



Application for Works Approval

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

Works Approval Number W6626/2021/1

Applicant Northern Star (Carosue Dam) Pty Ltd

ACN 116 649 122

File number DER2021/000666

Premises Carosue Dam Minesite
Mining Tenements M28/269, M31/220 and M31/295
MENZIES WA 6436
As defined by the premises map attached to the issued works approval

Date of report 15 June 2022

Decision Works approval granted

Samara Rogers
A/MANAGER, RESOURCE INDUSTRIES
REGULATORY SERVICES

an officer delegated under section 20 of the *Environmental Protection Act 1986* (WA)

Table of Contents

1. Decision summary	1
2. Scope of assessment	1
2.1 Regulatory framework	1
2.2 Application summary and overview of premises	1
2.3 Proposed works	2
2.4 EPBC Act	1
3. Risk assessment	1
3.1 Source-pathways and receptors	1
3.1.1 Emissions and controls	1
3.1.2 Receptors	3
3.2 Risk ratings	2
3.3 Detailed risk assessment for seepage from Carosue Dam TSF	6
3.3.1 Background	6
3.3.2 Water balance	6
3.3.3 Current TSF seepage management	9
3.3.4 Estimated seepage from proposed construction of Cell 4 and Cell 1-3	11
3.3.5 Risk rating of seepage	12
4. Conclusion	13
References	14
Appendix 1: Design and construction of Cell 1-3 and Cell 4	15
1. Cell 1-3 Design	15
1.1 Stage 4 of Cell 3	15
1.2 Cell 1-3	16
2. Cell 4 Design	19
3. Final cell arrangement of TSF	26
Appendix 2: Application validation summary	27
Table 1: Summary of TSF storage characteristics	1
Table 2: Proposed applicant controls	1
Table 3: Sensitive human and environmental receptors and distance from prescribed activity	3
Table 4: Risk assessment of potential emissions and discharges from the premises during construction and operation	3
Table 5: TSF annual water balance summary	8
Table 6: Consultation	13

Figure 1: Tailings storage plan (Cells 1-3 and 4) with forecast tailings production (FY22 to FY33).....	3
Figure 2: Distance to sensitive receptors using 1 km buffer.....	1
Figure 3: Water balance for the current TSF and associated processing infrastructure (unit = kL/month).....	7
Figure 4: Depth to water contour around TSF and Whirling Dervish – February to August.....	10
Figure 5: Estimated depth to groundwater after 10 years without recovery bores.....	11
Figure 6: Estimated depth to groundwater after 10 years with recovery bores	12
Figure 7: Current TSF cells. Cell 1-2 and Cell 3	15
Figure 8: Embankment design for Cell 3, Stage 4	16
Figure 9: Cell 3, Stage 4	16
Figure 10: Cell 1-3 design	18
Figure 11: Cell 4 design	20
Figure 12: Perimeter wall design with toe drain and cut off trench details.....	21
Figure 13: Decant structure and decant causeway.....	22
Figure 14: Underdrainage	23
Figure 15: Return water pond to capture underdrainage	24
Figure 16: Monitoring bores and piezometers	25

1. Decision summary

This decision report documents the assessment of potential risks to the environment and public health from emissions and discharges during the construction and operation of the premises. As a result of this assessment, works approval W6626/2021/1 has been granted.

2. Scope of assessment

2.1 Regulatory framework

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

2.2 Application summary and overview of premises

On 19 November 2021, the applicant submitted an application for a works approval to the department under section 54 of the *Environmental Protection Act 1986* (EP Act).

The application is to undertake construction works relating to Life of Mine tailings management at the premises. The premises is approximately 120 km north-east of the City of Kalgoorlie-Boulder.

The premises relates to the category 5 and assessed design capacity under Schedule 1 of the *Environmental Protection Regulations 1987* (EP Regulations) which are defined in works approval W6626/2021/1. The infrastructure and equipment relating to the premises category and any associated activities which the department has considered in line with *Guideline: Risk Assessments* (DWER 2020) are outlined in works approval W6626/2021/1.

Background

The cells currently in use for tailings storage were constructed in 2000 (Cell 1), 2001 (Cell 2) and 2014 (Cell 3). Cells 1 and 2 were constructed with partial underdrainage and Cell 3 with underdrainage under the decant pond area. Cells 1 and 2 were merged as one cell in 2019 at Stage 7 of both cells design. The construction method for all three cells was that of upstream lifts after the initial downstream embankment was constructed.

Operation of the tailings storage facility is authorised under licence L7465/1999/9. This licence allows for discharge of tailings to the tailings storage facility up to Stage 3 of Cell 3 and Stage 7 of Cell 1-2. Cell 3 Stage 3 was expected to reach capacity during February 2022 at the time of application for this works approval (W6626/2021/1) and the Stage 8 construction of Cell 1-2 was expected to be completed in time for discharge to cease into Cell 3 Stage 3.

Stage 8 of Cell 1-2 has been constructed under works approval W6568/2021/1. Discharge into Cell 1-2 has commenced under the time limited operations conditions of W6568/2021/1.

The TSF, when constructed to the final design crest elevation, will provide approximately 30.3Mm³ of storage. This will provide an equivalent total storage capacity of approximately 44 Mt or more than 10 years' storage life, based on a projected tailings production rate of 4.1 Mtpa and an adopted tailings dry density of 1.45 t/m³. The current throughput under the premise licence L7465/1999/9 is 4Mtpa. Northern Star intends on increasing the permissible throughput of the CDO Processing Plant to 5Mt per annum during the current LOM TSF licence amendment.

2.3 Proposed works

The stages of the works assessed under this application are:

- Stage 1. Stage 4 of existing Cell 3 will be raised to an embankment crest level of RL 381 m, Figure 3;
- Stage 2. The new Cell 4, will be developed as a paddock-type facility to the west of existing Cell 3. A perimeter embankment to enclose an internal impoundment surface area of approximately 120 ha at starter embankment crest elevation of RL 375.5 m will be constructed, Figure 4;
- Stage 3. Merging of Cells 1-2 and Cell 3 to form a Supercell 1-3 at crest level of RL 383 m, Figure 10;
- Stage 4. A further 4 stages of upstream raised embankment will be constructed at Cell 4 with a final embankment crest elevation of RL 383.5 m (Cell 4 Stage 1 to Stage 4); and
- Stage 5. A further 3 stages of upstream raised embankment will be construction at Supercell 1-3 with final embankment crest elevation of RL 389 m (Supercell 1-3 Stage 2 to Stage 4).

Construction of Stages 1 -3 above will be approved under this works approval. They entail the establishment of the new arrangement for the tailings storage facility. The completion of Stage 3 of this works approval is expected to be completed by 2027 as per the timeline in Figure 1.

Stages 4 and 5 relate to the construction of ongoing lifts to the TSF facility the approval of which may be managed via licence amendments. These stages are not expected to be required until 2029. Specific requirements for each lift will be included in the corresponding Final Design Report which will be provided to DWER prior to commencement of each raise.

Figure 1 shows the projected production rate of tailings over the financial year against the planned stages of deposition for each TSF cell. Construction of each TSF cell stage occurs prior to the deposition period shown.

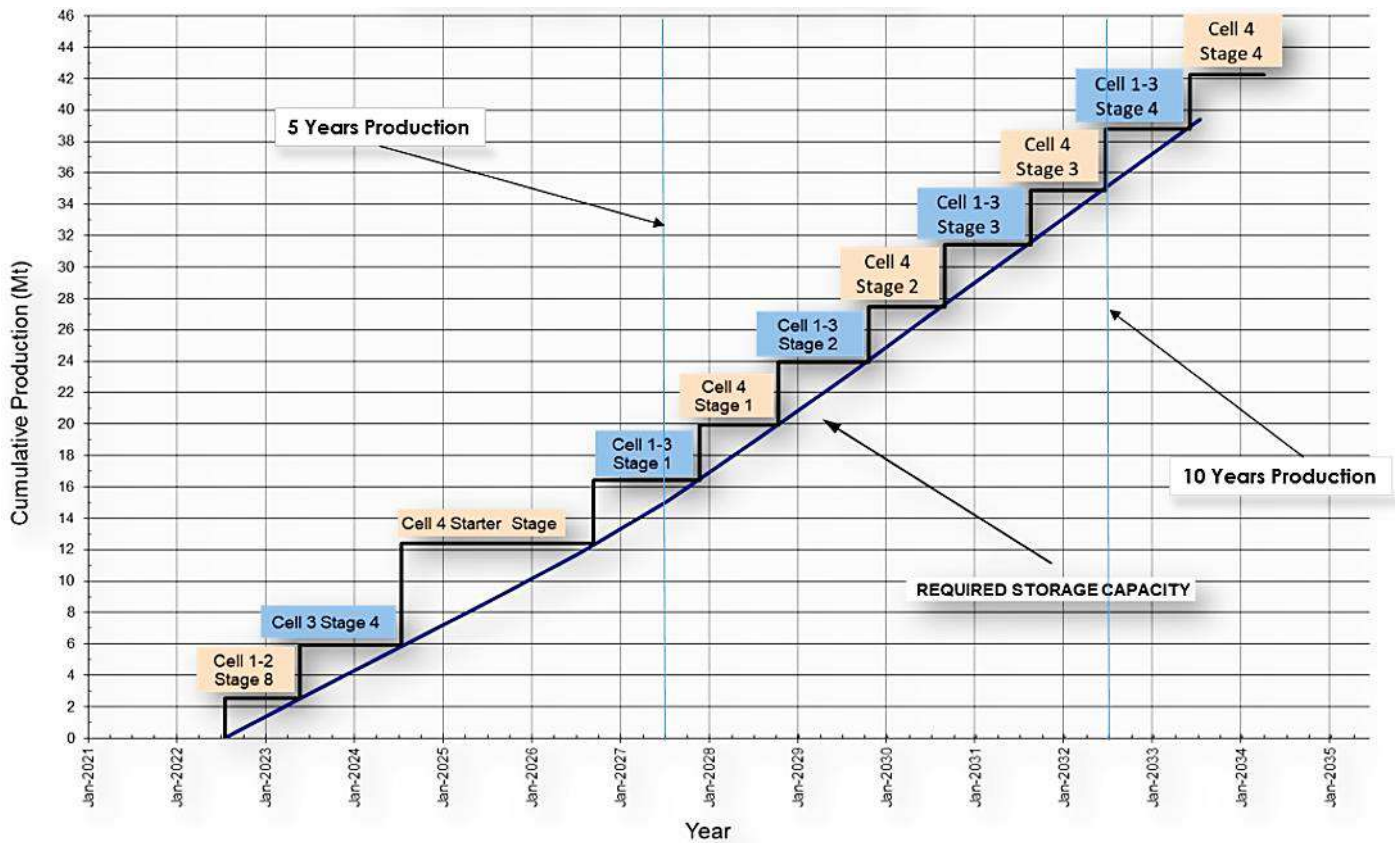


Figure 1: Tailings storage plan (Cells 1-3 and 4) with forecast tailings production (FY22 to FY33)

Table 1 shows the storage characteristics of each stage of the tailings storage development and an estimated time frame for each stage.

Construction details and design diagrams of Stages 1 – 3 of this works approval are provided in Appendix 1.

Table 1: Summary of TSF storage characteristics

Stages proposed in Works approval application	TSF cell stage	Height of rise (m)	Embankment crest RL (m)	Storage area (ha)	Storage volume (Mm ³)	Cumulative storage volume (Mm ³)	Cumulative storage capacity (Mt)	Cumulative storage life (years)	Rate of rise (m/year)
1 ¹	Cell 3 Stage 4	3.5	381	72.0	2.37	5.33	5.56	1.99	3.04
2 ¹	Cell 4 starter embankment		375.5	120.7	4.44	9.77	12.40	4.16	1.84
3 ¹	Cell 1-3 Stage 1 (merging of Cell 1-2 with Cell 3)	2	383	137.9	2.77	12.54	16.42	5.35	1.68
4 and 5. ²	Cell 4 Stage 1	2	377.5	121.4	2.42	14.96	19.94	6.24	2.25
	Cell 1-3 Stage 2	2	385	135.3	2.76	17.72	23.96	7.26	1.97
	Cell 4 Stage 2	2	379.5	119.1	2.42	20.14	27.47	8.12	2.33
	Cell 1-3 Stage 3	2	387	132.7	2.72	22.86	31.42	9.08	2.07
	Cell 4 Stage 3	2	381.5	118.1	2.39	25.25	34.90	9.93	2.36
	Cell 1-3 Stage 4	2	389	130.2	2.66	27.91	38.77	10.88	2.12
	Cell 4 Stage 4	2	383.5	117.1	2.37	30.28	42.22	11.72	2.37

1. Stages 1, 2 and 3 to be approved under this works approval.
2. Ongoing lifts to be managed through licence amendments

2.4 EPBC Act

The expansion of the TSF by the construction of Cell 4 was referred under the EPBC Act, managed by the Federal Department of Agriculture, Water and the Environment (DAWE), in relation to potential threat to malleefowl (*Leipoa ocellata*). The clearing of vegetation for the Cell 4 footprint will cause the destruction of malleefowl mounds. The decision from this referral was that; the proposed action is a controlled action and will require assessment and approval under the EPBC Act before it can proceed.

The Malleefowl Assessment (EPBC 2021-9026) under the EPBC Act is yet to be completed. This approval is managed DAWE in parallel to this Works Approval. No ground disturbance will commence until approval is granted by DAWE.

3. Risk assessment

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

To establish a risk event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission.

3.1 Source-pathways and receptors

3.1.1 Emissions and controls

The key emissions and associated actual or likely pathway during premises construction and operation which have been considered in this decision report are detailed in Table 2 below. Table 2 also details the control measures the applicant has proposed to assist in controlling these emissions, where necessary.

Table 2: Proposed applicant controls

Emission	Sources	Potential pathways	Proposed controls
Construction			
Dust	Material handling, vehicle movements, earthworks etc.	Air / windborne pathway	Dust suppression using saline water sprays and water carts. Cessation of a particular operation or an amendment to an operational procedure when dust cannot be controlled. Small, localised dust suppression, including mist spray.
Commissioning and Operation			
Tailings	Leaks and spills from pipeline	Direct contact with ground and vegetation. Ground contamination causing contamination of	All pipelines will be: <ul style="list-style-type: none">double skinned PE100 and will be constructed and installed in accordance with AS4130 and AS413, and the Plastics Industry Pipe Association of Australia Limited (PIPA) Guideline POP003.contained within bunded open trenches

Emission	Sources	Potential pathways	Proposed controls
		stormwater.	<p>sufficient in capacity to contain leaks and spillages between routine inspections.</p> <ul style="list-style-type: none"> inspected twice daily as per DWER licence conditions. fitted with automatic leak detection and shut off systems to minimise discharge and allow for maintenance and recovery of materials. The Citect processing plant control system monitors pressure in pipelines and water levels in tanks and dams. Upon an immediate drop in pressure within a pipeline or a dam is reaching capacity, mill control operators are alarmed and immediately shut down the plant to stop flow of material
	Overtopping of facility	<p>Direct contact with ground and vegetation.</p> <p>Ground contamination causing contamination of stormwater.</p>	<p>The embankments of the TSF are constructed to provide a minimum 0.5 m total freeboard (including an allowance for a 1% AEP 72 hour rain event) above the normal operating pond.</p> <p>Licence (7465/1999/9) condition 4 requires a total freeboard of 500mm and an operational freeboard is required by licence for all containment cells, dams, ponds and turkeys nests on the premises.</p> <p>12 hour inspections.</p>
	Dust from dry tailings	Air / windborne pathway.	Due to the short timeframe between lifts, dusting of tailings is not expected to occur as the material will retain moisture from operation of the cell.
Leachate	Seepage through base of TSF.	<p>Groundwater contamination</p> <p>Groundwater mounding</p>	<p>The supernatant pond size, when present, will be minimised as far as possible during operation of the facility, which will in turn reduce the risk of phreatic surface daylighting at the downstream face of the embankment and minimise outgoing seepage through the base of the TSF and its embankments.</p> <p>Underdrainage installed across base of TSF with a return water pond to capture it for pumping back to the process circuit.</p> <p>Monitoring bores installed around the TSF cells with a site trigger of 6mbgl for actions to be taken and a licence limit of 4mbgl.</p>
Decant return water	Leaks and spills from pipeline	<p>Direct contact with ground and vegetation.</p> <p>Ground contamination causing contamination of</p>	<p>All pipelines will be:</p> <ul style="list-style-type: none"> double skinned PE100 and will be constructed and installed in accordance with AS4130 and AS413, and the Plastics Industry Pipe Association of Australia Limited (PIPA) Guideline POP003.

Emission	Sources	Potential pathways	Proposed controls
		stormwater.	<ul style="list-style-type: none"> contained within bunded open trenches sufficient in capacity to contain leaks and spillages between routine inspections. inspected twice daily as per DWER licence conditions. fitted with automatic leak detection and shut off systems to minimise discharge and allow for maintenance and recovery of materials. The Citect processing plant control system monitors pressure in pipelines and water levels in tanks and dams. Upon an immediate drop in pressure within a pipeline or a dam is reaching capacity, pumps are automatically shut off and mill control operators are alarmed to immediately shut down the plant to stop flow of material
	Overtopping of process water dam	<p>Direct contact with ground and vegetation.</p> <p>Ground contamination causing contamination of stormwater</p>	Licence (7465/1999/9) condition 4 requires a total freeboard of 500mm and an operational freeboard is required by licence for all containment cells, dams, ponds and turkeys nests on the premises.

3.1.2 Receptors

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

Table 33 and Figure 2 below provides a summary of potential human and environmental receptors that may be impacted as a result of activities upon or emission and discharges from the prescribed premises (*Guideline: Environmental Siting* (DWER 2020)).

Table 3: Sensitive human and environmental receptors and distance from prescribed activity

Human receptors	Distance from activity / prescribed premises
City of Kalgoorlie-Boulder	Approximately 120km south-west of the Premises.
Pinjin Station	37km from the tailings storage facility
Environmental receptors	Distance from activity / prescribed premises
Lake Rebecca – (salt lake)	7-8 km north east (down hydraulic gradient) of the TSF
Underlying groundwater (non-potable purposes)	Within the Goldfields Groundwater Area (RIWI Act 1914 designated area). The groundwater level prior to operations was approximately 20 metres below ground level (mbgl). It has been locally modified by the TSF

	<p>operations and dewatering of pits.</p> <p>Groundwater is hypersaline with total dissolved solids (TDS) content being approximately 40,000mg/L.</p> <p>Pastoral bores</p> <ul style="list-style-type: none"> - Relief Hill Well, ~5.5km east of the process plant and TSF - Y4 bore – ~10km north of the process plant and TSF <p>Groundwater in the TSF area has been modified by the construction and operation of the existing TSF as well as dewatering and mining of the Whirling Dervish open pit. Groundwater mounding is evident in the TSF area with water levels rising in the north and west. In contrast, dewatering at Whirling Dervish has created a groundwater sink with water levels in the South east corner (MB1D) falling 26m. Water levels around the existing TSF vary depending on which cell is in operation. The standing water level (SWL) is highest on the north-eastern margin of the facility at MB6s (7.58mbgl in December 2021) and MB5 (8.37mbgl across the 2021 monitoring period).</p>
Surface water	<p>Catchments to the southwest and h of the TSF is currently diverted from the TSF Cell 3. Cell 4 will extend further into these catchment areas.</p>
Native vegetation.	<p>Acacia aneura (mulga) low woodlands associated with red loams over siliceous hard pan to the north and low woodlands of mixed mulga and Casuarina pauper (black oak) and Eucalyptus sp. on alkaline and calcareous soils to the south. Spinifex hummock grassland with eucalypt overstory on sand plain is common. Halophytic vegetation occurs throughout the region on paleo-drainage systems, breakaways and on some stony and alluvial plains. Highly saline soils support Atriplex (saltbush), Maireana (bluebush) and Tecticornia (samphire) shrublands, while less saline soils support mulga with saltbush or bluebush understory</p>
Threatened/Priority Flora	<p>From a survey of the area in June 2021, <i>Eremophila arachnoides</i> subsp. <i>tenera</i> (priority 3, recently downgraded from priority 1) is located within the surveyed area. Closest individuals are approx. 500m north west of the TSF.</p>
Threatened/Priority Fauna	<p>Malleefowl are active on the Premises. A survey during June 2021 of the area to be covered by Cell 4 found no sightings of birds, 10 nesting mounds classed “long abandoned”, 3 “recent failed”, 4 “recent abandoned” and 4 “recent potentially active”. The management of impact to this fauna is under the EPBC Act. Refer Section 2.4</p>

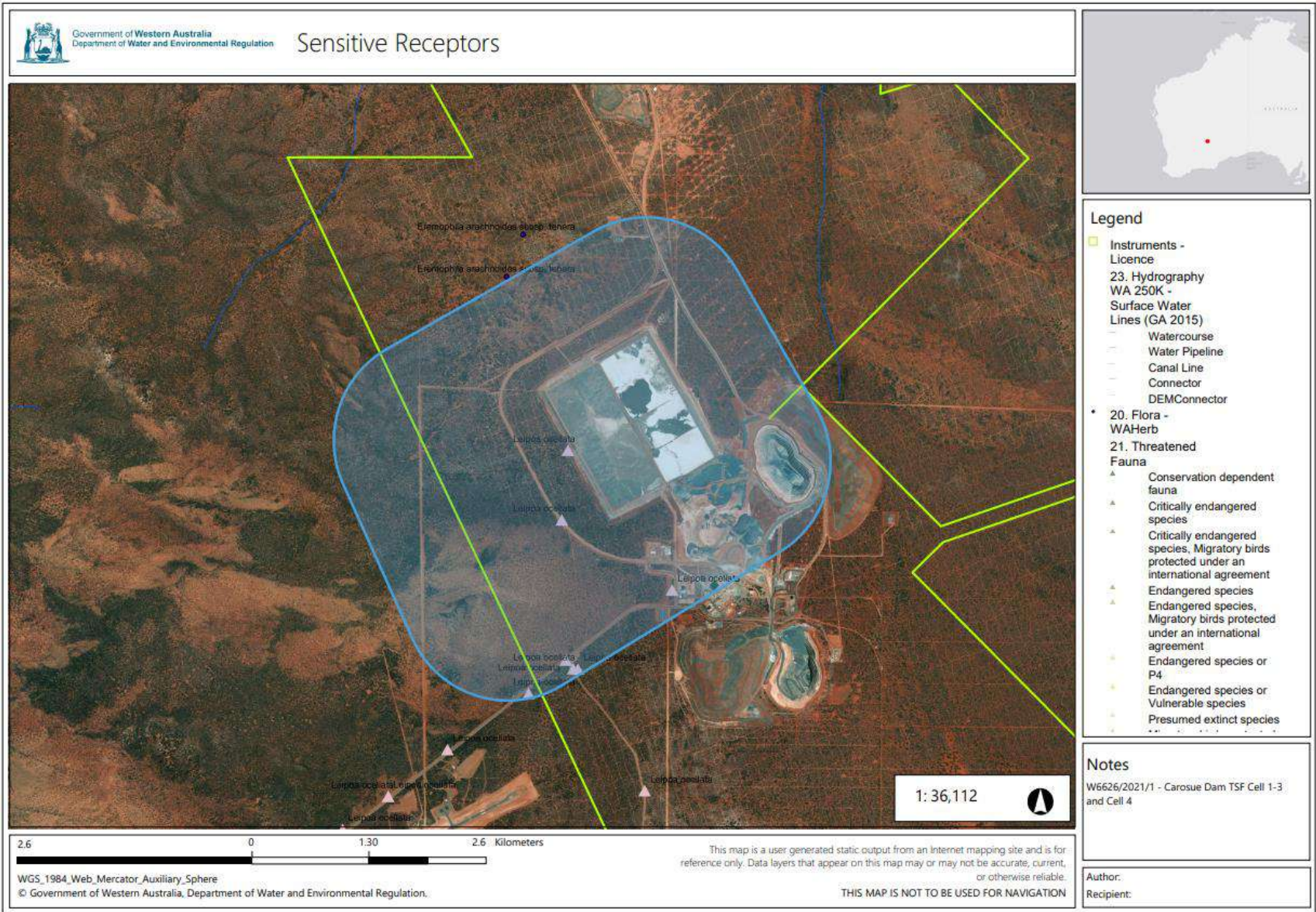


Figure 2: Distance to sensitive receptors using 1 km buffer

Works approval: W6626/2021/1

3.2 Risk ratings

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

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

Additional regulatory controls may be imposed where the applicant's controls are not deemed sufficient. Where this is the case the need for additional controls will be documented and justified in Table 4.

Works approval W6626/2021/1 that accompanies this decision report authorises construction and time-limited operations. The conditions in the issued works approval, as outlined in Table 4 have been determined in accordance with *Guidance Statement: Setting Conditions* (DER 2015).

A licence is required following the time-limited operational phase authorised under the works approval to authorise emissions associated with the ongoing operation of the premises i.e. Category 5 activities. A risk assessment for the operational phase has been included in this decision report, however licence conditions will not be finalised until the department assesses the licence application.

Table 4: Risk assessment of potential emissions and discharges from the premises during construction and operation

Risk Event					Risk rating C = consequence L = likelihood	Applicant controls sufficient?	Conditions of works approval	Justification for additional regulatory controls
Source/Activities	Potential emissions	Potential pathways and impact	Receptors	Applicant controls				
Construction								
Construction of raises on Cell 3, construction of Cell 4 and amalgamation of Cell 1-2 with Cell 3 to form Cell 1-3	Dust	Air/windborne pathway causing impacts to health and amenity	Vegetation Fauna – mallee fowl nests	Refer to Section 3.1	C = Slight L = Unlikely Low Risk	Y	No specific conditions for dust management are required.	
Operation								
Transport of tailings and decant/recovered seepage through pipelines.	Tailings	Direct deposition from pipeline leaks or spills causing contamination of soil Contaminated soil causing contamination of stormwater. Direct deposition on surrounding vegetation.	Vegetation Fauna – mallee fowl nests Surface water	Refer to Section 3.1	C = Moderate L = Possible Medium Risk	Y	Condition 1 – standard infrastructure and equipment condition. Includes position and dimensions of stormwater management infrastructure and pipeline infrastructure. Conditions 5-6 – standard compliance report conditions Conditions 10 and 12 – standard conditions permitting operation of infrastructure for 180 days once constructed and reported.	Construction details proposed by the works approval holder are conditioned to minimise risk from leaks and spills during operation.
	Decant/seepage recovery water							

Risk Event					Risk rating C = consequence L = likelihood	Applicant controls sufficient?	Conditions of works approval	Justification for additional regulatory controls
Source/Activities	Potential emissions	Potential pathways and impact	Receptors	Applicant controls				
Discharge of tailings to TSF.	Tailings	<p>Direct deposition from overtopping of TSF cells causing contamination of soil.</p> <p>Contaminated soil contaminating storm water runoff.</p> <p>Direct deposition on surrounding vegetation.</p>	<p>Vegetation</p> <p>Fauna – mallee fowl nests</p> <p>Surface water</p>	Refer to Section 3.1	<p>C = Moderate</p> <p>L = Possible</p> <p>Medium Risk</p>	Y	<p>Condition 2 – standard critical containment infrastructure condition. The 3 stages of TSF construction are detailed.</p> <p>Conditions 7-8 – standard critical containment infrastructure report conditions.</p> <p>Condition 11 – 13 standard conditions permitting operation of infrastructure for 180 days once constructed and reported.</p>	<p>Construction details proposed by the works approval holder are conditioned to minimise risk of overtopping.</p> <p>Conditions for operation of the TSF during limited time operations reflect the licence, L7465/1999/9, conditions already in place for the management of the TSF.</p>
	Leachate	<p>Seepage through ground into groundwater aquifers/creating perched groundwater aquifer.</p> <p>Surface expression of groundwater coming into contact with stormwater runoff.</p> <p>Mounding of groundwater into vegetation root zones</p>	<p>Groundwater aquifer</p> <p>Surface water</p> <p>Vegetation</p>	Refer to Section 3.1	<p>C = Moderate</p> <p>L = Unlikely</p> <p>Medium Risk</p>	Y	<p>Condition 2 – standard critical containment infrastructure condition. The 3 stages of TSF construction are detailed.</p> <p>Condition 3 – construction/installation condition for monitoring bores at the new TSF Cell 4.</p> <p>Conditions 7-8 – standard critical containment infrastructure report conditions. Baseline groundwater monitoring required.</p>	<p>Refer to Section 3.3</p> <p>Groundwater monitoring conditions for the new monitoring bores reflect the current licence, L7465/1999/9 conditions. This will enable the monitoring to be carried out and included with groundwater monitoring reporting for the whole TSF.</p>

Works approval: W6626/2021/1

Risk Event					Risk rating C = consequence L = likelihood	Applicant controls sufficient?	Conditions of works approval	Justification for additional regulatory controls
Source/Activities	Potential emissions	Potential pathways and impact	Receptors	Applicant controls				
							<p><u>for Cell 4 construction.</u></p> <p>Condition 11 – 13 standard conditions permitting operation of infrastructure for 180 days once constructed and reported.</p> <p><u>Condition 14 – monitoring of groundwater in new Cell 4 monitoring bores.</u></p>	

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

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

3.3 Detailed risk assessment for seepage from Carosue Dam TSF

3.3.1 Background

The expansion of the TSF would cause vertical leakage of tailings water through the floor of the TSF and contribute to mounding of the water table in the underlying saprolite aquifer, which in turn would enhance migration of TSF seepage within the local aquifer system.

The pre-mining water table is estimated as 19–22 metres below ground level (mbgl) within the weathering profile underneath the TSF, based on early investigations from the Whirling Dervish area. Seepage from the TSF has caused groundwater mounding around 8 mbgl beneath the northeast corner of the TSF whilst mining has produced a groundwater depression of 199 mbgl in the nearby Whirling Dervish Pit.

Seepage can potentially waterlog the root zone of vegetation causing health impacts and surface expression of seepage can potentially contaminate stormwater runoff. To mitigate these impacts the works approval holder engaged the consultant Pennington Scott to design appropriate TSF seepage recovery as necessary to ensure that there is no risk of waterlogging (water table less than 6 mbgl) or offsite TSF seepage migration off the works approval holder's tenements.

The licence for the premise, L7465/1999/9, establishes the following groundwater quality limits in condition 23 to control potential impacts of seepage on the environment:

- SWL = >4.0 mbgl
- Weak acid dissociable cyanide (WADCN) <0.5 mg/L

As per condition 23 if any limit is not met then the result must be investigated. Under condition 24 if the WADCN limit is exceeded then a Groundwater Recovery Plan must be designed and implemented. Condition 8 of the licence also requires that, upon becoming aware that depth to groundwater levels in monitoring bores around the TSF are less than 6.0 mbgl, then the works approval holder, within six months, must design and implement a Groundwater Recovery Plan.

The Groundwater Recovery Plan must meet the requirements of Condition 9 which include the developing of strategies to achieve and maintain the groundwater below the level limits. The works approval holder uses 6mbgl as a trigger to initiate actions before the SWL >4 mbgl limit is reached.

A recovery plan has not had to be implemented to date as the limit has not been exceeded. Modelling provided with the application for this works approval indicates that the SWL trigger value may be exceeded after 10 years and in worse case scenarios with the operation of Cell 4 and Cell 1 -3 without any TSF recovery bores.

3.3.2 Water balance

Figure 3 provides a water balance for the current TSF and associated processing infrastructure using the current figures. This water balance, as provided by the works approval holder with the application supporting document, does not include the inflow of rainfall. Rainfall inflow is however a small percentage of the inflow to the TSF and the tailings thickener removes approximately 54% of the water from the tailings prior to discharge and returns it to the process stream or the paste fill plant. Approximately 25% (49,000kL/month) of all water sent to the Tailings Storage facility is returned to the Process Plant for reuse through underdrainage and decant return pumps. An estimated 5% of the water in tailings is released as seepage with the remainder lost to evaporation and moisture retention.

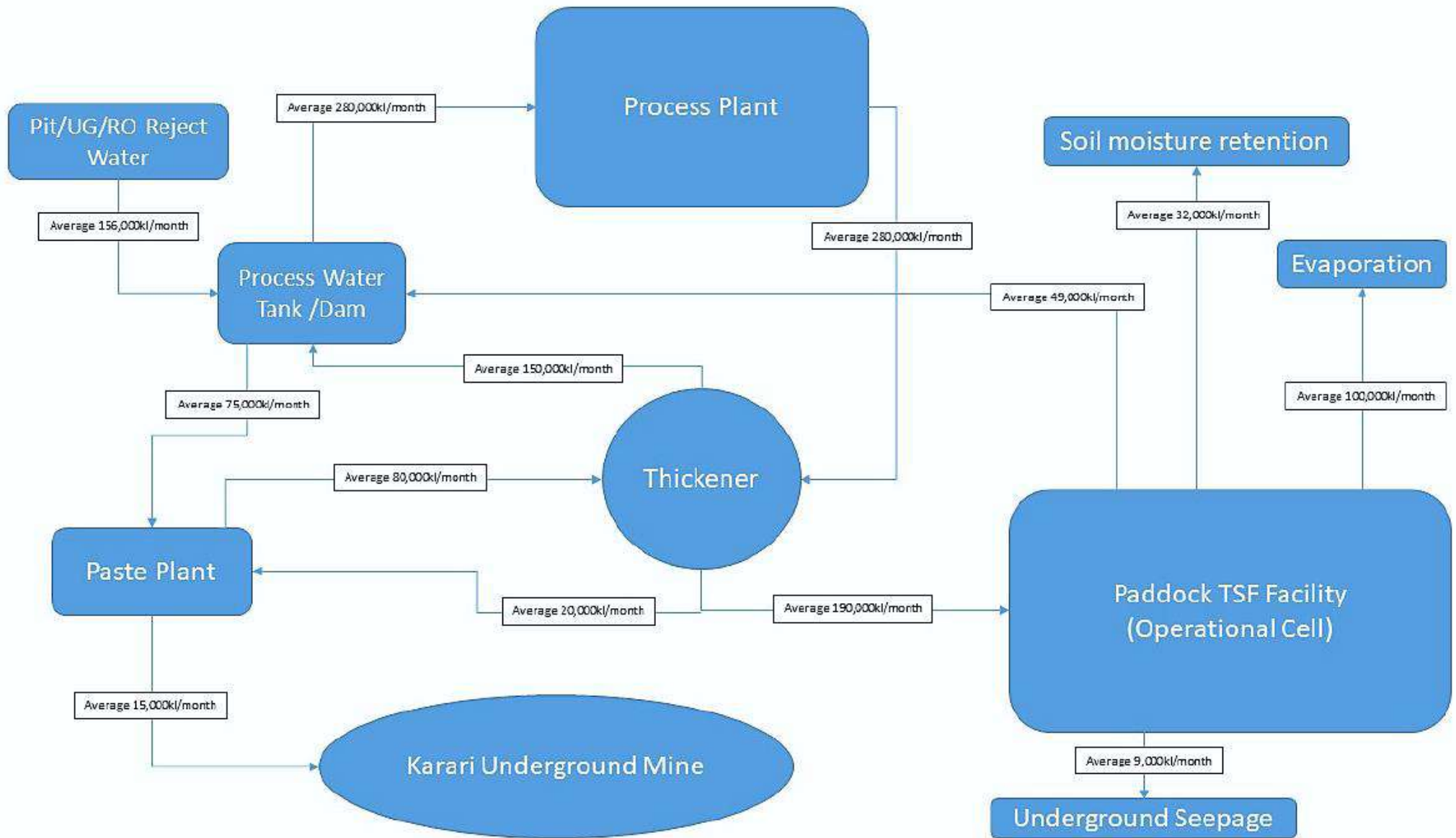


Figure 3: Water balance for the current TFS and associated processing infrastructure (unit = kL/month)

Works approval: W6626/2021/1

Future water balance estimates were provided in the TSF design report by Coffey (2021) and shown in Table 5 below. The water balance provided by Coffey does provide the same estimates as provided by the works approval holder in Figure 4. The water balance provided by Coffey however reflects estimates based on expected future conditions at the final stages of the TSF cells.

The results of the water balance analysis indicated:

- For Cell 3 Stage 4, an estimated annual water return of approximately 0.311 Mm³, which equates to 21% of annual slurry water inflow (i.e. 1.51 Mm³). The average water shortfall (or makeup water) is estimated at 1.20 Mm³/year.
- For Super Cell 1-3 Stage 4 (final stage), an estimated annual water return of approximately 0.388 Mm³, which equates to 18.0% of annual slurry water inflow (i.e. 2.21 Mm³). The average water shortfall (or makeup water) is estimated at 1.82 Mm³/year.
- For Cell 4 Stage 4 (final stage), an estimated annual water return of approximately 0.452 Mm³, which equates to 19.0% of annual slurry water inflow (i.e. 2.21 Mm³). The average water shortfall (or makeup water) is estimated at 1.78 Mm³/year.

Table 5: TSF annual water balance summary

Inflows (m ³ /year)		Outflows (m ³ /year)	
Cell 3 Stage 4 Operation			
Rainfall	104,906	Evaporation	434,128
Slurry water	1,507,692	Evapotranspiration	14,851
		Seepage	15,688
		Retention	840,000
Total inflow	1,612,599	Total outflow	1,304,667
		Return water	311,031m ³ /year
<i>Average water shortfall (or make up water) = Slurry (inflow) water – Return water</i>			1,196,661m ³ /year
Super Cell 1-3 Stage 4 Operation			
Rainfall	185,455	Evaporation	738,566
Slurry water	2,207,692	Evapotranspiration	27,949
		Seepage	42,274
		Retention	1,230,000
Total inflow	2,393,147	Total outflow	2,038,789
		Return water	388,081m ³ /year
<i>Average water shortfall (or make up water) = Slurry (inflow) water – Return water</i>			1,819,612m ³ /year
Cell 4 Stage 4 Operation			
Rainfall	170,916	Evaporation	709,537
Slurry water	2,207,692	Evapotranspiration	24,064
		Seepage	10,906
		Retention	1,230,000
Total inflow	2,378,608	Total outflow	1,974,507
		Return water	452,304m ³ /year
<i>Average water shortfall (or make up water) = Slurry (inflow) water – Return water</i>			1,782,388m ³ /year

3.3.3 Current TSF seepage management

Seepage from Carosue Dam TSF is historically managed by a tailings thickener reducing the water content prior to discharge to the TSF and differing underdrainage systems under the cells. Cells 1 and 2 were constructed with partial underdrainage and Cell 3 with underdrainage under the decant pond area. Cells 1 and 2 were merged as one cell in 2019 at Stage 7 of both cells design. The Carosue Dam Thickener also directly returns approximately 150,000kl per month of water to the processing circuit which would otherwise report directly to the TSF.

The TSF seepage rate has been steadily declining since the start of mining as the groundwater mound has developed. During the initial wetting phase, the TSF would have been losing up to 8L/s through its base, which has declined to its current rate of around 3.5L/s. Although there appears to be significant groundwater mounding around the TSF, the actual volumes of TSF seepage may be very low due to the low permeability of the clayey upper saprolite horizon. The TSF is also in close vicinity to Whirling Dervish Pit and recirculation of TSF seepage is believed to account for about 10% of the dewatering from Whirling Dervish.

The pre-mining water table was initially observed around 19–22 mbgl within the weathering profile underneath the TSF, based on early investigations from the Whirling Dervish area. Figure 4 illustrates the impact of the Whirling Dervish Pit on the groundwater flow around the existing TSF. The pit creates a sink that the seepage flows towards. The seepage on the northern edge of the TSF, where mounding is up to 7.85mbgl, is also expected to report to the pit in the long term. The expected post closure state of the pit is that it will partially fill with water and remain a groundwater sink.

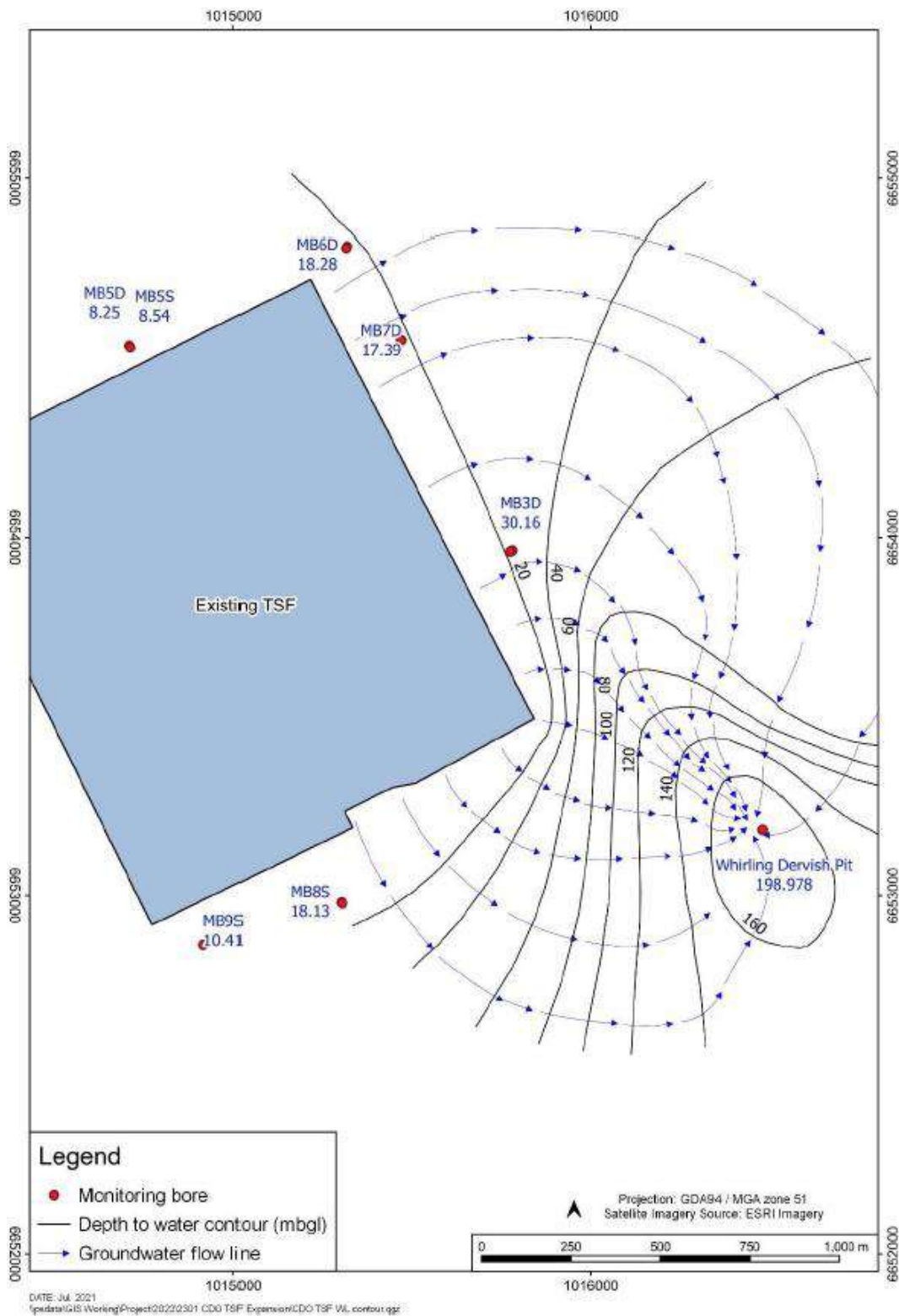


Figure 4: Depth to water contour around TSF and Whirling Dervish – February to August

3.3.4 Estimated seepage from proposed construction of Cell 4 and Cell 1-3

A surface and groundwater hydrological study for the TSF expansion looked at the future seepage transport from the TSF. The expansion of the TSF will cause vertical leakage of tailings water through the floor of the TSF and contribute to mounding of the water table in the underlying saprolite aquifer, which in turn would enhance migration of TSF seepage within the local aquifer system. The seepage rate from the proposed Cell 4 and Cell 1-3 arrangement of the TSF has been modelled using scenarios of seepage without recovery bores and seepage with recovery bores. Other controls currently mitigating seepage impacts from the TSF will remain in place.

The results of the seepage analyses indicated that total seepage from the TSF final stages would range between approximately 30 and 115 m³/d under normal operating conditions. The introduction of underdrainage system at the basin floor is anticipated to reduce the seepage losses through the basin floor area.

The estimated shallowest SWLs around the TSF after 10 years for both scenarios are shown in Figure 5 and Figure 6.

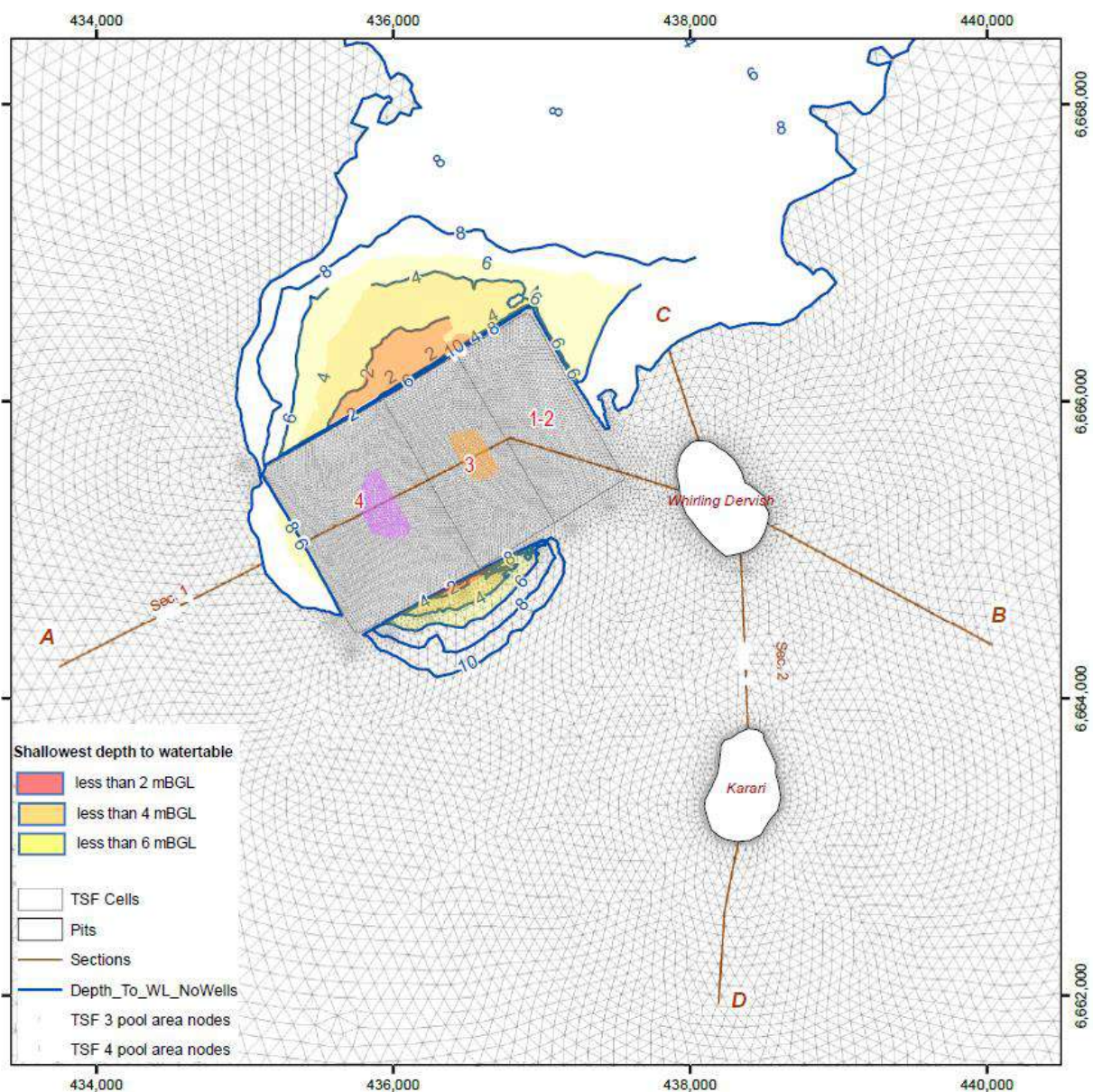


Figure 5: Estimated depth to groundwater after 10 years without recovery bores

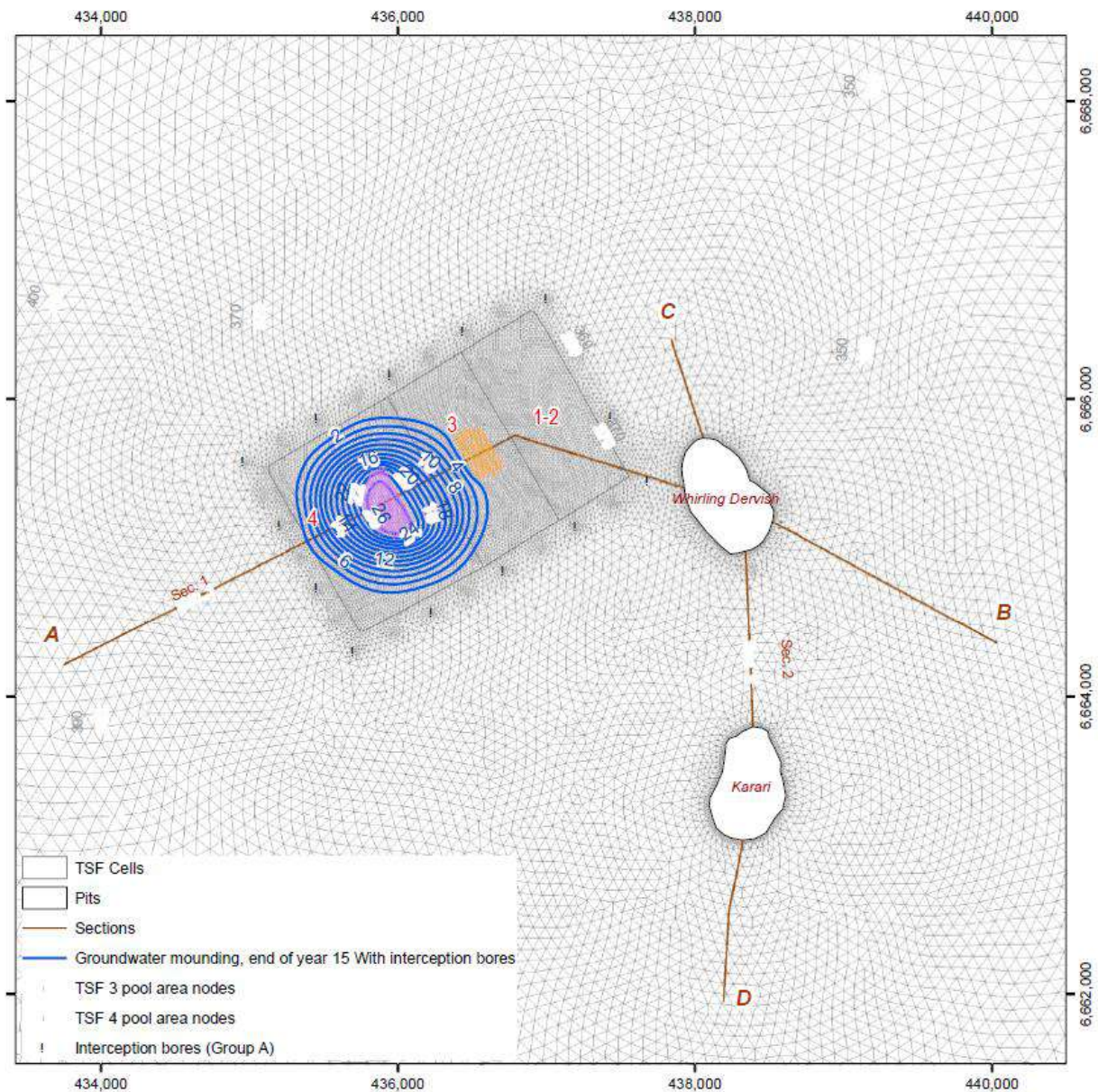


Figure 6: Estimated depth to groundwater after 10 years with recovery bores

3.3.5 Risk rating of seepage

The risk of the seepage causing impact on vegetation and surface water has been assessed previously as requiring licence conditions setting of a SWL limit of >4mbgl and a WADCN limit of <0.5mg/L. To avoid being non-compliant with the SWL limit the works approval holder has set a trigger level in their seepage management plan of 6mbgl. Modelling of the seepage from the TSF, assuming no recovery bores are installed, shows that both the trigger level and the limit will be exceeded within 10 years. Modelling of the same seepage over the same timeframe with recovery bores shows that the controls will effectively manage the seepage.

Consequence of seepage impacting the environment = Moderate

Likelihood of seepage impacting the environment with controls in place = unlikely

Consultation

Table 6 provides a summary of the consultation undertaken by the department.

Table 6: Consultation

Consultation method	Comments received	Department response
Application advertised on the department's website on 7/01/2022	None received	N/A
Application advertised in <i>West Australian</i> newspaper on 10/01/2022	None received	N/A
Local Government Authority (Shire of Menzies) advised of proposal on 7/01/2022	None received	N/A
Local Government Authority (City of Kalgoorlie-Boulder) advised of proposal on 7/01/2022	None received	N/A
Department of Mines, Industry Regulation and Safety (DMIRS) advised of proposal 7/01/2022	DMIRS replied on 19/01/2022 advising that: This works approval application is consistent with a mining proposal currently under assessment (on hold pending additional information from proponent) by DMIRS (Reg. ID: 101504). During the assessment of this mining proposal, a DMIRS Inspector of Mines – Geotechnical, reviewed the application and advised that geotechnical aspects had been sufficiently considered by the proponent. The assessing officer has raised questions regarding some environmental aspects of the mining proposal, however none that are specifically related to the TSF.	No response required.
Applicant was provided with draft documents on 3 June 2022	Updated premises map and Mallee fowl assessment provided. Details of Cell 1-3 decant were confirmed.	The decision report and works approval conditions were updated as necessary with the information provided.

4. Conclusion

Based on the assessment in this decision report, the delegated officer has determined that a works approval will be granted, subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

References

1. Department of Environment Regulation (DER) 2015, *Guidance Statement: Setting Conditions*, Perth, Western Australia.
2. Department of Water and Environmental Regulation (DWER) 2020, *Guideline: Environmental Siting*, Perth, Western Australia.
3. DWER 2020, *Guideline: Risk Assessments*, Perth, Western Australia.
4. Tetra Tech Coffey (Coffey 2021), *Carosue Dam Gold Mine TSF Cell 1-3 and Cell 4 Design Report*, Perth, Western Australia.
5. Pennington Scott (2021), *Surface and Groundwater Hydrological Studies for Life of Mine TSF Expansion Project: Carosue Dam Operations*, Perth, Western Australia.

Appendix 1: Design and construction of Cell 1-3 and Cell 4

1. Cell 1-3 Design

The TSF cells currently have the arrangement of a two cell facility: Cell 1-2 and Cell 3, Figure 7. Cell 1-2 was created when Cell 1 and Cell 2 both reached Stage 7 of their design heights and the merged cell has just been raised to Stage 8 (RL381).

With this works approval Cell 3 will be raised to an embankment crest level of RL 381 m, Stage 4 of the cell design. Once Stage 4 of Cell 3 has been filled with tailings and sufficiently dried the two current cells will be combined with one lift into Cell 1-3, Stage 1.

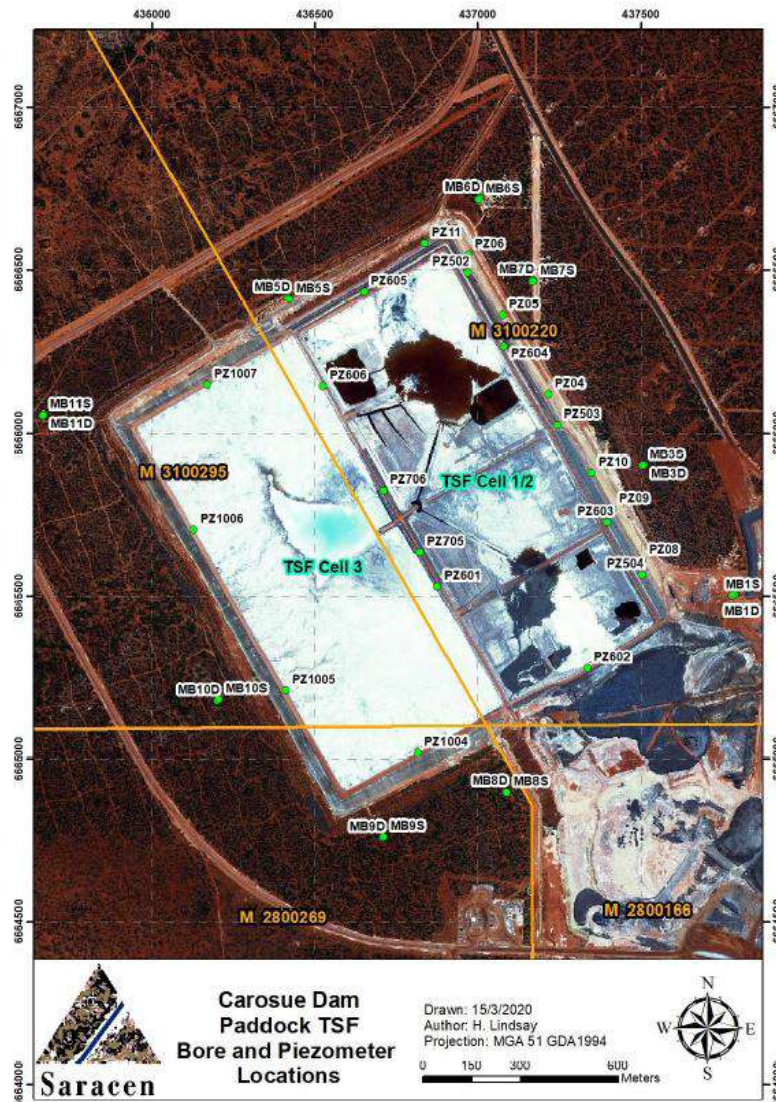


Figure 7: Current TSF cells. Cell 1-2 and Cell 3

1.1 Stage 4 of Cell 3

Stage 4 of Cell 3 will be an upstream lift of the outer embankments using dried tailings from Stage 3 of Cell 3 and an outer, erosion protection layer of waste rock. The divider embankment between Cells 1-2 and 3 will be the embankment of the Cell 1-2 Stage 8 raise.

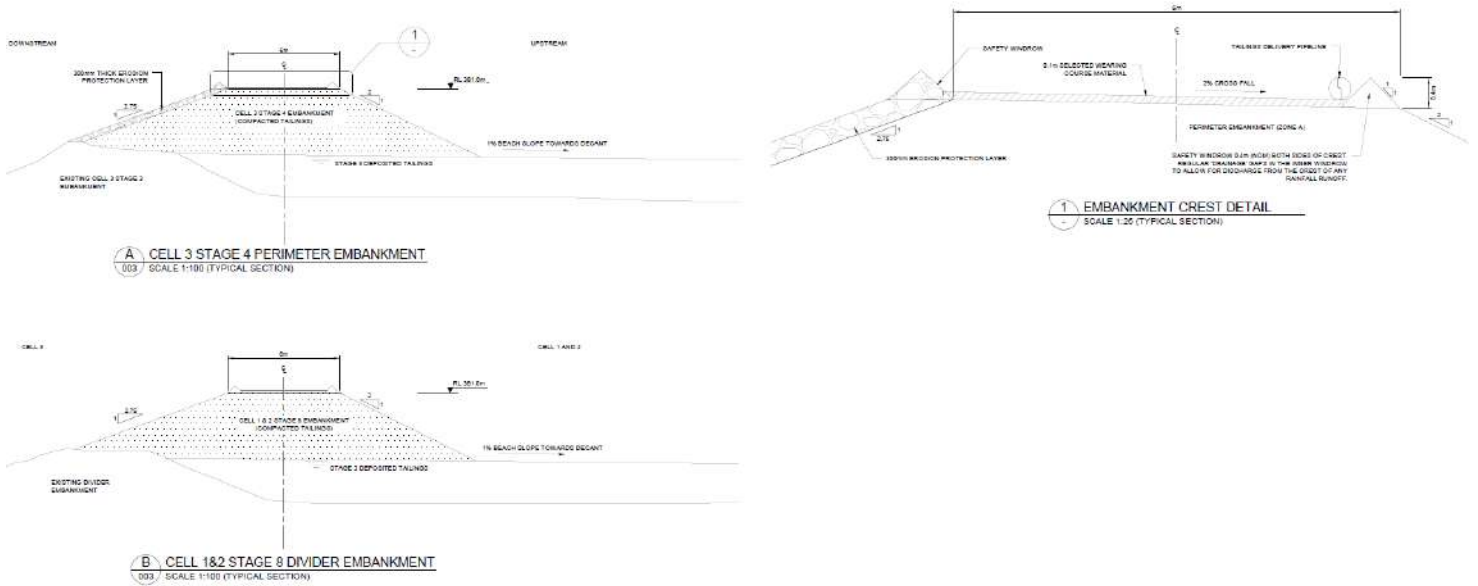


Figure 8: Embankment design for Cell 3, Stage 4

The arrangement of pipelines, decant tower and spigots will be as per Cell 3, Stage 3. Figure 9



Figure 9: Cell 3, Stage 4

1.2 Cell 1-3

Works approval: W6626/2021/1

The combining of the TSF cells Cell 1-2 and Cell 3 to form a super cell Cell1-3 will require the removal of existing drainage towers 4 and 5 as the dividing wall will be buried under tailings. The current Cell 3 decant structure will be retained and raised as the new Cell 1-3 decant structure. A new causeway to the decant will extend from the west wall of the cell, that is the dividing wall between the new Cell 4 and the super cell.

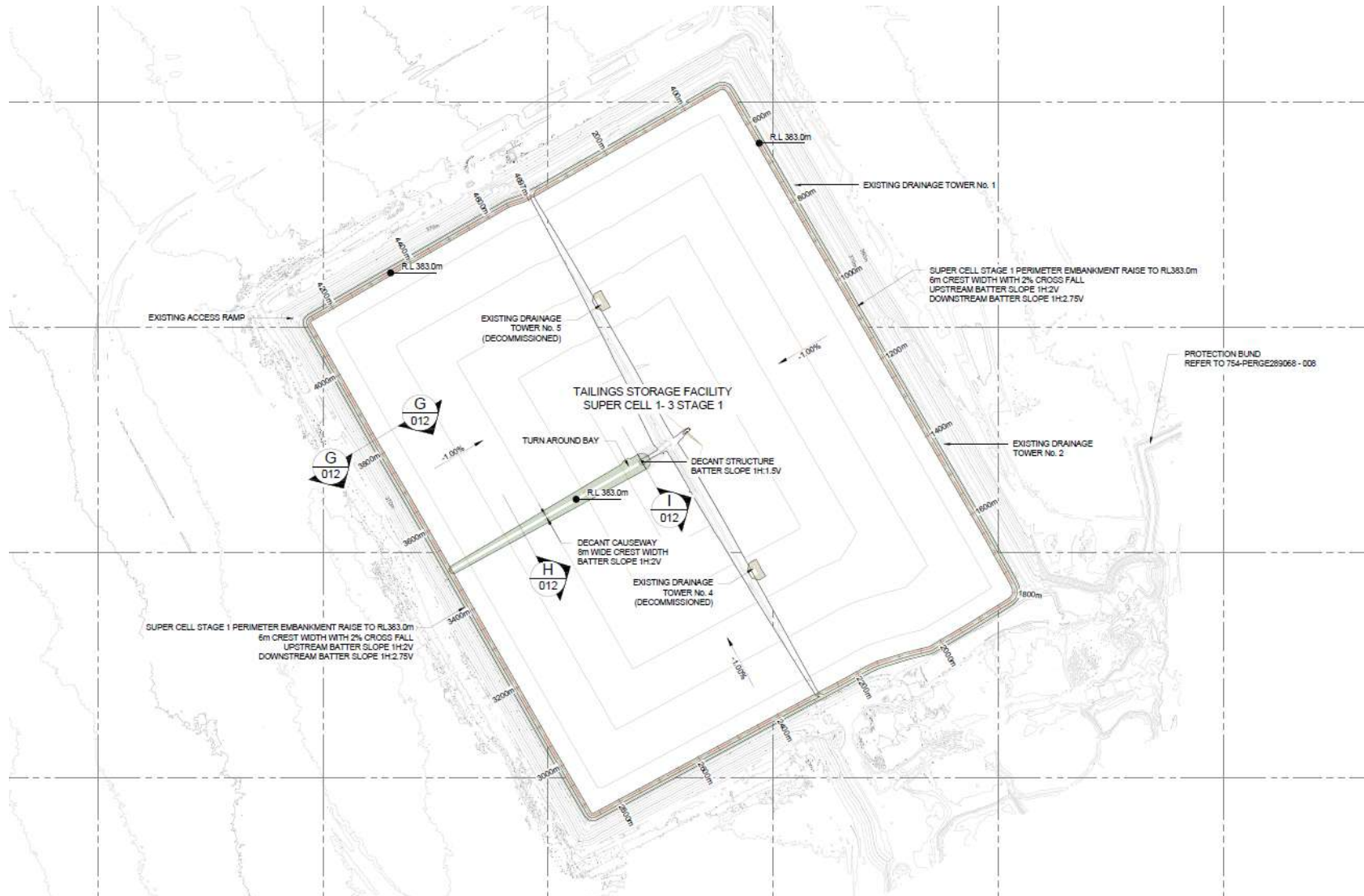


Figure 10: Cell 1-3 design

Works approval: W6626/2021/1

2. Cell 4 Design

Cell 4 is a paddock-type storage facility with a storage surface area of approximately 120.7 ha, abutting the southwest side of the existing Cell 3. The cell will include:

- soil surface compacted after topsoil stripping. Ground permeability beneath proposed TSF 4 tested to less than 1×10^{-7} m/s;
- walls constructed from compacted clay mine waste to a height of RL 375.5m Figure 11 and Figure 12;
- cut off trench at base of wall 2m deep and 4m wide at base and filled with compacted clay mine waste Figure 12;
- a decant constructed from a slotted concrete pipe and clean rock fill filter, RL 372.5m. Decant causeway constructed with mine waste to RL372.5m Figure 13 ;
- underdrainage across the entire base of the cell Figure 14;
- a return water pond to collect outflow from underdrainage, lined with geotextile and HDPE Figure 15;
- 6 monitoring bores and 12 vibrating wire piezometers Figure 16;.

Construction will include stripping of topsoil and compacting the base of the TSF to a permeability greater than 1×10^{-7} m/s. A cut off trench and underdrainage will be installed, and the wall is constructed using compacted clay mine waste.

The underdrainage lines will comprise slotted pipe (Megaflo 150 and 450 - slotted composite panel drain) covered in filter sand / fine aggregate wrapped in geotextile and stabilised with coarse aggregate or select rockfill. The underdrainage pipe will be placed above the stripping level. Underdrainage water collected via the underdrainage piping system will drain by gravity to an internal underdrainage sump. The minimum designated fall/gradient of the underdrainage pipe is 0.2%. The underdrainage sump will be located immediately adjacent to the upstream embankment toe, at the lowest point within the Cell 4 basin area (i.e. at the south-east corner).

Underdrainage water in the underdrainage sump will be recovered via an inclined riser pipe (DN 315 mm HDPE casing) housing a submersible pump (designed by others) to handle an estimated maximum flow of 2 L/s (or 165 m³/day) under normal operating conditions.

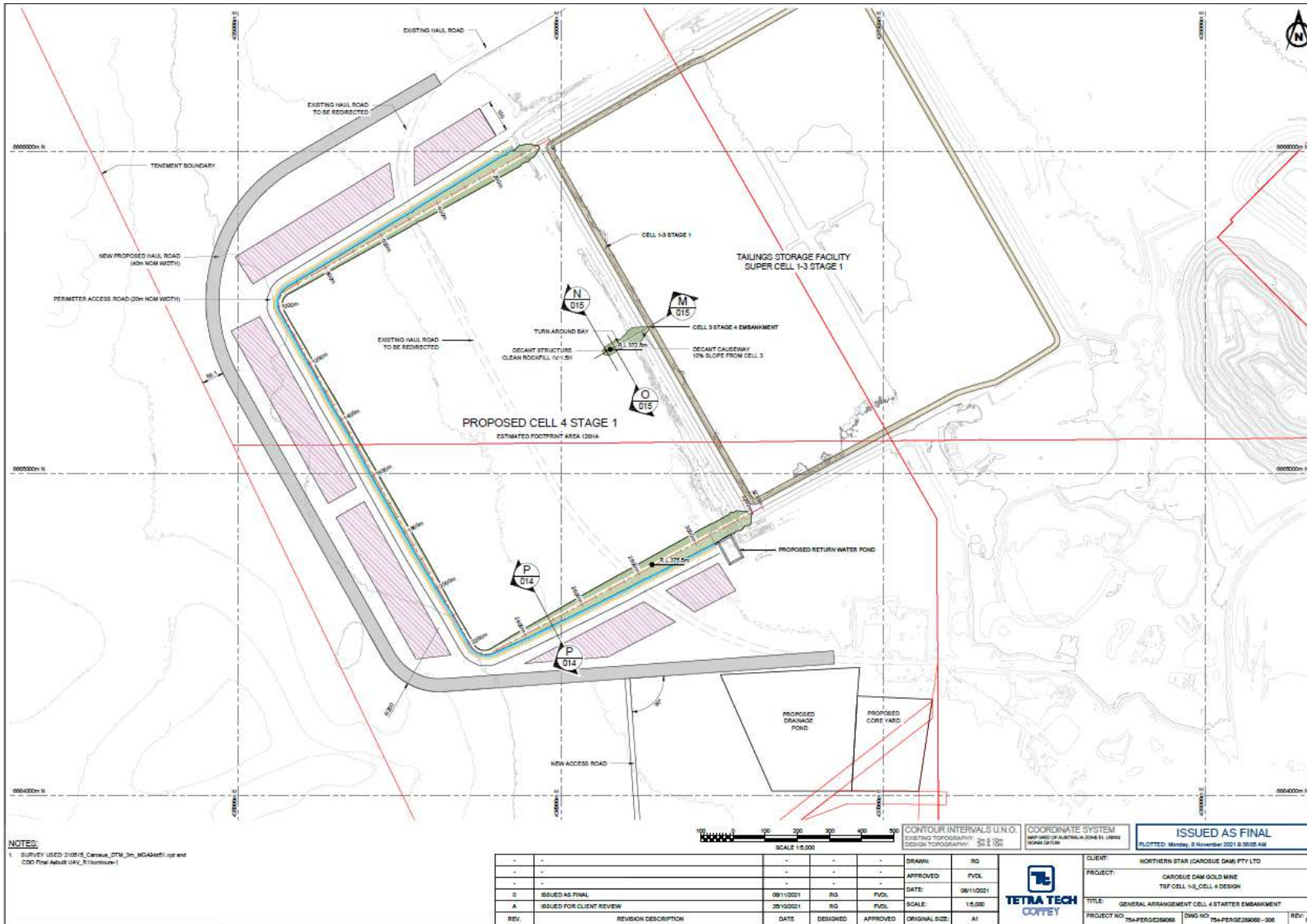


Figure 11: Cell 4 design

Works approval: W6626/2021/1

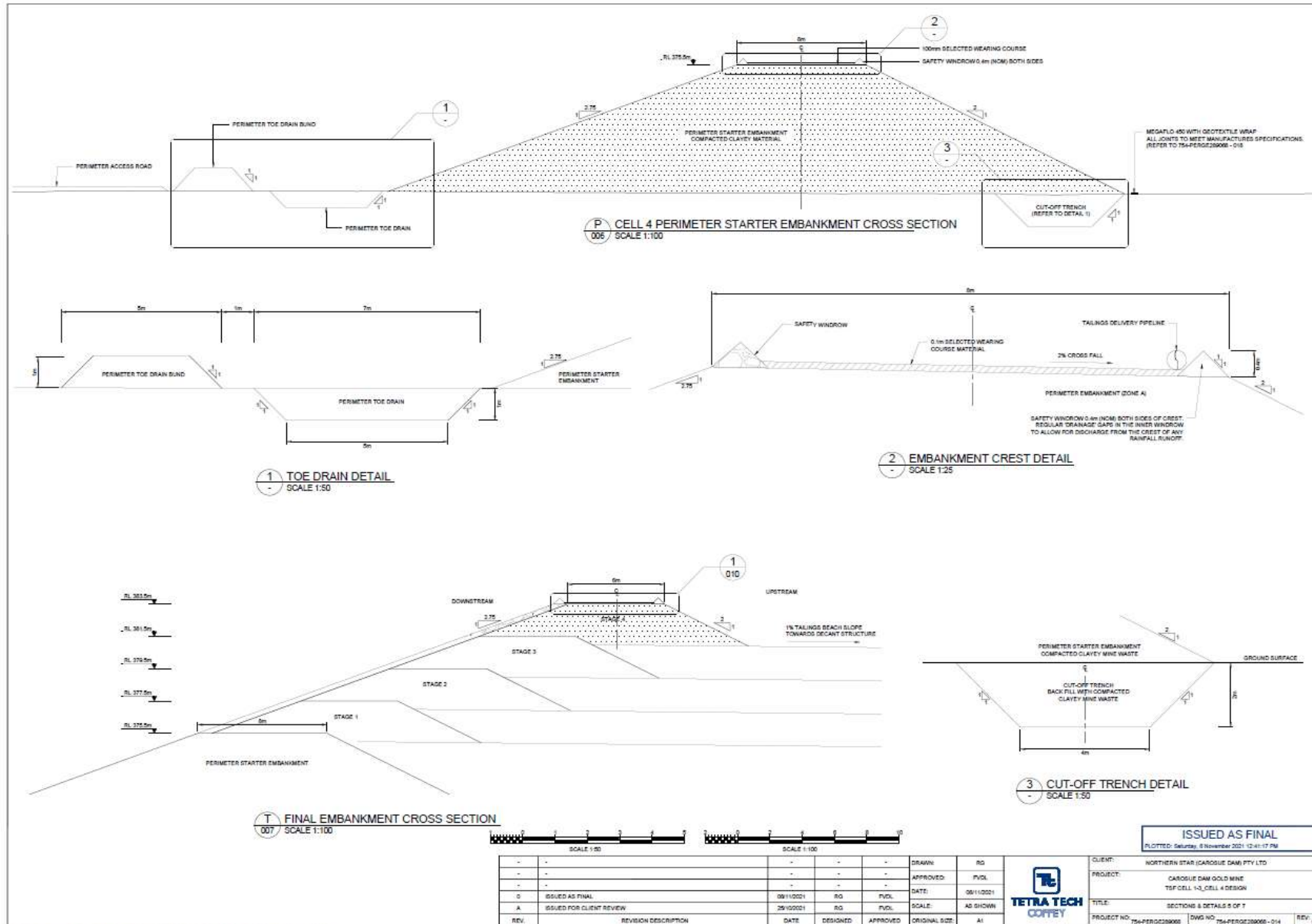


Figure 12: Perimeter wall design with toe drain and cut off trench details

Works approval: W6626/2021/1

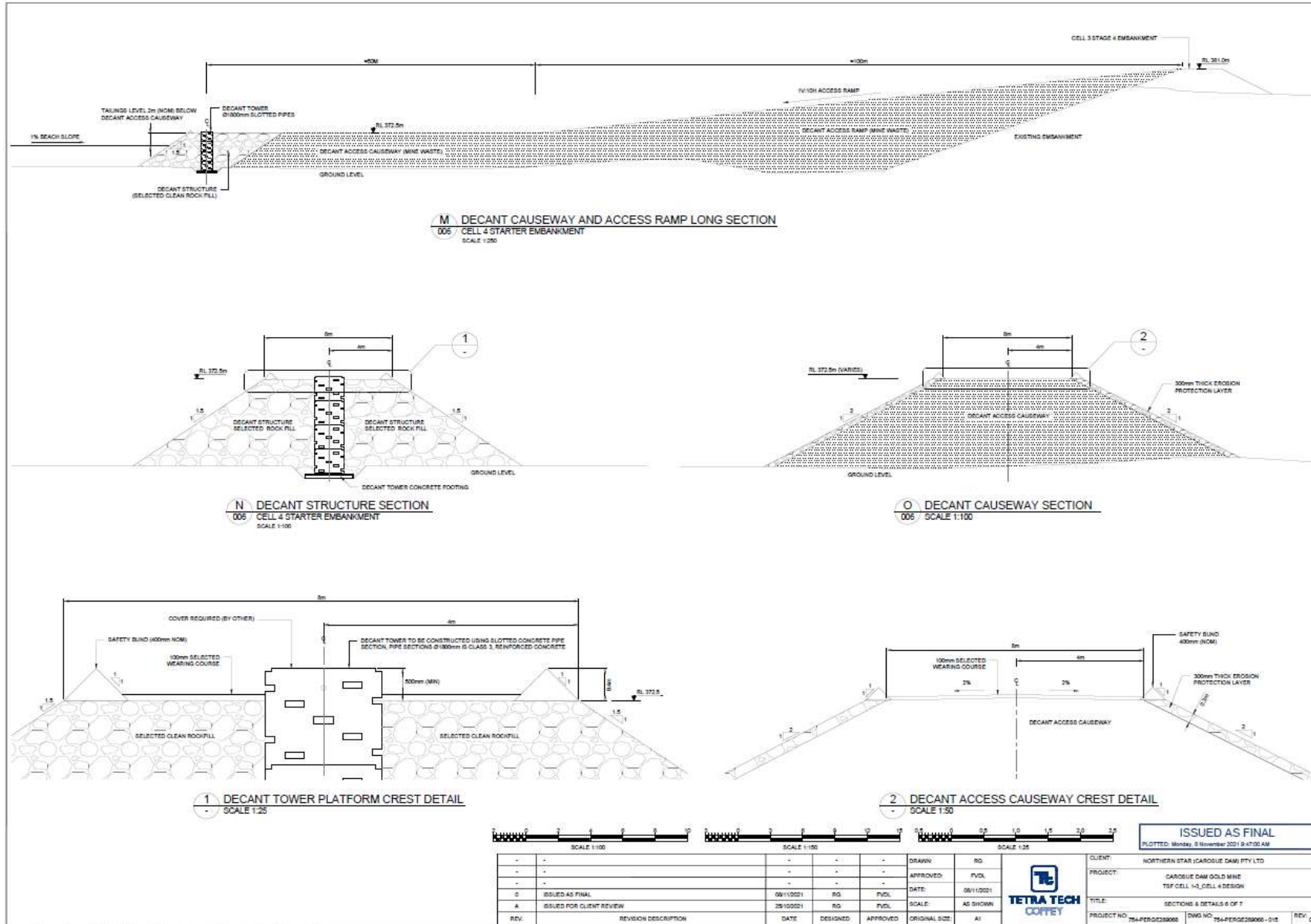


Figure 13: Decant structure and decant causeway

Works approval: W6626/2021/1

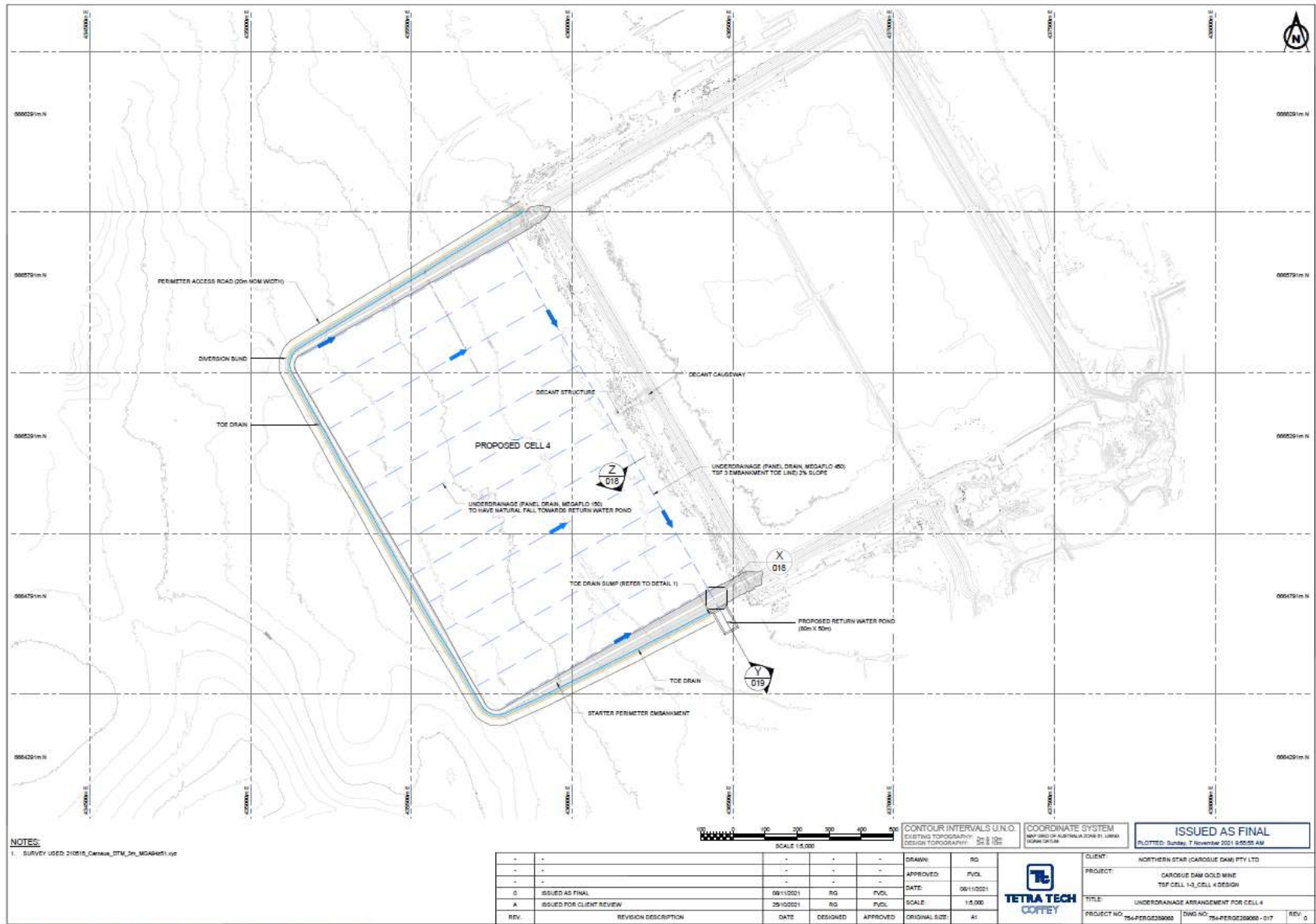


Figure 14: Underdrainage

Works approval: W6626/2021/1

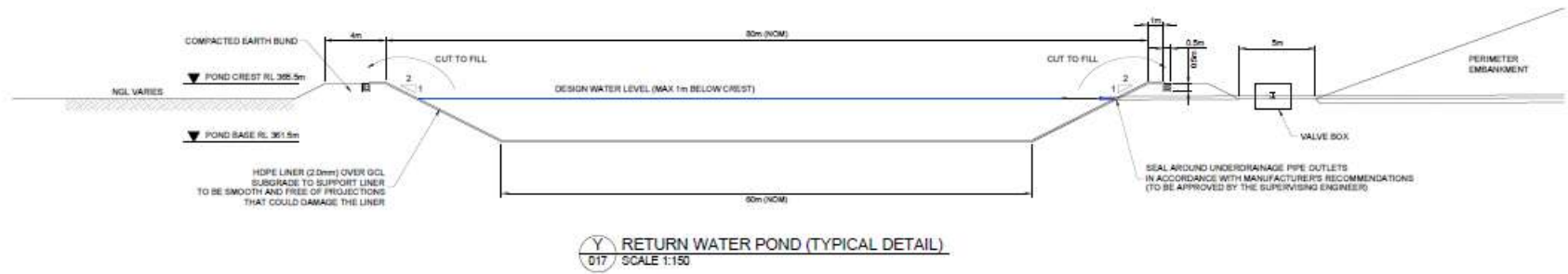


Figure 15: Return water pond to capture underdrainage

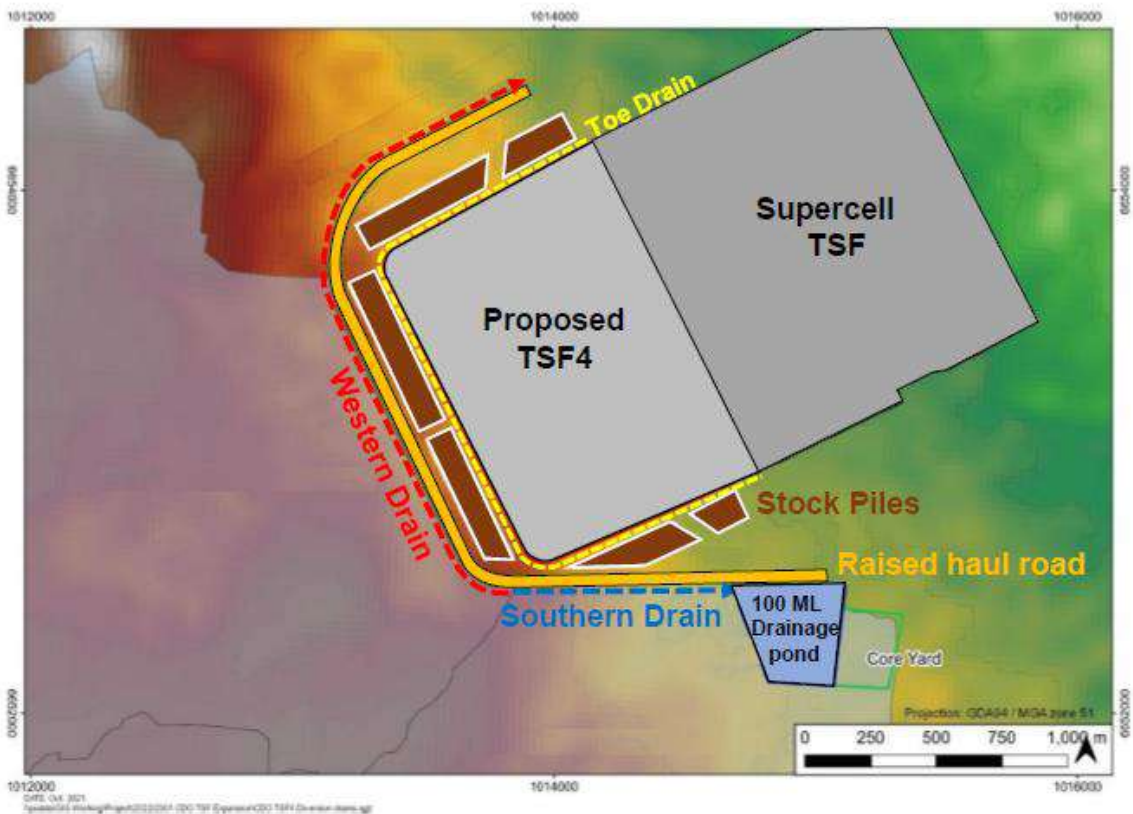
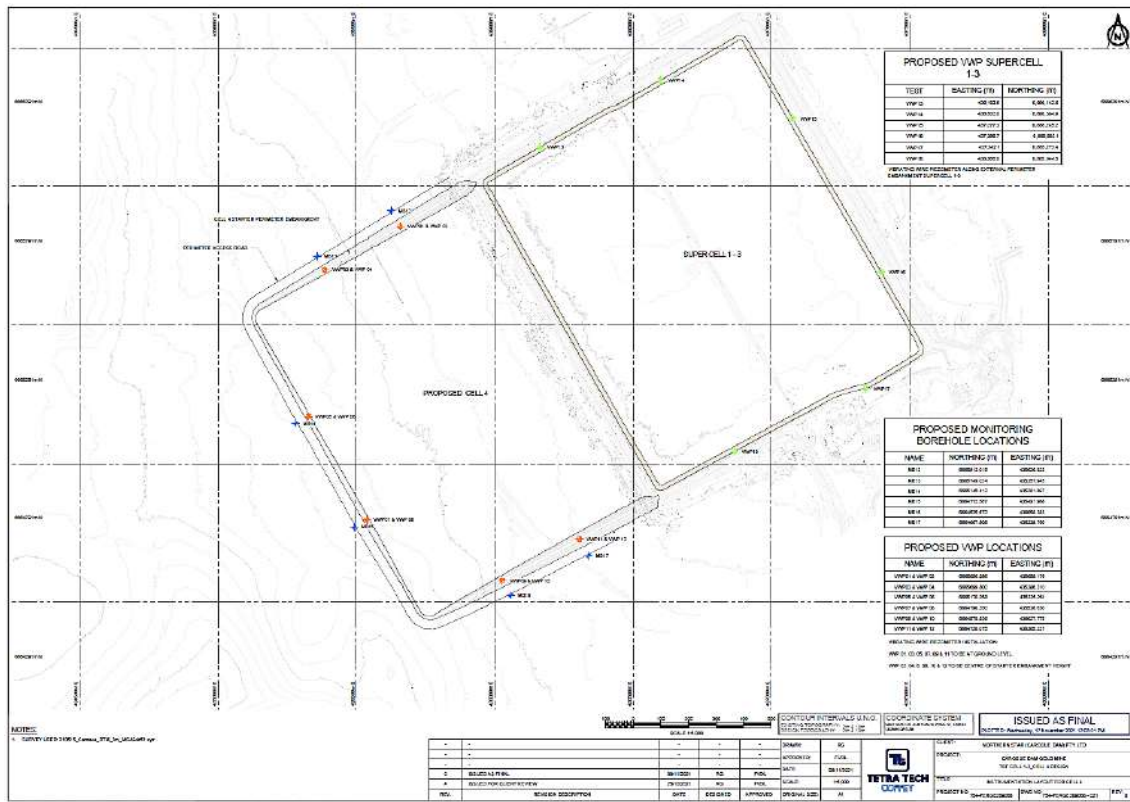


Figure 16: Monitoring bores and piezometers

Works approval: W6626/2021/1

3. Final cell arrangement of TSF

The final TSF will be a two cell paddock style TSF with stormwater diverted around the southern walls to the west and the south east.



Appendix 2: Application validation summary

SECTION 1: APPLICATION SUMMARY (as updated from validation checklist)				
Application type				
Works approval	<input checked="" type="checkbox"/>			
Licence	<input type="checkbox"/>	Relevant works approval number:		None <input type="checkbox"/>
		Has the works approval been complied with?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
		Has time limited operations under the works approval demonstrated acceptable operations?	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
		Environmental Compliance Report / Critical Containment Infrastructure Report submitted?	Yes <input type="checkbox"/> No <input type="checkbox"/>	
		Date report received:		
Renewal	<input type="checkbox"/>	Current licence number:		
Amendment to works approval	<input type="checkbox"/>	Current works approval number:		
Amendment to licence	<input type="checkbox"/>	Current licence number:		
		Relevant works approval number:		N/A <input type="checkbox"/>
Registration	<input type="checkbox"/>	Current works approval number:		None <input type="checkbox"/>
Date application received	19/11/2021			
Applicant and premises details				
Applicant name/s (full legal name/s)	Northern Star Resources (Carosue Dam) Pty Ltd. ACN: 116649122			
Premises name	Carosue Dam Minesite			
Premises location	M28/269, M31/220, M31/295			
Local Government Authority	Shire of Menzies			
Application documents				
HPCM file reference number:	DER2021/000666			
Key application documents (additional to application form):	DWERDT529321: CDO-APP-Cell 1_3 Cell 4 LOM TSF Supporting Info_FINAL			

SECTION 1: APPLICATION SUMMARY (as updated from validation checklist)

Scope of application/assessment

<p>Summary of proposed activities or changes to existing operations.</p>	<p>Construction of TSF Cells 1-3 Raises & Cell 4 developed for Life of Mine tailings management</p> <ol style="list-style-type: none"> 1. Stage 4 of existing Cell 3 will be raised to an embankment crest level of RL 381 m; 2. The new Cell 4, will be developed as a paddock-type facility to the west of existing Cell 3. A perimeter embankment to enclose an internal impoundment surface area of approximately 120 ha at starter embankment crest elevation of RL 375.5 m will be constructed; 3. Merging of Cells 1-2 and Cell 3 to form a Supercell 1-3 at crest level of RL 383 m; 4. A further 4 stages of upstream raised embankment will be constructed at Cell 4 with a final embankment crest elevation of RL 383.5 m (Cell 4 Stage 1 to Stage 4); and 5. A further 3 stages of upstream raised embankment will be construction at Supercell 1-3 with final embankment crest elevation of RL 389 m (Supercell 1-3 Stage 2 to Stage 4).
--	--

Category number/s (activities that cause the premises to become prescribed premises)

Table 1: Prescribed premises categories

Prescribed premises category and description	Assessed production or design capacity	Proposed changes to the production or design capacity (amendments only)
Category 5: Processing and beneficiation of metallic or non-metallic ore	4,000,000 tonnes per annual period	N/A

Legislative context and other approvals

<p>Has the applicant referred, or do they intend to refer, their proposal to the EPA under Part IV of the EP Act as a significant proposal?</p>	<p>Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p>	<p>Referral decision No: Managed under Part V <input type="checkbox"/> Assessed under Part IV <input type="checkbox"/></p>
<p>Does the applicant hold any existing Part IV Ministerial Statements relevant to the application?</p>	<p>Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p>	<p>Ministerial statement No: EPA Report No:</p>
<p>Has the proposal been referred and/or assessed under the EPBC Act?</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>Reference No: EPBC 2021/9026 Clearing of Mallee fowl mounds classified as a 'controlled action' on 29 September 2021. Approvals being assessed in parallel to this WA application.</p>

SECTION 1: APPLICATION SUMMARY (as updated from validation checklist)

<p>Has the applicant demonstrated occupancy (proof of occupier status)?</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>Mining lease / tenement <input checked="" type="checkbox"/> Expiry: M28/269 (Expires 01/05/2029), M31/220 (Expires 14/7/2041) M31/295 (Expires 01/05/2029)</p>
<p>Has the applicant obtained all relevant planning approvals?</p>	<p>Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/></p>	<p>If N/A explain why? Mining tenure</p>
<p>Has the applicant applied for, or have an existing EP Act clearing permit in relation to this proposal?</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>CPS No: 8000/2 is under assessment.</p>
<p>Has the applicant applied for, or have an existing CAWS Act clearing licence in relation to this proposal?</p>	<p>Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p>	<p>Application reference No: N/A Licence/permit No: N/A No clearing is proposed.</p>
<p>Has the applicant applied for, or have an existing RIWI Act licence or permit in relation to this proposal?</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>Licence/permit No: GWL157428(5)</p>
<p>Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the EP Act)?</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>Name: Goldfields Type: Proclaimed Groundwater Area Has Regulatory Services (Water) been consulted? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A <input type="checkbox"/> Regional office: Goldfields</p>
<p>Is the Premises situated in a Public Drinking Water Source Area (PDWSA)?</p>	<p>Yes <input type="checkbox"/> No <input checked="" type="checkbox"/></p>	<p>Name: N/A Priority: N/A Are the proposed activities/ landuse compatible with the PDWSA (refer to WQPN 25)? Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p>
<p>Is the Premises subject to any other Acts or subsidiary regulations (e.g. <i>Dangerous Goods Safety Act 2004, Environmental Protection (Controlled Waste) Regulations 2004, State Agreement Act xxxx</i>)</p>	<p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/></p>	<p>Mining Act 1978 Rights in Water and Irrigation Act 1914</p>

SECTION 1: APPLICATION SUMMARY (as updated from validation checklist)

Is the Premises within an Environmental Protection Policy (EPP) Area?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Is the Premises subject to any EPP requirements?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Is the Premises a known or suspected contaminated site under the <i>Contaminated Sites Act 2003</i> ?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	Mining tenement M31/220 Classification: N/A – awaiting classification Date of classification: N/A