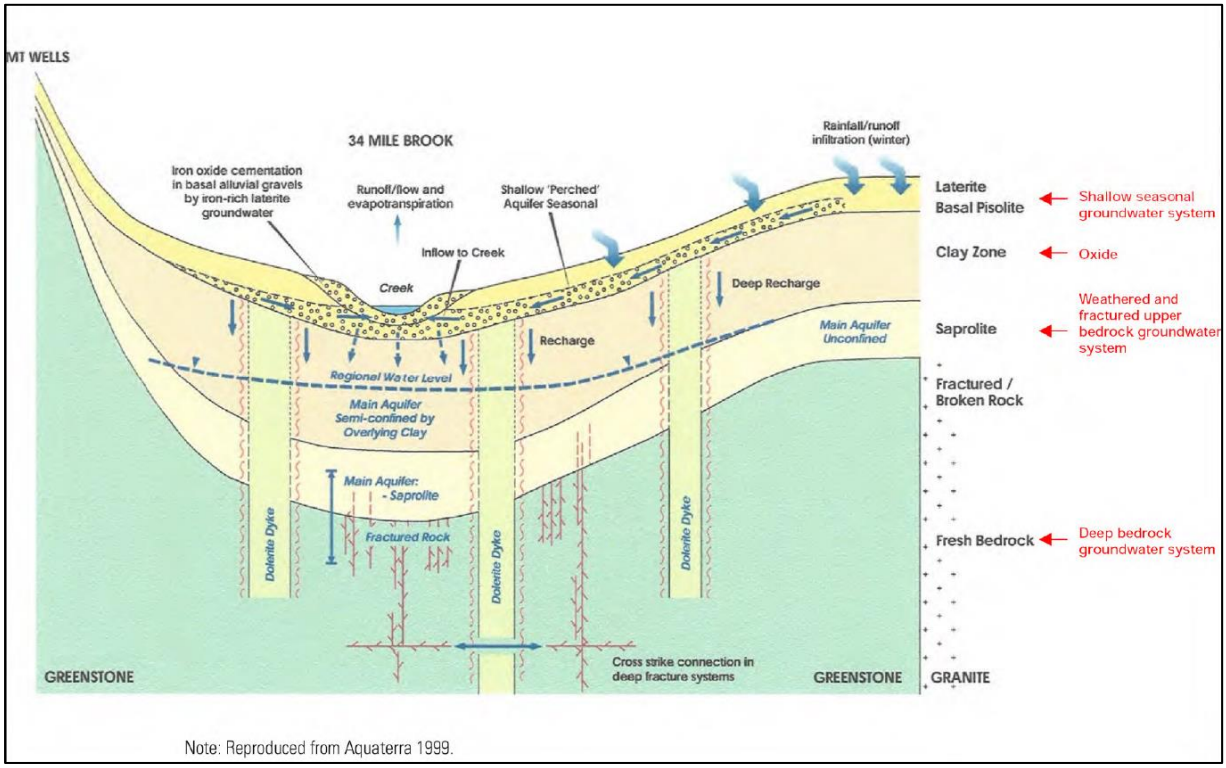
Groundwater in the seasonal shallow hydrogeological unit tends to be highly responsive to rainfall infiltration, with fluctuations in groundwater elevation that may change rapidly and atypical of regional groundwater responses. The main groundwater discharge is to alluvial sediments along creek channels.

Groundwater flow direction generally follows regional surface topography, which was predominantly in a south to south-westerly direction towards the Hotham River prior to the commencement of mining (Klohn Crippen Berger 2023). However, the local hydrogeological flow regime has been modified during the operation of the premises, due to mine dewatering of the Wandoo North and South Pits resulting in a cone of depression that draws groundwater towards the open mine pits. On the other hand, tailings deposition into the F1 RDA (as well as historical deposition into the adjacent R4 RDA) has resulted in groundwater mounding, with seepage-influenced groundwater migrating away from the facilities in a radial pattern (Klohn Crippen Berger 2023).

The local groundwater systems are primarily dominated by sodium and chloride ions, with relatively low proportions of sulfate. Metal and metalloid concentrations are also low. Pre-mining monitoring data indicated the salinity of the seasonal shallow hydrogeological unit ranged between 1,000 mg/L to 4,000 mg/L of total dissolved solids (TDS) (Strategen 2013), with fresher groundwater in the deeper fractured bedrock hydrogeological unit (Strategen 2014). During dewatering of the open mine pits, the TDS of groundwater inflow decreased down to approximately 2,000 mg/L, potentially in response to a flushing of the groundwater system with freshly infiltrated rainfall occurring at the pits and its surrounds (Strategen 2014).

Based on the Water Information Reporting database, there are no third-party groundwater users

around the premises, except for industrial or mining purposes. However, as the region is not located within a proclaimed groundwater area, a groundwater licence is not required to take groundwater under the *Rights in Water and Irrigation Act 1914*. However, a number of vegetation communities and surface water bodies at and around the premises have been classified as potential GDEs (Umwelt 2021).



Note: Reproduced from Aquaterra 1999.

Figure 7: Conceptual hydrogeological model at the premises

3.2 Source-pathways and receptors

3.2.1 Emissions and controls

The key emissions and associated actual or likely pathway during premises construction and operation, which have been considered in this Amendment Report are detailed in Table 6 below. Table 6 also details the proposed control measures the Licence Holder has proposed to assist in controlling these emissions, where necessary.

Table 6: Licence Holder controls

Emission	Sources	Potential pathways	Proposed controls
Construction			
Dust	Construction of the F1 RDA Stage 19 to Stage 22 embankment raises, including downstream buttressing and liner installation; Construction of perimeter sump SD3SU-B	Air / windborne pathway	• Dust suppression will be undertaken on unsealed and cleared areas, as well as locations with high dust risk, and/or where dust generation is visible. • Dust deposition gauges installed on the north-west perimeter of F1 RDA will continue to be monitored, along with newly installed dust deposition gauges located further north-east of the facility and to the east where rural residential premises are located. • Two Osiris real-time dust monitors recently installed near rural residential premises to the east of F1 RDA will be monitored.
Sediment laden stormwater		Overland runoff during rainfall events	None proposed.
Hydrocarbon and other chemical reagents		Loss of containment, resulting in leaks and spills	• Internal hydrocarbon management plan will be implemented, which specifies relevant procedures for hydrocarbon management and equipment maintenance, training and awareness information, maintenance and inspection schedules, as well as spill clean-up protocols.
Operation			
Dust (dried tailings)	Tailings deposition into the F1 RDA Stage 19 to Stage 22 embankment raise	Air / windborne pathway	• Tailings deposition will rotate throughout the facility to limit generation of fugitive dust from dried tailings. Deposition schedule and location can be modified (to a reasonable extent) to manage surface conditions at the tailings beach during strong winds when dust liftoff is more likely to occur. • Dust suppression will be undertaken where dust generation is visible. • Dust deposition gauges installed on the north-west perimeter of F1 RDA will continue to be monitored, along with newly installed dust deposition gauges located further north-east of the facility and to the east where rural residential premises are located. • Two Osiris real-time dust monitors recently installed near rural residential premises to the east of F1 RDA will be monitored.
Sediment laden stormwater		Overland runoff during rainfall events	• Saddle dam embankment benches will have a slight slope to the outer perimeter of the facility or rock-lined conveyance channel that directs stormwater flow to drop chutes. The drop chutes will be geotextile and/or rock-lined to reduce erosion.

Emission	Sources	Potential pathways	Proposed controls
Tailings seepage		Vertical infiltration and lateral migration of seepage through base and saddle dam walls	<u>Construction</u> • Embankment raises for Stage 19 to Stage 22 will be constructed using appropriate material, including low permeability fill from nearby borrow pits that meet required standard maximum dry density and optimum moisture content, as detailed in Knight Piesold (2023b). • Decant pond area has been lined with synthetic liner with a permeability of 10^{-13} m/s at the base of the facility, while areas outside of the decant pond area has been clay-lined. [1] New embankments and saddle dam areas constructed through the RDA expansion will also be lined appropriately. <u>Tailings deposition and decant pond management</u> • Tailings slurry will be treated with Caro's acid to reduce weak acid dissociable cyanide (WAD CN) concentrations at the residue booster station prior to being discharged into F1 RDA. • Tailings slurry will be discharged sub-aerially and be allowed to flow down a gentle tailings beach slope to facilitate deposition and drying of tailings, while collecting tailings supernatant at the decant pond. • Drying of tailings is maximised through implementation of a deposition strategy where discharge spigots are rotated around the facility to provide sufficient drying time for newly deposited tailings to consolidate, drain, and shed water. • Recovery of the decant water will be prioritised for reuse during ore processing. • The size of the decant pond will be managed and operated to maintain a minimum quantity of water at all times, such that the pond area does not exceed the extent of the underlying HDPE liner. • A separation distance of at least 200 m will be maintained between the decant pond boundary and the saddle dam walls. • Where decant pond size is anticipated to exceed the design size, captured seepage from the underdrainage system, leak collection recovery system (LCRS), and beach drains will be diverted to R4 RDA until decant pond size can be kept within its intended size.[1] • Inspection for the decant pond size and location, as well as the condition of the decant recovery infrastructure, will be undertaken daily.[1] • Inspection for the condition of the HDPE liner will be undertaken weekly. <u>Seepage management</u> • Seepage capture infrastructure will continue to be operated, including underdrainage system, leak collection and recovery system, beach drain, and toe drains (refer to Section 2.2.1 and

Emission	Sources	Potential pathways	Proposed controls
			Table 1).[1] • Perimeter sumps continue to be operated.[1] Perimeter sump SD3SU-B will be constructed between existing perimeter sumps SD3SU-A and SD3SU-C, with a deeper sump depth to be trialled. • Inspection for the condition of the underdrainage system, LCRS, and beach drain infrastructure will be undertaken daily. • Inspection of the saddle dams for visual evidence of seepage (e.g., wet areas, toe seepage, etc.) will be undertaken weekly. <u>Monitoring</u> • Existing 297 vibrating wire piezometers is considered adequate and will continue to be monitored for phreatic surface of the facility. • Groundwater monitoring bores near the RDA area will continue to be monitored monthly for standing water level and quarterly for groundwater quality.[1] Decommissioned monitoring bores will be replaced, subject to monitoring bore review (refer to Section 2.3.3 and Table 5). • Six additional monitoring bore locations have been proposed to monitor ambient groundwater levels and quality in cross-catchment environment. A shallow and deep bore will be installed at each of the proposed locations. • WAD CN will be monitored in tailings slurry after before and after treatment with Caro's acid prior to being deposited at the facility every six minutes and assessed against internal target level.[1] Contingency procedures will be implemented if measured WAD CN continually exceeds the target level, leading to plant shutdown if the issue cannot be rectified. • Water quality at the underdrainage system, LCRS, toe well, and decant pond will continue to be undertaken monthly. • Water quality at existing and new perimeter sumps will continue to be monitored monthly.[1] Nearby water lines (e.g., Boddy Brook, South Dandalup River) will also continue to be monitored.[1] • Vegetation condition around the F1 RDA perimeter will be monitored, visually every quarter and annually using multispectral data to determine plant cell density. • Phreatic surface of the F1 RDA, as well as its decant pond volume, freeboard, tailings beach width, and drainage system performance will be monitored and managed in accordance with Trigger Action Response Plan (TARP). • The RDA Groundwater Management Plan will be implemented (refer to Section 3.5.6).

Emission	Sources	Potential pathways	Proposed controls
Tailings slurry		Overtopping of F1 RDA saddle dams	• A minimum operating freeboard of 0.5 m will be maintained at saddle dams 3, 4, 5, 7, 8, and 9, while a minimum operating freeboard of one metre will be maintained at saddle 1, 2, and 10 as these saddle dams are lower.[1] • Recovery of the decant water will be prioritised for reuse during ore processing. • An emergency spillway has been designed for each embankment raise (Stage 19 to Stage 22) at the saddle separating the residue booster station and the Wattle Pit. The emergency spillway will be constructed to convey overflow from a 1:100,000 year annual exceedance probability (AEP) event to the neighbouring D1 Dam. However, the spillway will only be constructed if an unacceptably large decant pond is anticipated to develop due to prolonged extreme rainfall. • Inspection for the decant pond size and location, as well as freeboard allowance, will be undertaken daily.[1] • Decant pond elevation will be surveyed weekly to calculate available freeboard and pond volume, while bathymetric survey will be undertaken monthly.[1] • Decant pond volume, freeboard, and tailings beach width of the F1 RDA will be monitored and managed in accordance with Trigger Action Response Plan (TARP).
		Pipeline failure, resulting in leaks and spills	• Tailings delivery pipelines are fitted with automated, magnetic flow meter rupture detection, which will alert the control room once a 10% flow difference is detected between the processing plant and residue booster station.[1] • Tailings delivery leak detection system will automatically shut down pumping if the alarm has not been responded to within 20 minutes.[1] • Tailings delivery pipelines comprise HDPE-lined steel pipes, flanged at every 300 m interval. Weep holes and drain valves are present at each flange joint to show if any slurry or water is sitting in the gap between the HDPE inner pipe and steel outer pipe, indicating pipe liner failure. • Four emergency catchpits are present along the tailings delivery pipeline route to accept tailings slurry from the pipeline in the event of power outages, pump failures, and/or pump ruptures, with procedures in place to detect and manage slurry levels within catchpits during emergencies. • Saddle dam embankment crest will be constructed with 2% crossfall towards the upstream embankment to contain any potential spills from the tailings distribution system. • Lined sediment trenches are present and will be maintained at the downstream toe of each saddle dam to collect potential leaks from the embankment crest. • Tailings delivery pipeline (and return water pipeline) will be visually inspected twice daily.[1] • Tailings pipeline integrity will be assessed visually on an annual basis, typically during relocation

Emission	Sources	Potential pathways	Proposed controls
			to a newly constructed embankment raise. Inspection will check for potential damages and signs of wear to the pipe exterior, stub ends, and flanges. Any worn or damaged pipes will be resurfaced and/or replaced.
Decant water			• Return water pipeline (and tailings delivery pipeline) will be visually inspected twice daily.[1] • Return water will be treated with Caro's acid to further reduce WAD CN concentrations at the residue booster station prior to being sent for reuse in the processing circuit.[1]
		Dermal contact and direct ingestion by terrestrial fauna and avifauna	• Tailings slurry will be treated with Caro's acid to reduce weak acid dissociable cyanide (WAD CN) concentrations at the residue booster station prior to being discharged into F1 RDA. • WAD CN will be monitored in tailings slurry after before and after treatment with Caro's acid prior to being deposited at the facility every six minutes and assessed against internal target level (for wildlife protection, in accordance with the Licence Holder's International Cyanide Code certification).[1] Contingency procedures will be implemented if measured WAD CN continually exceeds the target level, leading to plant shutdown if the issue cannot be rectified. • Inspection will be undertaken daily for any potential fauna mortality at the facility. • Freshwater drinking troughs have been constructed around the facility and will be maintained to encourage transient fauna away from tailings beach and decant pond.
Seepage-impacted water	Water storage at existing and new perimeter sumps	Overtopping of perimeter sumps	• Perimeter sumps will be equipped with pumps intended for continuous pumping operation. • Sump pumps will be equipped with low level cut-off controls to ensure pump intake to ensure automatic, continuous pumping above a certain sump water level, while minimising risk of silt and fines ingress into the pump. • While sump may overtop during extreme rainfall events due to catchment runoff, additional mobile pumps can be temporarily introduced to remove excess water and maintain sump water levels.
		Vertical infiltration and lateral migration of seepage through sump base and walls	• Where possible, the new perimeter sump SD3SU-B will be made as deep as practicable, based on ground condition.
Tailings seepage; Seepage-impacted water	Water discharge and storage at the R4 RDA	Vertical infiltration and lateral migration of seepage through base and embankment walls	<u>Construction</u> • Facility has been constructed with an *in-situ* clay liner capped by one metre of consolidated residue, with a modelled permeability of 10^{-6} m/s.

Emission	Sources	Potential pathways	Proposed controls
			<u>Decant pond management</u> • Water input into the R4 RDA will continue to be managed, such that no raw water is discharged where it is not necessary. • Decant pond is currently equipped with a decant pump to return water to the processing circuit for reuse. <u>Seepage management</u> • Seepage capture infrastructure will continue to be operated, including underdrainage system. <u>Monitoring</u> • Existing vibrating wire piezometers, inclinometer, and groundwater monitoring bores[1] around the R4 RDA will continue to be routinely monitored. • Vegetation condition around the R4 RDA perimeter will be monitored, visually every quarter and annually using multispectral data to determine plant cell density. • Water quality at the decant pond will continue to be monitored monthly. Nearby water lines (e.g., Boggy Brook) will also continue to be monitored. [1] • The RDA Groundwater Management Plan will be implemented (refer to Section 3.5.6).
		Overtopping of R4 RDA embankment	• A minimum operating freeboard of 0.5 m will be maintained.[1] • Inspection for freeboard allowance will be undertaken daily.[1] • Decant pond elevation will be surveyed weekly to calculate available freeboard and pond volume. • Decant pond is currently equipped with a decant pump to return water to the processing circuit for reuse. • An emergency spillway has been designed to direct excess water to the D1 Dam, in the event of extreme storm event.
		Dermal contact and direct ingestion by terrestrial fauna and avifauna	• Seepage-impacted water (e.g., underdrainage system, LCRS, beach drain) from the F1 RDA will be pumped back to the F1 RDA decant pond, instead of the R4 RDA, due to higher levels of impact. Discharge of seepage-impacted water into R4 RDA is only authorised when the extent of the F1 RDA decant pond is expected to exceed the extent of the underlying HDPE liner and discharges need to be controlled.[1] • Water quality at the decant pond will continue to be monitored monthly.

Emission	Sources	Potential pathways	Proposed controls
			• Wildlife observations will continue to be made at R4 RDA. • A routine cobalt sediment monitoring program, a cobalt tissue monitoring program targeting macorphytes and localised fish tissue, a plan for dedicated, non-lethal Coot survey, and a life of mine tailings study for determining operational timeframe for R4 RDA will be developed.

Note 1: These proposed controls are already specified under existing licence L8306/2008/3.

3.2.2 Receptors

In accordance with the *Guideline: Risk assessments* (DWER 2020c), 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 7 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 2020b)).

Table 7: Sensitive human and environmental receptors and distance from prescribed activity

Human receptors [1, 2, 3]	**Distance from prescribed activity**
Rural residential premises	A number of rural residential premises are located to the east of the premises, along Chalk Brook Road. The closest premises is located approximately 6.5 km from the RDA area (Figure 4).
Recreational users	The Bibbulmun Track runs along the west of the RDA area, with the closest section of the track being approximately 500 m from the F1 RDA perimeter (Figure 5).
Environmental receptors	**Distance from prescribed activity**
Native vegetation	The premises is located within the northern jarrah forest biogeographic subregion, on a duricrusted plateau characterised by open forests of *Eucalyptus marginata* (jarrah) and *Corymbia calophylla* (marri). Other dominant tree species include *E. wandoo* (wandoo), with wandoo-marri woodlands becoming more predominant to the east. The western portion of the premises and beyond is located within the Dwellingup State Forest. Cumulative flora surveying has identified over 660 species, with at least 36 vegetation communities described at the premises (Mattiske Consulting 2021). The local floristic diversity is considered somewhat greater than western jarrah forest areas, as the flora reflect the interface between the eastern sections of the northern jarrah forest and the Wheatbelt region (Strategen 2013). Based on aerial imagery, native vegetation is present around the RDA area (Figure 8).
Priority ecological communities (PEC)	Remnant patches of the Priority 1 PEC – '*Mount Saddleback heath communities*' are mapped around the F1 RDA, both within and adjacent to the premises. The nearest PEC (with buffers included) is located adjacent to the F1 RDA southern perimeter and the R4 RDA western perimeter (Figure 8). Other nearby patches are located approximately 500 m south of the R4 RDA and approximately 800 m north of the F1 RDA.
Groundwater dependent ecosystem (GDE)	The Bureau of Meteorology's Terrestrial GDE Atlas has described the vegetation communities around the RDA area as being potentially GDE. Umwelt (2021) has refined the extent of GDE based on historical vegetation surveys. Notably, the three swamps (e.g., Pillow Swamp, Boomerang Swamp, and Round Swamp) and the associated riparian vegetation south of the R4 RDA are considered GDEs (Figure 6).
Conservation significant flora	While the majority of local flora and vegetation types at the premises are generally well represented at a regional scale, several floral species are restricted to the Boddington area and are considered to be of local and regional significance. These species typically occur in vegetation communities associated with shallow granitic soils (Strategen 2013). There are up to 87 potential conservation significant flora species within and around the premises. Historical surveys have indicated several priority flora around the RDA area

	(Strategen 2013; Mattiske Consulting 2021), including (Figure 8): 1. *Lasiopetalum cardiophyllum* (Priority 4), occurring primarily south of the RDA area, near and along the pipeline corridor and access road, as well as south-west of the F1 RDA and south of the R4 RDA. Isolated individuals have also been found around the F1 RDA perimeter. Two individuals are currently within the proposed F1 RDA expansion footprint. 2. *Senecio leucoglossus* (Priority 4), occurring along the southern to western perimeter of F1 RDA; 3. *Chordifex gracilior* (Priority 3), recorded at one location approximately 1.3 km west of the F1 RDA western perimeter. 4. *Hakea oldfieldii* (Priority 3), recorded at one location approximately 1.3 km west of the F1 RDA western perimeter.
Native fauna	The premises is divided into areas dominated by shrubland and woodland. Valley Wandoo woodland and lower slope heath vegetation communities have the richest faunal communities and is a significant habitat for many faunal species, particularly birds. Historical fauna surveys at the premises have recorded up to 91 bird species, 14 native mammal species, 13 amphibians, and 22 reptiles, most of which were well represented regionally (Strategen 2013). Most notably, kangaroos and birds have been observed to frequent the R4 RDA during site visits. A desktop fauna assessment identified 25 species protected under conservation legislation (Biostat 2021). Up to five species listed as matters of national environmental significance were recorded near the RDA area (Figure 9): 1. Woylie/Brush-tailed Bettong (*Bettongia penicillate Ogilbyi*) – Critically Endangered under the *Biodiversity Conservation Act 2016* (BC Act); Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); 2. Chuditch/Western Quoll (*Dasyurus geoffroii*) – Vulnerable under BC Act and EPBC Act; 3. Forest Red-tailed Black Cockatoo (*Calyptorhynchs banksia naso*) – Vulnerable under BC Act and EPBC Act; 4. Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) – Endangered under BC Act and EPBC Act; and 5. Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered under BC Act and EPBC Act. The endangered (under BC Act and EPBC Act) numbat (*Myrmecobius fasciatus*), while not recorded, was also likely to occur in the area. A significant portion of the native vegetation surrounding the RDA area has been classified as potential Black Cockatoo habitat, with potential breeding trees identified (Figure 10).
Surface water bodies	As detailed in Section 3.1.3, the premises is located within the Thirty-Four Mile Brook catchment. Key surface water bodies and creek line around the F1 RDA, includes (Figure 6): 1. South Dandalup River and its tributaries are located approximately 1.7 km from the northern perimeter of the F1 RDA. While the South Dandalup River was permanently flowing, it became ephemeral around 2002 due to declining rainfalls in the region, suggesting river flow was driven primarily by rainfall, rather than groundwater (Strategen 2013). The river flows westwards into Lake Banksiadale, which is a drinking water reservoir dammed by the South Dandalup Dam. The South Dandalup River is located within the South Dandalup Dam Catchment Area, a Priority 1 Public Drinking Water Source Area. A small portion on the eastern end of the catchment area is classified as Priority 2. 2. The D1 Dam water storage reservoir directly abuts the F1 RDA's Saddle Dam 1. The reservoir receives and stores freshwater from the forested

	upper section of the Thirty-Four Mile Brok. Water abstracted from the Hotham River is also stored at the D1 Dam. Water stored at the D1 Dam is utilised to support mining operations, including for ore processing. 3. Pillow Swamp, Boomerang Swamp, and Round Swamp are located to the south of the RDA area. From the F1 RDA, the swamps are 1.4 km, 1.8 km, and 3.4 km away, respectively. From the R4 RDA, the swamps are 1.1 km, 1.9km, and 2.6 km away, respectively. The swamps represent topographical low points, where perched groundwater is discharged to the surface (Strategen 2013). As such, these swamps and their associated riparian vegetation are considered GDEs. 4. Aside from the South Dandalup River to the north and the diverted Thirty-Four Mile Brook, a number of minor creek lines are also present to the east and south-east of the RDA area. The closest creek line is Boggy Brook, flows southwards into the Hotham River. At its closest, Boggy Brook is approximately 1.4 km and 1.0 km from the F1 RDA and R4 RDA, respectively.
Groundwater aquifer	As detailed in Section 3.1.4, local hydrogeology is dominated by four hydrogeological units (Figure 7). While the weathered and fractured upper bedrock hydrogeological unit is known to be the primary groundwater transmitting zone, the seasonal shallow hydrogeological unit is also an important consideration, as it is the shallowest hydrogeological unit and interfaces with either surface water bodies (i.e., swamps) and/or the root zone of native vegetation.
Cultural receptors	**Distance from prescribed activity**
Aboriginal heritage sites	Preservation of Aboriginal heritage, sites, and objects at the premises is currently managed under a Preservation of Aboriginal Heritage Agreement between the Licence Holder, the Gnaala Karla Booja Native Title Group, and the South West Aboriginal Land and Sea Council. The Agreement sets out the process for management of Aboriginal heritage sites within 20 km of the premises. A number of ethnographic and archeological surveys have been conducted at the premises since the early 1980s, with identified Aboriginal heritage sites being lodged with the Department of Plannings, Lands and Heritage. A number of heritage sites around the RDA area are currently classified as Lodged under the Aboriginal Cultural Heritage Inquiry System. The Hotham River (Place ID 27935) and the Dandalup River (Place ID 27937) are classified as registered Aboriginal heritage sites. The place types are classified as creation/dreaming narrative, with the Dandalup River also classified as a hunting place, plant resource, water source, and landscape feature. In addition to being Aboriginal heritage sites, these receptors will also be assessed as surface water bodies for the relevant risk events. A number of registered artefact and scatter sites were located in the vicinity of the RDA area (Place ID 4230, 4237, 18749). However, these will not be considered in the risk assessment as there is unlikely to be a complete source-pathway-receptor linkage for the relevant risk events.

Note 1: The Boddington township is not considered a sensitive receptor as there is unlikely to be a complete source-pathway-receptor linkage for the relevant risk events. Potentials impacts associated with the embankment failure resulting in a discharge of dried tailings and tailings slurry out of the F1 RDA is a geotechnical and safety issue that is being regulated by the Department of Mines, Petroleum and Exploration under the *Mining Act 1978* and the *Mine Safety and Inspection Act 1994*. Geotechnical aspects of the proposed activities have not been assessed under this application.

Note 2: Human health impacts associated with contamination of a PDWSA has been assessed as an environmental receptor. That is, the sensitivity of the PDWSA as an environmental receptor has also considered potential implications for human health impacts (as a result of its contamination).

Note 3: The Boddington *Gold* Mine accommodation village is not considered a sensitive receptor as this assessment excludes employees, visitors, and contractors of the Licence Holder. Protection of these parties often involve different exposure risks and prevention strategies typically provided under relevant workplace health and safety legislation.

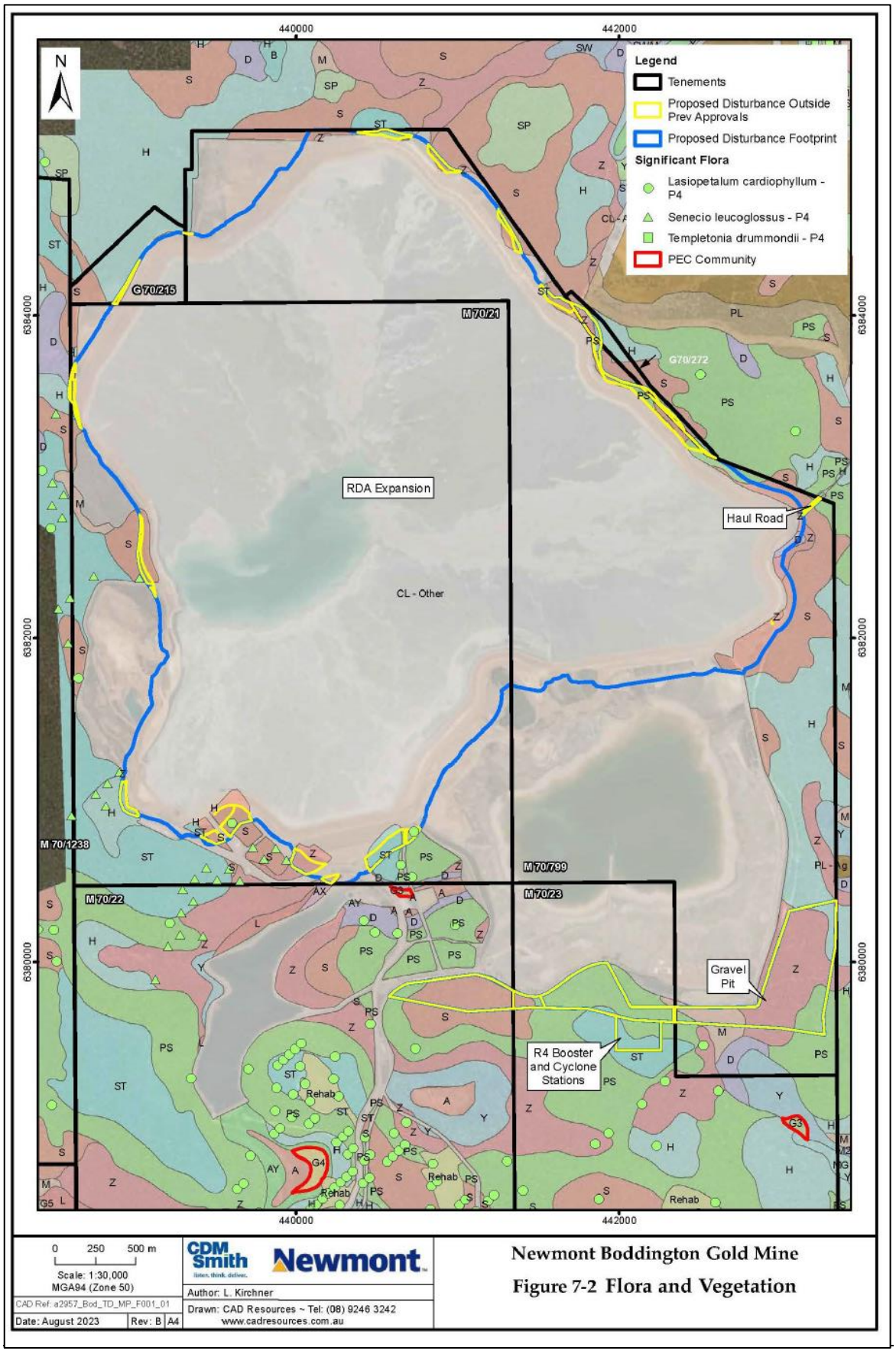


Figure 8: Vegetation community types, priority ecological communities, and conservation significant flora around the RDA area

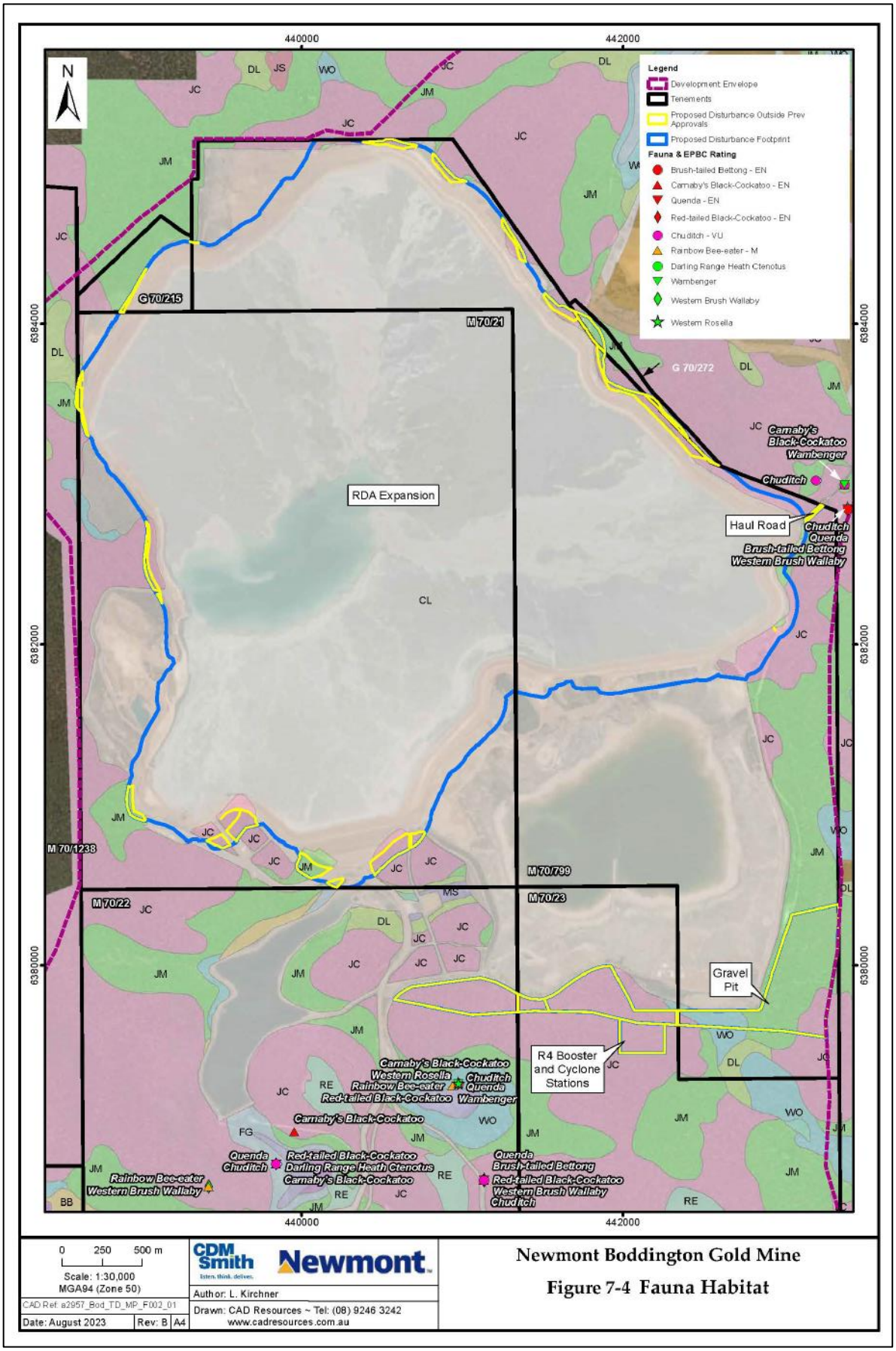


Figure 9: Conservation significant fauna sightings around the RDA area

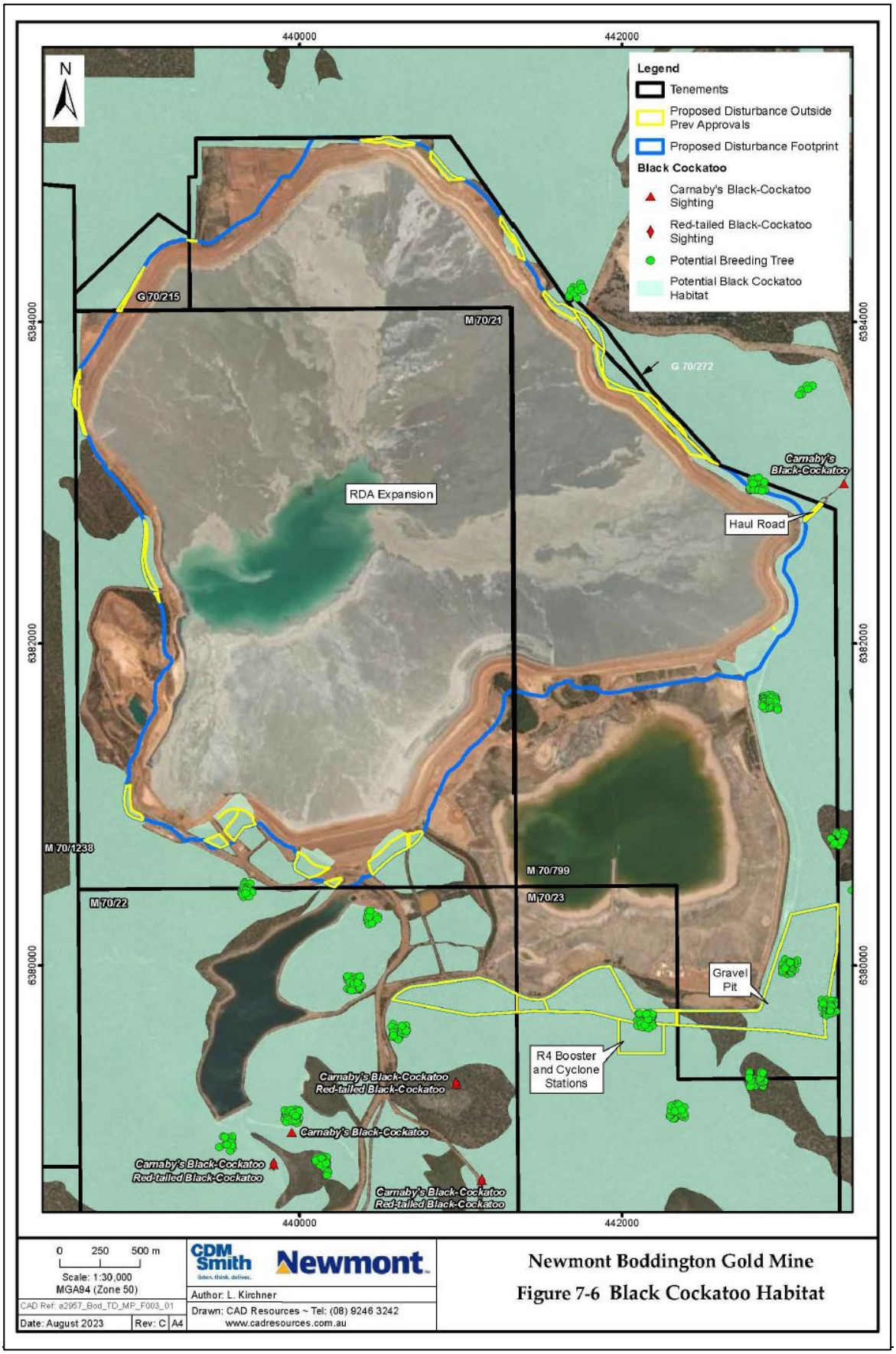


Figure 10: Cockatoo sightings, potential cockatoo breeding tree, and potential cockatoo habitat around the RDA area

3.3 Risk ratings

Risk ratings have been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020c) for those emission sources which are proposed to change and takes into account potential source-pathway and receptor linkages as identified in Section 3.2. Where linkages are incomplete they have not been considered further in the risk assessment.

Where the Licence Holder has proposed mitigation measures/controls (as detailed in Section 3.2), 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 8.

The Revised Licence L8306/2008/3 that accompanies this Amendment Report authorises emissions associated with the operation of the Premises i.e. tailings deposition into the F1 RDA Stage 19 to Stage 22 embankment raises.

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

Table 8. Risk assessment of potential emissions and discharges from the Premises during construction and operation

Risk Event					Risk rating[1] C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions[2] of licence	Justification for additional regulatory requirements
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Licence Holder's controls**				
Construction								
Construction of the F1 RDA Stage 19 to Stage 22 embankment raises, including downstream buttressing and liner installation; Construction of perimeter sump SD3SU-B.	Dust	***Pathway:*** Air / windborne pathway ***Impact:*** Impact to ecological health	Native vegetation, including PEC and priority flora.	Refer to Section 3.2.1	C = Slight L = Unlikely **Low risk**	Y	Condition 15 – Infrastructure construction requirements (amended); Condition 18 – Requirement to prevent and minimise dust emissions (no change).	N/A
	Sediment laden stormwater	***Pathway:*** Overland runoff during rainfall events ***Impact:*** Impact to ecological health		Refer to Section 3.2.1	C = Slight L = Possible **Low risk**	N/A	None	N/A
	Hydrocarbon and other chemical reagents	***Pathway:*** Loss of containment, resulting in leaks and spills ***Impact:*** Impact to ecological health		Refer to Section 3.2.1	C = Minor L = Unlikely **Medium risk**	Y	None	N/A
Operation								
Tailings deposition into the F1 RDA Stage 19 to Stage 22 embankment raise	Dust (dried tailings)	***Pathway:*** Air / windborne pathway ***Impact:*** Impact to human and ecological health, as well as amenity	Rural residential premises and recreational users (Bibbulmun Track).	Refer to Section 3.2.1 and Section 3.4.5	C = Moderate L = Unlikely **Medium risk** Refer to Section 3.4.	N	Condition 18 – Requirement to prevent and minimise dust emissions (no change); **<u>Condition 32 – Specified action to undertake dust monitoring review</u>** (new condition; additional regulatory requirement).	The Delegated Officer has determined that additional regulatory requirements are justified, including: • Dust monitoring review to assess potential impacts to rural residential premises. Refer to Section 3.4.6.
			Native vegetation, including PEC and priority flora; Surface water bodies, including the South Dandalup River, D1 Dam, swamps, and other creeks.	Refer to Section 3.2.1	C = Minor L = Unlikely **Medium risk**	Y	Condition 18 – Requirement to prevent and minimise dust emissions (no change).	N/A
	Sediment laden stormwater	***Pathway:*** Overland runoff during rainfall events ***Impact:*** Impact to ecological health	Native vegetation, including PEC and priority flora.	Refer to Section 3.2.1	C = Minor L = Unlikely **Medium risk**	Y	Condition 15 – F1 RDA embankment raise construction requirements (amended).	N/A
	Tailings seepage	***Pathway:*** Vertical infiltration and lateral migration of seepage through base and saddle dam walls ***Impact:*** Groundwater mounding and deterioration of groundwater quality, potentially resulting in impact to ecological health	Native vegetation, including PEC, GDE, and priority flora; Surface water bodies, including the D1 Dam, swamps, and other creeks. Groundwater aquifer	Refer to Section 3.2.1 and Section 3.5.6	C = Moderate L = Possible **Medium risk** Refer to Section 3.5.	N	Condition 1 – Maximum construction and operating height for F1 RDA (amended); Condition 4 – Containment infrastructure requirements for F1 RDA and perimeter sumps (no change); Condition 10 – Inspection requirements for F1 RDA embankment and decant pond (amended); Condition 13 – Operational requirements for F1 RDA and perimeter sumps (amended); Condition 15 – Infrastructure construction requirements (F1 RDA embankment raise, **<u>perimeter sump SD3SU-B</u>**) (amended; additional regulatory requirement); Condition 16 – Bore construction requirements (new condition); Condition 25 – Water balance monitoring (amended); Condition 26 – Process monitoring for WAD CN in	The Delegated Officer has determined that additional regulatory requirements are justified, including: • Construct perimeter sump SD3SU-B with minimum sump depth of 5.0 mbgl; • Specifying limit of 4.0 mbgl and 0.5 mg/L for standing water level and WAD CN, respectively; • Water quality monitoring at two surface waterbodies south of the F1 RDA; • Requirement for annual hydrological review to include ionic composition analysis and assessment against human drinking water guideline values (at relevant monitoring locations).
			Surface water bodies, including the South Dandalup River Groundwater aquifer, including South Dandalup Dam Catchment Area.		C = Major L = Unlikely **Medium risk** Refer to Section 3.5	N		

Risk Event					Risk rating[1] C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions[2] of licence	Justification for additional regulatory requirements
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Licence Holder's controls**				
							tailings slurry (amended); Condition 28 – Decant pond, seepage, and surface water monitoring **(including additional monitoring locations and specified limit for WAD CN)** (amended; additional regulatory requirement); Condition 29 – Groundwater monitoring **(including specified limit for standing water level and WAD CN)** (amended; additional regulatory requirement); Condition 30 – Vegetation condition monitoring (new condition); Condition 37 – Annual environmental reporting requirements **(including additional requirements for surface water and groundwater assessment)** (additional regulatory requirement).	Refer to Section 3.5.8.
	Tailings slurry	***Pathway:*** Overtopping of F1 RDA saddle dams ***Impact:*** Discharge to land, resulting in impact to ecological health	Native vegetation, including PEC and priority flora; Surface water bodies, including the South Dandalup River, D1 Dam, swamps, and other creeks.	Refer to Section 3.2.1	C = Major L = Rare **Medium risk**	Y	Condition 5 – Freeboard requirement (no change); Condition 10 – Inspection requirements for F1 RDA decant pond (amended); Condition 13 – Operational requirements for F1 RDA (amended); Condition 15 – Emergency spillway construction requirements (amended).	N/A
		Pathway: Pipeline failure, resulting in leaks or spills ***Impact:*** Discharge to land, resulting in impact to ecological health	Native vegetation, including PEC and priority flora; Surface water bodies, including the D1 Dam, swamps and other creeks.	Refer to Section 3.2.1	C = Moderate L = Unlikely **Medium risk**	Y	Condition 2 – Requirements for tailings delivery and return water pipelines (no change); Condition 4 – Containment infrastructure requirements for catchpits (amended); Condition 13 – Operational requirements for catchpits (amended).	N/A
	Decant water			Refer to Section 3.2.1	C = Moderate L = Unlikely **Medium risk**	Y		
		Pathway: Dermal contact and direct ingestion by terrestrial fauna and avifauna ***Impact:*** Impact to ecological health	Native terrestrial and avi-fauna.	Refer to Section 3.2.1	C = Moderate L = Unlikely **Medium risk**	Y	Condition 10 – Inspection requirements for wildlife mortality (amended); Condition 26 – Process monitoring for WAD CN in tailings slurry (amended); Condition 28 – Decant pond monitoring at F1 RDA **(including specified limit for WAD CN)** (amended; additional regulatory requirement).	N/A
Water storage at existing and new perimeter sumps	Seepage-impacted water	***Pathway:*** Overtopping of perimeter sumps ***Impact:*** Discharge to land, resulting in impact to ecological health	Native vegetation, including priority flora.	Refer to Section 3.2.1	C = Minor L = Unlikely **Medium risk**	N	Condition 4 – Containment infrastructure requirements for perimeter sumps (no change); **Condition 5 – Freeboard requirements** (amended; additional regulatory requirement); Condition 13 – Operational requirements for perimeter sumps (amended); Condition 15 – Perimeter sump SD3SU-B construction requirements (amended).	The Delegated Officer has determined that additional regulatory requirements are justified, including: • Minimum freeboard requirements of 300 mm at all existing and new perimeter sumps. The specification of a freeboard is a standard requirement for managing the risk of overtopping at containment infrastructures, where a loss of containment may potentially impact sensitive receptors (i.e., adjacent native vegetation). The risk was considered sufficiently significant to justify additional regulatory requirements due to the sump water quality and the location of the perimeter sumps around the perimeter of the F1 RDA, at the vegetation fringe.

Risk Event					Risk rating[1] C = consequence L = likelihood	Licence Holder's controls sufficient?	Conditions[2] of licence	Justification for additional regulatory requirements
Source/Activities	**Potential emission**	**Potential pathways and impact**	**Receptors**	**Licence Holder's controls**				
		Pathway: Vertical infiltration and lateral migration of seepage through sump base and walls ***Impact:*** Deterioration of groundwater quality, potentially resulting in impact to ecological health	Native vegetation, including priority flora; Groundwater aquifer, including South Dandalup Dam Catchment Area.	Refer to Section 3.2.1	C = Minor L = Possible **Medium risk**	N	Condition 4 – Containment infrastructure requirements for perimeter sumps (no change); Condition 13 – Operational requirements for perimeter sumps (amended); Condition 15 – Perimeter sump SD3SU-B construction requirements **(including specifying sump depth)** (amended; additional regulatory requirement).	The Delegated Officer has determined that additional regulatory requirements are justified, including: • Construct perimeter sump SD3SU-B with minimum sump depth of 5.0 mbgl. Refer to Section 3.5.8.
Water discharge and storage at the R4 RDA	Tailings seepage; Seepage-impacted water	***Pathway:*** Vertical infiltration and lateral migration of seepage through base and embankment walls ***Impact:*** Groundwater mounding and deterioration of groundwater quality, potentially resulting in impact to ecological health	Native vegetation, including PEC, GDE, and priority flora; Surface water bodies, including the D1 Dam, swamps, and other creeks; Groundwater aquifer.	Refer to Section 3.2.1	C = Moderate L = Unlikely **Medium risk**	Y	Condition 4 – Containment infrastructure requirements for R4 RDA (no change); Condition 13 – Operational requirements for R4 RDA (amended); Condition 25 – Water balance monitoring (amended); Condition 26 – Process monitoring for WAD CN in tailings slurry and catchpits (amended); Condition 28 – Decant pond and surface water monitoring (amended); Condition 29 – Groundwater monitoring (amended); Condition 30 – Vegetation condition monitoring (new condition).	N/A
		Pathway: Overtopping of R4 RDA embankment ***Impact:*** Discharge to land, resulting in impact to ecological health	Native vegetation, including PEC and priority flora. Surface water bodies, including D1 Dam, swamps, and other creeks.	Refer to Section 3.2.1	C = Moderate L = Unlikely **Medium risk**	Y	Condition 5 – Freeboard requirement (no change); Condition 10 – Inspection requirement for R4 RDA freeboard (no change).	N/A
		Pathway: Dermal contact and direct ingestion by terrestrial fauna and avifauna ***Impact:*** Impact to ecological health	Native terrestrial and avi-fauna.	Refer to Section 3.2.1 and Section 3.6.5	C = Moderate L = Possible **Medium risk** Refer to Section 3.6.	N	Condition 10 – Inspection requirements for wildlife mortality (amended); Condition 13 – Operational requirements for R4 RDA (amended); Condition 26 – Process monitoring for WAD CN in tailings slurry and catchpits (amended); Condition 28 – Decant pond monitoring at R4 RDA **(including monitoring of dissolved metal and metalloids)** (amended; additional regulatory requirement); Condition 31 – Sediment cobalt monitoring (new condition).	The Delegated Officer has determined that additional regulatory requirements are justified, including: • Monitoring of dissolved metal and metalloids at the R4 RDA decant pond, in addition to total metals. Refer to Section 3.6.6.

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

Note 2: Proposed Licence Holder's controls are depicted by standard text. **Bold and underline text** depicts additional regulatory controls imposed by department.

3.4 Detailed risk assessment for dust emissions from F1 RDA on human receptors

3.4.1 Background

Tailings deposition generally rotates around the northern, eastern, and southern perimeter of the F1 perimeter. The purpose of the tailings deposition strategy is to maximise the shedding and reclamation of tailings supernatant, as well as the drying and consolidation of tailings on the tailings beach. Once dried, the tailings beach surface is expected to form a hard crust that has to be broken and desiccated to release smaller dust particles that make it up.

Dust emissions will likely be generated from the tailings beach of the F1 RDA under the following conditions:

- Tailings beach area that is dry and desiccate;
- Tailings beach area that have not formed a hard crusted surface; and/or
- High velocity winds across the surface of the tailings beach.

The proposed construction and operation of the F1 RDA Stage 19 to Stage 22 embankment raises may result in greater risk of impact associated with tailings dust emissions. While the tailings deposition rate is unlikely to increase from existing rates (i.e., the Licence Holder has not increase for an increase in production capacity for Category 5 activities), the expansion will result in the saddle dam heights increasing by up to 9.2 m in total. The height of the facility and its tailings beach, which dwarfs the tree line to the east, may allow dust emissions from the beach to migrate further into the surrounding environment.

3.4.2 Potential adverse impacts from emission

Fugitive dust emission composed of particulate matter (PM), ranging in diameter from 0.005 µm to 100 µm, and are typically categorised by size, expressed as equivalent aerodynamic diameter (EAD) in micrometer (µm), as follows:

- Total suspended particulates (TSP), which generally includes PM of all diameters up to 100 µm;
- PM_{10}, which includes PM with an EAD equal to or less than 10 µm; and
- $PM_{2.5}$, which includes PM with an EAD equal to or less than 2.5 µm.

Exposure to PM may result in short-term (acute; e.g., eye or breathing irritation) and long-term (chronic) health impacts. While PM_{10} and $PM_{2.5}$ are not visible to the naked eye, they can be readily inhaled through the nose and throat to enter the lungs, with the latter potentially entering the bloodstream.

TSP, including PM with diameter greater than PM_{10}, are typically considered nuisance dust. While they are large enough to become trapped in the upper respiratory tract and excreted from the body, they can impact the local amenity as a result of deposition, soiling, and abrasion.

Furthermore, dust particulates emitted from dried tailings will likely have chemical characteristics that reflect those of its parent tailings material. The chemical composition of PM, especially PM_{10} and $PM_{2.5}$, may present additional adverse health risks, if inhaled.

A number of potential human receptors have been located around the premises, including the Boddington township. Nevertheless, the separation distance between the F1 RDA and the potential human receptors suggests that a complete source-pathway-receptor linkage was unlikely to exist. The Licence Holder has completed a dust modelling assessment to better understand potential dust emissions sources at the premises and how they might impact nearby potential human receptors (Ramboll 2022). The Licence Holder has also undertaken dust

deposition monitoring around the F1 RDA, where the monitoring data was used to inform the modelling parameters. Both the historical dust monitoring and dust modelling assessment will be considered in this detailed risk assessment, in section 3.4.3 and 3.4.4, respectively.

3.4.3 Dust monitoring assessment

Dust deposition gauge (DDG) monitoring commenced in late 2013 as part of a qualitative assessment of dust amenity around the premises (NBG 2024). In 2016, it is understood that the Licence Holder reconfigured the dust monitoring network following an inspection by the DMPE (known as the Department of Mines and Petroleum at the time), such that a number of DDG were relocated to the north-west perimeter of the F1 RDA. These include NBG-DM-08, NBG-DM-09, NBG-DM-10, and NBG-DM-11 (Figure 11).

In addition to these DDG, the Licence Holder also operates a number of real-time dust monitors throughout the premises, especially along the processing circuit for occupational health and safety purposes. A tapered element oscillating microbalance (TEOM) monitor is also operational on Communications Hill, located between the processing plant area and the inert landfill. Monitoring data from these locations will not be considered in this assessment, as they were not installed for the purposes of monitoring dust emissions from the F1 RDA.

These ambient dust monitors and relevant monitoring requirements are not currently required under existing licence L8306/2008/3. The licence only contains requirements for point-source dust and stack emission monitoring at the processing plant.

When comparing the depositional rate for total insoluble matter to the guideline value of 4 g/m^2/month (set out by the NSW EPA 2016), a number of exceedances were identified, and the following observations were made[9] (Table 9):

- Consistently across all four DDG, exceedances were likely to occur during the dry summer months, from around October until February.
- Exceedances likely occurred in two or more DDG during summer months, with comparable total insoluble matter, due to the close proximity of the four DDG to each other.
- In particular, relatively high rates of total insoluble matter were deposited in DDG during November and December of the 2021 summer period, with rates reaching up to 84.9 g/m^2/month at NBG-DM-09. This trend was also reported to the department by Ramboll (2022).
- Exceedances, and deposited dust trends more broadly, were likely driven by fugitive dust emissions from the F1 RDA, as DDG NBG-DM-02 and NBG-DM03 did not reflect the pattern of exceedances observed at the four DDG. Dust deposition rates at these DDG were likely to be influenced by other dust-generating activities (i.e., NBG-DM-03 likely receives more deposited dust due to its location near waste rock dumps).
- Given the relative rates of deposited dust observed, it can be inferred that the F1 RDA is potentially the largest dust-generating source at the premises (when it does occur).

Recently, five additional DDG were installed to the north-west and east further away from the F1 RDA (Figure 11) as a result of a review undertaken by Ramboll (2022; detailed further in Section 3.4.4). To date, monitoring of these DDG since April 2023 have found no exceedances (data no shown). This is likely attributed to greater separation distances between these additional DDG and the F1 RDA, noting that exceedances were still reported at the initial four

[9] While DDG monitoring data is available from 2017 onwards, the Licence Holder had not provided the data in the correct unit to allow for comparison against the guideline value. As such, historical monitoring data between 2017 and 2020 were not considered in this assessment.

DDG closest to the F1 RDA in some months.

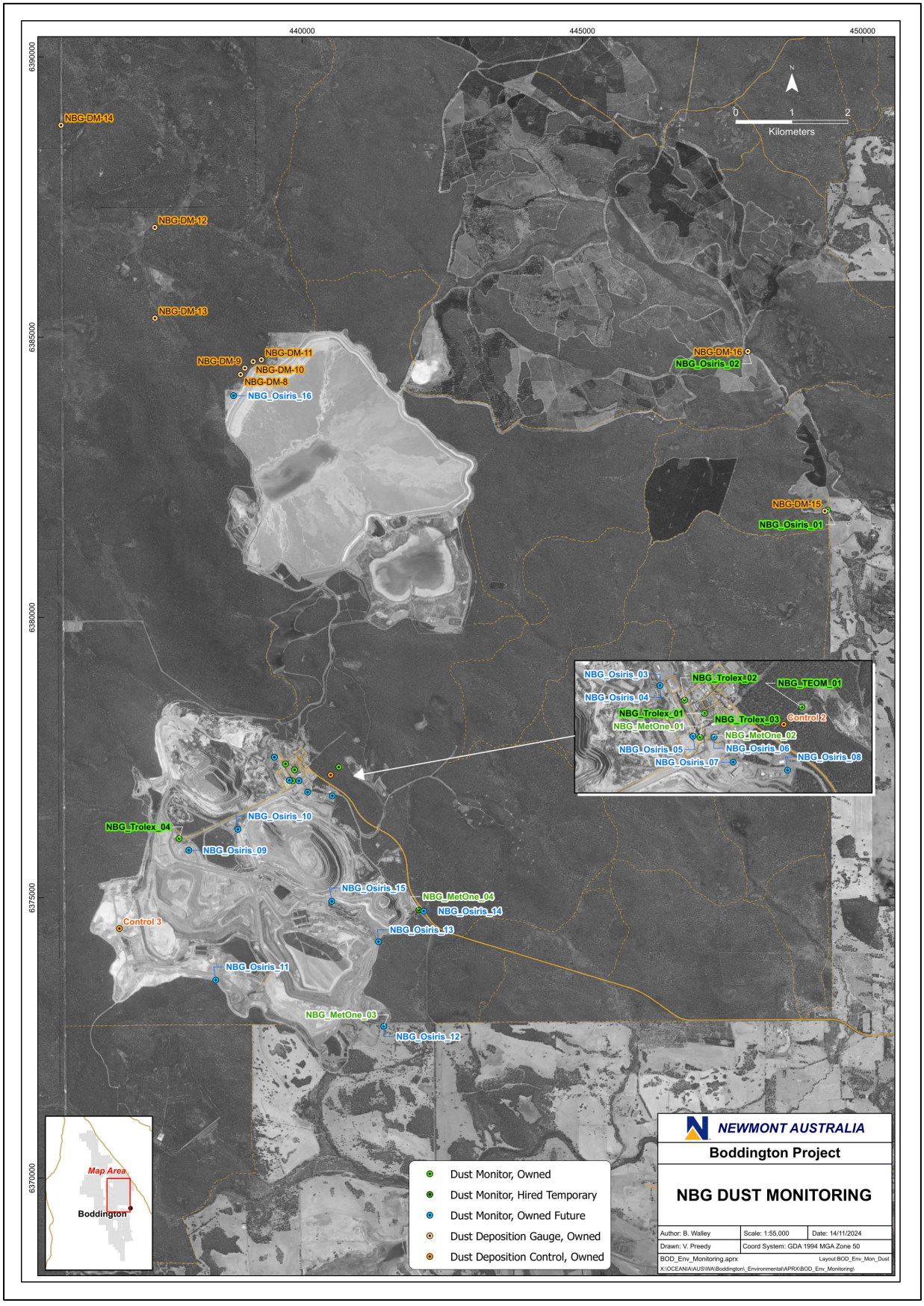


Figure 11: Dust monitoring locations (existing and planned)

Table 9: Dust deposition rate exceedances (expressed as total insoluble matter)

c	2021 (g/m²/month)²	2022 (g/m²/month)²	2023 (g/m²/month)²	2024 (g/m²/month)²
NBG-DM-08	**November (59.1)** **December (83.1)**	**January (4.4)** **February (6.1)** **December (23.4)**	**December (7.6)**	**January (13.8)**
NBG-DM-09	**October (4.9)** **November (84.9)** **December (71.8)**	**February (4.7)**	**December (7.2)**	**January (12.6)** **May (4.1)**
NBG-DM-10	**October (4.1)** **November (24.6)** **December (47.6)**	**February (4.9)** April (4.7) October (4.9) **December (19.1)**	**January (7.3)** **December (4.8)**	**January (12.4)** **May (5.7)**
NBG-DM-11	**November (23.8)** **December (21.2)**	**January (8.8)** **February (5.4)** **December (20.2)**	**January (5.0)**	March (8.7) **May (8.2)**
NBG-DM-02[1]	None	None	February (6.2)	None
NBG-DM-03[1]	None	None	February (4.5)	January (5.2) March (7.6) May (16.3)

Note 1: These monitoring locations have been classified by the Licence Holder as control sites (i.e., they are located away from the F1 RDA and associated dust deposition gauges, and likely contain deposited dust influenced by other dominant dust-generating activities and meteorological conditions).

Note 2: Red cell shading represent years where a monthly total insoluble matter deposition rate exceeding 4 g/m²/month was measured. Bolded values indicate exceedance observed at multiple dust deposition gauges.

3.4.4 Dust modelling assessment

To better understand potential air quality impacts and dust deposition rates associated with fugitive dust emissions from the premises, the Licence Holder undertook an air quality investigation in 2022 (Ramboll 2022). As part of the investigation, air dispersion modelling was completed to predict short-term (24-hour) and long-term (annual) cumulative[10] ambient ground level concentrations (GLC) for TSP, PM_{10}, and $PM_{2.5}$, at nearby sensitive receptors (Figure 12). Three scenarios were modelled, utilising the following emission rates from the RDA area:

1. **Scenario 1** – Emission rates from the RDA were based on the highest monitored deposition rate recorded at the DDG adjacent to the F1 RDA (i.e., 2021 annual period);
2. **Scenario 2** – Emission rates from the RDA were based on the average deposition rate recorded at the DDG adjacent to the F1 RDA from the 2017 to 2021 annual periods; and
3. **Scenario 3** – Emission rates from the RDA were based on historical average deposition

[10] Background dust concentrations were considered in the air dispersion modelling to assess potential cumulative impacts. Background concentrations were derived using the 70th percentile of the 24-hour average and annual average concentrations PM_{10} and $PM_{2.5}$ from the tapered element oscillating microbalance (TEOM) monitor at Communications Hill during the 2021 annual period. The background concentration values were taken as indicative background dust activity for the entirety of the region and were summed to the predicted model values to attain the cumulative ground level concentrations at each sensitive receptor location assessed.

rates recorded across all DDG (i.e., including NBG-DM-02 and NBG-DM-03) from the 2017 to 2020 annual periods (i.e., excluding the worst monitored year of 2021).

A summary of the predicted GLC under each modelling scenario is provided in Table 10.

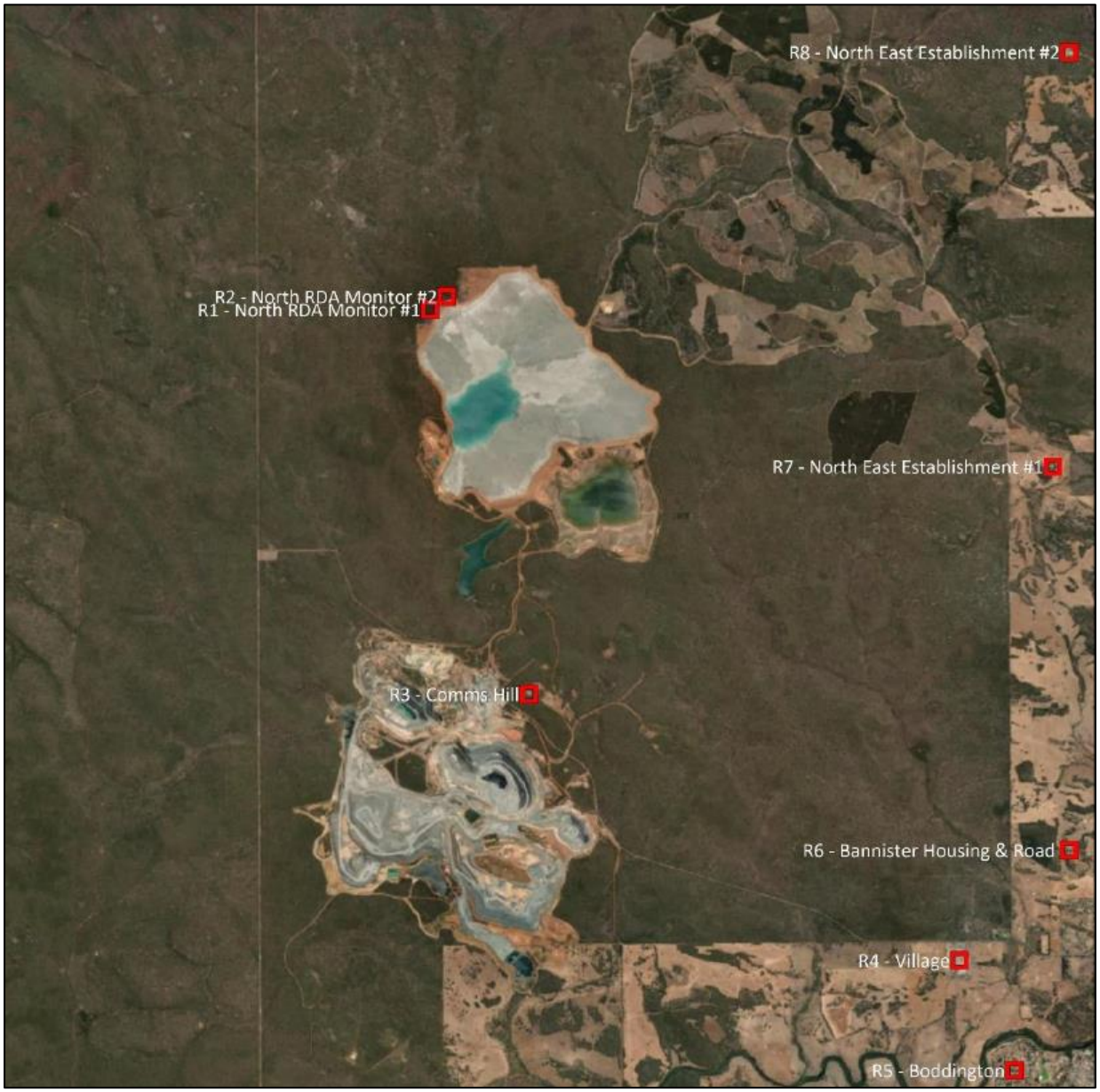


Figure 12: Location of monitoring locations, key areas and sensitive receptors considered in air dispersion modelling

Table 10: Maximum predicted PM_{10} and $PM_{2.5}$ ground level concentrations (including background)

Scenario	Averaging period	Assessment criteria (µg/m³)[1]	Background concentration (µg/m³)	Maximum predicted cumulative ground level concentration (µg/m³)[2]					
				Communications Hill (R3)[3]	Accommodation village (R4)	Boddington township (R5)	Bannister township (R6)	Dwelling #1 (R7)	Dwelling #2 (R8)
PM_{10}									
Scenario 1	24-hour	50	9.0	131.2	29.7	18.8	38.5	**134.2**	**51.8**
Scenario 2				110.3	29.7	18.8	38.5	**74.2**	31.2
Scenario 3				110.3	29.2	18.8	38.5	24.5	17.7
Scenario 1	Annual	25		24.7	10.2	9.6	9.9	10.6	9.6
Scenario 2				24.3	10.2	9.6	9.9	10.1	9.5
Scenario 3				23.9	10.1	9.6	9.9	9.6	9.4
$PM_{2.5}$									
Scenario 1	24-hour	50	1.26	37.8	8.1	4.9	11.1	24.3	8.6
Scenario 2				37.8	8.1	4.9	11.1	13.4	5.0
Scenario 3				37.8	7.9	4.9	11.1	4.5	4.1
Scenario 1	Annual	25		6.7	1.7	1.5	1.6	1.6	1.4
Scenario 2				6.6	1.7	1.5	1.6	1.5	1.4
Scenario 3				6.6	1.7	1.5	1.6	1.5	1.4

Note 1: Assessment criteria are based on the relevant guideline values from the *National Environment Protection (Ambient Air Quality) Measure (NEPM)* (**NEPC 2021**).

Note 2: Red cell shading with bolded values represent an exceedance of the relevant assessment criteria.

Note 3: Assessment criteria is not applicable at Communications Hill as it is a dust monitoring location on the premises, rather than a sensitive human receptor. Nevertheless, the operation of dust monitor at Communications Hill provides an opportunity for the predicted dust levels to be verified.

Based on the results of the air dispersion modelling, the following observations were made:

- No exceedances of the annual or 24-hour average assessment criteria for $PM_{2.5}$ were predicted at any of the sensitive receptors assessed.
- No exceedances of the annual average assessment criteria for PM_{10} were predicted at any of the sensitive receptors assessed.
- Exceedances of the 24-hour average PM_{10} assessment criteria were predicted at two residential dwellings located approximately seven to nine kilometres east of F1 RDA. While Dwelling #2 is only expected to marginally exceed the PM_{10} assessment criteria during the worst-case scenario (Scenario 1), Dwelling #1 (located closer to the F1 RDA, compared to Dwelling #2) was predicted to exceed the relevant assessment criteria during both worst-case and normal scenarios (Scenario 1 and 2, respectively). Under Scenario 1, the 24-hour average PM_{10} concentration at Dwelling #1 was predicted to reach up to 134.2 $\mu g/m^3$.
- Analysis of source contributions and meteorological conditions associated with the exceedances found that the exceedances were associated with emissions from the F1 RDA during periods when wind speeds exceeded the threshold (~7 m/s) for dust lift-off during dry conditions (i.e., summer months).

As dust monitoring had not previously been undertaken at the locations of sensitive human receptors, the predicted GLC at these locations could not be verified with empirical data during the investigation.

3.4.5 Licence Holder's controls

In considering these findings, the Licence Holder has since installed additional DDG further north-west and east of the F1 RDA to increase deposited dust monitoring offsite (Figure 11). The north-west DDG consisted of NBG-DM-12, NBG-DM-13, and NBG-DM-14, installed roughly along a transect.

The eastern DDG consisted of NMG-DM-16 and NBG-DM-17, installed close to the locations of sensitive human dwellings to better assess dust impacts to human health and amenity. In addition to the DDG, the Licence Holder has also co-located Osiris monitors with the two eastern DDG to undertake real-time monitoring of TSP, PM_{10}, $PM_{2.5}$, and PM_1, as well as wind speed and wind direction.

It is understood that the Licence Holder is currently planning to install additional real-time Osiris dust monitors south of the F1 RDA, around the mining and processing areas (Figure 11).

The establishment of additional dust monitoring locations was consistent with recommendations outlined by Ramboll (2022) following the dust monitoring review and air dispersion modelling. Further, Ramboll (2022) recommended implementation of greater dust mitigation measures for the F1 RDA during high wind speed conditions, including undertaking dust suppression at source locations, binding tailings beach surface with hydro-suppressants or hydro-mulch, progressively rehabilitating unused portion of the facility, and installing wind fences at the facility boundary in the direction where high wind speeds occur.

To manage fugitive dust emissions associated with the construction and continued tailings deposition into the Stage 19 to Stage 22 embankment raises at the F1 RDA, the Licence Holder has proposed several controls (Table 6), primarily focusing on dust suppression (where fugitive dust is visible), controlling the rotation of tailings deposition to ensure sufficiently moist conditions are maintained on the tailings beach, and improving dust monitoring network within and around of the premises (Figure 11).

3.4.6 Risk assessment

In reviewing the investigations and dust mitigation controls undertaken to date, the department

highlights the following:

- While the air dispersion modelling undertaken is in alignment with the department's *Air Quality Modelling Guidance Notes* (DOE 2006), the department does not endorse the use of emission rates derived from historical DDG monitoring due to significant uncertainties[11]. Further, the meteorological data provided did not include detailed information on the location of the monitoring site or specific parameters measured. The department cautions that, due to inherent uncertainties, fugitive dust modelling is generally not an accurate estimate of ambient dust concentrations and should not be relied upon as primary evidence when assessing potential dust impacts.
- The dust deposition gauge is intended to measure deposited dust as a means of assessing potential impacts to amenity. Due to the siting of the F1 RDA, an assessment for amenity may provide limited value. Furthermore, other potential impacts associated with deposited dust, such as impacts to vegetation health and primary productivity, are difficult to quantify, where existing guideline values [i.e., NSW EPA (2016)] are not as applicable. Nevertheless, dust deposition gauges can provide insight into deposited dust rates at sensitive human receptors, noting that an exceedance of the guideline value may not always result in observable amenity impacts, or vice versa. Consequently, the guideline value should be considered in conjunction with other sources of information (e.g., real-time dust monitoring, complaints survey, community consultation, etc) using a weight of evidence approach.
- The real-time Osiris dust monitors co-located with DDG NBG-DM-16 and NBG-DM-17 do not currently meet any relevant Australian Standard method for ambient air quality monitoring and do not provide data appropriate for the assessment of potential health impacts, nor were they installed at proximity to relevant sensitive receptors (i.e., Dwellings #1 and #2). However, these dust monitors can be used to monitor real-time ambient dust concentrations at locations within and at the boundaries of dust-generating areas or premises to ensure corrective management actions are implemented promptly, prior to fugitive dust reaching and impacting sensitive receptors.

While Dwellings #1 and #2 meets the generic separation distance of 2,000 m for gold ore operations, as outlined in the EPA (2005) *Guidance Statement 3*, the air dispersion model has predicted PM_{10} exceedances occurring at Dwellings #1 and #2 during the drier summer months. Consequently, the Licence Holder has expanded their dust monitoring network, including at locations close to Dwellings #1 and #2. While the department supports the proactive actions taken to date, dust monitoring strategy at the premises may need to be refined, given the above considerations, as well as incoming results from the additional monitoring locations.

Since 2018, the department has received two complaints from the general public in relation to dust emissions from the premises. The relevant periods for the complaints were from November 2020 to February 2021 (Ref: 60276), and November 2021 (Ref: 63343). The complaint made in November 2021 related to a dust plume travelling from the F1 RDA and intersecting approximately 2.7 km of the Bibbulmun Track. A similar dust plume was observed atop the F1 RDA during a site visit by the department in December 2021. These observations support the high dust deposition rates measured at nearby DDG during the 2021 summer period (Table 9).

[11] The Q-Q plotting showed that the initial model overestimated PM_{10} and $PM_{2.5}$ concentrations, suggesting the emission inventory was overly conservative. To address this, emission rates were adjusted based on dust deposition data. However, this approach may be problematic due to dust deposition gauges measuring settled dust, rather than airborne concentrations critical for environmental assessments. This approach may have introduced a disconnect between the adjustments and the actual source emissions. Adjusting emission rates based on dust deposition rates assume a consistent relationship between emission rate and deposition rate under varying meteorological conditions, which is rarely the case. The iterative adjustment of emissions to align with dust deposition data may have resulted in overfitting, which can cause models to accurately replicate specific conditions but fail to generalise to broader site conditions or other scenarios.

In considering the potential dust impacts to sensitive human receptors, including rural residential premises east of the F1 RDA and recreational users of the Bibbulmun Track to the west, the department considers the consequence of this risk event to be **moderate**. Based on the scenarios assessed in the air dispersion modelling, unacceptable levels of ambient dust may occur at sensitive receptors during dry summer months under certain conditions (i.e., similar to those resulting in high levels of fugitive dust emissions in 2021). However, such high levels of dust emissions have not been evident since 2021, as indicated by lower dust deposition rates and lack of dust complaints received. In considering this, the department considers the likelihood of this risk event to be **unlikely**. As such, the risk rating for potential health and amenity impacts associated with dust liftoff from the expanded F1 RDA on rural residential premises and recreational users was determined to be **medium risk**.

Predictions from the dust modelling undertaken by Ramboll (2022) justify further monitoring and investigation, which the Licence Holder is currently actioning. Further to this, the department has included a specified action requirement (condition 32) in amended licence L8306/2008/3 to undertake a dust monitoring review in relation to Dwellings #1 and #2.

Monitoring works undertaken should utilise real-time dust monitors, rather than relying sole on DDG, to better correlate significant dust liftoff events at dust sources with monitored dust concentrations. A monitoring period of twelve months was specified in the condition to capture seasonal variability in meteorological conditions.

3.5 Detailed risk assessment for tailings seepage emissions from continued tailings deposition into the expanded F1 RDA

3.5.1 Background

Through the expansion and continued tailings deposition of the F1 RDA, it is anticipated that tailings seepage will continue to be released into the environment through infiltration of the base and embankment walls of the facility. Tailings seepage, characterised by the source tailings slurry that is deposited into the RDA, has the potential to impact surrounding environmental preceptors, including nearby native vegetation, surface water bodies, and the local groundwater aquifers.

As detailed in Section 3.1.4, the historical and current operation of the F1 RDA has already modified local hydrogeological flow regimes, resulting in groundwater mounding the local water table, as well as other associated issues. In considering the proposed embankment raises to F1 RDA, a detailed risk assessment is required to assess the risk events associated with the proposed activities. The risk events assessed relate to tailings seepage from the F1 RDA infiltrating into the subsurface environment, potentially resulting in the following impacts:

1. Localised mounding of the water table, resulting in potential inundation of the root zone of surrounding native vegetation.
2. Localised mounding and contamination of the unconfined aquifer, resulting in uptake of seepage contaminants by surrounding native vegetation.
3. Subsurface lateral migration of seepage contaminants, resulting in contamination of groundwater within the South Dandalup Dam Catchment Area PDWSA, and potentially migrating to the nearby ephemeral South Dandalup River.
4. Subsurface lateral migration of seepage contaminants, resulting in contamination of groundwater near groundwater-dependent surface waterbodies (e.g., swamps, creeks).

3.5.2 Tailings seepage source characterisation

Tailings seepage is largely characterised by the properties of the source tailings slurry, which depends on the ore type, as well as the chemical reagents added during the mining and beneficiation process. Currently, tailings slurry deposited into the F1 RDA originates from ore

sourced from the Wandoo North and South open pits, processed via a carbon-in-leach (CIL) process at the processing plant, and treated at the residue booster station at the premises. The physical and chemical characteristics of the tailings slurry is unlikely to change as a result of the proposed activities.

Tailings geochemistry

The Licence Holder recently commissioned an investigation to characterise tailings geochemistry at the F1 RDA (Knight Piesold 2023a). Tailings samples collected represented a snapshot of the existing material contained within the facility at the time of the investigation. Tailings samples were sourced from various depths ranging from the surface (grab sample) down to approximately 26.5 m below the tailings beach surface. As the samples were collected near the RDA embankment, the sampled tailings material was generally coarser and unlikely to be representative of tailings slurry at the time of deposition. One tailings slurry sample was also collected from the processing plant, composited over a period of one month.

Tailings slurry generally contained approximately 50% to 65% of solids when deposited into the F1 RDA. Based on the geochemical characterisation investigation, tailings at the F1 RDA were expected to have the following characteristics:

- Tailings pH ranged between 7.1 pH unit and 8.6 pH unit, indicating circum-neutral to alkaline condition within the residue porewater.
- Electrical conductivity (EC) of the tailings ranged between 950 µS/cm to 12,990 µS/cm, with an average EC of 3,620 µS/cm, indicating the residue ranges between non-saline and highly saline. All highly saline tailings were sampled from the surface and may be influenced by salt accumulation at the tailings beach as a result of capillary rise of salts on the drying tailings beach. Tailings sampled at depth were relatively non-saline.
- Total sulfur content ranged between 0.05% and 0.30%, with an average sulfur content of 0.17%, which was determined by the investigators to be low. Sulfur was present as both acid-soluble sulfate and non-acid soluble sufur. Acid-insoluble was assumed to be present as sulfide sulfur. Maximum potential acidity (MPA) ranged between zero and a maximum of 7 kg H_2SO_4/tonnes, with an average MPA of 2 kg H_2SO_4/tonnes.
- While the trend is not strong, total sulfur content appears to be lower with depth. In the context of an RDA, the depth can be a proxy for tailings age, suggesting that the sulfur content of earlier tailings may have contained lower sulfur content compared to more recently deposited tailings.
- No trend was evident when examining the relationship between the proportion of both sulfate and sulfide sulfur in relation to total sulfur content and depth.
- The acid neutralising capacity (ANC) of the tailings ranged between 12 kg H_2SO_4/tonnes and 47 kg H_2SO_4/tonnes, with an average ANC of 27 kg H_2SO_4/tonnes. Broadly, high ANC were associated with deeper tailings samples. The ANC from carbonate minerals was generally low, averaging 2.7 kg H_2SO_4/tonnes. As the ANC in the tailings material is generally associated with non-carbonate minerals, the available neutralising capacity of these minerals may not be fully available at circum-neutral pH conditions, only becoming active once acidic conditions prevail.
- Based on the MPA and ANC results, all samples were found to contain negative net acid generating potential (NAPP), with values ranging between -12 kg H_2SO_4/tonnes and -44 kg H_2SO_4/tonnes (Figure 13). The ANC/MPA ratio ranged between 3.7 and 15.4, with an average ratio of 9.6, indicating a high factor of safety against acidification.
- These findings were true for both deposited tailings materials from the F1 RDA, as well as the composite tailings slurry, though the latter contained higher net acid generation pH (Figure 13).

- Whole rock multi-element analysis of tailings solids was conducted to derive geochemical abundance indices (GAI) and determine element enrichments within the solid fraction of the tailings. Arsenic, bismuth, chlorine, copper, molybdenum, sulfur, antimony, selenium, and tin were found to be at least slightly enriched in one of more samples. Of these, bismuth and molybdenum were found to be highly enriched, while arsenic, chlorine, antimony, selenium, and tin were significantly enriched in some tailings samples. Similar elements were enriched in the composite tailings slurry.
- Comparison of total elemental concentration against relevant guideline values[12] found that a number of tailings samples had exceeded the ecological assessment criteria for arsenic, sulfur, antimony, selenium, and vanadium. All samples exceeded the ecological assessment criteria for chromium and copper. Chromium and vanadium were not identified as being enriched, based on their GAI. No human health assessment criteria were exceeded.

An assessment of F1 decant pond water quality during the 2023 annual period found the following:

- Decant water pH ranged was relatively stable, ranging between 8.2 pH unit and 8.69 pH unit, indicating alkaline conditions.
- Decant water EC ranged between 7,134 µS/cm and 20,816 µS/cm, indicating saline conditions. Decant pond salinity was higher during summer months, reflecting a concentration of solutes under higher evaporation rates. Lower salinity observed during winter months likely reflected dilution of solutes due to mixing with rainfall.
- Total titratable acidity remained was low, ranging from below the limit of reporting of 1 mg/L and 6 mg/L. On the other hand, alkalinity (as calcium carbonate) was relatively high, ranging between 108 mg/L and 250 mg/L.
- Major ions were dominated by sodium, chloride, and sulfates.
- In terms of metals and metalloids, cobalt, copper, molybdenum, nickel, and tungsten were typically detected in the decant water at one or more order of magnitude above the limit of reporting.
- Concentrations of WAD CN were consistently detected above the limit of reporting, ranging between 3.66 mg/L and 10.1 mg/L.

[12] Assessment criteria are based on the relevant guideline values for recreational land uses/ public open space from the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (NEPC 2013).

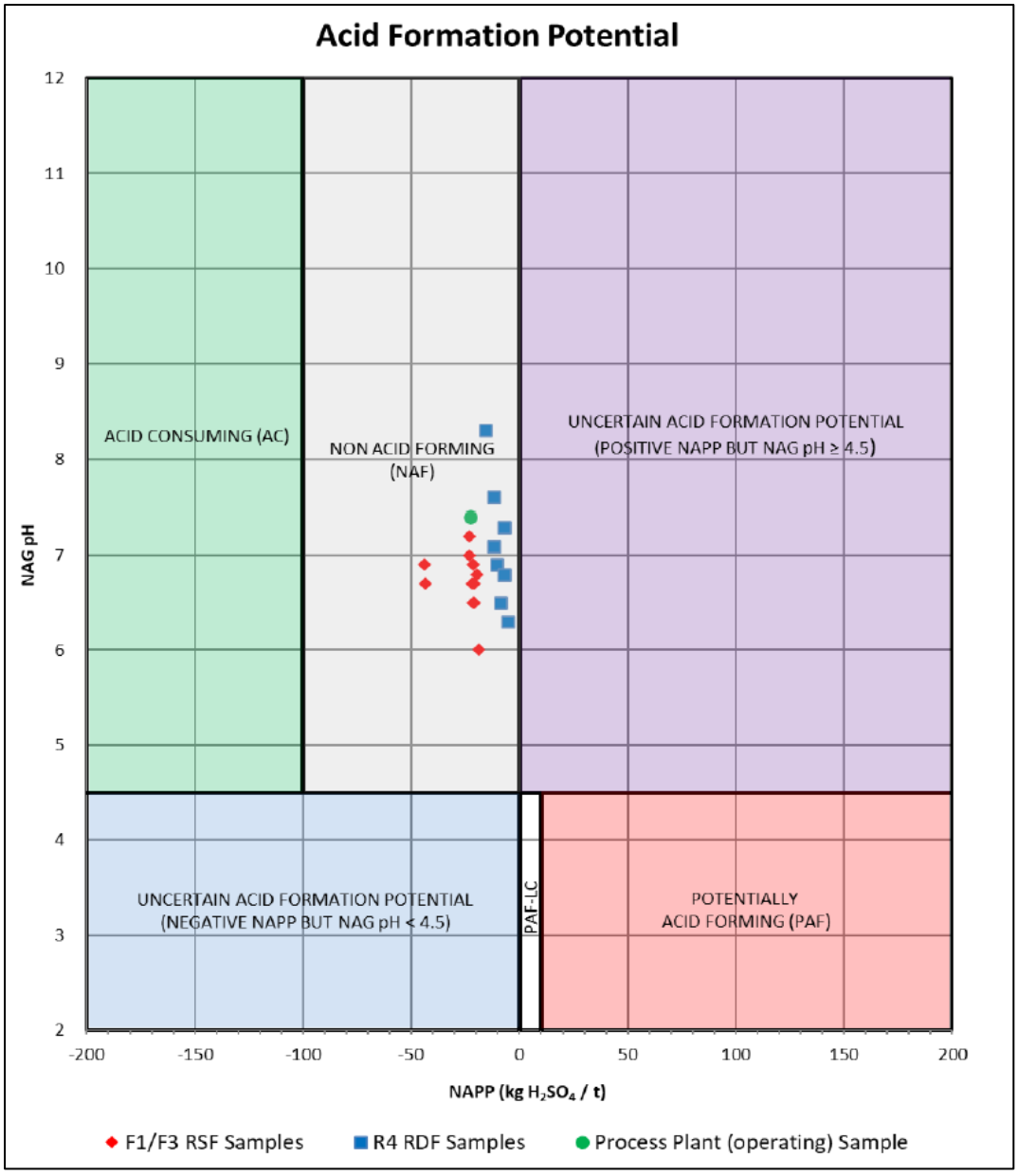


Figure 13:Acid formation potential for tailings at F1 RDA

Tailings seepage volume

Aside from its quality, the volume of tailings seepage emitted from a containment facility is an important consideration in assessing its impact to the environment. The volume of seepage has implications for contaminant loading entering the environment, as well as potential changes to the local hydrogeological flow regime.

Seepage analysis undertaken for the proposed embankment raises at the F1 RDA indicated that seepage through the saddle dam embankment walls can be controlled through the operation of seepage interception controls within the facility (Table 1). However, while the facility's decant pond currently overlies existing HDPE liner system, significant volumes of seepage is still expected to be lost to the environment through infiltration at the base of the facility.

Existing licence L8306/2008/3 requires the Licence Holder to provide monthly water balances for the F1 RDA, where seepage would be estimated as the residual of empirical water flow data,

such as rainfall, evaporation, water added to the facility as part of the tailings slurry, water removed from the facility through pumping of the decant pond, seepage intercepted and removed from the RDA (i.e., underdrainage system, LCRS, toe wells, etc.). The purpose of the water balance was to track the effectiveness in recovering decant water and reducing seepage flows from F1 RDA (DWER 2020a). Hence, seepage volumes estimated from the water balances may be used to inform the recent performance of the F1 RDA.

Between April 2020 and December 2022, seepage volumes from the F1 RDA were estimated to range between 29,132 m^3/month and 86,645 m^3/month, averaging at approximately 41,830 m^3/month. No seepage volumes were estimated for the 2023 annual period (NBG 2024). High fluctuations in seepage were reported during the 2020 annual period but have since remained relatively stable. Nevertheless, the department does not endorse the methodology adopted by the Licence Holder to estimate seepage.

Key findings: Methodology for estimating tailings seepage

Adopted methodology: According to Newmont Boddington Quarterly Environmental Reports (no longer required under existing licence L8306/2008/3), the Licence Holder assumes that 80% of seepage is captured by the underdrainage system, LCRS, and toe wells at all times. As such, tailings seepage estimated to be lost to the environment was back-calculated as the remaining 20% of these flows.

Department assessment: As stated in the department's Amendment Report (DWER 2020a), the purpose of a water balance is to monitor changes in seepage emitted from a containment facility. Direct measurement of seepage can be challenging. As such, construction of a water balance allows for seepage to be estimated as a residual after accounting for all other components that provide input or output of water from the containment facility. These components can typically be measured more readily (e.g., return water, toe drainage) or estimated to varying degrees (e.g., water discharged into the tailings beach as part of tailings slurry, rainfall, etc). The intent of monitoring the water balance components specified in existing licence L8306/2008/3 was to enable seepage volumes to be estimated through this method.

The adopted methodology is lacking in reliability, as the seepage estimated is directly dependent on the volume of seepage intercepted by existing infrastructure, where a higher volume of seepage intercepted would also result in higher volumes of seepage being released into the environment. Accordingly, estimated seepage volume and the volume of intercepted seepage have a near-perfect relationship (R^2 = 0.95), while this relationship is weaker when other components were considered, such as water discharged as tailings slurry (R^2 = 0.01) or return water (R^2 = 0.17).

Furthermore, the method relies heavily on the assumption that 80% of all seepage will be captured, which may not always be the case. For example, potential failure of the seepage recovery infrastructure may result in lower volumes captured. Consequently, with the adopted methodology, seepage estimated would also be lower, whereas the reality may be that a larger volume of seepage is being emitted into the environment.

Department action: The monitoring of an accurate and reliable water balance continues to be crucial for the continued operation of the F1 RDA. The Delegated Officer has amended existing condition 24 to better specify the methodology required to be used for deriving seepage estimates.

Nevertheless, the department has examined the water balance components to better understand current water flux at the F1 RDA. Decant water pumping was able to return a large proportion of water added as tailings slurry (averaging at approximately 82%) (Figure 14a), with

return water volumes exceeding tailings water volume during winter months, likely due to increased water input from winter rains. Similarly, the volume of intercepted seepage also follows a similar trend, with greater recovery during winter months (Figure 14b). Outside of decant pond recovery, an average of 18.9% of discharged tailings water was recovered through seepage management infrastructure. The greatest volume of seepage was recovered by the underdrainage, typically 100,000 m^3/month, with the other controls intercepting relatively lower volumes (<50,000 m^3/month).

While it appears significant volumes of water capture and removal is currently occurring at the F1 RDA, it is crucial for a reliable water balance to be constructed to estimate and track potential seepage losses. This is especially true for the F1 RDA, where water movements can be complex, with some intercepted water being returned to the decant pond.

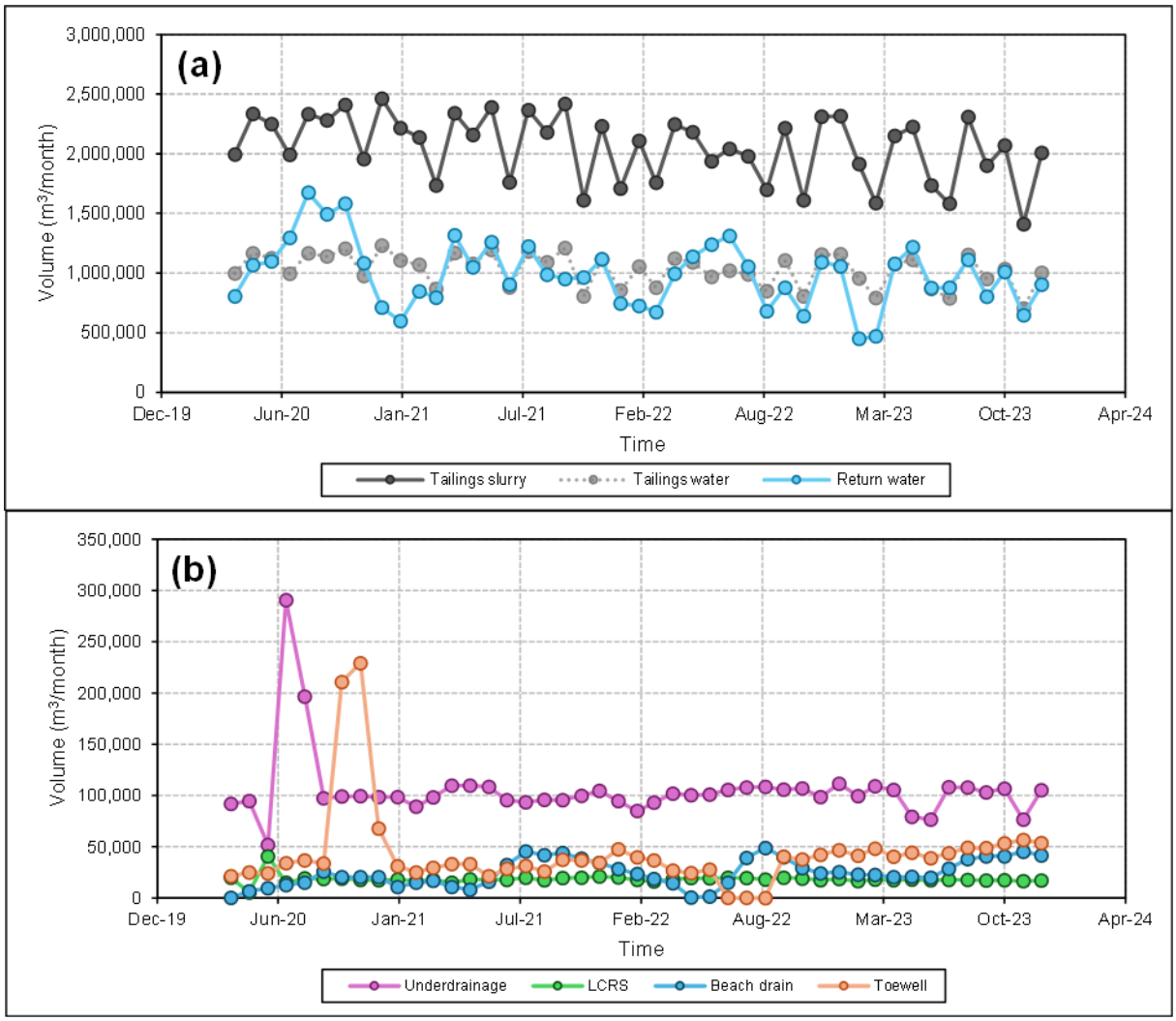


Figure 14: (a) Volume of tailings slurry deposited and return water recovered from the F1 RDA and (b) volume of tailings seepage recovered by various seepage management infrastructure at the F1 RDA

3.5.3 Potential adverse impacts from emission

The local hydrogeological setting of the F1 RDA, as well as the four primary hydrogeological units has been summarised in Section 3.1.4. Mechanisms by which tailings seepage is inferred to influence the local groundwater environment are shown in Figure 15 and summarised in Table 11.

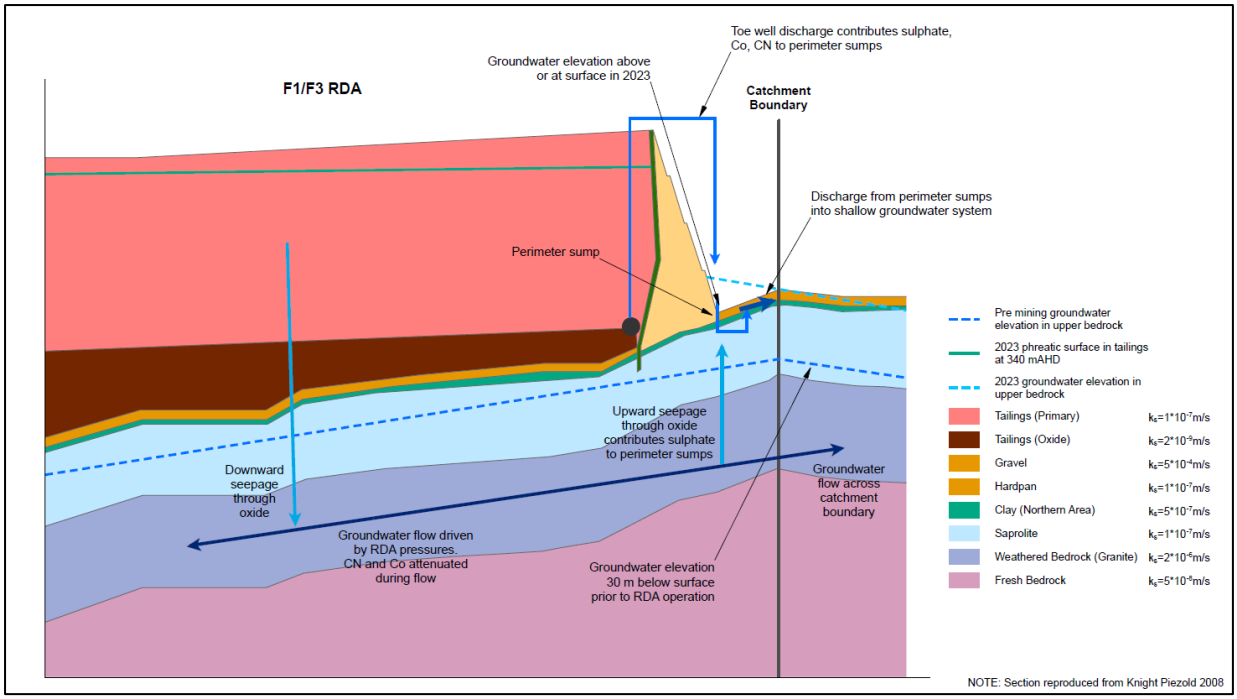


Figure 15: Conceptual hydrogeological model for seepage migration

Table 11: Seepage mechanisms and potential impacts to receptors

Sequence	Seepage mechanism	Potential impact to receptor(s)
1	The decant pond within the F1 RDA, as well as the saturated tailings within the facility creates hydraulic pressure acting on the underlying oxide unit. The hydraulic pressure is transmitted vertically through the oxide unit into the weathered and fractured upper bedrock hydrogeological unit, resulting in groundwater mounding.	Groundwater mounding within the weathered and fractured upper bedrock unit could potentially cause impairment of vegetation due to waterlogging of the root system. Only deep-rooted vegetation may be impacted through this mechanism, as the weathered and fractured upper bedrock hydrogeological unit is approximately 10 mbgl to 60 mbgl.
2	Further downgradient of the F1 RDA, groundwater mounding within the weathered and fractured upper bedrock unit is eventually transmitted upwards trough the oxide unit and into the seasonal shallow hydrogeological unit, resulting in shallow groundwater mounding near the facility.	Groundwater mounding within the seasonal shallow groundwater unit could potentially cause impairment of vegetation due to waterlogging of the root system. Impacts from this mechanism and pathway have been observed historically at Saddle Dam 3 and 7.
		Groundwater may express at the surface and potentially enter surface water environments, such as nearby swamps or creeks. This may occur either directly seepage directly enters surface water environment as runoff, or contaminants may accumulate in surface soils until it is flushed into surface water during rainfall events or other catchment runoff processes.
3	Eventually, seepage following these pathways may influence groundwater chemistry within both the weathered and fractured bedrock unit and the seasonal shallow groundwater unit.	Hydraulic gradient acting across the catchment boundary may result in radial flow and seepage migration into the South Dandalup Dam catchment area within the weathered and

Sequence	Seepage mechanism	Potential impact to receptor(s)
		fractured bedrock hydrogeological unit. Subsequently, a number of downstream impacts may occur, including contamination of drinking water dams (i.e., South Dandalup Dam).
4	Additionally, water discharged into and intercepted by the perimeter sumps surrounding the F1 RDA may also infiltrate and influence groundwater chemistry within the seasonal shallow groundwater unit that these sumps intercept.	Seepage-influenced sump water may increase salinity within the seasonal shallow hydrogeological unit near the perimeter sumps and drains, which may result in impairment to nearby vegetation. This is thought to have occurred historically at Saddle Dam 3.

In considering potential impacts to native vegetation surrounding the F1 RDA, the dominant vegetation species should be examined for their rooting systems, as well as tolerances towards waterlogging and increased salinity.

Eucalyptus marginata (jarrah) typically have dense lateral and feeder root structure in gravelly soils, with a root system expanding to a radius of up 20 m surrounding the tree, though typically concentrated within the top one metre of the soil profile (Kimber 1974). In addition, jarrah also have a secondary dense feeder root system at depths. These are usually a system of fine roots in the clay layer above the water table, up to depths of 20 mbgl to 30 mbgl. In this instance, secondary root system for jarrah at the premises would likely be situated within the oxide unit, above the weathered and fractured upper bedrock unit. A series of sinker roots with little branching connects the main root layers, resulting in all soil units being permeable to the root systems. Existing root channels allow these sinker roots to penetrate the lateritic layer and oxide unit to access deeper groundwater sources. Hence, jarrah can preferentially access soil-stored water sources, as well as deeper water sources during periods of low water availability.

Jarrah typically occurs on well-drained soil, noting that higher mortality may be observed in areas where waterlogging is common (Davison & Tay 1985). Waterlogging was also found to have significant anatomical and physiological effects on jarrah, with tylosed sapwood developing in the roots of waterlogged jarrah trees, which impacts the proportion of functional xylem vessels and limits water stored within the sapwood for use during drought periods (Davison 2014).

Little is known regarding the effect of elevated salinity of jarrah, though it is assumed that jarrah is relatively sensitive to changes in salinity. Salt tolerance in other *Eucalpyutus* species is varied.

Corymbia calophylla (marri) are known to have a similarly deep root system and utilise root channels the same way as jarrah does, though they are more dependent on having a dense shallow layer of lateral roots, usually within the top 500 mm of soil. Nevertheless, sinker roots may form through the clay layer and act as tap roots. Marri trees have slightly higher salt tolerance and can survive in areas with a saline water table or saline regolith by intercepting fresh soil moisture.

Environmental incident at Saddle Dam 3

During a site visit to the F1 RDA in March 2023, the department identified degraded vegetation condition near the vegetation fringe adjacent to Saddle Dam 3 (referred hereafter as the ‘impact site’). The impact site is located to the north-west of the F1 RDA, nearby several perimeter sumps and groundwater monitoring bores. Based on previous vegetation surveys, vegetation around the impact site was dominated by an overstorey of jarrah and marri, over a mid-stratum of smaller tree species (i.e., *Banksia grandis*, *Persoonia longifolia*, *Allocasuarina fraseriana*) over mixed understorey species.

The Licence Holder has investigated this incident to better understand exposure pathways and impacts from tailings seepage on environmental receptors. A timeline of observed events was illustrated in Figure 16 and Figure 17, and summarised below:

- Tailings deposition first took place at the F1 RDA on 1 August 2009, with tailings deposition from Saddle Dam 3 commencing in 2012.
- By November 2015, the area within Saddle Dam 3 had been completely filled with tailings, with Saddle Dam 3 being raised frequently to increase storage capacity of the F1 RDA. Groundwater elevation at nearby monitoring bore F1BR29D had risen by 30 m over the years (Figure 18b), indicating an increase in groundwater pressure within the weathered and fractured upper bedrock unit, though this rise was not reflected in the shallow bore (F1BR29S) (Figure 18a). This was likely a response to tailings deposition and the resultant seepage from the adjacent facility. No significant shifts in groundwater chemistry were observed in either bore at the time.
- In 2016 and 2017, surface pooling was observed along the Saddle Dam 3 embankment toe, as well as other parts of the F1 RDA. Perimeter drains and sumps were constructed to intercept and manage pooling, with Saddle Dam 3 receiving three sumps: SD3SU-A, SD3SU-B, and SD3SU-C. All three sumps were roughly equidistant to the impact site, with none being close to it.
- By November 2018, groundwater elevation within the shallow bore had risen as well, likely the result of pressure being transmitted through the oxide unit (Figure 18a). During this time, aerial photos of the area showed the first signs of vegetation impairment.
- By December 2019, groundwater levels within both shallow and deep bores remained elevated, with aerial photo continue to show vegetation impairment. It was also noted that TDS levels within the seasonal shallow groundwater unit was increasing, but not within the deeper weathered and fractured upper bedrock unit. As such, the increase in shallow groundwater salinity was thought to be driven by the re-infiltration of intercepted seepage at the nearby sumps.
- By December 2021, groundwater levels remained elevated, with TDS levels continuing to increase within the shallow seasonal groundwater unit and vegetation condition worsening.
- By July 2023, groundwater levels and TDS had decreased marginally (Figure 18). The reduction in TDS was thought to be caused by a seasonal influx of freshwater due to winter rainfall infiltration. Vegetation condition did not show signs of improvements until November 2023, where drainage works were undertaken to reduce surface saturation.

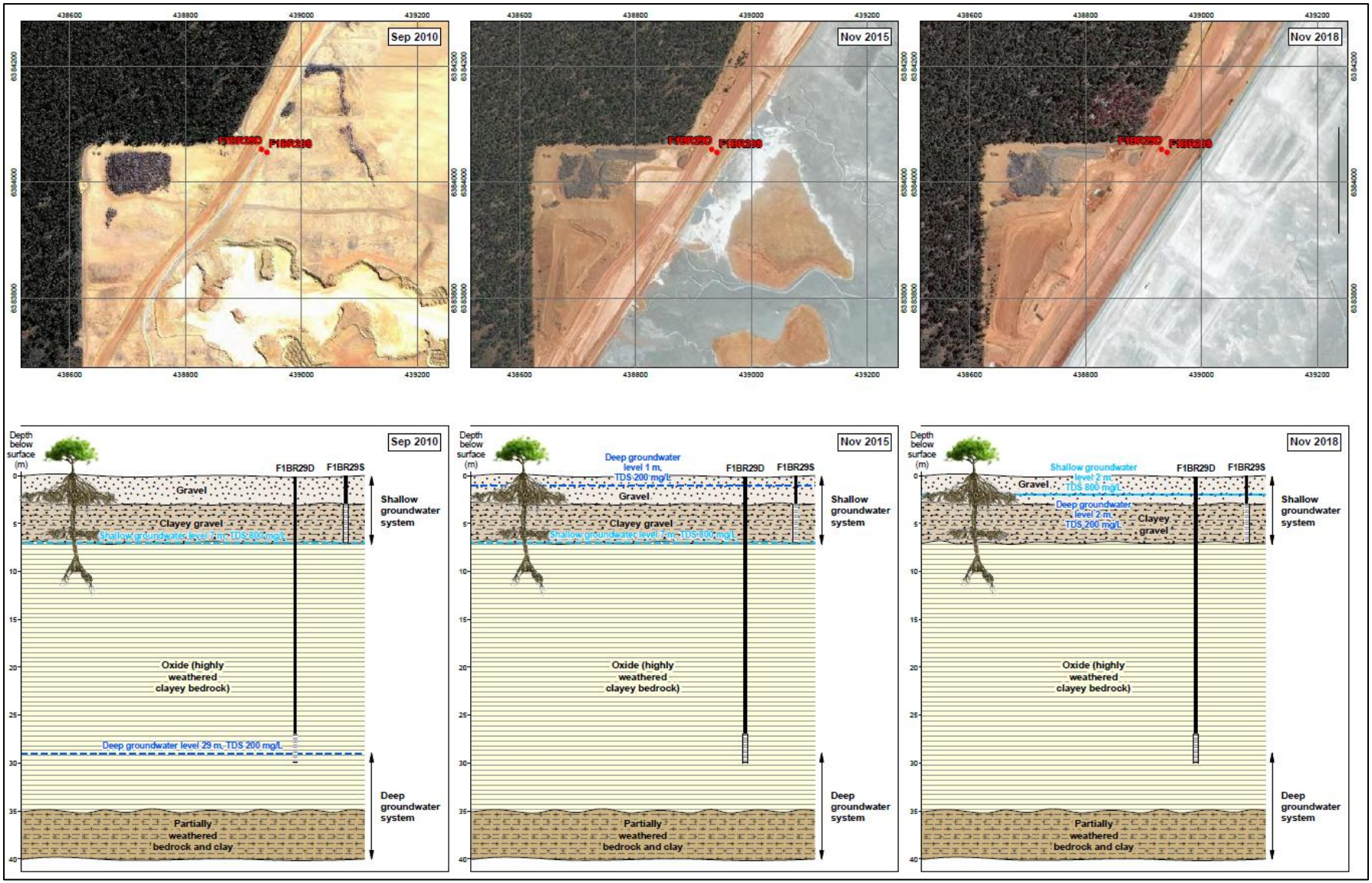


Figure 16: Aerial imagery and conceptual hydrogeological model of Saddle Dam 3 between 2010 and 2018

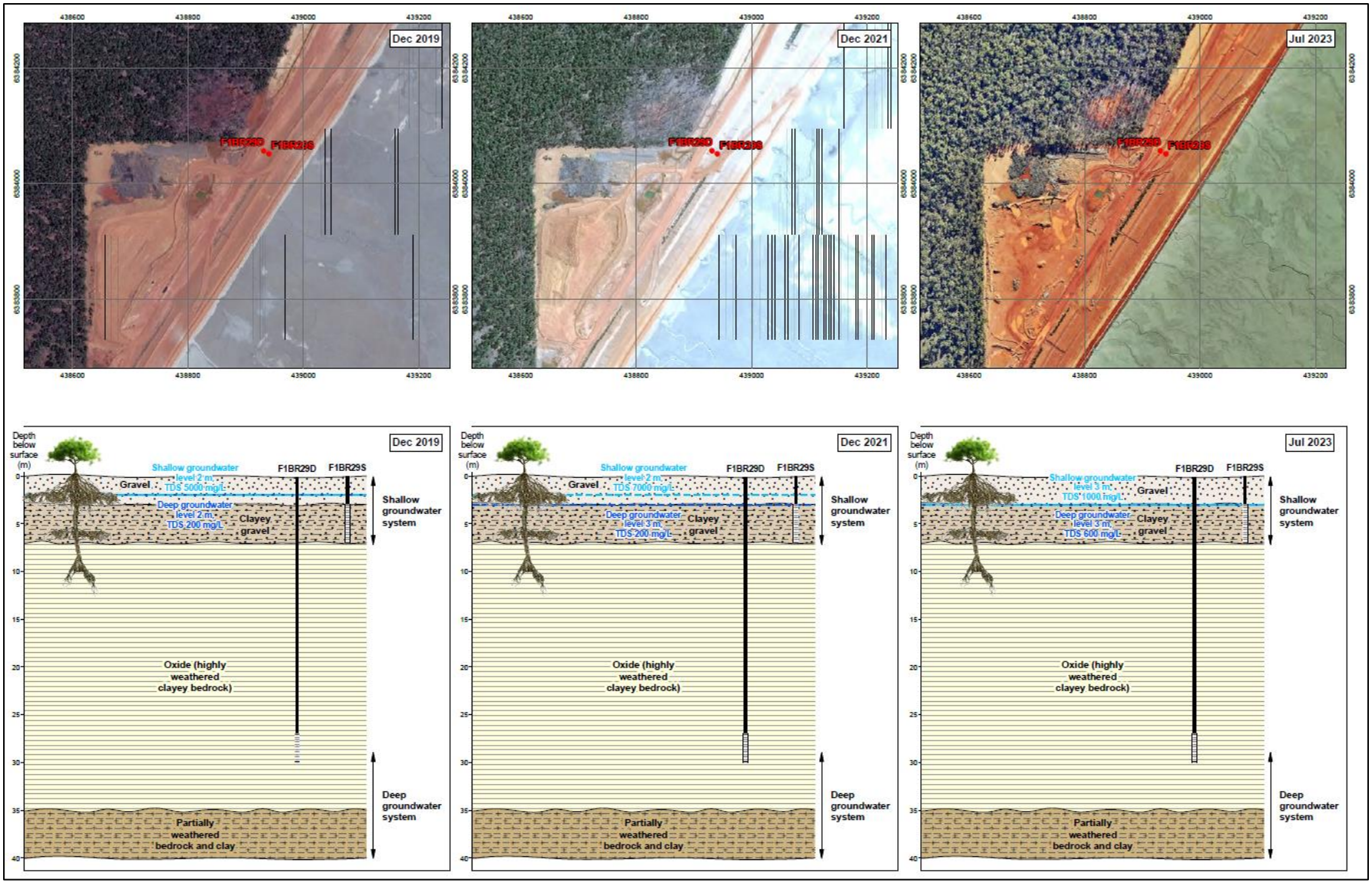


Figure 17: Aerial imagery and conceptual hydrogeological model of Saddle Dam 3 between 2019 and 2023

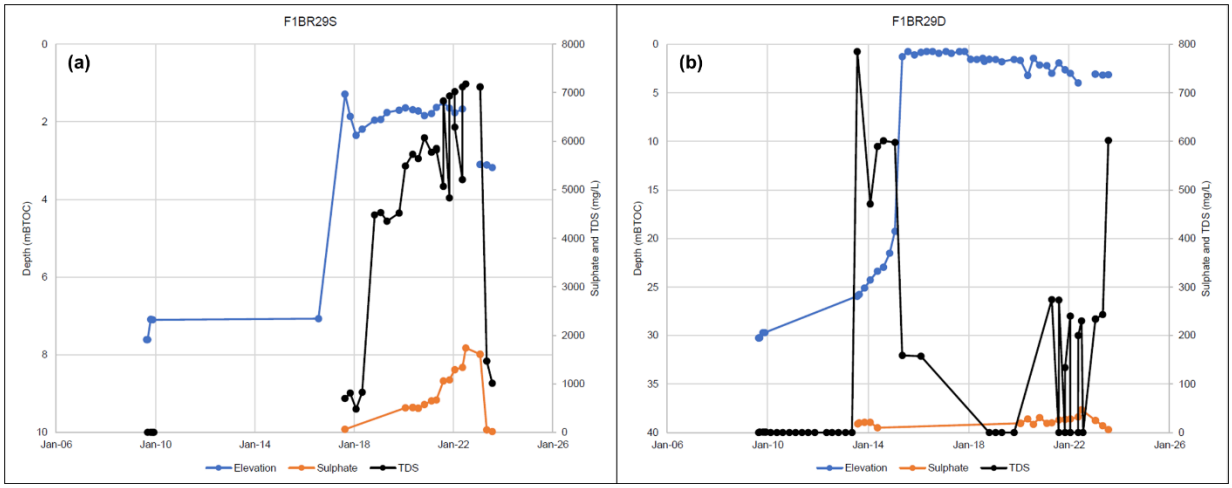


Figure 18: Groundwater level, total dissolved solid and sulfate concentrations at monitoring bores (a) F1BR29S and (b) F1BR29D

Based on this case study, the Licence Holder concluded the following:

- Changes in groundwater elevation within the deeper fractured bedrock unit did not result in observable impacts in vegetation condition. This is contrasted with changes in groundwater elevation within the seasonal shallow groundwater unit, which saw relatively rapid vegetation deterioration (i.e., within one to two years), despite the smaller extent of shallowing.
- Vegetation impairment may not necessarily be dependent on changes in groundwater chemistry. Vegetation impairment was evident even before an increase in TDS was observed. Similarly, a reduction in TDS during the winter of 2023 did not result in observable improvements in vegetation condition.
- Therefore, at Saddle Dam 3, the key groundwater factor affecting vegetation health was the groundwater depth within the seasonal shallow hydrogeological unit, suggesting that managing shallow groundwater depths would be an appropriate approach to protecting vegetation health from the impacts of groundwater mounding. These findings were consistent when considering the local vegetation type at the impact site, which consists primarily of jarrah and marri that are susceptible to waterlogging.
- In assessing potential impact to vegetation, groundwater elevation within the deeper weathered and fractured bedrock unit, the rate of groundwater elevation change, and the groundwater chemistry in both shallow and deep hydrogeological units do not appear to be key factors, or are at least secondary factors in relation to groundwater elevation within the seasonal shallow hydrogeological unit. While salinity may have detrimental effects on the local vegetation type, it was difficult to quantify in the context of this case study, though the absence of saline groundwater conditions was not sufficient to mitigate the impacts associated with a shallow water table.

3.5.4 Groundwater and surface water monitoring assessment

As the F1 RDA has been operating for over a decade, an assessment of the ambient groundwater levels and quality around the facility can provide empirical insights into the impacts of tailings deposition on sensitive receptors. The Licence Holder maintains a comprehensive groundwater monitoring network throughout the premises for various monitoring purposes. Approximately 110 groundwater monitoring bores are located within the RDA area to assess for potential impacts of tailings seepage on the environment.

Under existing conditions in licence L8306/2008/3, the Licence Holder is required to routinely monitor 33 groundwater bores. The monitoring data is assessed and compiled into an annual

hydrological review. This detailed risk assessment considered findings from the most recent review for the 2023 annual period (BDH 2024a), supported by findings from a historical groundwater review completed in 2019 (BDH 2019).

Groundwater monitoring bores were installed at various stages of the premises' operation, including (i) during oxide mining period under a different operator, for which no geological or well construction records are available (e.g., BUBR series bores), (ii) during both the oxide mining and current gold mining period (e.g., F1 series and several R4 series bores), and (iii) a singular monitoring bore intersecting fractured granite at over 100 mbgl for the purposes of investigating groundwater supply (i.e., R4BR109) (Figure 3).

Typically, each monitoring location comprises a shallow and deep bore, with the shallow bores typically screened in laterite gravel and hardcap extending to between 5 mbgl and 15 mbgl, while the deep bores are typically screened in weathered bedrock at the base of the oxide unit and extends to between 20 mbgl and 70 mbgl (Figure 3). Several monitoring bores are also screened within saprolite (Figure 3). Inconsistent screening likely stemmed from a historical lack in understanding of the local hydrogeological units at the time of their installation.

Over the operational life of the F1 RDA, tailings elevation, and consequently, the decant pond elevation, has increased. Corresponding to this is an increase in the pore pressure within the tailings, which has mirrored the rise in decant pond elevation (BDH 2019). These represent the maximum possible influence of the F1 RDA on the underlying hydrogeological units, if these pressures are being transmitted through the base of the facility.

Groundwater levels

In assessing groundwater levels, groundwater monitoring bores surrounding the F1 RDA are discussed broadly based their groupings (Table 12). Grouping of monitoring bores is based on their locations in relation to the F1 RDA, as described by BDH (2019) and shown in Figure 3.

Table 12: Groundwater level response to tailings deposition at F1 RDA

RDA area	Groundwater level trend	
	Up to 2019 annual period (BDH 2019)	2023 annual period[1] (BDH 2024a)
Saddle Dam 1	Monitoring bores in this area surrounded by the F1 RDA, R4 RDA and the D1 Dam. Groundwater levels are generally shallow, with bores closer to the D1 Dam showing responses corresponding to the D1 Dam seepage (i.e., R4BR11, O234BR3, F1BR48; not licensed bores), indicating strong hydraulic conductivity between the D1 Dam and groundwater aquifers. Monitoring bores closer to the F1 RDA were more influenced by groundwater mounding due to tailings deposition (i.e., F1BR15D, F1BR18D; not licensed bores), with shallowing groundwater levels mirroring the increase in decant pond elevation over time.	Groundwater levels have continuously increased in monitoring bores F1BR16D and F1BR19S over the 2023 annual period, though long-term groundwater levels remained relatively stable.
West	Groundwater levels have either remained stable or experienced a relatively small increase over time. Correlation between rising groundwater levels and rising decant pond elevation was also relatively weaker, compared to those observed at other areas of the F1 RDA. This is likely due to the HDPE liner and	Groundwater levels have remained stable, with gradual increase observed at some monitoring bores (i.e., F1BR19S, F1BR23D). Newly installed monitoring bores F1BR24D-2 and F1BR25D-2 also exhibited rising groundwater levels, though at relatively low rates.

RDA area	Groundwater level trend	
	Up to 2019 annual period (BDH 2019)	**2023 annual period[1] (BDH 2024a)**
	other seepage management infrastructure within F1 RDA, which is located closest to the West area, resulting in the capture of seepage emitted into the environment.	
Saddle Dam 3	Most monitoring bores responded strongly tailings deposition, with a rise in groundwater levels reflecting the rise in decant pond elevation over time. In general, a response was observed within deep bores first, while groundwater levels within shallow bores continue to reflect seasonal fluctuations. As groundwater levels measured in the deep bores reach the surface (i.e., the seasonal shallow hydrogeological unit, where most shallow bores were screened), shallow bores also exhibited groundwater mounding patterns.	Several monitoring bores continue to have groundwater levels near the surface and/or continue to increase over time (i.e., F1BR26S, F1BR26D, F1BR29S, F1BR29D, F1BR31S, F1BR31D). However, the F1BR29 series bores have exhibited gradual decreasing groundwater levels over the recent years. Groundwater levels within these monitoring bores are unlikely to increase further as they have nearly reached surface level and are currently being controlled by shallow perimeter sumps around the F1 RDA.
Saddle Dam 5	Groundwater mounding has stabilised in most monitoring bores since 2016 as groundwater level at these bores have reached surface and cannot rise further. It was reported that some bores have groundwater discharging from the standpipe collar. Surface expression of groundwater has also been observed at some topographic depressions near these bores.	Several monitoring bores continue to have groundwater levels near the surface and/or continue to increase over time (i.e., F1BR35D, F1BR36D). Groundwater levels within these monitoring bores are unlikely to increase further as they have nearly reached surface level and are currently being controlled by shallow perimeter sumps around the F1 RDA. In particular, monitoring bore F1BR35D has not been monitored since 2016 as the surrounding area has been saturated by surface expression of groundwater. The monitoring bore currently exists on the footprint of perimeter sump SD5SU-B and cannot be accessed. These conditions are expected to continue for the remainder of the F1 RDA operating life.
Saddle Dam 8		Monitoring bore F1BR38D continue to have groundwater levels near the surface and/or continue to increase over time.
R4	Monitoring bores in this area showed strong responses towards activities at the R4 RDA during historical oxide mining period. While groundwater mounding had either stabilised or decreased when the premises entered care and maintenance, the groundwater mound is thought to persist, potentially due to the current use of R4 RDA as a water storage reservoir. Monitoring bores closer to the F1 RDA (i.e., R4BR98 and R4BR99; not licensed bores) have also been influenced by decant pond elevation.	There are no monitoring bores associated with the R4 RDA area specified in existing licence L8306/2008/3.
Regional East	Groundwater levels within both shallow and deep monitoring bores follow seasonal fluctuations and aquifer recharge patterns,	No increases in groundwater levels were observed.

RDA area	Groundwater level trend	
	Up to 2019 annual period (BDH 2019)	**2023 annual period[1] (BDH 2024a)**
	as well as any long-term trends. Influence of tailings deposition from the F1 RDA is not evident at these monitoring bores.	
Regional North	Groundwater levels within both shallow and deep monitoring bores follow seasonal fluctuations and aquifer recharge patterns, as well as any long-term trends. Influence of tailings deposition from the F1 RDA is not evident at these monitoring bores. However, several monitoring bores to the north and north-east of the F1 RDA (i.e., F1BR34D and BUBR6, respectively) have historically shown groundwater level responses that mirror rising decant pond elevations.	Trends in groundwater levels remained the same, driven by seasonal fluctuations and long-term trends. Monitoring bores F1BR34D and BUBR6 continue to show increases in groundwater levels, though groundwater levels in the former monitoring bore had plateaued during the 2023 annual period. In addition to a shallowing trend, groundwater levels at monitoring bore BUBR6 continue to fluctuate significantly, likely responding to changes in both shallow and deeper aquifers due to the width of its screen. A more subtle and delayed response to groundwater mounding was observed in monitoring bore BUBR7, likely due to distance from the F1 RDA.

Note 1: Unlike the groundwater review undertaken in BDH (2019), the annual hydrological review (BDH 2024a) only assessed monitoring bores that are specified under licence L8306/2008/3. As such, updated trends for specific non-licensed bores highlighted in BDH (2019) are not available. Where this is the case, an assessment of the nearest licensed monitoring bore was undertaken as a proxy.

In general, groundwater mounding was more likely to occur and occur more significantly near the F1 RDA (**Figure 19**). Groundwater mounding is the most severe at the north-western portion of the facility, where groundwater levels at several monitoring bores are near the surface and/or are discharging from the standpipe collar. This is consistent with the location of the impact site, which is adjacent to Saddle Dam 3 on the north-western perimeter of the facility.

Following that, groundwater mounding was next most severe at the northern portion, the eastern portion, and finally, the western portion of the facility. Groundwater mounding to the south of the facility is co-influenced by tailings deposition from the F1 RDA as well as water storage at the D1 Dam.

Groundwater mounding has also been evident in regionally sited monitoring bores, including:

- F1BR34D – approximately 350 m directly north of the F1 RDA perimeter;
- BUBR7 – approximately 500 m north-east of the F1 RDA perimeter; and
- BUBR6 – approximately 460 m north-east of the F1 RDA perimeter.

It was also observed that groundwater levels have only approached and/or reached surface level at monitoring bores located around the perimeter of the F1 RDA (i.e., <4 mbgl). All regional groundwater monitoring bores still exhibit relatively deep groundwater levels, even within those that are exhibiting signs of groundwater mounding.

While groundwater mounding was most severe at the north-western perimeter of the F1 RDA, no signs of groundwater mounding have been observed at the regional monitoring bores in that direction (i.e., F1BR43 and F1BR44 series), though they are located further away from the facility perimeter at approximately 1.8 km.

In summary, the key factors that drive these groundwater mounding trends appear to be (i) the

distance from the F1 RDA and specifically, its decant pond[13], (ii) presence of the HDPE liner[14], and (iii) the presence of other groundwater-influencing activities[15].

Groundwater contours from BDH (2019) highlighted the changes to the local groundwater flow regime as a result of tailings deposition at F1 RDA. Currently, groundwater elevation remains highest immediately west of the F1 RDA due to naturally elevated topographic ridge, followed by radial outflow from F1 RDA, originating from the groundwater mound beneath the facility, flowing towards and across the surface water catchment boundaries into the South Dandalup and Saddleback Tree Farm catchments.

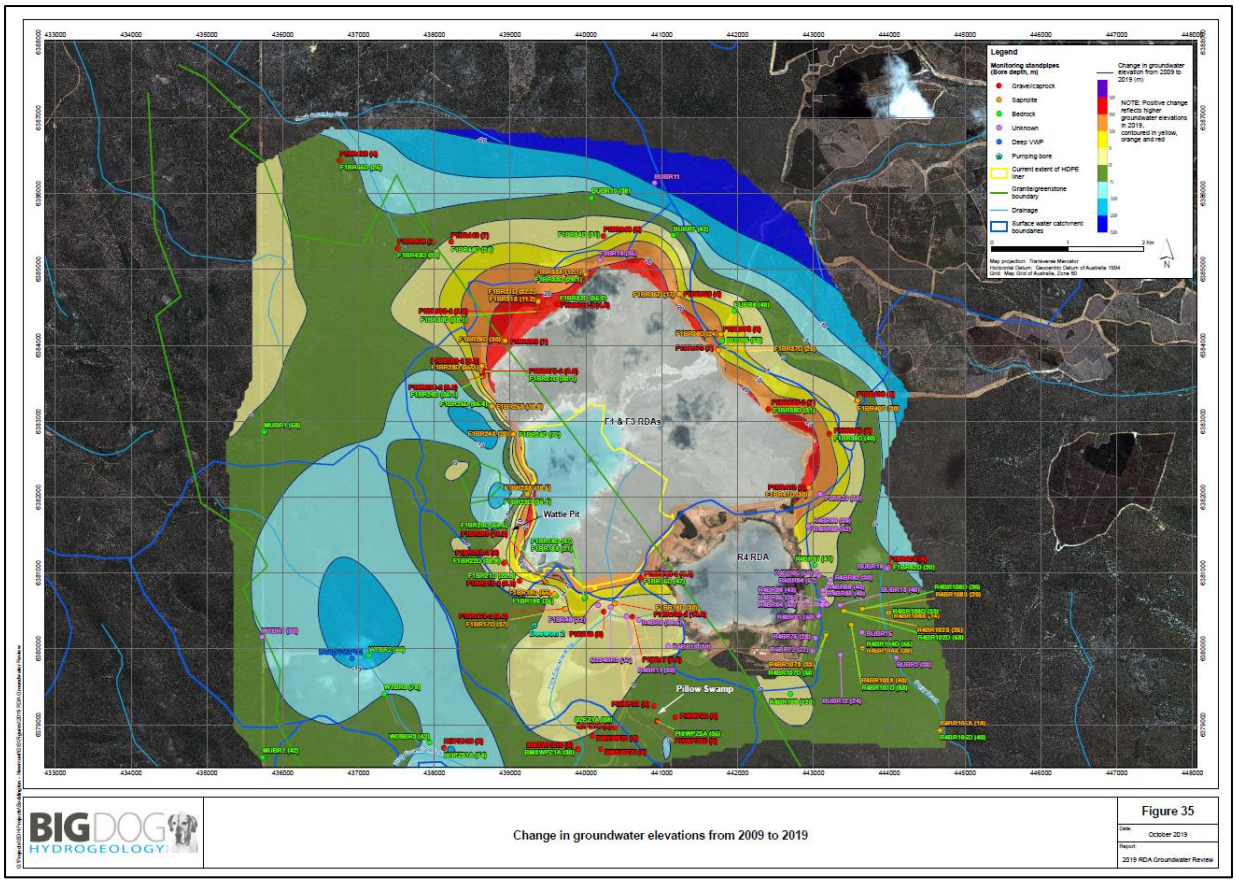


Figure 19: Changes in groundwater levels between 2009 and 2019

Groundwater quality

The Licence Holder undertakes routine analysis for several potential contaminants within ambient groundwater surrounding the F1 RDA. In 2019, BDH (2019) assessed the water quality within the F1 RDA decant pond, and studied changes in the chemical characteristics of tailings seepage as it infiltrated through the facility and was captured by the underdrainage system and LCRS, as well as the perimeter sumps.

[13] Groundwater mounding was less significant and more delayed in the eastern monitoring bores with almost no regional influence as the decant pond is located at the western portion of the facility.

[14] Groundwater monitoring bores along the western perimeter do not exhibit groundwater mounding signs as strong as those along the north-western perimeter, due to the HDPE liner (and associated underdrainage system and LCRS) that envelops most of the western portion of the F1 RDA.

[15] For example, water storage at the D1 Dam, persistent groundwater mounding from the R4 RDA during oxide mining period, drawdown impacts from mine dewatering, long-term climatic changes, etc.

They found that parameters were either:

- naturally more elevated in the surrounding groundwater than the tailings seepage, and thus not a significant contaminant (e.g., magnesium);
- diluted by underlying groundwater, resulting in lower concentrations as it interacts with groundwater (e.g., sulfate, chloride);
- geochemically attenuated, resulting in lower concentrations as it seeps through the facility (e.g., molybdenum);
- conserved and potentially more mobile within the groundwater system due to complexing with cyanide, resulting in constant or elevated concentrations in groundwater (e.g., cobalt); and
- pH of the tailings seepage increased as it seeped through the facility, like due to interacting with residual lime in the tailings mass, followed by a decrease as it mixes with the more acidic groundwater within the iron-rich gravel lithologies[16].

The water quality within the perimeter sumps were varied with location and time but were generally consistent with the quality of tailings seepage collected from the F1 RDA, including containing elevated sulfate concentrations and detectable concentrations of WAD CN (Table 13). A key shift was observed in 2018, when water collected from the F1 RDA toe wells were discharged to the sumps (rather than sent back to the decant pond), which saw an increase in molybdenum and cobalt within the sump water.

It was noteworthy that the ionic composition of sump water was most similar to those of tailings seepage at sump SD3SU-C, which is located where the most severe groundwater mounding has been observed (refer to Section 3.5.3). On the other hand, ionic composition of sump water from sump SD8SU-B was found to be most similar of those from unimpacted groundwater, which is the furthest from the decant pond. These observations suggest that tailings seepage from the F1 RDA was the major driver for sump water chemistry, and consequently, may influence groundwater quality as it migrates away from the facility.

It was concluded that sulfate (and hence, electrical conductivity and TDS) were the most reliable indicators of tailings seepage influence in groundwater, as sulfate is conserved during seepage and flow within the groundwater system. Cobalt was also determined to be a potentially suitable indicator, as it does not attenuate as rapidly as other metal and metalloids during groundwater flow.

In most monitoring bores located around the perimeter of the F1 RDA, rising groundwater levels correlated with an increase in sulfate concentration. This correlation was less evident between groundwater levels and other monitored contaminants. In some monitoring bores (e.g., F1BR37S and F1BR41D along the eastern perimeter at Saddle Dam 5 and 8, respectively; Figure 20c and Figure 20d), groundwater levels not only correlated with an increase in sulfate concentrations, but also a small increase in cobalt concentrations. Detection of WAD CN have also been occasionally reported at these monitoring bores, indicating some level of influence from tailings seepage.

[16] It has been hypothesised that local groundwater is variable and relatively acidic due to ferrolysis reactions., which releases hydrogen ions and generates acidity. That being said, the relationship between filterable iron concentration and pH at the premises does not appear to be strong. While pH is likely not diagnostic of tailings seepage chemistry, ferrolysis reactions may relate to rising groundwater levels, thus, tailings deposition and seepage may have an influence on groundwater pH.

Table 13: Concentration range for surface water parameters during the 2023 annual period

Parameter	Unit	Drinking water guideline value[2]	Concentration[7]			
			F1 decant pond[8]	Perimeter sumps[8]	South Dandalup River (SDBK2)	Boggy Brook (BGBK6)
Tailings seepage indicators						
Total dissolved solids	mg/L	600[3]	**4,970 to 13,700**	**180 to 9,600**	88 to 166	94
Sulfate	mg/L	250[3]	**1,140 to 3,450**	24 to **2,320**	3 to 9	<2 to <5
Cobalt[1]	mg/L	NA	0.289 to 0.707	<0.001 to 0.459	<0.001 to 0.002	<0.001
Weak acid dissociable cyanide	mg/L	0.08[4]	**3.66 to 10.1**	<0.004 to 0.076	<0.004	<0.004
Other parameters with applicable guideline value						
Field pH	pH unit	<4 to >11[5]	8.2 to 8.69	6.02 to 9.01	7.38 to 7.98	6.95 to 8.13
Arsenic[1]	mg/L	0.01	0.004 to **0.034**	<0.001 to **0.012**	<0.001 to 0.004	<0.001
Cadmium[1]	mg/L	0.002	0.0001 to 0.0003	<0.0001	<0.0001 to 0.0002	<0.0001
Chromium[1]	mg/L	0.05[6]	0.007 to **0.058**	<0.001 to **0.052**	<0.002 to 0.001	<0.001
Copper[1]	mg/L	2	0.1 to **16.3**	<0.05 to **35.4**	<0.001 to 0.007	<0.001 to 0.001
Mercury[1]	mg/L	0.001	<0.0001 to 0.0002	<0.0001 to 0.0002	<0.0001	<0.0001
Manganese[1]	mg/L	0.5	0.042 to 0.245	0.002 to **1.02**	0.011 to 0.076	0.02 to 0.024
Molybdenum[1]	mg/L	0.05	**0.224 to 0.802**	<0.001 to **0.188**	<0.001	<0.001
Nickel[1]	mg/L	0.02	**0.487 to 1.04**	<0.001 to 0.009	<0.001 to 0.002	<0.001
Lead[1]	mg/L	0.01	<0.001 to **0.016**	<0.001 to **0.011**	<0.001	<0.001

Parameter	Unit	Drinking water guideline value[2]	Concentration[7]			
			F1 decant pond[8]	Perimeter sumps[8]	South Dandalup River (SDBK2)	Boggy Brook (BGBK6)
Antimony[1]	mg/L	0.003	**0.005 to 0.019**	<0.001 to 0.002	<0.001	<0.001
Selenium[1]	mg/L	0.01	**0.02 to 0.06**	<0.0002 to 0.0004	<0.01	<0.01
Zinc[1]	mg/L	3[3]	<0.005 to 0.028	<0.005 to 0.084	<0.005	<0.005

Note 1: Total, unfiltered concentrations were measured, as specified under existing licence L8306/2008/3.

Note 2: Drinking water guideline values were adopted from the NHMRC & NRMMC (2024) *Australian Drinking Water Guidelines 6 2011* (version 3.9) for human health.

Note 3: In the absence of applicable drinking water guideline value for the protection of human health, guideline value for aesthetic purposes were adopted (e.g., taste, odour, purgative effects, etc.).

Note 4: In the absence of applicable drinking water guideline value for weak acid dissociable cyanide, the guideline value for total cyanide of 0.08 mg/L was adopted.

Note 5: In the absence of applicable drinking water guideline value for pH, interim criteria of no less than 4 pH unit and no more than 11 pH unit was adopted, as the NHMRC & NRMMC (2024) suggests that extreme pH values may have adverse health effects, though there is currently insufficient data to appropriately determine this.

Note 6: In the absence of applicable drinking water guideline value for total chromium, the guideline value for chromium(VI) of 0.05 mg/L was adopted.

Note 7: Exceedance of drinking water guideline value are shown as bolded, red text.

Note8: Drinking water quality guideline values are not applicable to assessment of water quality at this location. However, the comparison is undertaken to highlight water quality at this location relative to the other locations shown.

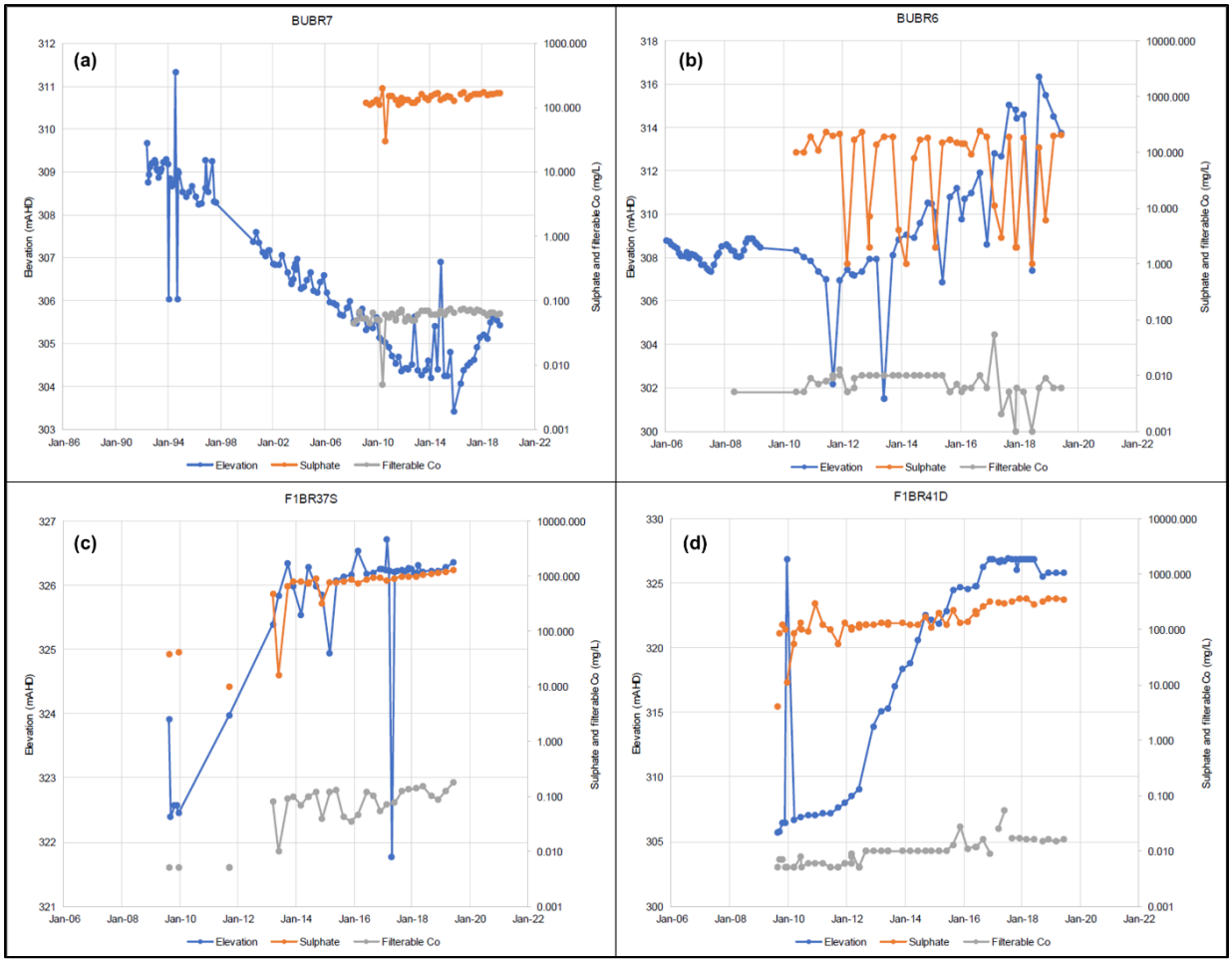


Figure 20: Groundwater level, sulfate, and filterable cobalt concentrations at (a) BUBR7, (b) BUBR6, (c) F1BR37S, and (d) F1BR41D

Significant changes to groundwater chemistry in regional bores have not yet been observed[17], even in those where groundwater levels have experienced an increase (Figure 20b). These changes may not have been observed yet due to mixing (i.e., dilution) of tailings seepage with groundwater, as well as natural geochemical attenuation processes (BDH 2019).

An assessment of groundwater quality from several regional monitoring locations (e.g., F1BR43D, F1BR34D, BUBR10, BUBR7, BUBR6) during the 2023 annual period found that contaminant concentrations did not exceed relevant human drinking water guideline values, except for isolated exceedances of antimony and lead. Slightly elevated nickel concentrations were consistently detected at monitoring bores F1BR34D and F1BR43D during the 2023 annual period. Elevated manganese and major ion concentrations were observed, though these may be more reflective of the chemical characteristics of the hydrogeological unit, rather than geochemical influence from tailings seepage.

These findings, along with observed impacts to native vegetation at Saddle Dam 3 (refer to Section 3.5.3) support that an increase in groundwater level can be used as the primary mechanism for identify groundwater mounding caused by tailings seepage, followed changes in groundwater chemistry, such as sulfate and TDS, and to a lesser extent, cobalt. The presence

[17] Groundwater quality within regional monitoring bores were characterised by variable pH between 4 pH unit and 8 pH unit, brackish (TDS between 1,000 mg/L and 7,000 mg/L), relatively low sulfate concentrations (<350 mg/L), low levels metals and metalloids, no detectable WAD CN.

of WAD CN may also be a key indicator, as it is not naturally occurring at significant concentrations.

Nevertheless, assessment of groundwater monitoring data from the oxide mining period suggests that tailings seepage may potentially impact on regional bores, even if they were cross-catchment (BDH 2019). By comparing the time difference between commencement of tailings deposition at F1 RDA and the first indications of groundwater mounding observed at each monitoring bore, the annual rate of seepage migration was estimated to range loosely between 23 m (i.e., at F1BR18D, located 100 m south of the facility) and 133 m (i.e., at BUBR6, located 460 m north-east of the facility), averaging at around 60 m per year. Virtually instantaneous groundwater level responses were observed within the deep bores F1BR30D, F1BR31D, and F1BR32D, located up to 200 m from the facility along the north-western perimeter. These migration rates are comparable to those predicted by Klohn Crippen Berger (2023), which mostly ranged from 50 m to 63 m, though they did not identify higher migration rates along the north-western perimeter.

Surface water quality

In addition to groundwater monitoring, monitoring information from nearby surface water bodies were also reviewed to determine potential impacts to water quality within these creeks and channels. Specifically, the South Dandalup River to the north-west (i.e., SDBK2) and Boggy Brook to the south-east (i.e., BGBK6) of the F1 RDA were considered due to their proximity to the F1 RDA. The South Dandalup River was especially important due to its siting within the Priority 1 South Dandalup Dam Catchment Area PDWSA and flows through to Lake Banksiadale. In reviewing monitoring data from the 2023 annual period, the department noted that:

- Monitoring data for the South Dandalup River and Boggy Brook were only available during the winter periods, as they are ephemeral water bodies. The former contains sufficient flow for sample collection from June to September, while the latter only contained sufficient flow during August and September.
- Compared to concentrations observed at the F1 RDA decant pond and perimeter sumps, sulfate and TDS concentrations were relatively low at both surface water bodies, reflecting only local runoff.
- Concentrations of WAD CN has been below the limit of reporting throughout the annual period, which is consistent with lack of detections in previous annual periods.
- Concentrations of cobalt were below the limit of reporting at Boggy Brook but detected at the limit of reporting at South Dandalup River on numerous occasions (i.e., 0.001 mg/L). The low concentrations detected likely reflect the geochemistry of upgradient catchments. Notably, elevated concentrations of cobalt, as well as copper, nickel, and zinc, were detected at the South Dandalup River during the September 2022 monitoring event, though an assessment of the ionic composition indicated no significant change in surface water type and likely sources (BDH 2023a). These concentrations were regarded as an isolated spike. No long-term trends for cobalt concentrations within surface water bodies have been observed.
- Concentrations of other parameters and potential contaminants were not detected above the limit of reporting, or where they were detected, were of low concentrations. This is contrasted with elevated levels of metals and metalloids, as well as major ions within the F1 decant pond (Table 13).
- Based on monitoring results from the 2023 annual period, water quality within the South Dandalup River was able to comply with relevant human and livestock drinking water guideline values (NHMRC & NRMMC 2024; ANZG 2018).

Key findings

Based on monitoring information provided to the department by the Licence Holder, the following observations were made:

- Mechanisms relating to the impacts of tailings seepage from the F1 RDA on local hydrogeological systems have been established, whereby the weathered and fractured bedrock hydrogeological unit (i.e., the primary groundwater transmitting aquifer) is impacted by the hydraulic pressure of the tailings seepage, which results in groundwater mounding, rising through the oxide hydrogeological unit and reaching the seasonal shallow hydrogeological unit. Groundwater mounding of this shallower aquifer may cause inundation of root zones and result in vegetation impairment, as observed historically.
- Based on groundwater monitoring during previous oxide mining periods, it is plausible for groundwater to infiltrate and rise through the oxide unit, despite its relatively low permeability.
- Based on current groundwater monitoring, the deep fractured bedrock hydrogeological unit also does not appear to be impacted by groundwater mounding.
- Due to groundwater mounding at the F1 RDA, local hydrogeological flow regime has been modified, such that groundwater flows radially outwards from the facility, which may result in impacts to surrounding catchments, including the Priority 1 and 2 South Dandalup Dam PDWSA.
- The most reliable indicator of groundwater mounding is standing water level, where groundwater is expected to rise within deeper bores (i.e., screened in the weathered and fractured bedrock hydrogeological unit) before changes can be observed in the shallow bores (i.e., screened in the seasonal shallow hydrogeological unit). However, rapid responses have been observed in some monitoring bores that likely intersect seepage pathways to the F1 RDA.
- Changes in groundwater chemistry due to tailings seepage occurs at a slower rate due to varying rates of solute migration, dilution with ambient groundwater, and geochemical attenuation. Sulfate, TDS, WAD CN, and cobalt have been established as key indicator parameters for indicating tailings seepage influences.
- Groundwater mounding is naturally most severe around the perimeter of the F1 RDA, especially along the north-west perimeter (resulting in vegetation death at the boundary of the facility), followed by the north and north-east. Groundwater mounding responses were delayed or less severe along the western perimeter, despite its proximity to the decant pond, likely due to the presence of the HDPE liner. Limited groundwater mounding was observed along the eastern perimeter, though existing groundwater mounding from historical operation of the R4 RDA may persist.
- Away from the F1 RDA, tailings seepage influences appear limited. Groundwater mounding is apparent in a number of monitoring bores to the north of the facility, though no changes in groundwater chemistry have been observed to date, indicating limited solute transport across the catchments.
- Surface water bodies, such as the South Dandalup River and Boggy Brook, do not appear to be impacted by tailings seepage. Unlike decant and seepage-impacted water at the F1 RDA, surface water quality at both locations complied with relevant human health and livestock drinking water guideline values.

Department assessment

The department found that these key findings from the investigations and reviews undertaken to date were generally sound. Nevertheless, the department indicates the following for the consideration of the Licence Holder:

- While the use of parameters such as sulfate, cobalt, and WAD CN can be useful chemical indicators for tailings seepage influence in the ambient groundwater environment, shifts in ionic composition of the ambient groundwater (as a result of the mixing of tailings seepage with ambient groundwater) can also be a useful indicator for the influence of tailings seepage. These shifts can be assessed using ionic ratios (e.g., sulfate:chloride mass or molar ratios) through Stiff diagrams and/or Piper plots. The department notes that BDH (2019) had previously employed this method on perimeter sump water chemistry to inform the source of inflows into the sumps.
- Under the influence of tailings seepage from the F1 RDA, groundwater mounding is more likely to occur and be detected at a faster rate at surrounding monitoring bores, compared to the transport of solutes. This is especially apparent in deeper saprock or fractured bedrock aquifers. Therefore, the Licence Holder should consider that evidence of geochemical responses to tailings seepage within these monitoring bores may be delayed, rather than completely absent.

3.5.5 Groundwater modelling assessment

The mechanisms and potential impacts of groundwater mounding from tailings deposition into the F1 RDA have been investigated, with existing impacts on the local hydrogeological regime and surrounding environmental receptors being routinely monitored. To support the proposed embankment raises at the F1 RDA, the Licence Holder undertook groundwater modelling to better understand future aquifer behaviour under the proposed activities (Klohn Crippen Berger 2023).

The investigation utilised an existing three-dimensional groundwater flow model to compare differences between scenarios involving the current and proposed operations (referred to as 600MT and 750MT, respectively), including both hydrodynamics simulation (e.g., quantifying seepage rates and fluxes, flow directions, and particle tracking) and solute transport components. The model domain incorporates key operational area within the premises, capturing regional groundwater flow influences as well as impacts and stresses associated with the premises operations (i.e., tailings deposition, open pit dewatering).

Under the 750MT scenario, groundwater modelling predicted that:

- Groundwater mounding around the F1 RDA would grow marginally wider, due to increased tailings deposition into the facility.
- Similarly, the impacts of pit dewatering and its cone of depression south of the F1 RDA would also increase, as a result of the increasing depth of dewatering at the open pits.
- The increase in hydraulic heads was most significant within the unlined footprint of the F1 RDA (i.e., 2.0 to 3.4 m rise), while the immediate vicinity of the facility would experience a rise of approximately zero to 2.0 m, extending towards north of the facility (Figure 21a). No increase in hydraulic head was predicted further east, west and south of the F1 RDA.
- Seepage rates were predicted to be relatively consistent throughout tailings deposition

from Stage 19 to Stage 22 of the F1 RDA[18], which would also be comparable to seepage rates under current operations (Figure 21c). Peak seepage rate was predicted to be <600 kL/day (or 7.0 L/s).

- Particle tracking simulations indicated that seepage migration would be relatively slow, with no significant differences in maximum seepage travel distance when compared to the 600MT scenario. Annual seepage migration rate was estimated to be between 50 m and 63 m, except in the south-western and south-eastern region, where it may be as high as 175 m potentially due to dewatering influences (Figure 21b).
- Solute transport modelling indicated that sulfate[19] loading released into the environment would increase by approximately 1.8%/year, based on differences in the mass budget between the two scenarios (Figure 21d). The sulfate plume was likely to migrate at the highest rate to the south of the F1 RDA (i.e., 94 m/year), followed by the south-western and north-eastern directions (i.e., 38 m/year to 43 m/year). However, very low sulfate concentrations were expected to reach the Hotham River by 2080 (i.e., ~0.1 mg/L[20]). There is expected to be limited sulfate migration to the west, north, and south-east of the facility (i.e., 22 m/year to 33 m/year).

Following the investigation, Klohn Crippen Berger (2023) suggested that the model confidence can be bolstered through additional calibration, using new information or monitoring data to improve accuracy of the hydrogeological units and their permeabilities simulated in the model.

[18] These seepage predictions operate under the assumptions that the seepage recovery systems at the F1 RDA (i.e., underdrainage system, LCRS, perimeter sumps, decant recovery, etc.) remained operational throughout the proposed embankment raises, as well as beyond up until the end of 2034 to ensure continued seepage capture after the cessation of tailings deposition.

[19] Sulfate was selected as the target chemical species for solute transport modelling due to its mobility, relatively low sorption, environmental risks, as well as the completeness of its historical monitoring dataset.

[20] This value does not consider other potential sulfate sources within the premises, nor does it account for potential dilution from seasonally variable surface water flows and/or runoff that may interact with the sulfate plume. As the model simulates 'worst-case' scenario for long-term post-closure predictions, typical attenuation processes (e.g., sorption, diffusion) were not applied to the solute transport model, though these processes would likely further retard the migration of the sulfate plume or reduce the concentration of the sulfate plume as it migrates.

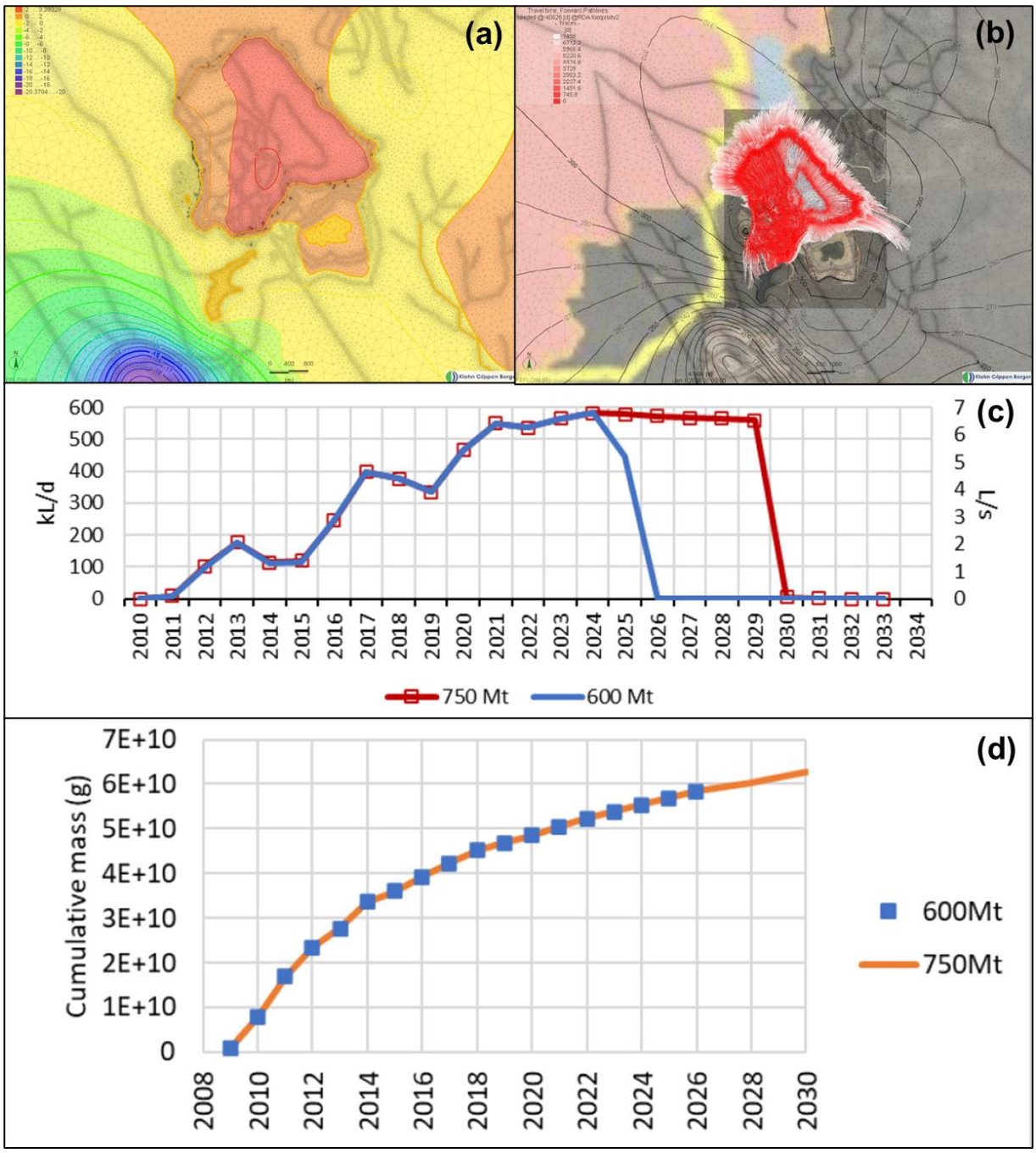


Figure 21: (a) Difference in predicted groundwater levels between the existing 600MT and proposed 750MT expansion; (b) simulated flow path using forward particle tracking under the proposed 750MT expansion; (c) predicted seepage rate under existing 600MT and proposed 750MT expansion; (d) predicted sulfate mass accumulation rate under existing 600MT and proposed 750MT expansion

Key Findings - Groundwater model review

The Licence Holder commissioned BDH (2023b) to review the groundwater modelling at the F1 RDA undertaken by Klohn Crippen Berger (2023). In the review, the following matters were highlighted:

- Some aspects of the model were not detailed in sufficient detail to facilitate a thorough review, including weathering classifications adopted when constructing the geological

model, not utilising the perimeter sumps as calibration targets, etc.

- The model has been calibrated to operational conditions and is therefore suitable for predicting operational conditions. The calculated calibration statistics were generally within expected limits.
- While the model considered the water balance of the facility, such as precipitation inputs and changes in tailings deposition rates (i.e., such that a larger decant pond would result in higher seepage rates), it did not consider the elevation of the decant pond, which was likely the primary driver of seepage as it defined the driving hydraulic head. That being said, the predicted differences between the 600MT and 750MT scenarios were not likely to be significantly vary, as the decant pond would only increase by around 10 metres under the proposed expansion.
- A major flaw of the adopted seepage calculations was the assumption that tailings seepage would cease shortly following the cessation of tailings deposition, as shown in Figure 21c. This assumption is not correct, as the facility is still expected to continue emitting tailings seepage at considerable rates following cessation of tailings deposition.
- Solute transport modelling may have been calibrated to overestimate sulfate concentrations as calibration primary relied on monitoring bores screened within the seasonal and shallow hydrogeological unit, including those located close to perimeter sumps that contain elevated sulfate concentrations. Furthermore, modelled sulfate responses began at 0 mg/L in 2009 and does not reflect existing natural background concentrations, which ranged between 50 mg/L and 400 mg/L.
- Due to the above, the model was considered to be inadequate for predicting closure conditions. Furthermore, other major deficiencies included: (i) role of perimeter sumps in controlling seepage migration was not described, investigated, or quantified; (ii) the seasonal shallow hydrogeological unit was assumed to be a saturated continuous hydrogeological unit; and (iii) closure designs and predictions for the RDA, the D1 Dam and the open pit were not inputted as part of closure modelling.
- The recommendation provided by Klohn Crippen Berger (2023) to undertake slug testing to improve model calibration to hydraulic stress was also not supported. This was because slug testing generates hydraulic parameters for the strata within a few metres of the tested bore and was inappropriate for defining processes occurring over larger scales and longer periods. Appropriate stresses for model calibration currently exist at the premises, including aquifer responses to (i) open pit dewatering, (ii) seepage from the RDAs, and (iii) groundwater abstraction at the Westwood Borefield.
- Most of the recommended locations for additional monitoring bore installation were also not supported, as they are located up to 5 km from the RDA area. While these may be appropriate for understanding regional hydrogeological conditions, they may not be relevant to the management of tailings seepage from the RDA during operations and in the short-term. Monitoring bores should be sited closer to the facility.

Department assessment

The department broadly agrees with the review undertaken by BDH (2023b). The groundwater model is limited by the conceptual model that underpinned the numerical model, as well as the boundary conditions used to simulate effects of the rising phreatic surface as a result of the proposed expansion.

For example, the assumption that the toe drains would capture all tailings seepage from the facility may not be valid due to the heterogeneity of the underlying geology, which can limit the efficacy of shallow drains in capturing deeper groundwater. This is further detailed by

Fortuna *et al.* (2021).

Further, the assumptions on seepage rates post-deposition should be examined more closely, as seepage is likely to continue being emitted from tailings storage facilities after tailings deposition has ceased (Williams 2008).

If these assumptions in the conceptual model are not valid, tailings seepage and associated contaminants would likely migrate further and at greater concentrations towards the surrounding environment than currently predicted by the numerical model.

In considering these findings, the department has only relied on the groundwater model prepared by Klohn Crippen Berger (2023) to inform potential impacts associated with the operation of the F1 RDA, which appears to be appropriate. Assessment and management of environmental impacts associated with closure and rehabilitation of the F1 RDA would typically fall under the regulatory remit of the *Mining Act 1978*.

3.5.6 Licence Holder's controls

Proposed controls for managing the impacts of tailings seepage from the proposed embankment raises at the F1 RDA on sensitive receptors have been detailed in Table 6. Proposed controls ranged from expanding HDPE lining, maximising tailings consolidation and supernatant recovery, maintaining operation of seepage recovery infrastructure, as well as routine inspections and monitoring. These controls are already being implemented under current operation of the F1 RDA, some of which have been conditioned within existing licence L8306/2008/3.

As stated in Section 2.4.1, the Licence Holder has designed a GMP for the purposes of monitoring and managing the impacts of tailings seepage and groundwater mounding around the F1 RDA.

Under the GMP, the Licence Holder has committed to:

1. Installing shallow and deep monitoring bores at six additional locations around the F1 RDA (as shown in Figure 3) to improve groundwater monitoring coverage across catchment boundaries.
2. Undertake quarterly groundwater monitoring at 108 monitoring locations around the RDA area (as shown in Figure 3) for standing water level and groundwater quality, including monitoring bores currently conditioned under existing licence L8306/2008/3[21].
3. Undertake annual plant cell density (PCD) assessment using multispectral data around the margins of the F1 RDA and R4 RDA, around autumn time. The extent of the initial assessment will be set to approximately 1.5 km around the RDA area and refined during future annual assessments with the use of groundwater monitoring data.
4. Undertake quarterly visual inspection of vegetation condition surrounding the RDA area (i.e., at the vegetation fringe abutting the perimeter of the RDA area) to determine and assess potential areas where vegetation impairment may be apparent. Monitoring locations will be established at all monitoring bores surrounding the RDA to provide for consistency and recordkeeping purposes. These observations will complement and verify findings from the PCD assessment.
5. Undertake vegetation transect monitoring to the east of the R4 RDA for changes in

[21] Proposed monitoring parameters will include, at a minimum: pH, EC, TDS, major ions (e.g., sodium, magnesium, calcium, potassium, sulfate, as well as bicarbonate, carbonate, and hydroxide alkalinity), dissolved metals and metalloids (e.g., arsenic, cobalt, copper, iron, manganese, molybdenum, nickel, and zinc), as well as total and WAD cyanide.

vegetation composition and density. Frequency of transect monitoring has not been determined and will likely depend on findings from the PCD assessment and visual inspections.

6. Install additional shallow and deep monitoring bores to better monitor and assess risks associated with tailings seepage migration and downgradient impacts.[22]

The GMP does not specify trigger levels for groundwater monitoring parameters. The reasons cited included the large potential spatiotemporal variation in groundwater elevations and chemistry, similarity between the hydrochemistry at the RDA area and the receiving groundwater environment, as well as changes in groundwater quality that have already occurred around the perimeter of the RDA area.

Instead, by understanding the mechanism on how groundwater mounding may result in native vegetation impairment, the GMP established triggers and associated management actions, based on a quasi-staged weight-of-evidence approach (Table 14).

Table 14: Proposed trigger and management actions

Monitoring parameter(s)	Monitoring frequency	Trigger(s)	Management action(s)
Groundwater level (i.e., standing water level)	Quarterly	Increase in groundwater level within a deep monitoring bore (i.e., screened within weathered and fractured bedrock hydrogeological unit) greater than the background variation.	Groundwater levels within the corresponding shallow bore will be assessed for signs of groundwater mounding. Note that the corresponding shallow bore will be routinely monitored regardless of whether this management action was triggered.
		Increase in groundwater level within a shallow monitoring bore (i.e., screened within seasonal shallow hydrogeological unit) greater than the background variation.	Condition of surrounding vegetation will be assessed for signs of stress, impairment, or death. Note that the visual condition of vegetation will be routinely monitored regardless of whether this management action was triggered.
Groundwater quality (i.e., total dissolved solids, sulfate, cobalt, weak acid dissociable cyanide, etc.)	Quarterly	Evidence of tailings seepage influence in ambient groundwater of cross-catchment monitoring bores, as determined by a suitably qualified and independent hydrogeologist as part of an annual groundwater review.	Within three months of the annual groundwater review: • Undertake a risk assessment on potential impacts to the downgradient groundwater environment; • Determine whether mitigation measures are required (e.g., seepage recovery bores), and if so, the relevant implementation

[22] Additional monitoring locations were deemed necessary, as the density of existing monitoring bores was concentrated at the perimeter of the RDA area, which is appropriate for early detection of tailings seepage influences. However, they may not be appropriate for providing a regional perspective, as they may be influenced by sump water re-infiltration and does not inform shifts in groundwater chemistry in hydraulically downgradient environments, especially across catchment boundaries.

Groundwater within cross-catchment environment is currently monitored by existing monitoring bores F1BR34D, F1BR39D, F1BR40D, F1BR44D, F1BR43D, BUBR6, BUBR7, and BUBR11. However, it was noted that several of these monitoring bores are usually dry, lack lithological bore logs to inform screened unit, or are screened inappropriately across two or more hydrogeological units. Furthermore, the monitoring coverage provided by the existing bore network is inadequate in some areas to the north and west of the F1 RDA.

Monitoring parameter(s)	Monitoring frequency	Trigger(s)	Management action(s)
			actions and timeframe; and • Report the results of the investigation and planned actions to the department.
Plant cell density (PCD)	Annual	Decline of 20% or greater within an individual one-hectare grid block.	Desktop review will be undertaken to discount the source of PCD as planned clearing and/or changes in infrastructure); and If the PCD decline was not caused by clearing and/or changes in infrastructure, a site inspection will be undertaken to visually verify the PCD results (see below) If PCD decline occurs within the established vegetation transect, transect monitoring may be undertaken, especially for individual tree health assessment
Visual monitoring of vegetation condition	Quarterly	Observable evidence of vegetation impairment, including vegetation stress and/or death.	Within three months of monitoring report being finalised: • Identify whether the impacted vegetation is located within an area approved for clearing. If so, no further actions will be taken. • If not, investigate potential of external causes for observed impairment (i.e., not relating to tailings seepage). If so, no further actions will be taken. • Relevant groundwater monitoring data will be assessed to determine whether observed impairment may be related to groundwater mounding and influence from tailings seepage. • If so, determine appropriate mitigation measures are required (e.g., improving, deepening or extending current perimeter drains and sumps, seepage recovery bores, etc.), including implementation actions and timeframe.
Transect vegetation monitoring	Not routine	Observable evidence of vegetation impairment, including vegetation stress and/or death.	

In addition to monitoring programs, the GMP also recommended upgrades to the existing perimeter sump and groundwater monitoring bore networks to improve and sustain tailings seepage interception as a result of the proposed expansion to the F1 RDA. These have been described in Section 2.3.2 and Section 2.3.3 and will be undertaken as part of works to raise the F1 RDA.

In relation to observed vegetation impairment at Saddle Dam 3, the Licence Holder has completed works in 2023 to improve existing perimeter drainage system to minimise overflow into and pooling within the impact site. During an inspection in November 2023, vegetation regrowth was observed at the margins of the impact site, though no improvements were apparent in the main area. Therefore, the Licence Holder has undertaken a geophysical survey

to identify preferential seepage flow pathways around Saddle Dam 3 and inform potential options for further seepage mitigation. As it is currently not known how much groundwater levels within the seasonal shallow hydrogeological unit has to be reduced to improve vegetation health, the Licence Holder proposed an adaptive monitoring approach, where:

1. Stage 1 will involve extending the perimeter trenches and sumps to be as close to the impact zone as feasible. The trenches and sumps will be excavated as deep as possible (depending on local geology) and backfilled with coarse rock to maximise groundwater inflows. Following this, the vegetation condition at the impact site as well as nearby monitoring bores F1BR29S and F1BR29D will be monitored quarterly until mid-2025. I
2. If no significant improvement in vegetation condition is observed by mid-2025, Stage 2 will be implemented, involving the installation of seepage recovery bores. The bores will be advanced to approximately 50 mbgl and be fully screened, so that submersible pumps can be installed deeper than 10 mbgl to capture groundwater from both seasonal shallow hydrogeological unit and depressurise the weathered and fractured bedrock hydrogeological units, which are the primary source of vegetation impairment and driver of groundwater mounding, respectively. Following this, the vegetation condition at the impact site as well as nearby monitoring bores F1BR29S and F1BR29D will continue to be monitored quarterly to determine whether refinement or expansion of Stage 2 mitigation measures is required.

The GMP also outlined groundwater management strategies after the closure of the F1 RDA as well as the anticipated construction of an additional RDA to the north-east of the F1 RDA. These strategies were not considered under this detailed risk assessment, as the former is typically regulated by DMPE under the *Mining Act 1978*, while the latter will need to be assessed under an application for a works approval.

3.5.7 Risk assessment

Based on the information presented, the department has assessed each relevant risk event and determined a risk rating for each risk event, based on the consequence and likelihood of impacts to sensitive receptors as a result of the proposed activities (Table 15), in accordance with the *Guideline: Risk assessments* (DWER 2020c).

Table 15: Risk rating for risk assessment for tailings seepage emissions

	Risk event	Consequence	Likelihood	Risk rating
Proposed activities: Operation of the F1 RDA above authorised saddle dam height of RL 361.0 m, through four-staged embankment raises to a maximum saddle dam height of RL 369.9 m. **Emission and pathway of concern:** Tailings seepage infiltrating vertically through the facility base and laterally through saddle dam walls.				
1	Localised mounding of water table, resulting in potential inundation of root zone of surrounding native vegetation.	**Moderate** Vegetation stress and/or death. Surrounding vegetation community is characterised by jarrah and marri trees, which are known to be susceptible to waterlogging.	**Possible** Groundwater mounding has been observed around the perimeter of the F1 RDA, in both deep and shallow monitoring bores. Further mounding in already severely mounded areas of the facility is not expected to occur as groundwater level is nearly at surface level. Groundwater mounding has been observed in some regional monitoring bores. Vegetation impacts have been observed historically in areas where groundwater mounding was most severe (i.e., north-west). However, no incident has been observed since incident at Saddle Dam 3. Perimeter sumps will be maintained. Perimeter sump SD3SU-B will be constructed to the north-west of the F1 RDA with a deeper sump depth trialled. Groundwater management plan has been developed and implemented, with a combination of routine and staged monitoring of both ambient groundwater and vegetation condition. As part of the groundwater management plan, remediation actions have been proposed for impacted vegetation areas at Saddle Dam 3.	**Medium risk** The controls proposed by the Licence Holder have been included in amended licence L8306/2008/3. Monitoring of ambient groundwater should continue in accordance with the licence conditions. The replacement of groundwater monitoring bores and the construction of deep perimeter sump SD3SU-B is supported. The department has included operational requirements to maintain storage capabilities of existing perimeter sumps. The department has also conditioned the proposed vegetation condition monitoring in the amended licence. Further, the department considers the following additional regulatory requirements to be necessary: • Construction of perimeter sump SD3SU-B to a minimum depth of 5.0 mbgl. • Specified limits for standing water level at regional cross-catchment groundwater monitoring locations.

	Risk event	Consequence	Likelihood	Risk rating
2	Localised mounding and contamination of unconfined aquifer, resulting in uptake of seepage contaminants by surrounding native vegetation.	**Moderate** Vegetation stress and/or death. Surrounding vegetation community is characterised by jarrah and marri trees, which are known to be susceptible to waterlogging. While the impacts of contaminant uptake are not well understood, salinity may have adverse impact on jarrah.	**Possible** Historical monitoring has shown that groundwater salinity has increased in the seasonal shallow hydrogeological unit following groundwater mounding from the weathered and fractured bedrock hydrogeological unit, though the impacts of this could not be ascertained due to existing vegetation impacts from root zone inundation. Infiltration of sump water and preferential seepage pathways are also thought to be present within the seasonal shallow hydrogeological unit, which allows tailings seepage contaminants to migrate directly through the shallow unit, bypassing conventional migration pathway through the deeper units.	**Medium risk** The controls proposed by the Licence Holder have been included in amended licence L8306/2008/3. Monitoring of ambient groundwater and perimeter sump should continue in accordance with the licence conditions. The department has also conditioned the existing monitoring of the water quality at the decant pond, underdrainage system and LCRS in the amended licence, to better understand tailings seepage chemistry. Furthermore, the department has conditioned the proposed vegetation condition monitoring in the amended licence. The replacement of groundwater monitoring bores and the construction of deep perimeter sump SD3SU-B is supported. The department has included operational requirements to maintain storage capabilities of existing perimeter sumps. The department considers the following additional regulatory requirements to be necessary: • Specified limits for WAD CN at regional cross-catchment groundwater monitoring locations.
3	Subsurface lateral migration of seepage contaminants, resulting in contamination of groundwater within South Dandalup Catchment Area Public Drinking Water Source Area (PDWSA), and potentially migrating to the nearby ephemeral South Dandalup	**Major** Potential contamination of the Priority 1 Lake Banksiadale and the South Dandalup Dam, which may reduce drinking water resource within Western Australia and result in legacy contamination issues. Loss of environmental value of	**Unlikely** Most severe groundwater mounding is currently limited to the perimeter of the F1 RDA, which is outside of the PDWSA, except at a few monitoring locations. Significant changes in groundwater chemistry have not been observed, especially for key tailings seepage indicators, such as sulfate,	**Medium risk** The controls proposed by the Licence Holder have been included in amended licence L8306/2008/3. Monitoring of ambient groundwater and perimeter sump should continue in accordance with the licence conditions.

	Risk event	Consequence	Likelihood	Risk rating
	River.	surface waterbody.	cobalt, and weak acid dissociable cyanide (WAD CN). Tailings seepage is unlikely to migrate to the South Dandalup Dam due to slow travel time and geochemical attenuation. However, contaminants may reach and express surficially at South Dandalup River, where it may be carried to South Dandalup Dam by catchment runoff. While low, the likelihood of this occurrence is higher than direct subsurface migration to the South Dandalup Dam. Water quality at South Dandalup River is currently being monitored monthly. Based on most recent data, groundwater quality at deep monitoring bores generally complied with human and livestock drinking water guideline value. Based on most recent data, surface water quality at South Dandalup River complied with human and livestock drinking water guideline value.	The replacement of groundwater monitoring bores and the construction of deep perimeter sump SD3SU-B is supported. The department has included operational requirements to maintain storage capabilities of existing perimeter sumps. Additional regulatory requirements have been addressed as part of Risk Event 1 and 2. Further, the department considers the following additional regulatory requirements to be necessary: • Modification to Annual Environment Report requirement to consider ionic composition as a method for detecting tailings seepage influence in ambient surface water and groundwater. • Modification to Annual Environmental Report requirement to consider human drinking water guideline values during assessment of surface water and groundwater quality at relevant monitoring locations.
4	Subsurface lateral migration of seepage contaminants, resulting in contamination of groundwater near groundwater-dependent surface waterbodies (e.g., swamps, creeks).	**Minor** Potential contamination and loss of environmental value of surface waterbody.	**Possible** Groundwater mounding has been observed around the perimeter of the F1 RDA, in both deep and shallow monitoring bores. Groundwater mounding to the south may be due to either the F1 RDA or the D1 Dam. Tailings seepage migrating southwards was thought to be captured by the D1 Dam. However, Pillow Swamp, Boomerang Swamp, and Round Swamp are located to the east of the D1 Dam, where tailings seepage may not be intercepted by the D1 Dam.	**Medium risk** The controls proposed by the Licence Holder have been included in amended licence L8306/2008/3. Monitoring of ambient groundwater and perimeter sump should continue in accordance with the licence conditions. The replacement of groundwater monitoring bores and the construction of deep perimeter sump SD3SU-B is supported. The department has included operational requirements to maintain storage capabilities of existing perimeter sumps.

	Risk event	Consequence	Likelihood	Risk rating
			Groundwater levels at these swamps and Boggy Brook are currently being monitored, in accordance with the Licence Holder's *Groundwater and Groundwater Dependent Vegetation Monitoring and Management Plan* (Umwelt 2021) under Ministerial Statement 971. Water quality at Boggy Brook is currently being monitored monthly under the existing licence. Based on most recent data, surface water quality at Boggy Brook complied with human and livestock drinking water guideline value.	Further, the department considers the following additional regulatory requirements to be necessary: • Ambient surface water monitoring at Pillow Swamp and Boomerang Swamp.[1] Detection of tailings seepage impacts at either Pillow Swamp and/or Boomerang Swamp may require necessitate surface water monitoring at Round Swamp as well.

Note 1: Refer to Appendix 1, Item 40 for justification for exclusion of Round Swamp from amended condition 28.

In accordance with the outcome of the risk assessment, the department has amended the existing licence conditions in the following manner.

Ambient groundwater monitoring program

It was identified that the proposed activities will result in the decommissioning of groundwater monitoring bores at several monitoring locations around the perimeter of the F1 RDA (refer to Section 2.3.3). The Licence Holder's proposed replacement monitoring bores and the rationale provided were adequate (Table 5). Monitoring bore F1BR16D is currently specified in existing licence L8306/2008/3 and will be impacted by the proposed activities. However, a replacement bore was determined to not be feasible due to spatial limitations at this monitoring location, which is located between the F1 RDA and D1 Dam. However, the Licence Holder has proposed to monitor the nearby existing monitoring bore O234BR3. As a result, the department has removed monitoring bore F1BR16D from amended condition 29 and replaced it with monitoring bore O234BR3, as per recommendations by BDH (2023c).

In addition to the licensed monitoring bores, the Licence Holder has proposed to monitor up to 108 groundwater monitoring bores surrounding the F1 RDA. The Licence Holder proposed to formalise the groundwater monitoring program under the GMP, rather than conditioned under amended licence L8306/2008/3.

While the department is supportive of the commitment made by the Licence Holder to undertake additional monitoring, regulation of monitoring programs under the licence is considered standard practice in terms of ensuring clarity and enforceability of said programs. Consequently, the department has reviewed the 108 monitoring bores proposed and revised the monitoring bores specified in amended condition 29. The following monitoring bores have been included in Table 16 of the amended licence, with the following reasons provided:

- **Ambient groundwater monitoring of the seasonal shallow hydrogeological unit** – Existing condition 28 requires a number of deep bores to be monitored. The shallow paired bores are not required to be monitored under existing licence L8306/2008/3. Understanding the local mechanisms for groundwater mounding and relevant trigger (as detailed in the GMP; BDH 2024b), the department has specified the relevant shallow bores in the amended licence for ambient groundwater monitoring, including O234BR3, F1BR22S-2, F1BR23S, F1BR24S, F1BR25S, F1BR35S, F1BR36S, F1BR38S-2, F1BR39S, F1BR40S, F1BR42S, R4BR105S, R4BR106S. A similar rationale is provided for the inclusion of monitoring bore F1BR19D in the amended licence, where only the shallow bore was specified under the existing licence. A total of 14 additional monitoring bores have been included in the amended licence.
- **Improved ambient groundwater monitoring resolution around F1 RDA perimeter** – To ensure adequate monitoring resolution throughout the perimeter of the F1 RDA, the department specified the relevant monitoring bores in the amended licence for ambient groundwater monitoring, including: F1BR41S and F1BR41D, R4BR107S and R4BR107D, as well as R4BR13. A total of five additional monitoring bores were included in the amended licence.
- **Ambient groundwater monitoring across catchment boundaries** – As impacts associated with tailings seepage have already been observed at operational monitoring bores, adequate attention should be given to potential impacts emerging hydraulically downgradient of the facility. This is particularly important around the northern portion of the F1 RDA, which abuts neighbouring catchments, including the Priority 1 South Dandalup Dam Catchment Area PDWSA. Consequently, the department has specified seven additional regional monitoring bores in the amended licence for ambient groundwater monitoring, including:
    - F1BR44S and F1BR44D, located north-west of the facility and hydraulically cross-gradient to monitoring bores F1BR43S and F1BR43D, to improve regional monitoring resolution.

- F1BR45S and F1BR45D, located north-west of the facility, further hydraulically downgradient of monitoring bores F1BR44S and F1BR44D, to monitor downstream impacts, which may also affect the neighbouring South Dandalup River.
- R4BR102S and R4BR102D, located south-east of the F1 RDA and R4 RDA, to monitor potential impacts hydraulically downgradient of the facilities. It was noted that currently licensed monitoring bores F1BR42D, R4BR105D, and R4BR106D are located further hydraulically downgradient along Boggy Brook, with no monitoring locations currently located hydraulically upgradient of Boggy Brook for monitoring impacts before reaching Boggy Brook.
- MUBR1, located approximately 3.2 km west of the facility, to monitor hydraulically downstream impacts. Due to the siting of the monitoring bore, only groundwater level is required to be monitored at this stage, consistent with the recommendation from the GMP.

Currently, groundwater monitoring bores specified in existing licence L8306/2008/3 have been classified as either monitoring sites or compliance sites, where compliance sites contained targets for several monitoring parameters. These targets were subsequently removed from the licence in an amendment in 2020.

Based on the assessment and classification undertaken by BDH (2019), the department considers it useful to reclassify the licensed monitoring bores as operational, regional, and non-RDA monitoring bores:

- **Operational monitoring bores** – Monitoring bores located within the monitoring zones shown in Figure 3. Operational monitoring bores are typically located at the perimeter or close to the F1 RDA, where impacts from tailings seepage have historically been observed. Groundwater monitoring at these bore locations allow seepage to be detected and tracked over time. These monitoring bores can also inform the risk of impact to fringe vegetation.
- **Regional monitoring bores** – Monitoring bores located outside the monitoring zones shown in Figure 3. Regional monitoring bores are located across catchment boundaries from the F1 RDA. Regional monitoring bores assess whether impacts from tailings seepage have occurred at neighbouring catchments, specifically the South Dandalup Dam Catchment Area, which is a Priority 1 PDWSA. Historically, the impacts of tailings seepage have not been observed within these monitoring bores.
- **Non-RDA monitoring bores** – Monitoring bores located further south of the F1 RDA have been classified as non-RDA monitoring bores, as they are likely to be more strongly influenced by other hydrogeological processes (e.g., dewatering drawdown) than groundwater mounding from the RDA. The department has not considered the adequacy of these monitoring bores as part of this detailed risk assessment. Therefore, no amendments have been made to this bore network.

Both the revised monitoring bore classifications, as well as revised monitoring bores specified in the amended licence, were based on current available information. The department acknowledges that the process of prioritising the importance of monitoring bores within a fractured bedrock aquifer setting can be challenging due to varying degrees of heterogeneity in the target geology. Furthermore, due to the complex hydrogeological regime within fractured bedrock aquifers, distinctions between operational monitoring bores (i.e., directly impacted by tailings seepage) and regional monitoring bores (i.e., currently unimpacted across catchment boundaries) may not be clear. Consequently, the licensed bores and bore classifications may be revised in the future, based on new information available.

The department has also specified limits for standing water level and WAD CN as additional regulatory requirements for ambient groundwater monitoring (refer to Section 3.5.8).

Additional regional monitoring bores and perimeter sump SD3SU-B

The proposed locations for additional groundwater monitoring bores (i.e., F1BR49 to F1BR54 series) are generally supported by the department. It is important that deep bores are installed within the weathered and fractured bedrock hydrogeological unit that is likely the primary groundwater transmission zone. The most effective method for identifying fracture zones would be through reviewing existing geological and geophysical information and undertaking additional ground-based geophysical investigations using electromagnetic and electrical techniques in areas where groundwater mounding is occurring. As such, the indicative locations for the installation and monitoring of additional monitoring bores have been specified under conditions 16 and 29 of the amended licence L8306/2008/3.

Existing perimeter sumps will continue to be maintained and operated through the F1 RDA Stage 19 to Stage 22 embankment raises. The continued operation of these sumps is important for intercepting and limiting the migration of tailings seepage in groundwater. Nevertheless, it is understood that the sump footprint and dimensions would be modified over time to accommodate necessary buttress extensions. While the department acknowledges modifications are inevitable for maintaining the safety and stability of the F1 RDA, it is also important that the capabilities of existing sumps are not compromised as a result. Hence, the department has specified operational requirements (including the maintaining existing sump storage capacities) under condition 13 of the amended licence.

Deepening of existing perimeter sumps are unlikely to be feasible. However, the Licence Holder has proposed to construct perimeter sump SD3SU-B at the topographical low point between existing perimeter sumps SD3SU-A and SD3SU-C, while trialling a deeper sump design to improve groundwater recovery. This is supported by the department, as groundwater mounding in this area presents the greatest risk towards the nearby PDWSA. Further, BDH (2019) suggested that increased seepage rates are expected to manifest primarily as an increase in sump pumping rates, especially in areas where groundwater levels have reached and stabilised at surface level. Relevant construction requirements for perimeter sump SD3SU-B have been included in condition 15 of the amended licence.

The department notes that, while it is supportive of the use of seepage recovery bores as a means of actively managing groundwater mounding, relevant bore design and locations has not been assessed and endorsed by the department.

Recommendations from Annual Hydrological Review

In addition to the risk assessment, the department also addressed several recommendations brought up in the most recent annual hydrological review (BDH 2024a):

1. The potential removal of mercury, selenium, lead and thallium from ambient surface water and groundwater monitoring programs specified under amended conditions 28 and 29. The rationale was that these parameters have been detected at or below the limit of reporting in surface water and groundwater, including the F1 RDA decant pond. The value of continuing the monitoring of these parameters was questioned. While this was not examined in detail under this assessment, the Licence Holder may propose these parameters be removed should adequate evidence be provided. However, the department notes that these parameters have been detected periodically at the decant pond, even within the 2023 annual period. Furthermore, in the same period, lead has been consistently detected at several groundwater monitoring locations. The department is also unlikely to remove the monitoring requirement for selenium, due to the associated risks with impacts to avifauna.
2. The potential removal of titratable acidity (as $CaCO_3$) from ambient surface water and groundwater monitoring programs specified under amended conditions 28 and 29. The

rationale was that surface water at the premises contains a neutral pH, with acidity values typically being less than 20 mg/L. While groundwater has naturally low pH in some locations, the groundwater is strongly buffered with no evidence of potential changes from tailings seepage. Monitoring of pH was suggested to be sufficient. The department disagrees with this rationale as titratable acidity is considered a better indicator of latent acidity potentially present in groundwater due to oxidation of sulfidic minerals, especially at the premises with relatively high buffering capacity. Continuation of such precautionary monitoring is deemed necessary, given the siting of the F1 RDA near the PDWSA.

3. Replacement of titanium with thallium from ambient surface water and groundwater monitoring programs specified under amended conditions 28 and 29. While thallium monitoring was previously specified under both conditions under expired licence L8306/2008/2, an error was made during the renewal of the licence, where the parameter was replaced with titanium. The Licence Holder sought clarification on this change, and following the department's advice, continued monitoring for thallium. The department has amended this error in both conditions to specify monitoring of thallium in surface water and groundwater, instead of titanium.
4. Potential removal of monitoring bore LPBR1 from ambient groundwater monitoring program specified under amended conditions 29. The monitoring bore has been dry since 2019 after a steady decline in groundwater level from 2010. The bore is thought to be affected by drawdown of the water table from mine dewatering of the nearby Wandoo North and South Pits. The department supports this recommendation, but stresses that the bore should be maintained throughout the operating life of the premises, as there is still value in monitoring once mine dewatering ceases. Consequently, monitoring bore LPBR1 has been removed from Table 16 in amended licence L8306/2008/3.
5. Potential removal of monitoring bore F1BR35D from ambient groundwater monitoring program specified under amended condition 29. Since 2016, the monitoring bore been inaccessible due to surface expression of groundwater and subsequent inundation of the area. The bore is currently within the flooded area associated with the expanded SD5SU-B sump, which is monitored monthly under amended condition 28. The monitoring bore has been flagged for replacement as part of the proposed expansion (Table 5). Consequently, monitoring bore F1BR35D has been removed from Table 16 in amended licence L8306/2008/3.

Vegetation condition monitoring

In accordance with proposed monitoring, triggers, and triggered actions for vegetation condition within the GMP, the department has specified vegetation condition monitoring in condition 30 of amended licence L8306/2008/3. The monitoring locations specified for vegetation condition monitoring corresponds to groundwater monitoring locations specified under amended condition 29. As requested by the Licence Holder, the department has also specified annual monitoring of plant cell density using multispectral imagery under amended condition 30 to complement visual monitoring.

Management actions based on those proposed in the GMP have also been included in amended condition 30, in the event where a decline in vegetation health and/or vegetation death has been observed. The department has also included a requirement to notify the CEO following identification of an impact caused by changes in local groundwater conditions.

Ambient surface water monitoring program

Similar to the existing groundwater monitoring bore classifications (described above), surface

water monitoring locations have also historically been classified as either compliance sites or background sites. With targets removed from the compliance sites, there are no significant differences between the two classes of monitoring locations. Consequently, the department has removed this classification.

In addition to water quality monitoring at perimeter sumps, the department has also included water quality monitoring at the F1 RDA decant pond, underdrainage system, and LCRS in amended condition 28. Monitoring at these potential tailings seepage sources may complement downstream monitoring at perimeter sumps, groundwater monitoring bores, as well as offsite surface water bodies.

The department has also specified additional regulatory requirements in the form of additional surface water monitoring locations (refer to Section 3.5.8).

Cyanide process monitoring

Currently, the Licence Holder is required to undertake real-time monitoring of WAD CN in return water passing through the residue booster station, with a specified limit of 30 mg/L over a 15-minute averaging period. The treated return water will be sent to the processing plant for ore processing. As the risk of potential impact is likely to be low, the department has amended the requirement to instead require WAD CN monitoring for tailings slurry that will be deposited at F1 RDA.

The concentration of WAD CN in deposited tailings presents a greater risk compared to return water, as tailings supernatant may be exposed to environmental receptors through several pathways, including seepage to the underlying groundwater or ingested as drinking water by transient wildlife.

Under the Cyanide Management Plan, the Licence Holder aims for WAD CN in treated tailings slurry and decant pond water to be no higher than 42.5 mg/L and 30 mg/L, respectively.

Consequently, the department has specified a limit of 50 mg/L over a 60-minute averaging period for WAD CN in treated tailings slurry. This limit aligns with notification requirements under existing condition 36, as well as the WAD CN target at perimeter sumps under existing condition 27, for the protection of wildlife in the event tailings supernatant is ingested.

Revision to the water balance monitoring

A water balance for the F1 RDA has been monitored by the Licence Holder since 2021. However, this assessment revealed that the monthly seepage volume estimated was not derived with the intended methodology (refer to Section 3.5.2). Consequently, the department has amended condition 25 to better specify the requirements for water balance monitoring.

3.5.8 Additional regulatory requirements

Based on the risk assessment in Table 15, the department has determined that additional regulatory requirements should be implemented to manage the risk of impact from the proposed activities on sensitive receptors.

Depth of perimeter sump SD3SU-B

The Licence Holder has proposed to construct a proper perimeter sump at location SD3SU-B, at the topographic low point between existing perimeter sumps SD3SU-A ad SD3SU-C. As the location currently collects water, it is likely able to intercept tailings seepage migrating away from the F1 RDA. For this perimeter sump, the Licence Holder has proposed to trial the

construction of a deeper sump.

The department supports the proposed deep sump construction at this location, due to high levels of groundwater mounding along the north-western perimeter of the F1 RDA, as well as its proximity to the nearby PDWSA further north and north-west of the premises. Consequently, the department has specified a minimum sump depth of 5 mbgl as an additional regulatory requirement for the construction of perimeter sump SD3SU-B in condition 15 of the amended licence.

The minimum depth requirement was informed by BDH (2023b, 2024b), which indicated that the effectiveness of perimeter sumps may be bolstered by increasing sump depth in the following ways:

- Prevent potentially impacted water from the sump from seeping into the seasonal shallow groundwater system;
- Drain groundwater from the seasonal shallow groundwater system into the sumps, which will minimise the risk of groundwater mounding impacting the root zone of nearby vegetation;
- Intercept groundwater rising through the oxide unit from the underlying weathered and fractured bedrock aquifer before it enters the seasonal shallow groundwater system;
- Create a local lowering in groundwater levels within the weathered and fractured bedrock groundwater system, which would drive preferential capture of seepage and groundwater, compared to continual flow into the receiving environment; and
- Allow the sumps to continue capturing groundwater and seepage for longer during closure, when local groundwater levels have settled as a result of cessation of tailings deposition.

Furthermore, the department views the operation of deeper sumps necessary, where feasible to do so, due to a predicted increase in seepage rates as result of continued tailings deposition into the F1 RDA. Impacts were thought to manifest most evidently in areas where groundwater levels have reached and stabilised near ground surface levels (e.g., Saddle Dam 3 perimeter), resulting in the need for greater sump interception and pumping.

Specification of limits for groundwater monitoring parameters

The GMP has indicated that the specification of trigger levels was not possible due to several factors (e.g., large background and seasonal variation, etc). Consequently, trend-based triggers were proposed for groundwater level and groundwater quality, with trigger exceedances prompting further investigation.

The department understands that setting triggers is challenging, particularly for operational monitoring bores, which are located close to the F1 RDA perimeter. Given that previous investigations have established groundwater mounding, that is, an increase in groundwater level, to be the earliest and most reliable indicator of tailings seepage influence, the department has specified a limit of 4.0 mbgl on standing water level in amended condition 29.

The limit has been applied to only regional monitoring bores due to the following reasons:

- Regional monitoring bores require higher level of protection, as groundwater mounding at these monitoring bores suggest tailings seepage has crossed catchment boundary and may pose a non-negligible risk to surrounding receptors, especially the PDWSA.
- Regional monitoring bores are currently able to comply with the specified limit of 4.0 mbgl.
- Operational monitoring bores are located close to the perimeter of the F1 RDA, where environmental receptors are present but are of lower sensitivity.

- Operational monitoring bores are located close to the perimeter of the F1 RDA and are within the same catchment as the facility. Perimeter sumps are also present in the area to manage groundwater mounding. As most of the perimeter has been cleared, there is also potential for additional seepage recovery measures to be implemented with relative ease, should it be required (i.e., installation of seepage recovery trenches and/or bores).
- A number of operational monitoring bores are not able to comply with the specified limit as they are already impacted by groundwater mounding.

Furthermore, the department has also specified a limit of 50 mg/L and 0.5 mg/L for WAD CN at surface water and ambient groundwater monitoring locations, respectively, under amended condition 28 and 29. The limit has been applied to both operational and regional monitoring locations. This is because, unlike other parameters, WAD CN is typically not found in the natural environment in significant concentrations, allowing for a standardised approach towards setting a limit. This approach has been adopted by the department for the management of cyanide in gold tailings seepage.

Groundwater monitoring bore network review at Saddle Dam 3

Under the GMP, the Licence Holder has proposed to install additional groundwater monitoring bores around the west, north, and east of the F1 RDA to better monitor tailings seepage impacts across catchment boundaries.

While the department agrees that the proposed monitoring bores will improve groundwater monitoring around the F1 RDA, additional monitoring locations should be considered to the north-west and north of the facility:

- To the north, there is no regional monitoring bore beyond those proposed for installation at the boundary of the F1 RDA disturbance footprint.
- To the north-west, there is a considerable distance between existing operational monitoring bores and existing F1BR43 and F1BR44 series regional bores. It is also noted that the former is adjacent to a tributary of the South Dandalup River, with F1BR46 series regional bores present further hydraulically downgradient.

These two areas of the F1 RDA were highlighted due to the relatively significant groundwater mounding and impacts already observed, as well as the siting of the neighbouring PDWSA. Notably, the existing F1BR43, F1BR44, and F1BR45 series monitoring bores are located within the PDWSA, which may not be adequate for detection of tailings seepage prior to migration into the PDWSA.

However, the Licence Holder has expressed concerns over the feasibility of installing groundwater monitoring bores at the specified areas, due to the following reasons (refer to Appendix A):

- The specified locations being within State Forest with no current access. Works to install groundwater monitoring bores will likely require native vegetation clearing to establish an access track and drill pad. Further approvals to clear native vegetation may be required. Cultural surveys may also potentially be required, which may require considerable time to action. Access through the nearby Bibbulmun Track have also been considered and found to be complicated.
- Access and works within the State Forest is further impeded by the winter season to minimise the risk of dieback infestation, in accordance with the Licence Holder's Weed and Disease Management Plan (as required under MS 971).
- The value of installing monitoring bores hydraulically downgradient of the Saddle Dam 3 may not be justified, when considering the need for further native vegetation clearing.
- Further, it was highlighted that existing groundwater monitoring bores are being

monitored frequently, with additional monitoring bores to be installed prior to the commencement of operations of the F1 RDA Stage 19 embankment raise. The most recent hydrogeological review in 2023 also indicated that while groundwater mounding has been observed at the catchment boundary in some locations, there has been no migration of solutes or change in groundwater chemistry across catchment boundaries.

- At the scheduled rate of works, the F1 RDA will likely have a remaining operating life of approximately four years, from which the Licence Holder is planning to transition tailings deposition to the planned RDA 2.

While the department considers higher groundwater monitoring resolution to be justified in areas surrounding the PDWSA, the proposed groundwater monitoring bores at F1BR51 and F1BR52 may be sufficient at this stage. Monitoring of ambient groundwater at these locations, which are hydraulically downgradient of the impacted operational monitoring bores, may enable delineation of the tailings seepage plume.

Consequently, the department has included a specified action in condition 32 of the amended licence to undertake a groundwater monitoring bore review around Saddle Dam 3 to determine whether additional monitoring bores are required further downgradient of the proposed F1BR51 and F1BR52 series monitoring bores, following installation and monitoring of these monitoring bores.

Ambient surface water monitoring at swamps south of F1 RDA

The department considers ambient surface water monitoring at the nearby Pillow Swamp and Boomerang Swamp located south of the F1 RDA to be required. These swamps were found to be groundwater-dependent ecosystems, which receive groundwater discharge.

Groundwater modelling has suggested greater flow rates to the south, likely driven by continuous mine dewatering at the Wandoo North and South Pits. While some tailings seepage migrating southwards may be intercepted by the D1 Dam, the swamps are located further east of the D1 Dam and may be influenced by tailings seepage. Furthermore, groundwater mounding from the oxide mining period has not dissipated at the R4 RDA (BDH 2019) or is at least persisting due to continued water storage and mounding from the neighbouring F1 RDA.

Therefore, monitoring at these swamps is considered required to understand potential impacts. The department understands that these swamps currently have associated monitoring bores and are being monitored for drawdown impacts from nearby groundwater abstraction under Part IV of the EP Act. Potential impacts from tailings seepage are not monitored as part of the existing monitoring program.

Consequently, the department has included these monitoring locations in amended condition 28 of the amended licence, in line with other surface waterbodies currently monitored under licence L8306/2008/3.

Due to issues concerning access and potential requirements for further approvals by other decision-making authorities highlighted by the Licence Holder (refer to Appendix A), the department has not required monitoring of Round Swamp at this stage. Round Swamp is located further south of the F1 RDA, making it less likely to be impacted, at least prior to impacts being potentially observed at either Pillow Swamp or Boomerang Swamp. Surface water monitoring from Pillow Swamp and Boomerang Swamp will be assessed prior to determining whether monitoring at Round Swamp is justified.

The monitoring of the associated groundwater monitoring bores at these swamps may complement ambient surface water monitoring, though this was not included in the amended licence as they are already regulated under MS 971. Should the risk rating for the relevant risk event increase, the department may consider requirements for monitoring ambient groundwater quality at these swamps under licence L8306/2008/3 to be justified.

Specification for surface water and groundwater assessment in Annual Environmental Report

As mentioned in Section 3.5.4, there is good evidence supporting the monitoring of sulfate, cobalt, and WAD CN as indicators of tailings seepage from the F1 RDA. However, distinct shifts in chemical composition of groundwater can also be studied through the use of ionic ratios graphed into Stiff diagrams or Piper plots, which has previously been investigated by BDH (2019). As such, the department has amended condition 37 to specify this as part of the annual environmental reporting requirements.

Furthermore, the department considers that the siting of the F1 RDA next to the South Dandalup Dam Catchment Area PDWSA to require an assessment of ambient surface water and groundwater monitoring information against human health drinking water guidelines (NHMRC & NRMMC 2024) as part of the annual hydrological review required under amended condition 37. The assessment should only be undertaken for relevant monitoring locations (e.g., monitoring bores located near or within the PDWSA and South Dandalup River). Consequently, the department has specified the comparative assessment be required only at surface monitoring location SDBK2 and the following groundwater monitoring locations: BUBR10, F1BR34S, F1B34D, F1BR43S, F1BR43D, F1BR44S, F1BR44D, F1BR45S, F1BR45D, F1BR51S, F1BR51D, F1BR52S, and F1BR52D.

3.6 Detailed risk assessment for cobalt exposure to ecological receptors at R4 RDA

3.6.1 Background

As mentioned in Section 2.2.2, the R4 RDA is a historical oxide tailings storage facility, currently being utilised as a water storage facility for future reuse of water for ore processing and other purposes. Most notably, R4 RDA receives water intercepted from F1 RDA, which may be impacted by tailings seepage. During a site visit in December 2018, the department observed the R4 RDA as a significant habitat for terrestrial fauna and avifauna. Indeed, it was found that the R4 RDA hosts a poorly diverse aquatic ecosystem, with fauna visiting seasonally and opportunistically (Hydrobiology 2023).

Since then, the Licence Holder has commissioned numerous investigations to better understand potential risks associated with wildlife being exposed to the water stored at the R4 RDA. Under the CEO-initiated licence review, the department has considered the findings to date in this detailed risk assessment.

3.6.2 R4 RDA water quality characterisation

In 2019, Golder (2019b) undertook a review of water quality from the R4 RDA[23]. The review primarily consisted of development of a water balance for the facility, review of monitoring data, followed by geochemical modelling using both water quality and water balance information[24].

[23] The review primarily focused on metal and metalloid contaminants. Nutrients were not considered as it was not compatible with the geochemical model utilised for the review, owing to differing geochemical processes. Additionally, the input of nutrient-dense treated wastewater from sources such as Storm Water Pond 1 were relatively small. Cyanide was not considered, as concentrations were found to meet the requirements of the Cyanide Code.

[24] The model utilised *Phreeqc* to calculate annual concentrations in a time-step manner. Mixing ratios were estimated using on annual water inputs and outputs at the R4 RDA. The model accounted for aquatic speciation and mineral

The review found that:

- Water quality at the R4 RDA had generally varied but improved over time, especially for copper, which had ranged between 1 mg/L and 213 mg/L prior to 2001, when the facility was used for oxide tailings deposition.
- Water from the F1 RDA underdrainage and LCRS system, as well as perimeter sumps, which are discharged to the R4 RDA to varying degrees, contained higher median concentrations of cobalt, manganese, molybdenum, nickel, and lead.
- Geochemical modelling predicted that, by 2032, water quality at the R4 RDA will become less saline and more acidic (i.e., approximately 6.4 pH unit). Concentrations of aluminium, arsenic, copper, mercury, molybdenum, and selenium were predicted to decrease, while concentrations of cadmium, cobalt, manganese, nickel, lead, and zinc were predicted to increase.

3.6.3 Potential adverse impacts from emission

The R4 RDA is an enclosed waterbody, absent of surface connection to other waterbodies or watercourses. Therefore, it would not be able to be readily colonise or re-colonised by aquatic receptors, such as fish. The facility is unfenced, and as its embankment slopes gently down to the water, would allow the water to be readily accessible by terrestrial fauna. Beyond the waterline, there are low-lying shrubs and grasses to the east, west, and south of the facility.

Transient fauna has been observed using the R4 RDA opportunistically, especially as a water resource. Wildlife observation records at the facility have been recorded since September 2009, with typical receptors being waterbirds and ducks [e.g., Pacific black duck (*Anas superciliosa*), grey teal (*A. gracilis*), and Australian shelduck (*Tadorna tadornoides*)], black swans (*Cygnus atratus*), white-faced herons (*Egretta novaehollandiae*), red-capped plovers (*Anarhynchus ruficapillus*), sandpipers, silver gulls (*Chroicocephalus novaehollandiae*), terrestrial birds [e.g., emus (*Dromaius novaehollandiae*) and swallows], and kangaroos. Between September 2009 and February 2019, approximately 600,000 wildlife observations had been logged, identifying 57 types of birds over the monitoring period (Golder 2019a). These are considered the key ecological receptors for the purpose of this detailed risk assessment.

The water quality review (Golder 2019b) had adopted default guideline values from the ANZG (2018) for the 90% and 95% species protection level as assessment criteria for a Tier 1 risk assessment[25]. Lower levels of species protection were adopted as the R4 RDA was a constructed waterbody and does not represent a pristine, natural environment. The review found that historical median and predicted filterable metal and metalloid concentrations were able to comply with the relevant assessment criteria, except for copper, cobalt, and zinc. By modifying the default guideline values to account for the hardness of the water at the facility, copper and zinc were found to be compliant with the modified assessment criteria, leaving only cobalt as

saturation but conservatively excluded potential metal and metalloid sorption of sediments (i.e., the model did not allow certain minerals to precipitate, even if they were super-saturated in actuality). Detailed specifications and assumptions adopted for the model are not shown in this Amendment Report.

[25] The review acknowledged that the ANZG (2018) default guideline values were designed for the protection of freshwater aquatic ecosystems (e.g., fish, amphibians, invertebrates, algae, and aquatic plants, not ecological receptors that are relevant to this risk assessment. Therefore, compliance with these assessment criteria may not necessarily translate to adequate protection of the ecological receptors at R4 RDA.

However, Golder (2019b) have noted that gill-breathing aquatic organisms (e.g., fish, aquatic invertebrates) are likely at greater risk from exposure to waterborne contaminants. This was because the respiratory surfaces of animals have poorer discrimination, and are therefore more susceptible, against chemicals, compared with the gastrointestinal tract. Thus, guidelines for the protection of aquatic organisms may be sufficiently conservative for the protection of air-breathing receptors that are exposed to water through pathways such as ingestion and dermal contact.

the sole contaminants that had exceeded its assessment criteria.

Cobalt is a naturally occurring element in the earth's crust. It is released during the weathering processes and is strongly bound by mineral and organic-mineral complex (Kosiorek & Wyszkowski 2019). Due to rapid binding of cobalt by organic matter, clay minerals, iron, and manganese in oxide form, cobalt does not persist in an oxidised form for long in water. The result is typically substantial cobalt accumulation in the bottom sediments of freshwater and marine environments (Kosiorek & Wyszkowski 2019).

Cobalt mobility and solubility is determined mainly by its form and sorption processes. Changes in physicochemical conditions may result in cobalt being re-released into the water column. Cobalt is not biodegradable. After its introduction, it constantly circulates within it in different forms.

Elevated cobalt concentrations in flora may disrupt physiological, biochemical, and metabolic processes. While cobalt plays a role in assisting with enzymatic and metabolic processes in aquatic fauna, high concentrations in both freshwater and marine environments can lead to excessive accumulation in internal organs (Kosiorek & Wyszkowski 2019). This accumulation is typically incorporated in inedible parts of fauna, such as gills, kidney, liver, intestines, shell, exoskeleton, etc. Cobalt may also accumulate in edible parts, such as skin and flesh, albeit at lower levels. Not limited to only fish, elevated cobalt uptake has been recorded in bivalves, shrimps, blue-green algae and freshwater algae.

Cobalt may bioaccumulate through the food chain in both terrestrial and avi-fauna. Studies have shown, for example, elevated cobalt concentrations within bird organs (Albayrak & Mor 2011). Females contained more cobalt in their kidneys, due to increased food consumption during egg formation. Mansouri et al. (2012) observed higher cobalt concentrations in the organs of migratory birds, compared to sedentary birds, which was again attributed to differences in quality and source of their diets. Increased cobalt content can also accumulate in bird feathers, due to interstitial excretion from their internal organs (Norouzi et al. 2012).

Default guideline values for cobalt are available for the protection of aquatic organisms in both freshwater and marine environments (ANZG 2018). However, the default guideline value for cobalt of 0.0014 mg/L was based on the lowest available chronic data endpoint (i.e., no observable effects on water flea reproduction at 0.0028 mg/L) with an applied safety factor of two. Golder (2019b) had adopted this default guideline value for a Tier 1 risk assessment.

Due to the low reliability of the default guideline value, it may not be appropriate to undertake site-specific adjustments of the guideline value under a Tier 2 risk assessment. Currently, no formal cobalt guideline values exist for the protection of terrestrial and/or avifauna. Consequently, the impacts of elevated cobalt concentrations in surface water of the R4 RDA, and the associated risks, are not well understood.

3.6.4 Cobalt risk assessment

Following the Tier 1 detailed risk assessment (Golder 2019b; refer to Section 3.6.2 and Section 3.6.3), Golder (2019a) undertook a Tier 3 desktop environmental risk assessment to derive an acceptable concentration of cobalt at R4 RDA waters as a site-specific assessment criterion. The details of this assessment will only be summarised below and not elaborated in detail as the work was updated and built upon by Hydrobiology (2023).

At the time, Golder (2019a) focused the assessment primarily on dietary consumption of cobalt-impacted food items on avifauna species. Other exposure pathways were determined to have relatively negligible impact or were unable to be assessed due to data limitations. Based on historical wildlife records at the R4 RDA, eight avifauna species were selected as focal species. In considering their feeding strategy, diets, area use factors, and a tolerable daily intake (TDI) of 7.61 mg/kg body weight/day, the assessment found that a potentially unacceptable risk was presented to all focal species, assuming cobalt concentration at the R4 RDA was 0.11 mg/L. The red-necked stint (*Calidris ruficollis*) was the focal avifauna species found to be at greatest

risk. Golder (2019a) concluded that cobalt concentrations should not exceed 0.034 mg/L, for the protection of avifauna utilising the facility, which was less conservative than the low-reliability default guideline value of 0.0014 mg/L (ANZG 2018).

In 2023, Hydrobiology (2023) undertook an updated environmental risk assessment, aimed at refining the previous assessment by Golder (2019a) while addressing identified data gaps, such as characterisation of bioavailable cobalt in various media and food sources[26]. The assessment was expanded to not only consider cobalt exposure through consumption but also include drinking water and incidental ingestion of sediment that had not been previously investigated. Furthermore, mammals (e.g., wallaby and kangaroo) were added as focal species to the assessment.

The assessment found that drinking water had a negligible impact on total daily cobalt concentration ingested and was not considered further. On the other hand, the incidental ingestion of sediment did result in small differences in total daily cobalt concentration ingested in all focal species and was determined to have a non-negligible impact. The total daily cobalt concentration ingested through both dietary consumption and incidental sediment ingestion are shown in Table 16.

By assuming a TDI of 7.61 mg/kg body weight/day for avifauna and 7.33 mg/kg body weight/day for mammals, hazard quotients (HQ) were derived for each focal species (Table 16), where a HQ value exceeding one indicated cobalt intake that exceeded the adopted TDI, representing a potentially unacceptable risk.

All focal species had a HQ value of <1, indicating that the risk to these species were generally low, except for the coot (HQ = 1.1). The HQ of the grey teal was also relatively high (HQ = 0.91). The diet of these two omnivorous avifauna species consisted of a high proportion of submerged macrophytes, which was a major driver for these elevated HQ values.

Compared to the HQ values estimated by Golder (2019a) (data not shown), the updated HQ values were consistently lower. This was likely due to the more conservative higher estimated cobalt content applied to food sources in the previous investigation.

By 2032, it was predicted that cobalt concentrations in the sediments at R4 RDA would potentially triple (Table 16) (Golder 2019b). By applying a higher sediment cobalt concentration (i.e., 61.5 mg/kg), total daily cobalt intake increased across all focal species, resulting in a similar increase in HQ values (Table 16). However, HQ values remained below one, except for the coot and grey teal.

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[26] Diffusive gradient thin-film samplers found only approximately 50% of dissolved cobalt was labile in surface water. Sequential extraction of sediment found approximately 30% of cobalt in readily available form, with potential for further release through sediment microbial processes.

Bioavailable cobalt fractions are relevant to undertaking biotic uptake, but in this case, total cobalt concentrations are also a relevant consideration for drinking water and sediment ingestion due to partial dissolution of solid phasis in acidic stomach environments, which can release bound cobalt fractions.

Cobalt concentrations in aboveground vegetation samples varied significantly from vegetation growing under water (i.e., submerged filamentous macrophytes) and other march vegetation growing along the shoreline (e.g., samphire, saltbush, sword sedge). Bioconcentration factor of 0.14 was derived for cobalt uptake by marsh vegetation from sediment.

Submerged macrophytes contained a higher cobalt concentration than previously predicted, with dominant uptake mechanisms difficult to establish as macrophytes can take up cobalt in both the water column and in sediments.

Fish tissue was found to contain low to moderate cobalt concentrations. Healthy fish populations were observed at the R4 RDA, with continued recruitment through the operational life of the facility.

Cobalt concentrations in invertebrate tissue were challenging to characterise, due to potential for colloidal material to be adsorbed to the exoskeleton, which was included in the cobalt analysis. Due to this uncertainty, cobalt concentrations in invertebrate tissue were conservatively assumed to be equal to cobalt concentrations in fish tissue, based on literature review.

Based on these findings, Hydrobiology (2023) concluded that the risk of cobalt exposure to ecological receptors were generally lower than previously thought, due to lower cobalt content in their food sources at the R4 RDA. However, fauna that ingested submerged macrophytes at R4 RDA were likely to be at risk of excessive cobalt exposure, due to relatively high cobalt concentrations detected within these plant tissues. On the other hand, non-submerged, marsh vegetation presented an acceptable risk to both terrestrial marsupial and avifauna species.

Dietary consumption was found to be the primary exposure pathway for cobalt, followed by incidental ingestion of cobalt-enriched sediments. Exposure through drinking water, dermal contact, and incidental ingestion during feather preening were considered to have negligible impacts.

Future risks associated with cobalt exposure were difficult to quantify due to uncertainties associated with future cobalt deposition rates in sediments and vegetation uptake, especially for submerged macrophytes. However, cobalt intake is expected to increase due to increased cobalt concentrations in the sediment, water column, and subsequently, submerged macrophytes.

Noting this, a trigger value for the acceptable level of cobalt in submerged macrophyte tissues was back-calculated to be 296.4 mg Co/kg. Empirical tissue data from two macrophyte samples indicated a mean concentration of 324.5 mg Co/kg. Similarly, a trigger value for fish tissue of 0.38 mg/kg was derived, based on the maximum cobalt concentration detected in 20 *Pseudogobius olorum* tissue samples (Hydrobiology 2023).

3.6.5 Licence Holder's controls

In considering the investigations undertaken to date, the Licence Holder has proposed to continue monitoring efforts specified by Hydrobiology (2023) to collect empirical data to support and verify the outcomes of the risk assessment. These actions include:

- Undertake monthly water quality monitoring at the R4 RDA, which is currently being undertaken.
- Undertake wildlife observations at the R4 RDA, including recording and reclaiming any deceased avifauna found within or surrounding the facility to conduct post-mortem studies, which is currently being undertaken.
- Develop a routine sediment monitoring program for cobalt at the R4 RDA.
- Develop a cobalt tissue monitoring program, targeting macrophytes and fish, to develop a broader understanding of bioconcentration factors within the water column and sediment.
- Prepare a plan to conduct a dedicated, non-lethal coot survey to further investigate potential for unacceptable cobalt intake.
- Progress life of mine tailings study to determine timeframe for closure of the R4 RDA as an impacted water storage facility.

Table 16: Summary of focal species, diet, area use factor, and hazard quotient for cobalt

Common name (Scientific name)	Fauna type	Estimated body weight (g)	Diet	Estimated dietary portion				Estimated area use factor	Fresh matter ingestion (mg/day)	Tolerable daily intake (mg Co/day)	2023 (Current)		2032 (Predicted)	
				Aquatic vegetation	Marsh vegetation	Invertebrate	Fish				Estimated total daily cobalt intake (mg/day)	Hazard quotient	Estimated total daily cobalt intake (mg/day)	Hazard quotient
Red-necked stint (*Calidris ruficollis*)	Shorebird	25	Omnivore	0%	50%	50%	0%	0.25	22.7	0.19	0.03	0.14	0.08	0.42
Black-fronted dotterel (*Elseyornis melanops*)	Shorebird	32	Insectivore	0%	0%	75%	0%	0.25	27.5	0.24	0.02	0.10	0.07	0.30
Sand piper (*Actitis hypoleucos*)	Shorebird	51.6	Insectivore	0%	0%	100%	0%	0.25	33.0	0.39	0.03	0.07	0.09	0.22
Grebe (*Tachybaptus novaehollandiae*)	Waterbird	100	Insectivore	0%	0%	100%	0%	0.5	50.0	0.76	0.03	0.04	0.09	0.12
Coot (*Fulica atra*)	Waterbird	520	Herbivore	40%	15%	15%	0%	0.5	58.0	3.96	3.9	**1.1**[1]	N/A	N/A
Grey teal (*Anas gracilis*)	Waterfowl	470	Omnivore	25%	25%	25%	0%	0.5	99.2	3.58	3.6	0.91	N/A	N/A
White-faced heron (*Egretta novaehollandiae*)	Wading bird	993	Carnivore	0%	0%	75%	25%	0.5	211.8	7.56	0.13	0.02	0.38	0.05
Musk duck (*Biziura lobata*)	Waterfowl	550	Carnivore	0%	0%	25%	75%	0.5	159.6	4.19	0.09	0.02	0.29	0.07
Wallaby	Marsupial	5,000	Herbivore	0%	100%	0%	0%	0.25	902.6	36.7	0.71	0.02	4.68	0.13
Kangaroo	Marsupial	30,000	Herbivore	0%	100%	0%	0%	0.25	3,014.2	219.9	2.4	0.01	15.63	0.07

Note 1: Hazard quotient above 1.0 are bolded in red, representing potentially unacceptable risk of cobalt exposure to the focal species.

3.6.6 Risk assessment

The R4 RDA was initially constructed as an oxide residue disposal area. Now, it is utilised as an operational water management facility to support mining operations at the premises. Nevertheless, the facility is considered to have incidental environmental values due to the presence of a surface water body for periods of the year.

While the presence of transient terrestrial and avifauna at the R4 RDA, along with their behaviours and utilisation of the facility, have been well documented, the potential exposure risks associated with interacting with potentially impacted water at the R4 RDA was not previously characterised.

Based on a Tier 1 risk assessment, the water quality at the facility is unlikely to pose a significant risk to fauna. It was noted that the adopted assessment criteria were designed for protection of aquatic ecosystems, though it was considered to be sufficiently conservative to be applied to terrestrial and avifauna (Golder 2019b). Of the metal and metalloid contaminants investigated, cobalt was the only contaminant of potential concern.

Subsequent Tier 3 risk assessments indicated that cobalt exposure at the R4 RDA may not pose a significant risk to transient fauna, except for those who feed on submerged macrophytes as part of their diets (Hydrobiology 2023). Cobalt content in fish and invertebrate tissues was lower than previously thought, which resulted in contrasting risk outcomes between Golder (2019a) and Hydrobiology (2023). The contrast between the two investigations also emphasised the importance of collecting and utilising empirical data to inform relevant species hazard quotients.

In considering the potential impacts associated with elevated cobalt exposure at the R4 RDA to ecological receptors, the department considers the consequence of this risk event to be **moderate**. However, based on the estimated cobalt intake, as well as the lack of fauna mortality and/or incidents relating to cobalt (or any other potential contaminant) exposure at the R4 RDA, the department considers the likelihood of this risk event to be **unlikely**. As such, the risk rating for potential impacts of cobalt exposure on ecological receptors at the R4 RDA was determined to be **medium risk**.

It is understood that the risk of impact can vary between species, due to differences in dietary patterns and toxicity tolerances. Long-term monitoring of cobalt sources (e.g., perimeter sumps, F1 RDA underdrainage system) should be monitored, as well as ambient water quality within the R4 RDA. As such, condition 28 has been amended to include these monitoring locations.

The department understands that the Licence Holder is currently undertaking routine ambient water quality analysis at the R4 RDA for total metal concentration. Analysis of total metals in surface water is considered appropriate as it also captures metal fractions associated with suspended solids in surface water, which can be potentially ingested by fauna. However, the department considers the monitoring of filterable metal concentrations to also be of value at the R4 RDA, as filterable metals provide a better indication of bioavailable fractions. Furthermore, monitoring of filterable metal concentrations enables an assessment of monitoring results against predicted concentrations detailed in Golder (2019a). As such, the department has included the monitoring of filterable/dissolved metal and metalloid parameters as an additional regulatory requirement.

Monitoring of ambient sediment quality should also be undertaken to better understand metal accumulation within the sediment environment, considering that the greatest contributor of cobalt within faunal diet is thought to be submerged macrophytes, which can take up cobalt from both the water column and sediment. Consequently, the department has included condition 31 in the amended licence to specify ambient sediment monitoring for cobalt.

As proposed by the Licence Holder, the department expects routine wildlife monitoring to continue at the R4 RDA, especially during summer periods, where the presence of a water body may attract more terrestrial and avifauna. Any faunal impacts associated with interactions with

the R4 RDA should be reported to the department, including any fauna mortality. Condition 10 has been amended to require inspection for fauna mortality at the R4 RDA.

4. Consultation

Table 17 provides a summary of the consultation undertaken by the department.

Table 17: Consultation

Consultation method	Comments received	Department response
Department-initiated licence review advertised on the department's website from 28 August 2023 to 18 September 2023.	None received.	N/A
Shire of Boddington advised of application on 16 July 2024.	The Shire of Boddington responded on 6 August 2024, stating that: (i) The proposal was consistent with the Shire of Boddington Local Planning Scheme No. 3; and (ii) The proposed borrow area will require a development approval, which the Shire of Boddington is already liaising with the Licence Holder on.	The department has noted this information.
Department of Mines, Petroleum and Exploration (DMPE) advised of application on 16 July 2024.	The DMPE responded on 7 August 2024, stating that: (i) The scope of the application broadly aligned the scope of Mining Proposal Reg ID 121521, which was under assessment at the time of the response; (ii) The geotechnical stability and safety aspects of the proposed embankment raises will be assessed by DMPE; and (iii) DMPE are aware of the vegetation impacts adjacent to the F1 RDA	The department has noted this information. Potential impacts to human and ecological receptors associated with embankment failure resulting in a release of tailings slurry from the F1 RDA has not been assessed under this amendment, as it is being assessed under the *Mining Act 1978*. The department understands that Mining proposal Reg ID 121521, whose scope broadly aligns with this application, was granted on 27 June 2025. As a result, the department is satisfied that the potential impacts to human and ecological receptors associated with embankment failure have been adequately assessed.
Water Corporation advised of application on 16 July 2024.	The Water Corporation responded on 23 August 2024, stating that: (i) A preliminary assessment was undertaken, with more detailed analysis recommended; (ii) Impacts associated with potential facility failure resulting in significant discharge to the South Dandalup catchment were considered catastrophic and likely to render the drinking water dam unsuitable; (iii) There is also a risk to drinking water quality from potential changes in local hydrology;	The department has noted this information and has considered it in the assessment of this application. Potential impacts to human and ecological receptors associated with embankment failure resulting in a release of tailings slurry from the F1 RDA has not been assessed under this amendment, as it is being assessed under the *Mining Act 1978*. The department also notes that impacts associated with the F1 RDA post-operations (e.g., decommissioning, closure, rehabilitation, etc) has not been

Consultation method	Comments received	Department response
	(iv) Based on the supporting documents provided, specific comments were made on potential groundwater impacts, embankment failure, and spillway construction, noting that the industry standard for managing drinking water catchments generally skewed towards risk avoidance; (v) The proposed expansion to the F1 RDA represents risk creep, with the assessment prepared by the Licence Holder primarily based on current risk profiles, rather than consideration of absolute risks to drinking water catchment; and (vi) The proposed expansion of the facility likely represented a long-term risk, which the Water Corporation was likely to inherit following end of the mine life and potentially in perpetuity.	assessed under this amendment, as it is being assessed under the *Mining Act 1978*. Nevertheless, in line with the regulatory framework for Part V Division 3 of the *Environmental Protection Act 1986*, the department has considered impacts associated with emissions and discharges from the operation of the F1 RDA due to the proposed activities and the adequacy of proposed and existing controls to manage these emissions and discharges, which may indirectly address potential post-mining legacy environmental issues. A detailed risk assessment on the potential impact of tailings seepage on key environmental receptors, including the adjacent Public Drinking Water Source Area, has been undertaken as part of this amendment.
Licence Holder was provided with draft licence amendment on 8 May 2025.	Refer to Appendix 1.	Refer to Appendix 1.
Licence Holder was provided with revised draft licence amendment draft on 15 July 2025.	Refer to Appendix 2.	Refer to Appendix 2.

5. Conclusion

Based on the assessment in this Amendment Report, the Delegated Officer has determined that a Revised Licence L8306/2008/3 will be granted, subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

5.1 Summary of amendments

Table 18 provides a summary of the proposed amendments and will act as record of implemented changes. All proposed changes have been incorporated into the Revised Licence L8306/2008/3 as part of the amendment process.

Table 18: Summary of licence amendments

Condition no.	Proposed amendments[1]
Cover page	Updated formatting and premises instrument history table.
Condition 1 – Authorised construction and operating height	Updated Table 1 to: • Increase F1 RDA maximum construction and operating height from 361.0 mRL to 369.9 mRL (Stage 19 to Stage 22 embankment raises); and • Correct topological error and improve clarity.
Condition 2 –	Updated condition to specify relevant pipeline routes, as referenced in Figure 4.

Condition no.	Proposed amendments[1]
Pipeline requirements	
Condition 4 – Containment infrastructure	Updated condition to improve clarity. Updated Table 2 to: • update current and proposed perimeter sumps; • specify pumping system for catchpits; and • Update table formatting, figure reference, and improve clarity.
Condition 5 – Freeboard requirements	Updated Table 3 to: • **Specify a freeboard requirement of 300 mm for F1 RDA perimeter sumps**; and • Update table formatting and figure reference.
Condition 6 – Waste acceptance requirements	Updated Table 4 to: • Update figure reference due to changes in figure numbering in Schedule 1 of the amended licence. • Include Note 1 to reference the *Landfill Waste Classification and Waste Definitions 1996 (as amended 2019)*.
Condition 7 – Waste processing requirements	Updated Table 5 to: • Update figure reference due to changes in figure numbering in Schedule 1 of the amended licence. • Include Note 1 to reference the *Landfill Waste Classification and Waste Definitions 1996 (as amended 2019)*.
Condition 10 – Inspection requirements	Updated Table 6 to: • Include daily visual inspection for birds or wildlife mortality at the F1 RDA and R4 RDA; • Include daily visual integrity inspection for decant pump, drainage system, LCRS, and beach drainage, as well as visual inspection of decant pond size and location for the F1 RDA decant pond; • Include weekly visual integrity inspection for HDPE liner at F1 RDA; • Include Note 1 to reference freeboard requirements in condition 10 as part of the inspection requirements; and • Update table formatting and figure reference.
Condition 13 – Infrastructure operational requirements	Updated Table 8 to: • Include operational requirements for the F1 RDA, R4 RDA, F1 RDA perimeter sumps and catchpits.
Condition 14 – F1 RDA embankment raise construction requirements	Updated condition to specify relevant F1 RDA embankment raises authorised under this condition.
Condition 15 – Infrastructure construction requirements	Updated Table 10 to: • Authorise the construction of F1 RDA Stage 19 to Stage 22 embankment raise, including specifying design and construction requirements; • Authorise the construction of perimeter sump SD3SU-B, including **specifying design requirements**;

Condition no.	Proposed amendments[1]
	• Include timeframe for construction of perimeter sump SD3SU-B; • Authorise the construction of the F1 RDA emergency spillway, independent of the construction of any authorised embankment raises; • Update table formatting and figure reference.
Condition 16 – Bore installation requirements	New condition included in amended licence to: • Authorise installation of 28 groundwater monitoring bores at 14 monitoring locations, as a combination of (i) replacement monitoring bores and (ii) proposed additional regional monitoring bores, including specifying design, construction, and installation requirements and timeframe.
Condition 17 – Waste acceptance requirements	Updated Table 12 to: • Update figure reference due to changes in figure numbering in Schedule 1 of the amended licence.
Condition 20 – Monitoring standards	Updated condition to specify relevant Australian Standards for ambient sediment quality monitoring.
Condition 21 – Monitoring frequency	Updated condition to specify requirements for annual monitoring.
Condition 25 – Water balance monitoring	Updated condition to improve clarity and requirements of the condition when estimating seepage volume.
Condition 26 – Process monitoring	Updated Table 13 to: • Remove requirement to monitor WAD CN in return water; • Include requirement to monitor WAD CN in tailings slurry prior to being discharged to the F1 RDA, including specifying limit of 50 mg/L over a 60-minute averaging period; • Update table formatting to improve clarity.
Condition 28 – Surface water monitoring	Updated Table 15 to: • Update current and proposed perimeter sumps for monitoring; • Include monitoring of F1 RDA decant pond, underdrainage sump, and LCRS sump; • Include monitoring of R4 RDA decant pond, including for **dissolved metals and metalloids**; • Include monitoring of the F1 RDA replacement perimeter sumps; • **Include monitoring of Pillow Swamp and Boomerang Swamp;** • **Modifying the existing target of 50 mg/L for WAD CN from a target to a limit;** • Update classification of monitoring locations, such that compliance sites and background sites are classified as the same (background sites); • Remove requirements for titanium monitoring and include requirements for thallium monitoring, due to a previous typological error. • Remove Note 5 as perimeter sump SD8SU-D has been decommissioned and perimeter sump SD8SU-D1 has been constructed. • Updated table formatting and figure numbering.
Condition 29– Groundwater	Updated Table 16 to: • Update classification of monitoring locations, such that existing classifications

Condition no.	Proposed amendments[1]
monitoring	monitoring sites and compliance sites are replaced with classifications of operational bores, regional bores, and non-RDA bores; • Include monitoring of existing monitoring bores O234BR3, F1BR19D, F1BR22-2, F1BR23S, F1BR24S, F1BR25S, F1BR35S, F1BR36S, F1BR38S-2, F1BR39S, F1BR41S, F1BR41D, R4BR107S, R4BR107D, R4BR13 as operational monitoring bores (including provisions to replace some of these bores due to decommissioning); • Include monitoring of existing monitoring bores F1BR40S, F1BR42S, F1BR44S, F1BR44D, F1BR45S, F1BR45D, R4BR102S, R4BR102D, R4BR105S, R4BR106S, and MUBR1 as regional monitoring bores; • Include monitoring of proposed monitoring bores F1BR49S, F1BR49D, F1BR50S, F1BR50D, F1BR51S, F1BR51D, F1BR52S, F1BR52D, F1BR53S, F1BR53D, F1BR54S, and F1BR54D as regional monitoring bores; • **Specify a limit of 4.0 mbgl for standing water level (only for regional monitoring bores) and 0.5 mg/L for WAD CN (for all groundwater monitoring bores);** • Remove requirements for titanium monitoring and include requirements for thallium monitoring, due to a previous typological error. • Remove monitoring requirements for monitoring bores F1BR16D and LPBR1.
Condition 30 – Vegetation condition monitoring	New condition included in amended licence to require plant cell density monitoring using multispectral imagery and photographic monitoring for vegetation at 37 groundwater monitoring locations, including specifying management actions.
Condition 31 – Sediment monitoring	New condition included in amended licence to specify sediment monitoring requirements at the R4 RDA decant pond.
Condition 32 – Specified action	New condition included in amended licence for the following specified actions: • To undertake a dust monitoring review within 18 months of the amendment; and • To undertake a groundwater monitoring network review around F1 RDA Saddle Dam 3 within six months of commencing operation of the F1 RDA Stage 19 embankment raise.
Condition 34 – Recordkeeping requirements	Updated condition numbering referenced.
Condition 37 – Annual environmental report requirements	Updated Table 18 to: • **Include additional reporting parameters required for surface water monitoring (condition 28) and groundwater monitoring (condition 29), including ionic composition analysis and assessment against relevant drinking water guidelines;** • Include reporting requirements for the newly added vegetation condition monitoring (condition 30) and sediment monitoring (condition 31); • Update table formatting and condition numbering referenced.
Condition 38 – Environmental compliance report requirements	Updated condition to streamline reporting timeframes under both conditions 14 and 15, such that the environmental compliance report for infrastructure constructed under either condition will be required to be submitted to the CEO within 90 calendar days of the infrastructure being constructed.
Condition 39 – Environmental compliance report requirements	Updated condition to streamline reporting timeframes under both conditions 14 and 15.

Condition no.	Proposed amendments[1]
Condition 40 – Bore construction report requirements	New condition included in the amended licence to specify reporting requirements for the installation of new groundwater monitoring bores under condition 16.
Condition 41 – Notification requirements	Updated Table 19 to: • Include requirement to notify the CEO following completion of planned discharge of water from underdrainage, LCRS drainage and beach drainage to R4 RDA; • Update table formatting and condition numbering referenced.
Definitions	Updated Table 20 to: • Include definitions for Australian drinking water guideline values, ARI, ASTM D5092/D5092M-16, AS 1726, AS/NZS 5667.12, Environmental Compliance Report, and F1 RDA Stage 19-22 Design Report; • Remove definition of suitably qualified geotechnical engineer; • Modify definition of suitably qualified engineer to include requirements for experience working in civil or geotechnical engineering, where the relevant infrastructure relates to an embankment raise (refer to amended condition 39).
Schedule 1: Maps	• Updated table to include general purpose lease G70/272. • Updated Figure 1 (map of the boundary of the prescribed premises) to include general purpose lease G70/272; • Shifted Figure 10 (site layout and infrastructure) from existing licence to Figure 2 in amended licence, with no changes made to the figure; • Updated Figure 3 (containment infrastructure – RDAs) to include current existing and proposed perimeter sumps; • Updated Figure 4 (containment infrastructure – processing) to include tailings slurry and return water pipeline routes; • Updated Figure 8 (surface water monitoring sites) to include current existing and proposed perimeter sumps, additional background surface water monitoring locations, and updated monitoring location classification; • Updated Figure 9 (groundwater monitoring sites) to include additional operational and regional groundwater monitoring locations and updated monitoring location classification; • Included new Figure 10 to specify extent of multispectral data collection for plant cell density monitoring. • Included new Figure 11 to specify indicative location of the F1 RDA emergency spillway. • Removed existing Figure 5 (location of camp wastewater treatment plant) and Figure 7 (cyanide destruction circuit vent) due to being shown in Figure 2. • Updated figure caption formatting.
Schedule 2: Construction drawings	New schedule included in the amended licence to: • Specify extent of HDPE liner extension required during each stage of the F1 RDA Stage 19 to Stage 22 embankment raise (Figure 12).

Note 1: **Bold and underline text** depicts additional regulatory controls imposed by department.

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Appendix 1: Summary of Licence Holder's comments on risk assessment and draft conditions (8 May 2025)

	Amended condition	Summary of Licence Holder's comment	Department's response
Background: The Licence Holder responded on 27 May 2025 with 45 comments on the draft amended licence and a request for a revised draft amended licence be provided for comment. To minimise further comments from arising from the second revision of the draft amended licence, the department wrote to the Licence Holder on 17 June 2025, responding to the 45 comments raised, and where required, sought further information or clarification from the Licence Holder. Further information was provided by the Licence Holder on 25 June 2025. Additional information was also received by the department on 27 June 2025, 2 July 2025, and 7 July 2025, following further correspondence between the department and the Licence Holder. Information provided to the department on the above dates were considered by the department in responding to the comments below and in the preparation of the second revision of the draft amended licence L8306/2008/3. Appendix 1 does not contain any comments pertaining to the second revision of the draft amended licence.			
1	----	The Licence Holder requested the registered business address on the cover page of the licence be updated to: Level 5, 500 Hay Street, Subiaco WA 6008.	The department has updated the registered business address on the cover page of the amended licence.
2	----	The Licence Holder requested that the 'F1/F3 RDA' be referred to as 'F1 RDA' on the amended licence.	The department has updated the amended licence text accordingly.
3	Condition 4 – Containment infrastructure requirement (F1 RDA)	In Table 2, the Licence Holder requested that the material '*residue tailings generated from gold and copper production and associated activities'* be retained in the licence.	The department has noted this erroneous deletion and has retained the material in Table 2 on the amended licence.
4	Condition 4 – Containment infrastructure requirement (F1 RDA)	In Table 2, the Licence Holder requested that materials accepted for F1 RDA included water from the beach drain, toe well and toe drainage. The Licence Holder clarified that water from these locations were currently being pumped to the R4 RDA and it would be difficult to direct the water to the F1 RDA.	**<u>Toe well and toe drain</u>** With regard to toe well and toe drain, the department had made an error in the draft amended licence by including it as an accepted material at F1 RDA. The department has corrected this error and ensured that it is accepted at only R4 RDA, as per current practice. The department has not retained the discharge of toe well and toe drain water at F1 RDA due to the need to, where possible, minimise water input into the active RDA to control seepage generated from the

	Amended condition	Summary of Licence Holder's comment	Department's response
		While the Licence Holder has no issues with water from beach drains, toe wells and toe drains be authorised for discharge at F1 RDA, they require it to also be authorised for discharge at the R4 RDA.	facility. **<u>Beach drain</u>** On 17 June 2025, the department requested further clarification on the discharge location for beach drain water, noting that the existing licence, previous Amendment Reports and the supporting documentation submitted referred to the discharge of beach drain water back to the F1 RDA, not R4 RDA, due to the more impacted nature of this water (compared to other sources, such as perimeter sump water). It was also for this reason that seepage collected from the underdrainage system and LCRS were sent back to the F1 RDA, rather than to R4 RDA (outside of situations outlined under existing condition 11). Further information received from the Licence Holder on 25 June 2025 indicated that the beach drain water had been redirected to R4 RDA for discharge since December 2022 due to construction requirements at F1 RDA, which required pipelines to be removed. A notification was provided to the department at the time. In a meeting with the Licence Holder on 27 June 2025, it was stated that, prior to the construction works in December 2022, beach drain water was discharged back to the F1 RDA, as required under the licence. At the time, the department indicated that, with the completion of construction activities, the necessary pipeline should be re-installed to enable discharge of beach drain water back to the F1 RDA, in accordance with the existing licence requirements. Discharge of beach drain water to the R4 RDA is only authorised under the existing licence, where the requirements of condition 11 are met in their entirety. Consequently, the department has not amended the condition to accept beach drain water at R4 RDA (outside of condition 11). Beach drain water is acceptable at the F1 RDA. A licence amendment will be required in the future to modify this arrangement and authorise the discharge of beach drain water into R4 RDA. Similarly, water from perimeter sump SD8SU-C1, which also receives beach drainage, should be returned to the F1 RDA, unless authorised to discharge into R4 RDA under condition 11.
5	Condition 4 – Containment infrastructure requirement (F1 RDA)	In Table 2, the Licence Holder noted that sump SD8SU-A1 (on the existing licence) and SD8SU-E (on the draft amended licence, proposed to be the replacement sump to SD8SU-A1) no longer existed. Further, where the existing licence required water from sump SD8SU-A1 be discharged to F1 RDA (i.e.,	On 17 June 2025, the department requested further information from the Licence Holder as: 1. the department was not aware that sump SD8SU-A1 no longer existed, noting that it was still specified on the existing licence. 2. the updated figure provided did not include replacement sump SD8SU-

	Amended condition	Summary of Licence Holder's comment	Department's response
		not the R4 RDA, like the other sumps, as this sump also accepted beach drain water). The Licence Holder provided an updated figure showing the location and names for the perimeter sumps for the Stage 19 to Stage 22 embankment raises.	E, which was proposed in the application form. The Licence Holder responded with the following: **<u>Existing sump SD8SU-A1</u>** On 25 June 2025, the Licence Holder explained that the existing sump was made smaller and renamed to SD8SU-C2 in May 2025 to facilitate buttress extension at Saddle Dam 8. Since December 2022, water from existing sump SD8SU-A1 (and SD8SU-C2) was pumped to the R4 RDA for construction reasons detailed in Item 4 above. A new sump SD8SU-D1 was constructed in April 2025, with water from the SD8SU-C2 then being pumped to the new sump, and subsequently to the R4 RDA. While a notification was sent to the department noting the need to discharge beach drain water to R4 RDA in December 2022, the department was not aware of the modifications to sump SD8SU-A1 or the completion of SD8SU-D1 (noting that the department had assessed and authorised the construction of this replacement sump for SD8SU-D in February 2022 but had not received any compliance reports to date). The department highlights that the Licence Holder must operate the prescribed premises in accordance with their licence. The department has amended Table 4 to reflect current sump network, including the renaming of SD8SU-A1 to SD8SU-C1, removal of the decommissioned SD8SU-D and inclusion of replacement sump SD8SU-D1. Existing conditions 15, 34, and 35 relating to the construction and compliance reporting of SD8SU-D1 will remain on the amended licence, as the relevant compliance report has not been received at the date of this amendment. **<u>Replacement sump SD8SU-E</u>** In a meeting with the Licence Holder on 27 June 2025, it was highlighted that the replacement sumps proposed in the supporting documentation of the licence amendment application, where it was anticipated that all existing sumps be decommissioned and replaced with new sumps at nearby locations. However, the Licence Holder explained that the replacement sumps will no longer be constructed, as the existing sumps will not be decommissioned. However, the sump footprint and location may be modified throughout the proposed embankment raises to meet stability requirements via buttress expansions. The Licence Holder stressed the need for flexibility in the licence condition to modify sump extents and locations to maintain sump effectiveness
6	Condition 4 – Containment infrastructure requirement (F1 RDA)	In Table 2, the Licence Holder responded to the department's enquiry to confirm that sump SD8SU-E will be the replacement for the existing sump SD8SU-A1. Refer to Item 5 above.	

	Amended condition	Summary of Licence Holder's comment	Department's response
			as the facility expands. Further information was sought on the current and proposed sump locations and extents on 27 June 2025, with response provided by the Licence Holder on 2 July 2025, 7 July 2025, and 9 July 2025. Consequently, the department has removed all conditions pertaining to the construction and operation of replacement perimeter sumps from the amended licence. The department has also modified conditions relating to the existing sumps to ensure they reflect current sump network. Furthermore, the department has included operational requirements in condition 13 for the existing storage capacity of perimeter sumps to be maintained, though the Licence Holder is able to modify sump footprints to meet operational needs, so long as the performance (i.e., storage capacity) of the sumps are not reduced.
7	Condition 4 – Containment infrastructure requirement (R4 RDA)	In Table 2, the Licence Holder requested that the list of perimeter sumps be revised to reflect updated sump network.	Based on the further information received (refer to Item 5 above), the department understands that replacement sumps will not be constructed as part of the Stage 19 to Stage 22 embankment raises. Furthermore, there has been modifications to the existing sump network shown on the existing licence. As such, the department has updated the list of perimeter sumps to reflect the current sump network at F1 RDA.
8	Condition 4 – Containment infrastructure requirement (F1 RDA perimeter sumps)	In Table 2, the Licence Holder requested that the list of perimeter sumps be revised to reflect updated sump network.	
9	Condition 4 – Containment infrastructure requirement (Perimeter sump SD8SU-A1)	In Table 2, the Licence Holder requested this containment infrastructure be removed from the amended licence as the sump no longer exists (refer to Item 5).	
10	Condition 4 – Containment infrastructure requirement (F1 RDA replacement perimeter sumps)	In Table 2, the Licence Holder requested this containment infrastructure be removed from the amended licence as the sumps will no longer be constructed (refer to Item 5).	
11	Condition 4 – Containment infrastructure requirement (Catchpit 1-4)	In Table 2, the Licence Holder requested the following requirement be added to Table 2 for the catchpits 1-4: • Incorporated with pumping system.	The department has added this infrastructure requirement to Table 2.
12	Condition 5 – Freeboard	In Table 3, the Licence Holder requested that F1 RDA replacement perimeter sumps be removed from the	The department has removed reference to the F1 replacement perimeter sumps

	Amended condition	Summary of Licence Holder's comment	Department's response
	requirement	amended licence as the sumps will no longer be constructed and operated (refer to Item 5).	from Table 3. Freeboard requirements were still specified for existing F1 RDA perimeter sumps.
13	Condition 5 – Freeboard requirement	In Table 3, the Licence Holder requested removing freeboard requirements for the F1 RDA and R4 RDA, noting that freeboard requirements were already legislated by the Department of Mines, Petroleum and Exploration (DMPE) under the Work Health and Safety (Mines) Regulations 2022, as well as relevant Codes of Practice. The Licence Holder noted that regulatory duplication would occur as a result of freeboard specification on licence L8306/2008/3. The Licence Holder indicated that the F1 RDA was being managed in line with the Global Industry Standard for Tailings Management (GISTM), International Commission on Large Dams (ICOLD) and Australian National Committee on Large Dams (ANCOLD). In addition, the Licence Holder requested further clarification on the additional regulatory requirement to maintain a freeboard of 300 mm at the F1 RDA perimeter sumps, noting that the sump areas are subject to flooding during heavy rainfall events. During these events, it was unlikely that impact would be presented to the surrounding environment.	**F1 RDA and R4 RDA** On 17 June 2025, the department wrote to the Licence Holder explaining that the freeboard requirements for F1 RDA and R4 RDA were existing requirements on licence L8306/2008/3. Freeboard requirements are considered a standard condition for the regulation of tailings storage facilities on licences under Part V of the EP Act, as they manage risk associated with overtopping events, which may result in a release of tailings into the surrounding environment. The department acknowledged that there may be some degree of regulatory duplication between the licence and relevant tenement conditions. Nevertheless, the assessment and regulation of overtopping, which may result in emissions and discharges to the environment falls under the regulatory remit of Part V of the EP Act. As such, the department has retained the freeboard requirement for F1 RDA and R4 RDA. **F1 RDA perimeter sumps** Freeboard requirements are considered a standard condition for containment infrastructure on licences under Part V of the EP Act, they manage risk associated with overtopping events, which may result in a release of tailings into the surrounding environment. While the Licence Holder has cited potential for localised flooding and potentially overtopping of the perimeter sumps, the department noted in a letter dated 17 June 2025, that the Licence Holder had cited, in written correspondence dated 13 March 2025, the potential for additional mobile pumps be temporarily deployed to remove excess water and control sump water levels. The department had relied on information provided in completing its risk assessment and in specifying relevant controls. This matter was not discussed further, following the letter dated 17 June 2025. As such, the department has retained the freeboard requirement for the F1 RDA perimeter sumps.
14	Condition 6 – Waste	The Licence Holder requested that waste types in Table 4 be amended to reference the relevant	The department has included this reference as Note 1 in Tabel 4 of the

	Amended condition	Summary of Licence Holder's comment	Department's response
	acceptance requirement	guideline (i.e., *Landfill Waste Classification Waste Definitions 1996*).	amended licence.
15	Condition 10 – Inspection requirement	In Table 2, the Licence Holder responded to the department's request to provide a figure showing the pipeline route for tailings delivery and return water. An updated Figure 4 was provided.	The department has updated Figure 4 in Schedule 1 as well as reference Figure 4 in Table 4 in the amended licence.
16	Condition 11 – Authorised discharge to R4 RDA	The Licence Holder requested that beach drainage be removed from the condition authorising discharge to the R4 RDA, as water from beach drains were already being to the R4 RDA.	The department notes that the existing licence does not authorise the discharge of water from the beach drains into R4 RDA, outside of condition 11 (refer to Item 4). As such, the department has not amended condition 11.
17	Condition 11 – Authorised discharge to R4 RDA	The Licence Holder requested an amendment to condition 11 to authorise discharge of water from the F1 RDA underdrainage system and LCRS to R4 RDA during the construction of Saddle Dam 1 and Saddle Dam 2.	In a letter dated 17 June 2025, the department indicated that a risk event involving further discharge of water from the F1 RDA underdrainage system and LCRS was not considered in the initial risk assessments (aside from volumes already expected to be discharged as a result of existing requirements during high rainfall events). As this amendment was relevant to the operation of the F1 RDA, the Delegated Officer would consider the amendment. However, an updated risk assessment would be required to be undertaken, which would require additional information and time to be completed. The Licence Holder provided historical monitoring information on 25 June 2025 to support the assessment. However, upon further correspondence between 27 June 2025 and 2 July 2025, the Licence Holder has indicated that they no longer wish for the assessment to be updated, if doing so would result in further delays to this application. As such, the department has not amended condition 11.
18	Condition 13 – Operational requirement (F1 RDA)	In Table 8, the Licence Holder requested that the requirement that '*the F1 RDA decant pond extent must not exceed the extent of the underlying HDPE liner during normal operation and for storm events up to 25 year ARI for up to 24 hours*' be removed as the requirement was not possible and has no environmental or geotechnical impact, were it to occur. The Licence Holder further notes that the tailings	In a letter dated 17 June 2025, the department indicated to the Licence Holder that the requirement was adopted from the relevant Design Report, submitted to the department for assessment. Furthermore, the Design Report (for the Stage 19 to Stage 22 embankment raise) had already taken into consideration the total storage volume of 3.6 Mm^3, as well as the flatter tailings beach slope of 1V:300H. The department disagrees with the argument that the decant pond extent will have no environmental or geotechnical implications. While the geotechnical aspects do not fall within the regulatory remit of Part V of the EP Act, the

	Amended condition	Summary of Licence Holder's comment	Department's response
		beach slope was approximately 1V:300H, which was less steep than the designed 1V:160H slope. The flatter beach slope meant that pond area may increase rapidly. The Licence Holder already prescribes a performance target of 1.6 Mm^3 for the decant pond, though the facility does have additional capacity. The Licence Holder also highlighted the presence of seepage recovery equipment throughout the entire basin of the facility, not merely over the HDPE liner. The requirement for the decant pond to remain within the HDPE liner extent was an internal best practice control, but not an essential one.	department highlights that decant pond extent outside of the HDPE liner extent may increase seepage generated through the premises. The presence of seepage recovery equipment cannot be realistically expected to capture all seepage infiltrating through the tailings mass. Furthermore, the Licence Holder is authorised, under condition 11, to direct captured seepage to the R4 RDA for discharge, rather than the F1 RDA, in the event that the decant pond extent would exceed the HDPE liner extent. As such, the department, in relying on design specifications prepared by suitably qualified geotechnical engineers, has decided to specify the requirement in the amended licence. This matter was not discussed further, following the letter dated 17 June 2025.
19	Condition 13 – Operational requirement (F1 RDA)	In Table 8, the Licence Holder requested that water from the underdrainage system, LCRS, beach drainage, toe well and toe drainage be authorised to be discharged at R4 RDA, in addition to the F1 RDA decant pond.	The department has not amended the requirement to authorise discharge to the R4 RDA, as this is currently only authorised under condition 11. With regard to toe well and toe drain, the department had made an error in the draft amended licence by specifying its discharge to the F1 RDA decant pond. The department has corrected this error and ensured that it is only discharged to R4 RDA, as per current practice. The department has not retained the discharge of toe well and toe drain water at F1 RDA due to the need to, where possible, minimise water input into the active RDA to control seepage generated from the facility.
20	Condition 13 – Operational requirement (R4 RDA)	In Table 8, the Licence Holder indicated that the requirement to operate and maintain the LCRS at the R4 RDA cannot be met, as the facility is not equipped with its own LCRS. Further correspondence received from the Licence Holder on 25 June 2025 confirmed that the specification of an LCRS at R4 RDA within the NBG RDA Operating Manual was an error.	The department has removed this requirement from the amended licence. This change has not materially altered the outcome of the risk assessment involving R4 RDA.
21	Condition 13 – Operational requirement (F1 RDA perimeter sump)	In Table 8, the Licence Holder clarified that there are (and will be) 11 perimeter sumps, not 12. Furthermore, the following requirements were requested to be removed: • Requirement for water from existing sump	The department has amended the number of sumps to 11, based on updated sump network (refer to Item 5). **SD8SU-A1** Based on further information provided on 25 June 2025 (refer to Item 5), the department has renamed the sump from SD8SU-A1 to SD8SU-C1. However,

	Amended condition	Summary of Licence Holder's comment	Department's response
		SD8SU-A1 be pumped to the F1 RDA decant pond, as all sump water is being sent to R4 RDA for discharge. • Requirement for replacement perimeter sumps to be constructed and operational prior to decommissioning of existing sumps.	the requirement to send water from this sump to the F1 RDA is retained on the amended licence, as this was the requirement of the licence for SD8SU-A1 under the existing licence. Water management for sump SD8SU-A1 was managed differently from the other perimeter sumps, as it also collects beach drain water from the nearby saddle dam. Therefore, the water was previously considered not appropriate for continuous discharge to R4 RDA (outside of condition 11). **Requirement to replace perimeter sumps** Based on further information provided on 25 June 2025 (refer to Item 5), the department has removed this requirement as the existing sumps will no longer be decommissioned as part of the Stage 19 to Stage 22 embankment raises.
22	Condition 13 – Operational requirement (F1 RDA replacement perimeter sump)	In Table 8, the Licence Holder requested this containment infrastructure be removed from the amended licence as the sumps will no longer be constructed (refer to Item 5).	Based on the further information received (refer to Item 5 above), the department understands that replacement sumps will not be constructed as part of the Stage 19 to Stage 22 embankment raises. As such, this infrastructure has been removed from the amended licence.
23	Condition 14	The Licence Holder requested that the condition text be updated to include F1 RDA Stage 19 to Stage 22 embankment raises.	In a letter dated 17 June 2025, the department explained that construction requirements for the Stage 19 to Stage 22 embankment raises have been explicitly specified in condition 15. Doing so improves clarity on the expectations and requirements of the licence, as well as streamlines compliance assessment processes. Conditions referencing external documents are not in line with current licensing format for Part V instruments. As such, the department has not amended condition 14. Condition 14 in the amended licence is only intended to apply up until the construction of the Stage 18 embankment raise.
24	Condition 14	In Table 9, the Licence Holder requested that the relevant Design Report for the F1 RDA Stage 19 to Stage 22 embankment raises be referenced in the condition text.	
25	Condition 15 – Construction requirement (Thirty-Four Mile Brook Diversion Pond spillway)	In Table 2, the Licence Holder responded to the department's enquiry to confirm that sump SD8SU-E will be the replacement for the existing sump SD8SU-A1. Refer to Item 5 above. In Table 10, the Licence Holder responded to the department's enquiry on timeframes on the construction of the spillway, specifying that construction is scheduled for the fourth quarter of 2025. Prior to it, the construction of culverts crossing	No issue. The department has retained construction requirements for the Thirty-Four Mile Brook Diversion Pond spillway in the amended licence. No timeframe is specified.

	Amended condition	Summary of Licence Holder's comment	Department's response
		the main haul road was scheduled for June 2025. The North Clear Water Pond was decommissioned and backfilled in 2024, with pumps and reticulation infrastructure modified to the Thirty-Four Mile Brook Diversion Pond by April 2025.	
26	Condition 15 – Construction requirement (F1 RDA Stage 19 to Stage 22 embankment raises)	In Table 10, the Licence Holder queried the conditioning of construction specifications for the proposed embankment raises, specifically: • Embankment heights, as they had already been specified under condition 1. • Embankment construction detail, such as raising of saddle dam 2 by centreline construction, as these specifications have been assessed and approved by DMPE and may result in regulatory duplication. Specification of construction design on the amended licence may necessitate a licence amendment in the future, should there be any subsequent changes made to the design at a later date.	The department has noted the duplication in specifying embankment heights in conditions 1 and 15. As such, specification of embankment heights in Table 10 has been removed in the amended licence. The department has also removed specifications for construction method at each saddle dam, considering it is adequately regulated by DMPE. The department notes that construction and design requirements can be conditioned, even where there is regulatory overlap with another decision-making authority, where the relevant infrastructure or equipment may affect the nature and extent of an emission or discharge. Further, the specification of an external document does not negate the requirement to amend the licence, should a change that meets the criteria specified in section 53 of the EP Act be made.
27	Condition 15 – Construction requirement (F1 RDA Stage 19 to Stage 22 embankment raises)	In Table 10, the Licence Holder responded to the department's request to provide a figure showing the extent of the HDPE liner at each stage of embankment raise. Figure 12 was provided. The Licence Holder noted that HDPE liner extension for Stage 20 will be undertaken at the same time as the Stage 19 extension. The same will be undertaken for the Stage 21 and Stage 22 extensions.	The department has no issues with the proposed staged approach to the HDPE liner extension. The department has included Figure 12 in the amended licence.
28	Condition 15 – Construction requirement (F1 RDA Stage 19 to Stage 22 embankment raises)	In Table 10, the Licence Holder requested that the requirement for the underdrainage system to be extended during each embankment raise be removed. In response to a request for clarification by the department on 17 June 2025, the Licence Holder	On 17 June 2025, the department queried the removal of the underdrainage system extension, noting that the requirement was adopted from the relevant Design Report, submitted to the department for assessment. On 25 June 2025, the Licence Holder clarified that the underdrainage system comprised pipework and the HDPE liner, with the pipes currently having

	Amended condition	Summary of Licence Holder's comment	Department's response
		responded on 25 June 2025, explaining that the underdrainage system comprised pipe works and the HDPE liner.	extended to their full extent as of the Stage 18 embankment raise. The Stage 18 to Stage 22 embankment raises will only include extension of the HDPE liner (refer to Item 27 above). Consequently, the department has removed this requirement from Table 10 in the amended licence. With the current extent of the underdrainage pipework, this change has not materially altered the outcome of the risk assessment involving R4 RDA.
29	Condition 15 – Construction requirement (F1 RDA emergency spillway)	In Table 10, the Licence Holder responded to the department's request to provide a figure showing the location of the emergency spillway for the F1 RDA. Figure 11 was provided.	The department has included Figure 11 in the amended licence.
30	Condition 15 – Construction requirement (F1 RDA replacement perimeter sump)	In Table 10, the Licence Holder requested this infrastructure be removed from the amended licence as the sumps will no longer be constructed (refer to Item 5). Furthermore, the additional regulatory requirement to construct (and/or deepen existing) sumps to approximately 5 mbgl was considered practical or safe, with the potential to cause geotechnical stability issues due to the close proximity of the perimeter sumps to the F1 RDA toe. The Licence Holder also requested that references to sump SD8SU-E be removed.	Based on the further information received (refer to Item 5 above), the department understands that replacement sumps will not be constructed as part of the Stage 19 to Stage 22 embankment raises. As such, this infrastructure has been removed from the amended licence, including replacement sump SD8SU-E. **Additional regulatory requirement for deeper perimeter sumps** As no replacement sumps will be constructed, the requirement to construct sump depth to 5 mbgl or greater was not applicable. It is likely not practical to cease operation of existing sumps to undertake deepening works. Further, deepening of existing sumps may result in safety and stability issues. On 25 June 2025, the Licence Holder indicated that it may be possible to excavate deeper in some areas where the sump is of a greater distance away from the F1 RDA toe (e.g., SD3SU-B). Around sump SD3SU-B, the local groundwater mound is relatively shallow, where a deeper sump may be beneficial. Hence, the Licence Holder proposed to use sump SD3SU-B as a trial to prove the concept. The department agrees with the Licence Holder's view that the area around sump SD3SU-B presents the greatest risk, due to historically shallow groundwater levels, observed impacts to fringe vegetation, as well as proximity to the neighbouring Public Drinking Water Source Area (PDWSA). As such, the department has conditioned the construction of perimeter sump SD3SU-B, with an additional regulatory requirement to construct the sump to a minimum depth of 5 mbgl.

	Amended condition	Summary of Licence Holder's comment	Department's response
31	Condition 16 – Well construction requirement	In Table 10, the Licence Holder responded to the department's request to provide a figure showing existing and proposed groundwater monitoring bores with updated classification. Updated Figure 9 was provided on 25 June 2025.	In a letter dated 17 June 2025, the department noted that the figure provided included only existing groundwater monitoring bores. On 25 June 2025, the Licence Holder provided an updated figure, containing six additional regional monitoring locations, as proposed in their Groundwater Management Plan. On 27 June 2025, the department highlighted that two monitoring locations specified as additional regulatory requirement have not been included in the figure. On 2 July 2025, the Licence Holder proposed two locations for the additional monitoring bores hydraulically downgradient of the F1 RDA Saddle Dam 3. However, the Licence Holder continued to stress that the installation of these groundwater monitoring bores would be resource-intensive and require other approvals, including for native vegetation clearing. The requirement of these two additional groundwater monitoring bores may not be justified, given the past performance of the facility, as well as the remaining operational life of the F1 RDA. Upon reviewing the information provided by the Licence Holder, the department has agreed that, at this stage, given the challenges associated with installing further downgradient bores, proposed F1BR51 and F1BR52 series groundwater monitoring bores may be adequate for monitoring potential offsite seepage impacts in groundwater. Consequently, the department has removed the requirement to install the two additional groundwater monitoring bores. Nevertheless, the department has included specified actions in condition 32 to require a groundwater monitoring network review be undertaken around Saddle Dam 3 to assess whether additional groundwater monitoring bores would be required, following installation and monitoring of the F1BR51 and F1BR52 series groundwater monitoring bores.
32	Condition 16 – Well construction requirement	While the Licence Holder was in agreement with the installation of additional groundwater monitoring bores, the requirements of Table 10 were difficult to follow, with a number of concerns raised: 1. Lack of time to provide definitive monitoring bore location and ID, due to time required to further consult with the Licence Holder's hydrogeologist. 2. Lack of clarity on additional regulatory	**Further consultation with hydrogeologist** While the department understands that the exact location of a bore installation is subject to change, based on ground conditions, the department does not accept that the Licence Holder does not have adequate time to provide indicative locations and bore IDs for the department's consideration, noting that locations were loosely proposed in the Groundwater Management Plan. On 25 June 2025, the Licence Holder provided an updated Figure 9, containing the indicative locations and bore IDs for six additional regional monitoring locations.

	Amended condition	Summary of Licence Holder's comment	Department's response
		requirement to install an additional four bores at two locations, and whether it was in addition to the six locations proposed under the Groundwater Management Plan. 3. Requirement for additional clearing, as well as numerous approvals and access issues, in order to install additional monitoring bores within State Forest area north-west of saddle dams 3 and 4. 4. One of the monitoring bores proposed in the Groundwater Management Plan will likely overlap with the future RDA2 footprint. RDA2 will have its own groundwater monitoring network that is currently being designed, and therefore, should not be required at this stage. 5. Existing monitoring bore F1BR44 is currently dry and might need to be re-drilled. 6. Timeframes specified for the installation of these monitoring bores are not considered realistic, due to limited access to forested area during the winter period (as per other approval requirements), as well as the need for further approvals to undertake works within the State Forest area.	**Lack of clarity on additional monitoring bores** In a letter dated 17 June 2025, the department clarified that, in addition to the six locations proposed under the Groundwater Management Plan, two monitoring locations were specified as additional regulatory requirements. **Requirement for additional clearing, access, and approvals** The department understood that the installation of additional regional monitoring bores may present logistical issues. However, the department highlighted the need for adopting a risk-based approach, not simply a logistical one, when discussing whether additional monitoring bores are required. Furthermore, the regional monitoring bores were proposed by the Licence Holder under their Groundwater Management Plan. On 25 June 2025, the Licence Holder provided an updated Figure 9 containing existing monitoring bores, as well as the six additional monitoring bores proposed in the Groundwater Management Plan. On 2 July 2025, the Licence Holder continued to stress the logistical challenges for installing bores at the two locations required by the department. Following further justification, the department has removed this additional regulatory requirement (refer to Item 31). **RDA2 monitoring bores** Through verbal correspondence with the Licence Holder as well as a letter dated 17 June 2025, the department advised that the RDA2 (and its corresponding monitoring bore network) has not been assessed and authorised under Part V of the EP Act. Furthermore, the installation of RDA2 and corresponding monitoring bores will not be undertaken until a later date (i.e., closer to the end of F1 RDA's s operating life). Therefore, the department does not consider future groundwater monitoring bores installed for RDA2 to be an adequate substitute for the required regional monitoring bores to assess potential impacts to groundwater associated with operation of the F1 RDA Stage 19 to Stage 22 embankment raises. The department advised that the Licence Holder may propose an alternative location, where it was feasible to install the monitoring bore, while meeting the requirements of its siting (i.e., to monitor ambient groundwater across the catchment boundary to the north-east of F1 RDA). On 25 June 2025, an updated Figure 9 was provided, with the indicative location for the monitoring bore, which the department considers to be appropriate.

	Amended condition	Summary of Licence Holder's comment	Department's response
			<u>Re-drilling of F1BR44</u> On 17 June 2025, the department requested standing water level monitoring data on monitoring bore F1BR44. The information was provided to the department on 25 June 2025 and 27 June 2025. Having reviewed the monitoring data, the department understands that: • F1BR44D has been dry, while the nearby F1BR43S does contain water. • F1BR43S and F1BR44D are both dry. The department considers the existing bores to be adequate for continued monitoring purposes. While monitoring bore F1BR44D is occasionally dry, groundwater has been consistently detected at the nearby F1BR43D, which is several metres deeper. At this stage, the department has not required the installation of a replacement bore for F1BR44D. **<u>Timeframes for installation of additional monitoring bores</u>** In a letter dated 17 June 2025, the department indicated that the specification of a timeframe ensures that proposed monitoring bores are installed within an appropriate timeframe. However, the department may vary timeframes depending on logistical and/or other constraints, where adequate justification is provided. To date, no alternative timeframe has been proposed by the Licence Holder for the department's consideration. As such, the department has retained the timeframe on the amended licence.
33	Condition 21 – Monitoring frequency requirement	The Licence Holder stated that the frequency requirement specified for annual monitoring may be dependent on many variables, including access to appropriate contractors and consultants.	The specification for annual monitoring is standardised across Part V instruments. As such, the department has retained the requirement in the amended licence.
34	Condition 25 – Water balance requirement	The Licence Holder queried the definition of '*estimated water volume discharged to the F1 RDA*'. Furthermore, the Licence Holder suggested an alternative condition that requires the annual reporting of the F1 RDA water balance to note all inputs and outputs as part of the Annual Environmental Report.	In a letter dated 17 June 2025, the department clarified that the '*estimated water volume discharged to the F1 RDA*' referred to water volume in tailings slurry, not rainfall. The department has modified the condition text to better specify this. The department also notes that reporting of the water balance has been specified as a requirement of the Annual Environmental Report in condition 37

	Amended condition	Summary of Licence Holder's comment	Department's response
			of the amended licence.
35	Condition 37 – Annual environmental reporting requirement	In Table 20, the Licence Holder requested that the department reconsider the reference to *'assessment against human drinking water guidelines'*. The Licence Holder argues that the premises and F1 RDA are not located within a proclaimed groundwater area under the *Rights in Water and Irrigation Act 1914*. Historical groundwater monitoring has showed that groundwater within the local fractured rock aquifer is not fit for consumption, and thus, incompatible with any limits adopted under relevant human drinking water guidelines. For example, salinity and sulfate levels shown in monitoring data showed that groundwater would be unsuitable for human consumption without treatment. Furthermore, the bores at the premises have been impacted by tailings seepage. As such, the Licence Holder would not be able to comply with human drinking water guideline values, with limited options for actions as many parameters being naturally occurring. The Licence Holder insisted that reporting of trends and changes in trends is most appropriate, as is currently being done.	In a letter dated 17 June 2025, the department responded with the following: • The department has not explicitly specified limits for parameters monitored in the groundwater monitoring program in condition 29 of the amended licence. The department has simply required the Licence Holder to assess ambient groundwater monitoring data within the context of relevant human drinking water guidelines. • While the premises is not located on a proclaimed groundwater area, the department highlighted that the premises (and the F1 RDA) are located in close proximity to a Priority 1 public drinking water source area. The department further notes that tailings seepage from the F1 RDA is able to migrate offsite, based on hydraulic pressure. Potential impacts to the nearby PDWSA warrants closer examination of groundwater monitoring information. • In relation to the target aquifer for assessment, the department noted that impacts were not limited to fractured rock aquifer. Seasonal shallow groundwater system may also be impacted by tailings seepage. It has also been reported that shallow monitoring bores at the perimeter of F1 RDA were showing signs of impact, with the possibility of tailings seepage migrating through shallow preferential flow pathways. The department considers the view taken with regards to the target aquifer to be limited. • While the department agreed that analysis of spatiotemporal trends is useful for detecting changes and potential impacts to groundwater, the department considers this approach to be too generic and inadequately definitive (i.e., the degree of change that must be observed for groundwater to be considered impacted is subjective). Assessment of monitoring data using spatiotemporal trends as well as against human drinking water guideline values provides more context to the state of groundwater. • Furthermore, the department had only specified the assessment against human drinking water guideline values at relevant monitoring locations. While the department has not been prescriptive in specifying the relevant monitoring locations, it is intended that the assessment be undertaken for monitoring locations close to or within the PDWSA. • In regard to the ability for the Licence Holder to comply with the relevant guideline values, the department, in completing a detailed risk

	Amended condition	Summary of Licence Holder's comment	Department's response
			assessment (refer to Section 3.5) undertook a preliminary assessment of surface water and groundwataer monitoring data for the 2023 annual period and found that relevant monitoring locations were able to comply with the relevant guideline values, with isolated exceptions observed in groundwater. In conclusion, the department believes that assessment of monitoring trends within the context of the Australian human drinking water guideline values can improve confidence in monitoring and managing potential impacts to sensitive water resources. As such, the department has retained the requirement in the amended licence.
36	Condition 30 – Vegetation monitoring requirement	The Licence Holder sought further clarification on the requirements on the condition. Specifically, the omission of plant cell density monitoring was queried, noting that identifying vegetation changes through photographic assessment alone was difficult. Further, the Licence Holder sought clarification on the definition of 'visual inspection of vegetation' and may require advice from a specialist to ensure that photos taken are representative of the area. The Licence Holder also queried whether the condition also applies to areas already subject to vegetation impact (i.e., Saddle Dams 3 and 4)	**Plant cell density monitoring** In a letter dated 17 June 2025, the department explained to the Licence Holder that, while not specified as a condition in the draft amended licence, the department had considered monitoring of plant cell density in its risk assessment and expects the Licence Holder to undertake it, in accordance with their Groundwater Management Plan. On 25 June 2025, the Licence Holder wrote to the department requesting that plant cell density monitoring be specified in the licence. As such, the department has included it in the amended licence. **Visual inspection of vegetation** In a letter dated 17 June 2025, the department confirmed it had not specified a methodology for visual inspection of vegetation. Ultimately, it is up to the Licence Holder to determine the most appropriate and representative methodology for vegetation monitoring. The department also emphasised the importance of photographic and visual monitoring. While the Licence Holder places emphasis on plant cell density monitoring, the department noted that the plant cell density will only be measured annually, while photographic monitoring was proposed to be undertaken more frequently, on a quarterly basis. **Existing impacted areas at Saddle Dams 3 and 4** Based on the extent of the plant cell density monitoring and locations for visual vegetation monitoring, it is likely that the impacted areas around Saddle Dams 3 and 4 perimeters are included in the scope of monitoring. However, given that impacts in these areas have already been reported to the department previously, further reporting is not required in accordance with

	Amended condition	Summary of Licence Holder's comment	Department's response
			Table 17. The department also noted that the Licence Holder had committed to remedial actions and monitoring of the impacted are in Saddle Dam 3, as outlined in their Groundwater Management Plan.
37	Condition 31 – Sediment monitoring requirement	In Table 18, the Licence Holder responded to the department's request to provide a figure showing the proposed sediment monitoring location at R4 RDA. Updated Figure 8 was provided. On 25 June 2025, the Licence Holder confirmed that the monitoring location ID is R4 SED.	The department has included Figure 8 in the amended licence.
38	Condition 32 – Specified action requirement (dust monitoring review)	The Licence Holder requested further information and clarification on whether Osiris dust monitors were sufficient for continuous real-time monitoring requirements under the condition, noting that the department had stated that Osiris monitors were not recognised under any existing Australian Standard sampling methodology and cannot be used to assess against national air quality guideline values. Despite this, the Licence Holder emphasised the practicality of Osiris dust monitors for offsite and remote monitoring, where power is not available at some locations. Further, the Licence Holder raised concerns on being able to meet the PM_{10} criteria specified in Table 19, as offsite dust monitors may be subject to external factors and land uses, such as rural farming activities, prescribed burning, etc. Using dust assessments undertaken at Port Hedland as an example, the national PM_{10} air quality guideline value did not result in significant health impacts, where a less conservative guideline value was adopted. The Licence Holder highlighted that the premises' surrounds were less densely populated than Port Hedland, with only two primary rural farming premises identified as human receptors of potential	In a letter dated 17 June 2025, the department responded with the following: **Monitoring timeframe** The department clarified that the real-time monitoring period of three years detailed in the draft Amendment Report was an error. The department confirmed that the timeframe specified in draft condition 32 of twelve months was correct. Due to the lower risk profile (as highlighted by the Licence Holder), the department did not intend for the Licence Holder to undertake a comprehensive and long-term dust monitoring program. As such, the department had specified a monitoring period of only twelve months, without specifying the number of dust monitors, monitoring locations, or monitoring methodology (other than the need for continuous real-time monitoring). **Use of Osiris dust monitors for dust monitoring** The department acknowledges that a proper health impact assessment cannot be undertaken without dust monitors using Australian Standard methodologies. As such, the outcomes required by the specified action have been amended to address this. The assessment of monitoring data and any subsequent conclusions and recommendations drawn from it should consider the limitations of the monitoring methodology. **Offsite dust sources** While it is possible that offsite dust sources may influence the ambient dust monitors, the department highlighted steps that the Licence Holder could take to elucidate potential dust sources, including installation of additional portable

	Amended condition	Summary of Licence Holder's comment	Department's response
		concern. Furthermore, the Licence Holder identified that recent approvals obtained by third-party mining companies may result in land clearing and mining activities through portion of the prescribed premises, with offsite monitoring not being able to differentiate between dust sources.	dust monitors at potential dust sources and correlating periods of high dust concentration with meteorological information. While the department acknowledges that determining dust sources may be challenging, the department considers the investigation warranted, given the potential exceedances predicted by ambient dust modelling (Ramboll 2022). The department reiterated that the aim of the specified action was to verify the model predictions. Additional monitoring and/or investigations may be warranted, should monitoring data support the model predictions regarding air quality criteria exceedance.
39	Condition 28 – Ambient surface water monitoring requirement	In Table 15, the Licence Holder responded to the department's request to provide an updated Figure 8, showing the location of replacement perimeter sumps and new background monitoring locations, as well as updated classification.	In a letter dated 17 June 2025, the department noted that the figure provided did not include replacement perimeter sumps and some of the background locations (e.g., Round Swamp, Pillow Swamp, Boomerang Swamp). Further correspondence with the Licence Holder revealed that the replacement perimeter sumps were no longer proposed for construction (refer to Item 5) and that Round Swamp was no longer included in the surface water monitoring program (refer to Item 39 below). An updated Figure 8 was provided on 25 June 2025 and included in the amended licence.
40	Condition 28 – Ambient surface water monitoring requirement	The Licence Holder sought clarification as to the need to monitor from the Round Swamp, Pillow Swamp, and Boomerang Swamp, noting that they were not impacted by mining activities. The Licence Holder indicated that the swamps were ephemeral and rarely contained water. The swamps were also heavily vegetated, making access and sample collection difficult. Further, the swamps were located on perched aquifers (i.e., the seasonal shallow groundwater system) that are isolated from the primary groundwater transmission zone (i.e., underlying fractured rock aquifer). This meant that the swamps were solely reliant on rainfall and surface runoff for recharge and are not impacted by groundwater mounding or dewatering drawdown from mining operations. Lastly, the swamps may potentially be	In a letter dated 17 June 2025, the department clarified that the addition of the three swamps are surface water monitoring locations was included in the draft amended licence as additional regulatory requirements. This was because groundwater mounding from the F1 RDA and seepage-impacted groundwater may impact these swamps due to the southerly regional groundwater flow direction within the catchment, exacerbated by the hydraulic gradient generated by mine dewatering to the south. Further, the D1 Dam, which might intercept some level of seepage, is located south-west of the F1 RDA, with no monitoring information available on potential impacts to these surface water bodies directly to the south. The department also clarified that the inability to collect samples due to dryness or insufficient water at a monitoring location does not constitute a non-compliance, with almost all surface water monitoring locations in the existing licence also of an ephemeral nature. The perched nature of the swamps does not simply mean they will not be impacted by groundwater mounding. Historical monitoring has shown that groundwater mounding has been able to seep upwards through the less

	Amended condition	Summary of Licence Holder's comment	Department's response
		impacted in the future by third-party mining activities.	permeable oxide units, resulting in connectivity between aquifer units. Based on verbal correspondence with the Licence Holder on 13 June 2025, it is understood that the Licence Holder has concerns especially with Round Swamp, noting that it is located within a registered Aboriginal heritage site and may require additional approvals for access. In considering this, the department has amended Table 15 to require monitoring at only Pillow Swamp and Boomerang Swamp, as they are located closer to the F1 RDA and are more likely to be impacted by tailings seepage first. However, detection of tailings seepage impacts at these monitoring locations may trigger an updated risk assessment, where the monitoring of Round Swamp may also be justified. An updated Figure 8 containing Pillow Swamp and Boomerang Swamp was provided on 25 June 2025 and included in the amended licence.
41	Condition 29 – Ambient groundwater monitoring requirement	In Table 16, the Licence Holder sought clarification as to what the limit value of 4.0 was being applied to at the regional monitoring bores.	In a letter dated 17 June 2025, the department clarified that the limit was applied to standing water level at regional monitoring bores.
42	Condition 31 – Sediment quality monitoring requirement	The Licence Holder sought clarification on the requirement for a sediment monitoring program, noting that the presence of cobalt and copper have been established at R4 RDA. The presence of cobalt was attributed to the parent material. The cobalt concentration within R4 RDA was not expected to vary significantly, with the Licence Holder already undertaking monthly surface water monitoring for a number of parameters, including cobalt.	In a letter dated 17 June 2025, the department clarified that the water quality assessment completed in 2019 identified cobalt as a significant contaminant of concern, with concentrations predicted to increase by 2032. Subsequently, environmental risk assessment reported that up to 30% of cobalt in sediment was readily available for biological uptake. Furthermore, submerged macrophyte was found to contain relatively high cobalt concentrations, though it was not possible to differentiate uptake sources between water column and sediment. Furthermore, in a memo submitted to the department on 30 January 2023, the Licence Holder had proposed to develop an ongoing cobalt sediment monitoring program, along with other recommendations. While the department considered extensive investigations to be unwarranted at this stage, owing to a lack of observed wildlife incidents relating to water consumption at R4 RDA to date, the undertaking of a cobalt sediment monitoring program would allow cobalt dynamics at the R4 RDA to be more holistically understood and may inform future quantitative risk assessments, should there be a need for it. As such, the department has retained the monitoring requirements in the amended licence.
43	----	The Licence Holder requested that the 'F1/F3 RDA'	This has been addressed, under Item 2.

	Amended condition	Summary of Licence Holder's comment	Department's response
		be referred to as 'F1 RDA' on the amended licence.	
44	----	The Licence Holder requested that tables associated with ambient surface water and groundwater monitoring be shown in the licence condition text, rather than in Schedule 3: Monitoring to minimise confusion, improve ease of interpretation and minimise excessive use of appendices.	The department has removed Schedule 3 from the amended licence. Relevant Tables 15 and 16 have been added to conditions 28 and 29, respectively, in the amended licence.
45	----	On 25 June 2025, the Licence Holder requested that the assessed design capacity for the village wastewater treatment plant be amended from 270 m^3/day to 600 m^3/day. The existing design capacity was outdated and an 'out of box' design capacity. Since its installation, the village wastewater treatment plant had undergone numerous automation and technical improvements, which has allowed a treatment cycle to reduce from 12 hours to six hours. The increased design capacity has no impacts on the prescribed premises category or the licence's annual fee amount.	As this amendment was not specified prior to the acceptance of the application nor was it related to the existing scope of the licence amendment (i.e., operation of RDAs), the department has decided not to assess this amendment at this point in time. A separate application will need to be submitted to consider this amendment to the licence.

Appendix 2: Summary of Licence Holder's comments on risk assessment and draft conditions (15 July 2025)

	Amended condition	Summary of Licence Holder's comment	Department's response
Background: The Licence Holder responded with comments on 30 July 2025, 31 July 2025, and 4 August 2025, primarily providing information requested by the department in the revised draft amended licence.			
1	Condition 37	Similar to comments provided on the draft amended licence on 27 May 2025, the Licence Holder requested that the requirement to undertake a comparative assessment of surface and groundwater monitoring results against human drinking water guideline values, highlighting the following: • It was unclear whether the condition was referring to the Australian Drinking Water Guidelines (ADWG) as it was vaguely phrased in the condition and not defined in Table 22. • An assessment against the ADWG can result in misleading and broad-brush conclusions being made, which do not reflect the complex geochemical and hydrogeological landscape at F1 RDA. • Furthermore, licence L8306/2008/3 and associated Annual Environmental Reports are publicly available documents, and the inclusion of an ADWG assessment may be misconstrued by the general public. • The ADWG is only applicable for water intended for human consumption or if the water impoundment forms part of a drinking water supply system. Conversely, many of the surface water monitoring locations specified in condition 28 do not meet this purpose, and that the premises is not located within a Public Drinking Water Source Area nor is the groundwater resource proclaimed under the *Rights in Water and Irrigation Act 1914*. Furthermore, current seepage modelling did not predict widespread contamination off the premises. • While it is possible that surface water and groundwater monitoring locations can comply with the ADWG guideline	The department's response to the comments, as shown in Appendix 1, also applies to these comments. The department acknowledges that the application of the ADWG is intended for human drinking water and that there is potential for the general public to misinterpret its purpose when referenced in a licence for a prescribed premises, especially without clear context for their inclusion. In line with the department's *Strategic policy: Protecting public drinking water source areas in Western Australia*, the Western Australian Government has endorsed the ADWG for the protection of drinking water resource within the state. This includes protection of catchments and source water, with an emphasis on prevention, rather than remediation. The department considers the ADWG (and its guideline values) to be applicable, due to the proximity between the premises (and the F1 RDA) and nearby PDWSA catchment. While predictive modelling has indicated minimal impacts to the PDWSA, the department is cognisant of limitations associated with numerical modelling, which should be verified with empirical monitoring information. While a number of monitoring bores have been examined historically, there remains a dearth of long-term monitoring data to confidently assess potential risks to the PDWSA. To address this, the department, in line with recommendations from a suitably qualified hydrogeologist, has required the installation of additional regional monitoring bores. The department acknowledges that the local hydrogeology at

	Amended condition	Summary of Licence Holder's comment	Department's response
		values, it was also highlighted that the water quality at many surface water and groundwater monitoring locations could not meet the ADWG guideline values, being highly variable and driven by seasonality. This was evident in the analysis of historical monitoring results. • For example, a number of groundwater monitoring bores contain pH below 5 pH unit. However, these acidic groundwater conditions likely reflect the iron-rich environment, where naturally occurring ferrolysis reactions generate acidity. These acidic conditions have also been observed in other iron-rich groundwater systems in Western Australian mines. In other instances, groundwater pH at operational monitoring bores exhibited alkaline conditions, at a pH greater than decant water. The source of these elevated pH measurements was not known. Finally, background groundwater total dissolved solids concentrations can range between 500 mg/L and 7,000 mg/L, which easily exceeds the aesthetic guideline value set out in the ADWG. • Based on historical monitoring, it is known that fluctuations in groundwater conditions may reflect the age of the groundwater, degree of local recharge, and the geochemistry of the weathered bedrock. • It was noted that raw mine water was sourced from the Hotham River, which is considered highly degraded with salinity reaching 10,000 mg/L, depending on the season. The water quality at the Hotham River, as well as groundwater abstracted from the Westwood Borefield, would not meet the ADWG guideline values and would require treatment. • Given these considerations, it appears unreasonable to require explanations be given for not meeting the ADWG guideline values in the Annual Environmental Report. • Existing requirements in licence L8306/2008/3 to discuss trends, deviations, and fluctuations against historical monitoring data is considered consistent and sufficient, without the need to require additional comparison against the ADWG guideline values.	the F1 RDA is complex. The department considers the examples highlighted by the Licence Holder to be valid. However, reliance solely on trend analysis, particularly in complex hydrogeological settings, may make the identification of potential issues difficult or delayed. This is where the application of ADWG guideline values may be beneficial, especially considering the context of the surface water and groundwater environment. Nevertheless, the department reiterates that the proposed amendments do not specify a limit based on ADWG guideline values on any parameters in relation to surface water and groundwater monitoring. Furthermore, the department appreciates that several surface water monitoring locations specified in condition 28 are not appropriate for the application of ADWG guideline values. However, there are a number of monitoring locations where the application of these guideline values is appropriate. For example, surface water monitoring location SDBK2 is located within a Priority 1 PDWSA and flows towards the South Dandalup Dam. Conversely, the Hotham River is not an appropriate example as it is not located within the PDWSA and is located several kilometres away from the PDWSA. In this instance, there is no justification for ADWG guideline values to be applied to the Hotham River. Similarly, not all groundwater monitoring bores are relevant to the ADWG assessment. Monitoring bores that are within or hydraulically upgradient of the PDWSA are the ones that would likely benefit from the ADWG assessment. Because of this, the department had specified the assessment be undertaken for relevant monitoring locations, rather than all monitoring locations. Consequently, the department has specified relevant surface water and groundwater monitoring locations that should be considered in the comparative assessment. These include all surface water and regional groundwater monitoring locations within PDWSAs (e.g., SDBK2, F1BR34, F1BR43, F1BR44, F1BR45, F1BR52, BUBR10), as well as those monitoring locations that are hydraulically upgradient of the PDWSA (e.g., F1BR51).

	Amended condition	Summary of Licence Holder's comment	Department's response
			Furthermore, the department has defined the ADWG guideline values in Table 22 of the amended licence.
2	----	The Licence Holder responded to the department's request for updated figures, specifically: • Figure 1 has been updated to include general purpose lease G70/272. • Figure 3 has been updated to only show current and proposed perimeter sumps around the F1 RDA. • Figure 4 has been updated to show the CIL containment sump, which was not included in the previous figure revision.	The department has updated the relevant figures in the amended licence.
3	----	In Table 4 of this Amendment Report, the Licence Holder confirmed the proposed elevation of HDPE liner for F1 RDA Stage 19 to Stage 22 embankment raises.	None.