



# Decision Document

## *Environmental Protection Act 1986, Part V*

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**Proponent:** **Ravensthorpe Nickel Operations Pty Ltd**

**Licence:** **L8008/2004/3**

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**Registered office:** Level 1, 24 Outram Street  
WEST PERTH WA 6005

**ACN:** 092 506 584

**Premises address:** Ravensthorpe Nickel Operations  
Mining tenements M74/114, M74/115, M74/116, M74/123, M74/144,  
M74/145, M74/173, M74/174, M74/175,  
RAVENSTHORPE WA 6346

**Issue date:** Wednesday, 01 May 2013

**Commencement date:** Tuesday, 14 May 2013

**Expiry date:** Wednesday, 13 May 2026

### **Decision**

Based on the assessment detailed in this document the Department of Environment Regulation (DER) has decided to issue an amended licence. DER considers that in reaching this decision, it has taken into account all relevant considerations and legal requirements and that the Licence and its conditions will ensure that an appropriate level of environmental protection is provided.

Decision Document prepared by: Louise Lavery  
Senior Licensing Officer

Decision Document authorised by: Tim Gentle  
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## 1 Purpose of this Document

This decision document explains how DER has assessed and determined the application and provides a record of DER's decision-making process and how relevant factors have been taken into account. Stakeholders should note that this document is limited to DER's assessment and decision making under Part V of the *Environmental Protection Act 1986*. Other approvals may be required for the proposal, and it is the proponent's responsibility to ensure they have all relevant approvals for their Premises.

## 2 Administrative summary

Administrative details	
Application type	Works Approval <input type="checkbox"/> New Licence <input type="checkbox"/> Licence amendment <input checked="" type="checkbox"/> Works Approval amendment <input type="checkbox"/>
Activities that cause the premises to become prescribed premises	<b>Category number(s)</b> <b>Assessed design capacity</b>
	5      13 900 000 tonnes per annual period
	31      1 606 000 tonnes per annual period
	52      70 MW per annual period
54      300 m <sup>3</sup> per day	
Application verified	Date: 20 January 2016
Application fee paid	Date: N/A
Works Approval has been complied with	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/>
Compliance Certificate received	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/>
Commercial-in-confidence claim	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
Commercial-in-confidence claim outcome	N/A
Is the proposal a Major Resource Project?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Was the proposal referred to the Environmental Protection Authority (EPA) under Part IV of the <i>Environmental Protection Act 1986</i> ?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Referral decision No: 633 on 5 September 2003 Managed under Part V <input type="checkbox"/> Assessed under Part IV <input checked="" type="checkbox"/>



Is the proposal subject to Ministerial Conditions?	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	Ministerial statement No: 633 EPA Bulletin No: 930 and 1093
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the <i>Environmental Protection Act 1986</i> )?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	Department of Water consulted Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Is the Premises within an Environmental Protection Policy (EPP) Area If Yes include details of which EPP(s) here.	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Is the Premises subject to any EPP requirements? If Yes, include details here, eg Site is subject to SO <sub>2</sub> requirements of Kwinana EPP.	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	

### 3 Executive summary of proposal and assessment

Ravensthorpe Nickel Operations Pty Ltd, a wholly owned subsidiary of First Quantum Minerals Australia Nickel Pty Ltd (FQMAN), operates the Ravensthorpe Nickel Operations (RNO) under licence L8008/2004/3 plus the Ravensthorpe Nickel Operations Tamarine Quarry (RNOTQ) under licence L8660/2012/1. Limestone from the RNOTQ is fed into the main process operations at the RNO Premises administered by this licence.

RNO lies approximately 35 km east of Ravensthorpe and 155km west of Esperance along South Coast Highway. The operation is located within the Shire of Ravensthorpe in Mineral field 74 and the Phillips River District and is 571 km by road from Perth.

RNO produce a mixed nickel-cobalt hydroxide product (MHP) from locally sourced ore from three nickel laterite deposits, Halley's, Hale-Bopp and Shoemaker-Levy. Halley's is the only deposit that has been mined to date. Two types of ore are currently mined: limonite and saprolite. The MHP ore is upgraded through the beneficiation process and followed by a series of treatments utilising pressure and atmospheric acid leach technology and solution purification techniques. MHP is containerized or bagged and transported by road to either Fremantle Port or exported through the Esperance port in sealed sea containers.

The mining operation uses open-pit mining techniques utilising diggers and haulage trucks.

The RNO facility includes;

- primary crushing,
- beneficiation,
- pressure acid leach,
- atmospheric leach,
- partial neutralization,
- counter-current decantation,
- secondary neutralisation,
- acid production,
- power generation,
- reagent storage,
- tailing storage facility,
- product storage,
- heavy machinery workshop, and
- wastewater treatment plant at the employee accommodation camp.

The Company has environmental management systems in place at the Ravensthorpe Operation. The procedures and protocols that form the operating framework of the Company's environmental management systems are in line with ISO 14001 and Equator Principles requirements. The overall



goals include: a commitment of management to pollution prevention; compliance with pertinent environmental regulations and legislation; and continual improvement to protect the environment.

### **Environmental Setting**

The RNO is located within the Shire of Ravensthorpe. Land use in the surrounding area is primarily wheat and sheep farming with the nearest sensitive receptor located 4.4km away from the RNO plant facility.

The region features a flat to generally undulating sandplain, falling gradually to the coast 40 km to the south. The RNO encompasses Bandalup Hill, which forms a prominent rise (230 m AHD) within the surrounding sandplain (varying from 160 to 180 m ADH around the base of the hill). The soils in the RNP area are grey siliceous sands overlying gravel, gravelly clay or subsoil; with expanses of surface soils comprising either gravelly sand or clay.

RNO lies in the upper reaches of the Jerdacuttup River catchment. Flow in the Jerdacuttup River is seasonal due to the sparseness of rainfall and the absence of significant aquifers to sustain a base flow. Many of the drainage lines in the area terminate and dissipate into groundwater aquifers during runoff events. All three catchments in the RNO area drain into Bandalup Creek, approximately 8 km southwest of the Ravensthorpe Nickel Operation site.

The groundwater table is typically at elevations between 90 to 120 m AHD and flows to the southwest. Historical land clearing for agriculture in the area has resulted in regional groundwater having elevated salinity levels; in turn surface water systems in the area are also saline.

The Ravensthorpe region has mean daily maximum temperature in January is about 29°C, with the average maximum in July of approximately 16°C. The area has an average annual rainfall of about 426 mm, of which the majority falls from May through to October. Predominate winds are from the north-west and south-east directions and mainly within the range of 3.0 to 8.5 m/s.

### **Prescribed Premises Categories**

RNO has been assessed under the provisions of the *Environmental Protection Regulations 1987* as the following prescribed categories:

#### **Category 5 – Processing plant**

Ore from the RNO run of mine (ROM) stockpile is fed into the primary crusher (consisting of a ROM bin and sizer) and then slurried in a ball mill with water to produce a feed slurry for either the high pressure acid leach (HPAL) circuit or atmospheric leach circuit depending on the ore type (limonite or saprolite).

The HPAL circuit leaches the nickel and cobalt from the ore slurry. The resulting solution is then washed in a counter current decant (CCD) circuit to separate the leach solution from the waste residue. The pregnant liquor solution is then further processed and the waste residue is neutralised and discharged to the TSFs.

There are two above ground engineered TSFs for tailings deposition. TSF1 was originally constructed as a single cell in 2007. In 2011 a north-south embankment was installed to divide it into two cells (East and West) in order to improve decant pond management. In 2013 a new TSF2 was constructed to the south of TSF1, utilising TSF1's southern embankment as a common wall between the two facilities. Supernatant from the TSFs is decanted and returned to the process plant with surplus discharged to nineteen adjacent evaporation ponds. The evaporation ponds are HDPE lined to achieve a permeability of between  $1 \times 10^{-10}$  to  $1 \times 10^{-11}$  m/s.

#### **Category 31 – Chemical manufacturing**

RNO operates the plant that includes a sulfur conversion process which involves the melting of prilled solid sulfur, burning of the sulfur to produce sulfur dioxide (SO<sub>2</sub>), conversion of SO<sub>2</sub> to sulfur trioxide (SO<sub>3</sub>) and the adsorption of SO<sub>3</sub> to produce sulfuric acid. Running at full capacity, the acid plant can produce approximately 4,400 tonnes of sulfuric acid per day.



### **Category 52 – Power generation**

RNO produces electricity primarily from two sources:

1. 3 steam turbines, (2 online and 1 back up) which have a capacity of 18 MW each for a total of 54 MW.
2. 8 diesel generators, which have a capacity of 2 MW each or a total of 16 MW.

The diesel generators normally provide emergency power but can also be operated in line when the steam turbines have insufficient steam due to the acid plant operating below capacity.

### **Category 54 – Sewage facility**

RNO treats sewage generated from the plant site, administration facility and accommodation village using a wastewater treatment plant (WWTP) which utilises anaerobic and aerobic treatment ponds. Treated effluent is discharged to an 18ha irrigation area located adjacent to the WWTP. Plots in the irrigation area can be isolated and/or rotated therefore reducing overloading and pooling of treated effluent to the land.

### **September 2016 Licence Amendment**

On 16 January 2016 the applicant submitted a licence amendment application for:

- approval for the progressive construction of raises to embankments of the existing TSFs to heights of RL 147m for TSF1 and RL 137m for TSF2.

DER has also made the following amendments in parallel to this application:

- administrative amendments; and
- the removal of redundant licence conditions.

The risk from use of other containment infrastructure, fugitive dust emissions, air emissions, and discharges to land have not been reassessed as part of this licence amendment.

Approval for the Mining Proposal under the *Mining Act 1978* to raise the embankments of the TSFs located on the prescribed mining leases was granted by the Department of Mines and Petroleum (DMP) on 29 December 2015.



## 4 Decision table

All applications are assessed in line with the *Environmental Protection Act 1986*, the *Environmental Protection Regulations 1987*, DEC's Policy Statement - Limits and targets for prescribed premises (2006), and DER's Operational Procedure on Assessing Emissions and Discharges from Prescribed Premises. Where other references have been used in making the decision they are detailed in the decision document.

<b>DECISION TABLE</b>			
<b>Works Approval / Licence section</b>	<b>Condition number W = Works Approval L = Licence</b>	<b>Justification (including risk description &amp; decision methodology where relevant)</b>	<b>Reference documents</b>
<b>General conditions</b>	L1.2.1	Previous licence conditions 2 and 3 have been removed from the licence in accord with DER's Guidance Statement: Setting Conditions, as these conditions are considered unenforceable.	General provisions of the <i>Environmental Protection Act 1986</i> .  DER (2015) <i>Guidance Statement: Setting Conditions</i> , October 2015
<b>Premises operation</b>	L1.3.1	Previous licence conditions 7 and 14 have been replaced by condition 1.3.1.	General provisions of the <i>Environmental Protection Act 1986</i> .
	L1.3.2 – 1.3.3	Previous licence conditions 4 and 5 have been replaced by conditions 1.3.3 and 1.3.2 respectively. A clarification to the TSF freeboards has been made in line with the spillway design.	Golder (2015a) <i>Ravensthorpe Nickel Operations Tailings Storage Facilities Embankment Raise Design Report</i> , unpublished report for FQM Australia Nickel Pty Ltd, Report Number 147645021-010-R-Rev1, September 2015.
	L1.3.4 L1.3.5	L1.3.4 specifies requirements for inspections of tailings pipelines, freeboard and supernatant pond sizes. This is a regulatory control imposed in regard to	Appendix A



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<b>Works Approval / Licence section</b>	<b>Condition number W = Works Approval L= Licence</b>	<b>Justification (including risk description &amp; decision methodology where relevant)</b>	<b>Reference documents</b>
		<p>TSFs' risks. Refer to Appendix A for further detail of DER's assessment and decision making.</p> <p>Previous licence condition 16 is replaced by condition L1.3.5.</p>	<p>General provisions of the <i>Environmental Protection Act 1986</i>.</p>
	L1.3.6 L1.3.7 L1.3.8	DER's assessment and decision making for the embankment raises for TSF1 and TSF2 and subsequent operation is detailed in Appendix A.	Appendix A
	L1.3.9 – L1.3.12	<p>Previous licence conditions 9 to 11 and 13 specifying the start-up and operating conditions for the sulfuric acid plant have been replaced by conditions 1.3.9 – 1.3.12. These conditions have not been reassessed. Notification requirements previously licenced as condition 12 are included in condition L5.3.1. Associated requirements for monitoring of wind speed and direction and maintenance of the meteorological station have been specified in conditions L3.6.1 and L3.6.2 to ensure this equipment is maintained appropriately and provides accurate records.</p>	L8008/2004/3
<b>Emissions general</b>	L2.1.1	Limits will be set through the emission section of the licence and therefore regarding recording and investigation of exceedances of limits has been included.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Point source emissions to air including monitoring</b>	L2.2.1, L3.2.1 - L3.2.3	<p><b>Normal Operations</b></p> <p>These conditions have been transferred from the previous licence condition (previous condition 22). In this version of the licence all emission points to air are specified. An associated requirement to supply an updated map identifying all the emission points to air is required by IR1, improvement condition L4.1.1.</p> <p>A modification to the reporting units for sulfur dioxide and sulfuric acid mist emissions from the acid plant has been made, to represent the emissions in terms of tonne of 100% acid produced in order to directly monitor the performance of the acid plant as against the original design criteria of sulfur dioxide emitted at the design rate of 1.8 kg/tonne 100% H<sub>2</sub>SO<sub>4</sub> acid produced.</p>	<p>Ambient Air Assessment Criteria, National Environmental Protection Measure (Ambient Air Quality)</p> <p>DEC (2011) Environmental Assessment Report for L8008/2004/2</p>



<b>DECISION TABLE</b>			
<b>Works Approval / Licence section</b>	<b>Condition number W = Works Approval L= Licence</b>	<b>Justification (including risk description &amp; decision methodology where relevant)</b>	<b>Reference documents</b>
		<p><b>Abnormal Operations</b></p> <p>Conditions specifying requirements for a cold acid plant start up are included as Premises operations conditions 1.3.9 – 1.3.10. These replace previous conditions 9 and 10. These conditions have not been reassessed as part of this amendment, however conditions for maintenance of the meteorological station and recording of its monitoring results have been added to the licence as conditions 3.6.1 and 3.6.2.</p> <p>Conditions 1.3.11 and 1.3.12 replace previous conditions 11 and 13 requiring the acid plant to shut-down in the event of poor operating conditions as specified in condition 1.3.11. These conditions have not been reassessed as part of this amendment.</p>	
<b>Point source emissions to surface water including monitoring</b>	N/A	There are no point source emissions to surface water from the Premises.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Point source emissions to groundwater including monitoring</b>	N/A	There are no point source emissions to groundwater from the Premises.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Emissions to land including monitoring</b>	L2.3.1, L2.3.2, L3.3.1	Emissions to land have not been reassessed as part of this amendment. Conditions 2.3.1, 2.3.2 and 3.3.1 have been included to replace conditions 14, 17, 18 and 21 (in part) of the previous licence.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Fugitive emissions</b>	L2.4.1	Fugitive emissions have not been reassessed as part of this amendment. Condition L2.4.1 replaces previous licence conditions 8c) and 8d). Previous general dust requirements 8a) and 8b) have been removed from the licence in	General provisions of the <i>Environmental Protection Act 1986</i> .



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	L3.5.1, Table 3.5.1 L3.5.2	accord with DER's Guidance Statement: Setting Conditions.  Ambient air quality monitoring conditions L3.5.1, Table 3.5.1 and L3.5.2 replace previous licence conditions 23 and 24, respectively. These have not been reassessed as part of this amendment.	
<b>Odour</b>	N/A	As the previous licence did not impose controls on odour, no specified conditions have been included in this section.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Noise</b>	N/A	As the previous licence did not impose controls on noise, no specified conditions have been included in this section. The <i>Environmental Protection (Noise) Regulations 1997</i> apply.	<i>Environmental Protection (Noise) Regulations 1997</i>  General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Monitoring general</b>	L3.1.1 – 3.1.5	Standard monitoring conditions 3.1.1 – 3.1.5 have been added to the Licence as monitoring of surface water discharges and ambient groundwater monitoring is required by the Licence. These replace previous licence conditions 20 (in part) and 21.	Australian Standards AS/NZS 5667.1, AS/NZS 5667.10 and AS/NZS 5667.11
<b>Monitoring of inputs and outputs</b>	N/A	No monitoring of inputs or outputs is required by the Licence.	N/A
<b>Process monitoring</b>	L3.4.1	Recording of tailings disposed to TSFs and decant water recovered is required under condition L3.4.1. This also provides a check against the total annual amount of tailings authorised to be disposed of TSF1 and TSF2, as described in condition L1.3.2.	N/A
<b>Ambient quality monitoring</b>	L3.5.1, Table 3.5.1 L3.5.2	Refer to section Fugitive emissions above for the description of ambient air quality monitoring.  Table 3.5.2 has been included for monitoring of ambient groundwater quality.	General provisions of the <i>Environmental Protection Act 1986</i> .



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	L3.5.1, Table 3.5.2	<p>This replaces previous licence condition 21. Monitoring parameters and frequency are the same as the existing monitoring regime.</p> <p>DER's assessment and decision making for the embankment raises for TSF1 and TSF2 and subsequent operation is detailed in Appendix A.</p>	
<b>Meteorological monitoring</b>	L3.6.1 L3.6.2	As the conditions relating to monitoring of dust conditions at the TSF and sulfuric acid plant start up are specified in relation to wind conditions as measured by the meteorological station at site DDG4, conditions in relation to meteorological monitoring and performance of the station have been included in this section.	N/A
<b>Improvements</b>	N/A	<p>Previous conditions 6 (evaporation pond aeration trial) and 25 (installation of pump station and pipeline to transfer water from mine drainage – north dam to the buffer ponds) have been removed from the licence as the work required by these conditions has been completed.</p> <p>For condition 6, FQM requested that a previous application to extend the time frame for the evaporator trial be withdrawn on 27 May 2015 and hence this condition has been removed from the Licence.</p> <p>In regard to condition 25, a statement provided in 2015 RNO AER (FQM Australia Nickel, 2015) indicated the pipeline and pump station were commissioned in March 2014. This was confirmed by DER at a compliance inspection completed on Tuesday 14 July 2015.</p> <p>No additional improvement conditions are specified at this time.</p>	<p>Email from Tony Petersen, FQM Australia Nickel to DER dated 27/05/15, 2:19 PM.</p> <p>FQM Australia Nickel (2015) <i>Ravensthorpe Nickel Operations Annual Environmental Report: Licence L8008/2004/4, 1 January 2015 to 31 December 2015</i></p>
<b>Information</b>	L4.1.1 – 4.1.3 L4.2.1 – 4.2.3 L4.3.1	Standard conditions 4.1.2 and 4.2.1 replace conditions 28 and 27 of the previous licence.	General provisions of the <i>Environmental Protection Act 1986</i> .
<b>Licence</b>	N/A	The Licence duration has been extended by an Amendment by Notice under	DER (2016) Amendment by



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<b>Duration</b>		s59 of the <i>Environmental Protection Act 1986</i> of 29 April 2016 and the Licence now has an expiry date of 13 May 2026.	Notice, 29 April 2016



## 5 Advertisement and consultation table

Date	Event	Comments received/Notes	How comments were taken into consideration
04/08/16	Proponent sent a copy of draft amended instrument	<p>Comments as follows:</p> <ul style="list-style-type: none"><li>• Updates to category 52 capacity and premises description</li><li>• Request to amend inspection frequency in Table 1.3.2.</li><li>• Request to update the operating heights in Table 1.3.3 consistent with the 300mm freeboard limits</li><li>• Request to modify condition 1.3.8 to replace the annual water balance with an annual assessment of standing water levels against the model in Golder (2012)</li><li>• Updates to the abatement in Table 2.2.1</li><li>• Correction to the units for volumetric flow in Table 3.2.1</li><li>• Request to maintain six monthly monitoring for acid plant emissions to air</li><li>• Request to modify the method used to sample SO<sub>3</sub> emissions from the Acid Plant Main Stack</li><li>• Clarification to definition of particulate matter in Table 3.5.1</li><li>• Complementary changes in the decision document for category 52 and premises description.</li></ul>	Comments adopted with a modification made to condition 1.3.8 to include assessment of groundwater quality and depiction of results with a contour map.



## 6 Risk Assessment

Note: This matrix is taken from the DER Corporate Policy Statement No. 07 - Operational Risk Management

**Table 1: Emissions Risk Matrix**

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Moderate	High	High	Extreme	Extreme
Likely	Moderate	Moderate	High	High	Extreme
Possible	Low	Moderate	Moderate	High	Extreme
Unlikely	Low	Moderate	Moderate	Moderate	High
Rare	Low	Low	Moderate	Moderate	High



## Appendix A

### Premises Operation - Tailings Storage Facility 1 & 2 Embankment Raise to RL 147m & RL 137m respectively

Ravensthorpe Nickel Operations (RNO) is proposing to increase the embankment heights in TSF1 and TSF2 to RL 147 m by a series of progressive upstream 1.5m lifts, following an initial upstream or downstream 3m lift. RNO engaged Golder Associates Pty Ltd (Golder) to complete the design and engineering works for two tailings storage facility (TSF) embankment raises (TSF 1 and TSF 2).

RNO has two TSFs: TSF 1 (constructed in 2007) and TSF 2 (constructed in 2013). They are located on cleared farmland on a site that slopes 1% to the south, a total fall of 24 m over a 2.4 km distance (Golder 2015b). The two facilities share a common embankment (TSF1 southern embankment). The TSF 1 design was modified in 2011 to split a single cell into two cells (east and west). Part of the change in design was to address the risk of rising groundwater levels from seepage, particularly to the south of TSF1, due to the decant pond being held against the main embankment during the initial operation of TSF1. RNO subsequently altered the design of the TSF by splitting it into two cells, ensuring that the decant pond is held in the centre of the two cells which should assist in reducing groundwater levels in this area.

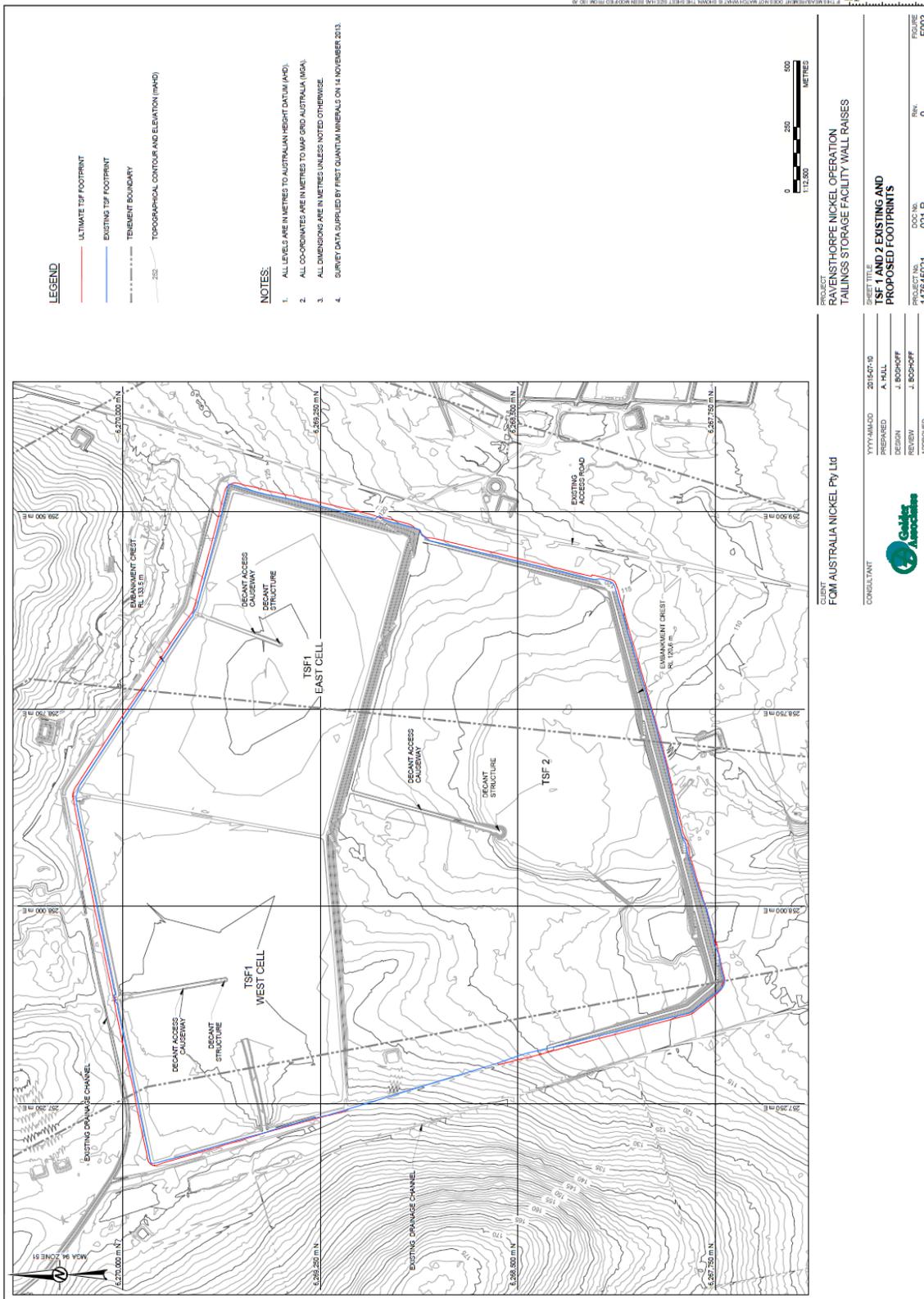
TSF1's two storage cells, east and west, occupy a total area of approximately 190 ha with a maximum embankment height of 15 m. TSF 2 is a single cell facility occupying an area of 224 ha with an average embankment height of 9 m above natural ground level at the southern wall. Refer to Figure 7 following for more detail.

Restrictions in storage capacity resulted in active deposition to the west and east cells within TSF 1 ceasing in September 2013 and December 2013 respectively, and deposition to TSF 2 commencing. As of May 2015, approximately 12 months of storage capacity remains within TSF 2. The existing TSFs are located on M74/115, M74/116 and M74/175; the proposed TSF embankment raises will remain within these tenement boundaries.

The embankment raising strategy considered for the TSFs will involve an initial upstream or downstream 3 m raise using either clay fill borrowed from nearby borrow sources or beneficiation plant rejects or a mixture of tailings and sand from the beneficiation plant. Subsequent raises are forecast to be 1.5 m height upstream construction, providing approximately 12 months tailings capacity.

The current tailings management strategy was developed to address the construction of future embankment raises in an upstream direction. Based on the final crest elevations of RL 147 m and RL 137 m for TSFs 1 and 2, a tailings production rate of 4.56 Mtpa and an *in situ* dry density of 0.9 t/m<sup>3</sup>, the remaining life of TSF1 is approximately 15 years, with 12 years remaining for TSF 2. After this time additional storage capacity will be required to address the life-of-mine tailings requirements.

Note DER does not risk assess the likelihood of structural failure as it is addressed by geotechnical assessment by DMP under the *Mines Safety and Inspection Act 1994*.



**Figure 7: TSF1 and TSF2 footprints, showing location of embankments, decant embankments and site contours**



Key risks associated with the operation of TSF1 and 2 and proposed embankment raises are as follows:

### **Normal Operations – Impacts to groundwater from TSF 1 and 2 Seepage**

#### Emission Description

*Emission:* Impacts from tailings seepage to underlying unconfined groundwater aquifer.

*Impact:* Deterioration of groundwater quality due to seepage, due to an increasing concentration of sulfates in groundwater. Groundwater mounding (increasing groundwater table in the vicinity of the TSFs) potentially impacting on land productivity. Groundwater in the vicinity of the TSF migrates to the south west. Currently the groundwater is not utilised by third parties for livestock or agriculture. Land use south of TSF2 is farmland. Baseline groundwater salinity (pre mining operations) is in the range of 4000 to 30 000 mg/L, baseline pH being between 4 and 7.

Seepage modelling and water balances conducted as part of the design for the life of the forecast embankment raises indicated that the average rate of seepage for TSF 1 east cell is 16% of total inflows, TSF 1 west cell also estimated at a 16% average of total inflows per embankment raise and TSF2 estimated at an average 7% of total inflows (comprising both tailings and rainfall) (Golder 2015a).

*Controls:* Clay soils underlie TSF2, extending to depths greater than 3m (Golder 2015b). A 300mm compacted clay liner is installed under TSF1 and TSF2. Additionally seepage controls installed as part of the original TSF1 design include cut off trenches along the upstream toes of the eastern, western and southern embankments, and a basin underdrainage collection system with finger drains and main collector drains to an underdrainage collection tower.

The Licensee manages the TSFs according to a Tailings Operation Manual and has also given a commitment as part of the application to increase the TSF embankments' heights, that the decant pond will be managed to minimise its size to an approximate 10% of the total surface area of each cell (Section 6.4.3 of Golder 2015a). Daily inspections of the supernatant/decant pond levels will be conducted (Section 6.5.1 of Golder 2015a).

#### Risk Assessment

*Consequence:* Minor: whilst increases in groundwater levels were recorded south of TSF1 for the period 2008 – 2011 (pre splitting of the TSF1 into two cells), groundwater monitoring for the period 2013 to 2016 has recorded relatively stable groundwater standing water levels (FQM Australia Nickel 2015). It is likely that further increases in tailings will not result in significant changes in groundwater levels providing the TSFs are managed as per the commitments made in the TSF Design Report (Golder 2015a). An increasing trend in sulfate concentrations in groundwater in some bores has been noted over the 2013 - 2016 period; however it is also noted that this groundwater is not currently used for livestock or agriculture.

*Likelihood:* Possible: seepage is forecast at the rate of 16% of total inflows for TSF 1 East and 16% for TSF 1 West, 7% for TSF2.

*Risk Rating:* Moderate

#### Regulatory Controls

A requirement to complete an annual assessment of groundwater mounding and quality in the vicinity of the TSFs and compare the results to the modelled predictions of Golder (2012) is required by condition 1.3.8. This will aid in measuring the performance of the TSFs and management of decant ponds as against the forecast seepage rates. A graphical depiction of the groundwater plume is also required by condition 1.3.8, which will allow clearer representation of the extent of impact from seepage.



Monitoring of the decant pond size is required by condition 1.3.4. A monitoring program of the ambient groundwater quality and standing water levels is required by Licence condition 3.5.1 in monitoring bores surrounding the TSFs.

In the event that results indicate a rising trend in either groundwater levels or concentrations additional measures can be placed on the Licence to manage seepage.

#### Residual Risk

*Consequence:* Minor

*Likelihood:* Possible

*Risk Rating:* Moderate

#### **References**

Golder (2012) *Stage 3 Expansion Seepage and Solute Modelling Ravensthorpe Nickel Operations Tailings Storage Facility*, December 2012.

Golder (2015a) *Ravensthorpe Nickel Operations Tailings Storage Facilities Embankment Raise Design Report*, unpublished report for FQM Australia Nickel Pty Ltd , Report Number 147645021-010-R-Rev1, September 2015.

Golder (2015b) *Works Approval Application Supporting Document – Ravensthorpe Nickel Operation, Embankment Raises for Tailings Storage Facility 1 and 2*, unpublished report for FQM Australia Nickel Pty Ltd, Report Number 147645021-021-R-Rev1, July 2015.

FQM Australia Nickel (2015) *Ravensthorpe Nickel Operations Annual Environmental Report: Licence L8008/2004/4, 1 January 2015 to 31 December 2015*.

#### **Emergency Operation: Overtopping of TSF1 or TSF2**

##### Emission Description

*Emission:* Overtopping of TSF1 or 2 during operations and/or following the progressive embankment raises to RL 147m and 137m.

*Impact:* Release of tailings including tailings decant water to land; potential to impact tributaries of Jerdacuttup River (including Bandalup Creek). Tailings are saline (approximately 4000 mg/L – 11000 mg/L TDS) and contain trace metal concentrations.

TSF1 and TSF 2 are located to the south and down gradient of the process plant and adjacent native vegetation. Leased farmland is located to the south, which is the likely flowpath of any discharge from overtopping. Potential impact to native vegetation to the west, depending on the point of discharge. RNO is located in the Fitzgerald Biosphere Reserve (FBR) buffer zone, which is land that links the Fitzgerald River National Park with vegetation to the north-east, connecting to the Great Western Woodlands (Golder 2015b).

*Controls:* Design of the intermittent stages of embankment raises to RL 147m and RL 137 m complies with ANCOLD (2012) and DME (1999) guidance for freeboards, with a freeboard of 300mm allowing capacity for a 1 in 100 year, 72 hour event (which is estimated at 180mm; section Golder 2015b). Each TSF has been designed with a spillway according to ANCOLD 2012 (Golder 2015b). In the event of a breach of freeboard in TSF1 East or West cells, tailings would flow via a spillway downstream to TSF2, whereupon the freeboard would also require breaching before discharge from the spillway in TSF2. The use of spillways should ensure all overtopping discharges are directed to the south away from native vegetation and the main worker locations.



The Licensee has committed to daily inspections and regular surveys of the decant pond size to ensure adequate freeboards are maintained (section 6.5.1 of Golder 2015a).

#### Risk Assessment

*Consequence:* Moderate: a discharge of tailings material would result in impact to productive agricultural land, and potential to impact adjacent native vegetation of conservation significance if discharged to the west.

*Likelihood:* Rare: the spillway design, capacity of the TSFs to contain a 1 in 100 year, 72 hour duration rainfall event and operational controls to minimise the decant pond size and inspect freeboards and pond sizes daily reduce the likelihood of facilities overtopping.

*Risk Rating:* Moderate

#### Regulatory Controls

Condition 1.3.3 has been placed on the Licence to ensure that the specified freeboards for TSF1 and 2 are maintained. Condition 1.3.4 requires regular inspections of freeboard of the embankments. Condition 1.3.6 requires the embankment raise to be constructed as per the submitted design documents (Golder 2015a). Conditions 4.2.4 and 4.2.5 require compliance documents to be submitted following each stage of the TSF 1 and 2 embankment construction works. A restriction on operation heights remains in effect until successful submission of compliance documentation is completed (conditions 1.3.6, 4.2.4, 4.2.5).

#### Residual Risk

*Consequence:* Moderate

*Likelihood:* Rare

*Risk Rating:* Moderate

#### **References**

ANCOLD (2012) *Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure*, May 2012

Department of Minerals and Energy (1999) *Safe Design and Operating Standards for Tailings Storage Facilities*

Golder (2015a) *Ravensthorpe Nickel Operations Tailings Storage Facilities Embankment Raise Design Report*, unpublished report for FQM Australia Nickel Pty Ltd , Report Number 147645021-010-R-Rev1, September 2015.

Golder (2015b) *Works Approval Application Supporting Document – Ravensthorpe Nickel Operation, Embankment Raises for Tailings Storage Facility 1 and 2*, unpublished report for FQM Australia Nickel Pty Ltd , Report Number 147645021-021-R-Rev1, July 2015.