Decision Report

Application for Works Approval

Division 3, Part V *Environmental Protection Act 1986*

Works Approval Number	W6265/2019/1
Applicant	Atlantic Vanadium Pty Ltd
ACN	610 583 090
File Number	DER2019/000145
Premises	Windimurra Vanadium Project Mining Tenements: M58/178, M58/279 and M58/280 MOUNT MAGNET WA 6638
Date of Report	25 March 2020
Status of Report	Final

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1. Definitions of terms and acronyms

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

Table 1: Definitions

Term	Definition
AACR	Annual Audit Compliance Report
ACN	Australian Company Number
AEP	Annual exceedance probability
AER	Annual Environment Report
AMV	Ammonium Meta-Vanadate
ASC NEPM	*National Environmental Protection (Assessment of Site Contamination) Measure 1999*
Category/ Categories/ Cat.	Categories of Prescribed Premises as set out in Schedule 1 of the EP Regulations
CMB Circuit	Crushing, Milling and Beneficiation Circuit
CS Act	*Contaminated Sites Act 2003* (WA)
CTSF	Calcine Tailings Storage Facility
Decision Report	refers to this document
Delegated Officer	an officer under section 20 of the EP Act
Department	means the department established under section 35 of the *Public Sector Management Act 1994* and designated as responsible for the administration of Part V, Division 3 of the EP Act.
DWER	Department of Water and Environmental Regulation As of 1 July 2017, the Department of Environment Regulation (DER), the Office of the Environmental Protection Authority (OEPA) and the Department of Water (DoW) amalgamated to form the Department of Water and Environmental Regulation (DWER). DWER was established under section 35 of the *Public Sector Management Act 1994* and is responsible for the administration of the *Environmental Protection Act 1986* along with other legislation.
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
EP Regulations	*Environmental Protection Regulations 1987* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)

Existing Licence	The Licence issued under Part V, Division 3 of the EP Act and in force prior to the commencement of, and during this Review
GCL	Geosynthetic clay liner
HDPE	High density polyethylene
m^3	cubic metres
Minister	the Minister responsible for the EP Act and associated regulations
MS	Ministerial Statement
mtpa	million tonnes per annum
MVPL	Mid-west Vanadium Pty Ltd
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
Nm^3	Normal cubic metre(s) of air
NMTSF	Non-magnetic Tailings Storage Facility
Noise Regulations	*Environmental Protection (Noise) Regulations 1997* (WA)
Occupier	has the same meaning given to that term under the EP Act.
PM	Particulate Matter
PMA	Precious Metals Australia
PM_{10}	means particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less
Prescribed Premises	has the same meaning given to that term under the EP Act.
Premises	refers to the premises to which this Decision Report applies, as specified at the front of this Decision Report
Primary Activities	as defined in Schedule 2 of the Revised Licence
Review	this Licence review
Revised Licence	the amended Licence issued under Part V, Division 3 of the EP Act following the finalisation of this Review.
Risk Event	As described in *Guidance Statement: Risk Assessment*
SAG Mill	Semi-Autogenous Grinding Mill
UDR	*Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA)

V_2O_5	Vanadium Pentoxide
V_2O_3	Vanadium Trioxide
Works Approval Holder	Atlantic Vanadium Pty Ltd
WRS	Waste Rock Stockpile
µg/m^3	micrograms per cubic metre
µg/L	micrograms per litre

2. Purpose and scope of assessment

Atlantic Vanadium Pty Ltd (Atlantic) submitted to DWER an application for a Works Approval under the EP Act. The application submitted on 12 February 2019 was not validated because of critical information missing. Atlantic resubmitted the application on 14 June 2019 and further changes to the application on 1 November 2019. The works approval application is for:

- installation and commissioning of new plant infrastructure;
- increase in the production capacity for beneficiation;
- development of additional cells in the non-magnetic tailings storage facility;
- modifications to wastewater treatment plants and management;
- development of an inert waste dump at Waste Rock Stockpile 2; and
- installation of liner on a section of the Calcine Tailings Storage Facility.

Other infrastructures associated with the Premises are not included in this assessment.

The Premises is located on mining tenements M58/178, M58/279 and M58/280 which are approximately 600 km north-east of Perth and 80 km south-east of Mount Magnet. (Figure 1: Windimurra Vanadium Project

This assessment has resulted in DWER issuing Works Approval W6265/2019/1 (Issued Works Approval) which is contained in Attachment 1.

2.1 Application details

Table 2 lists the documents submitted during the assessment process.

Table 2: Documents and information submitted during the assessment process

Document/information description	Date received
Windimurra Works Approval Application (A1764652)	12/02/2019
Resubmission of Works Approval application for Atlantic Vanadium Pty Ltd (A1797230)	14/06/2019
Response to Works Approval Application Request for Further Information (DWERDT219952)	01/11/2019

3. Background

The Windimurra Vanadium project commenced in 1999. In 2003, the site was placed in care and maintenance. During operations, sodium oxalate was used as a sodium source in the vanadium separation process. Sodium oxalate slurry was supplied by the Alcoa alumina refinery in Pinjarra, WA. Sodium oxalate slurry was stored in tanks within the plant area. Sodium oxalate slurry continued to be provided for a period of five months after operations had ceased, and was stored in the middle of the Non-Magnetic Tailings Storage Facility (NMTSF). An approximate 20,000 tonnes of sodium oxalate slurry was stored in NMTSF.

The mine was closed in 2004 and the majority of the plant was decommissioned, leaving the kiln, leach vats and some tanks in place. Several ownership changes and periods of operation

have occurred since.

In January 2011, construction restarted for recommencement of operations. The plant layout and process was different from the original operation between 1999 and 2003. Sodium oxalate was replaced by soda ash. In February 2014, a major fire occurred in the beneficiation plant and activities related to mining and ferrovanadium production ceased. The site has been in care and maintenance since 2015. In May 2016, Atlantic Vanadium Pty Ltd acquired the Windimurra Vanadium project assets.

The currently approved project comprises mining of vanadium ore by open cut methods, processing on site and transport of vanadium product to the Port of Fremantle for export.

Table 3 lists the prescribed premises categories that have been applied for.

Table 3: Prescribed Premises Categories applied for

Classification of Premises	Description	Current approved production design capacity or throughput	Proposed production or design capacity or throughput	Change in infrastructure
Category 5	Processing or beneficiation of metallic or non-metallic ore	3,900,000 tonnes per annum	4,500,000 tonnes per annum	- 8 MW SAG mill - 2.5 MW Ball mill - Magnetite thickener
Category 44	Metal smelting or refining	10,515 tonnes per annual period	unchanged	- Deammoniator - V_2O_5 Fusion Furnace - V_2O_5 Flaking Wheel
Category 63	Class I inert landfill	N/A	500 tonnes	Waste Rock Stockpile 2
Category 85 **To be Category 54**	Sewage facility	62 cubic metres per day	152 cubic metres per day	Modifications to wastewater treatment plant inputs

Figure 1: Windimurra Vanadium Project

4. Overview of Premises

This section provides an overview of the proposed operations at the Premises, with Table 4 showing the two previous processing plant flowsheet components and the proposed upgraded plant flowsheet, subject to this application.

Table 4: Overview of process plant changes 1999 – current (Umwelt, June 2019)

Infrastructure component	Xstrata operated (1999 – 2003)	MVPL operated (2011 - 2014)	Current Atlantic Vanadium proposal
Primary crusher	Jaw crusher	Gyratory crusher	Existing gyratory crusher
Secondary, tertiary crushers, high pressure grinding rolls (HPGRs)	None	Yes	None proposed (previous crushers and HPGRs removed)
Dry screens	None	Yes	None proposed
Crushed ore stockpile	None	Yes	Stockpiling not proposed
AMV flash dryer	None	Yes	Yes existing
2 * AMV V_2O_3 reduction kilns	None	Yes	One removed and the other placed into care and maintenance; replaced by new deammoniation kiln
Deammoniation kiln	Yes	Yes	New kiln proposed
Ferrovanadium Furnace	None	Yes	Placed into care and maintenance
Fusion furnace and flaking wheel	Yes	None	New furnace and flaking wheel to be installed
Flake packaging	Yes	None	Yes; new packaging area to be installed

4.1 Category 5 – Processing of metallic or non-metallic ore

4.1.1 Beneficiation plant and associated infrastructure (*Umwelt, June 2019*)

The current crushing plant will be demolished and replaced with a Semi-Autogenous Grinding (SAG) Mill and the magnetic separation circuit will be rebuilt. The major refinery circuit modifications comprise installation of a new deammoniator, a V_2O_5 fusion furnace and a V_2O_5 flaking wheel. The ferro-vanadium smelting circuit will be retained on care and maintenance.

Figure 2 shows a schematic of the Processing Plant Key Stages.

All new components within the crushing, milling and beneficiation circuit will be sited on concrete slabs surrounded by bund walls to prevent potentially contaminated water leaks and spills from entering the environment. The bund design will be sized to accommodate 110% of the volume of the largest vessel within the bund or 25% of the total volume of all vessels within the bund,

whichever is larger, and a 1 in 20 year 24 hour rainfall event (as per Australian Standard 1940:2017). Sump pumps will be installed in all bunds to prevent overflows by relocating any contained water back into the processing circuit as shown in Figure 3.

Areas under pipe racks and conveyors will remain unlined and any process spills outside the bunded areas will be removed immediately and disposed to HDPE lined waste containment facilities. Bunding of the existing Tailings Thickener will be improved where practicable to contain leaks and spills.

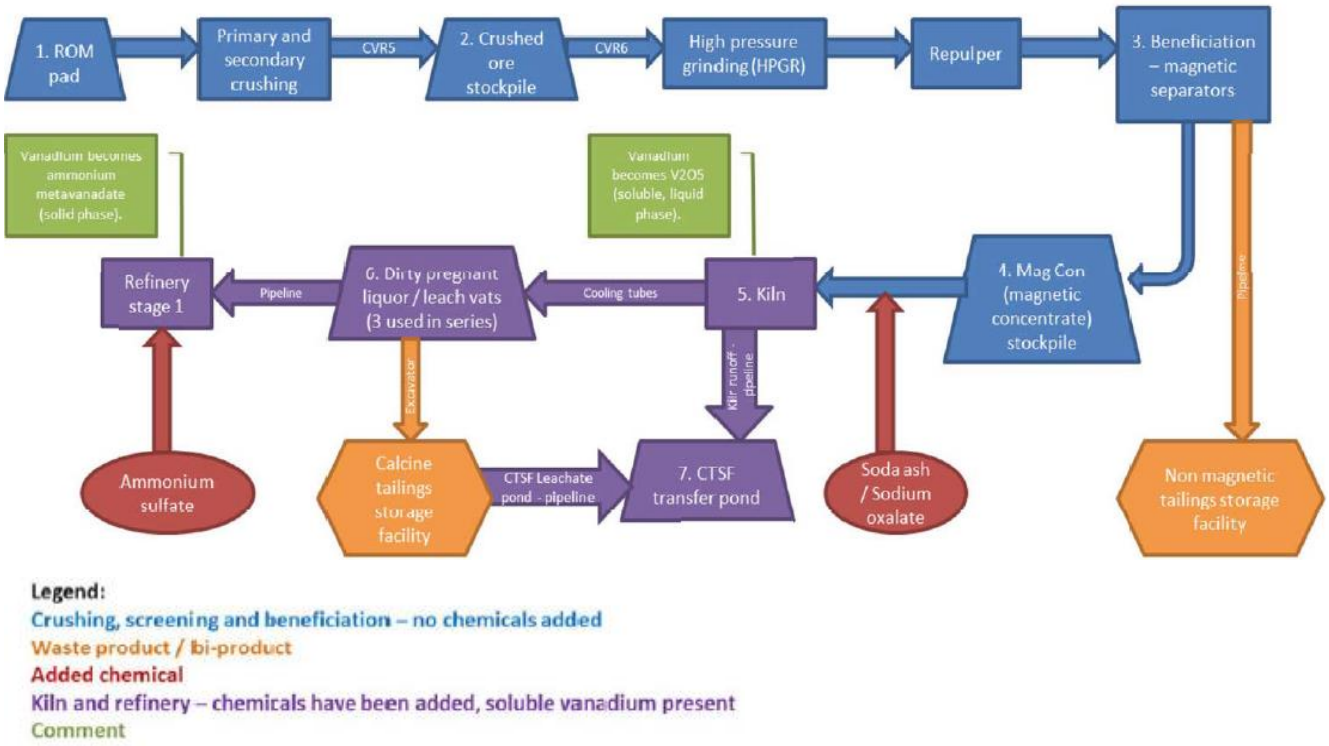


Figure 2: Schematic of Processing Plant Key Stages (Umwelt, April 2017)

Crushing, Milling and Beneficiation (CMB) Circuit

SAG Mill

The existing three-stage crushing and High Pressure Grinding Rolls (HPGR) circuit will be replaced with an 8 Mega Watt (MW) SAG mill operating in closed circuit with screens. The main components include:

- Mill shell (drum) and ends;
- Feed hopper; and
- Trammel screen and pebble crusher (cylindrical screen attached to the discharge end of the mill to remove and crush oversize material or “pebble” from the ground product.

The process will involve crushed ore of approximately 120 mm fed to the SAG mill via the existing surge bin located under the gyratory crusher. The SAG mill will grind the crushed ore to an 80% target passing size (P80) of approximately 425 µm with the grinding action being provided by a combination of 125 mm steel balls and rocks within the mill charge. Recycled process water from the tailings thickener, magnetic concentrate thickener and tailings dam return water will be added to the mill feed chute and mixed with the ore coming off the crusher product conveyor to produce a slurry. This slurry will be directed through the SAG mill for

grinding where it exits onto a trommel screen with an aperture of 12 mm. Pebbles greater than 12 mm will be discharged to a conveyor where they will be transferred to a pebble storage bin and recycled back to the SAG mill feed. The undersize slurry from the trommel will flow to the mill discharge hopper for further processing.

Regrind Ball Mill

A new 2.5 MW ball mill will be added alongside the existing 2.5 MW ball mill in the magnetic concentrate regrind section of the circuit. The main components will include:

- Mill shell (drum) and ends;
- Feed hopper; and
- Trommel screen.

The addition of a second ball mill will enable the final magnetic concentrate produced to reach a P80 of 90 µm to meet concentrate specifications.

The regrind ball milling circuit takes magnetic concentrate from the magnetic concentration circuit roughing stage and grinds it finer to allow liberation of impurities from the magnetite. The regrind ball mills will reduce the concentrate to a P80 of approximately 90 µm that will then undergo further magnetic separation to remove the bulk of the silica and aluminium contaminants.

Magnetic Concentrate Thickener

The partially constructed magnetic separation circuit will be completed with the addition of a magnetite thickener to facilitate production of magnetic concentrate. The Main component will include:

- Thickener tank;
- Rake mechanism support structure (bridge);
- Underflow and overflow pumping systems.

The concentrate thickener takes final magnetic concentrate slurry produced by the magnetic concentration circuit cleaning stage and allows the solids to settle out to a higher density prior to the final filtration stage. Feed to the thickener will be approximately 35% solids and the thickener underflow will reach approximately 70% solids. The overflow water recovered will be recycled back to a new higher capacity Process Water Tank (1,000 m^3) for re-use in the CMB plant. Water from production bores is also sourced and stored in the Process Water Tank for use within the Processing Plant.

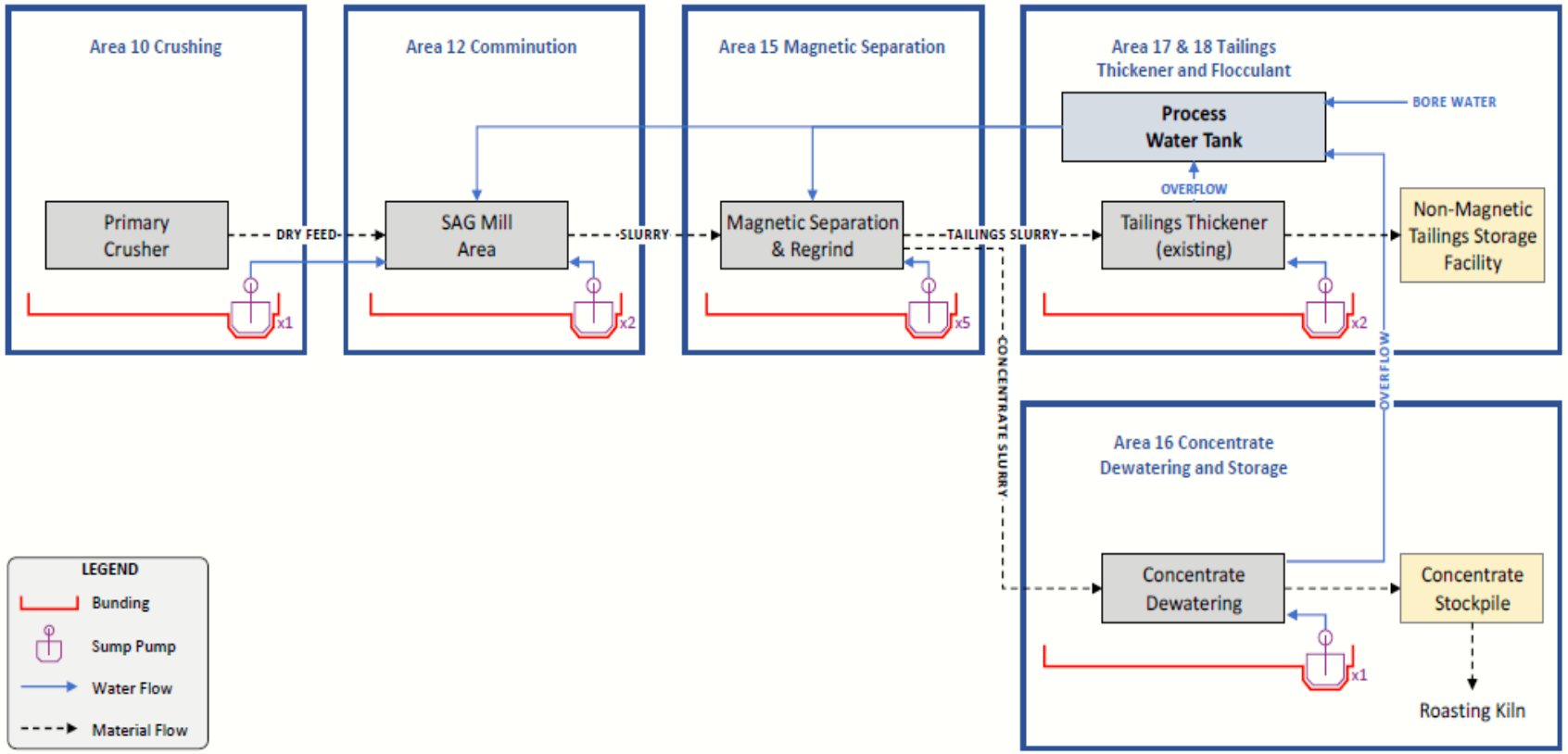


Figure 3: Indicative process flow of contaminated water within bunding at processing plant

Refinery Zone

Modifications in the Refinery Circuit are largely associated with refurbishing existing equipment and with improving material handling aspects of the plant. The primary output of the Refinery will be V_2O_5 flake, as opposed to V_2O_3 powder.

Deammoniator

The new Deammoniator will replace one of the existing V_2O_3 reduction kilns. This takes material from the Ammonium Meta-Vanadate (AMV) precipitation area, dries the cake and subjects it to temperatures of approximately 550^{o}C in an oxidising atmosphere. This decomposes the AMV, driving off the ammonia gas and provides V_2O_5 power.

Off-Gas Venturi Scrubbing System

The new Venturi Scrubbing System will remove any solids from the off-gas stream, which will flow onto the existing V_2O_3 off-gas system, which is capable of removing ammonia gas. The off gas containing small amounts of V_2O_5 powder and NH_3 gas is treated through a wet venturi scrubber to remove any dust particulates followed by a dilute acid scrubber to remove the ammonia.

V_2O_5 Fusion Furnace

Operates at approximately 700^{o}C to produce a molten V_2O_5 stream. This molten product exits the Fusion Furnace onto the cooled rotating V_2O_5 Flaking Wheel.

V_2O_5 Flaking Wheel

Solidifies the molten stream into a fused flake product.

V_2O_5 Packaging Plant

Cooled flake from the V_2O_5 Flaking Wheel is transferred to a storage bin and is packaged into either 205L drums or 1,000kg bulk bags depending on the final market destination.

Figure 4 shows the process flow chart (part 1) for the existing infrastructure, new and future components of the process.

Bag House Filter System

Fugitive dust from the V_2O_5 Fusion Furnace and packing operations are captured in the Bag House Filter System.

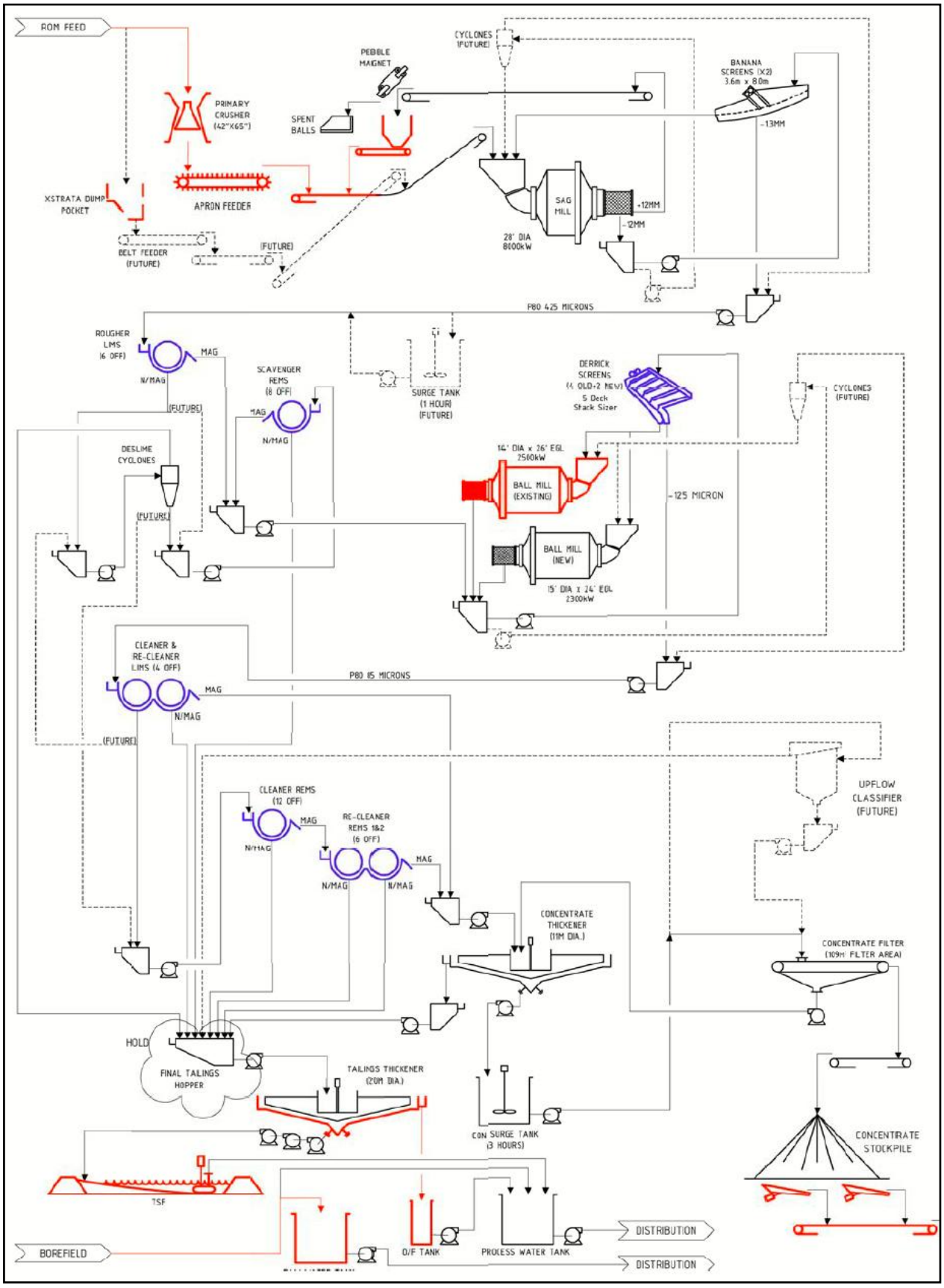


Figure 4: Windimurra Vanadium Project process flow chart (part 1). Red line – existing plant; purple line – already procured; black line – new plant; and dotted line – future plant

4.1.2 Non-Magnetic Tailings Storage Facility (ATC Williams, February 2019)

A revised NMTSF design has been created for the recommencement of operations and will increase the tailings storage capacity to 48,772,873 Mt in order to accommodate the estimated tailings generation of 2.5 – 3.2 million tonnes per annum, for up to 19 years.

The NMTSF is currently one single facility with a perimeter embankment. The works approval application is to convert this facility into three separate cells, with two internal embankments constructed from tailings borrowed from within each of the cells. The proposed arrangement for the final facility is as per Figure 5.

The intent in separating the facility into three is to isolate the area where sodium oxalate is stored (cell 2) and allow tailings deposition to Cells 1 and 3 in advance of works to recover the sodium oxalate for reprocessing (Umwelt, June 2019).

The general design approach provides for the co-disposal of tailings into a single NMTSF landform divided into three cells. The NMTSF will be progressively developed throughout the depositional stages into its final landform. Staged construction of the NMTSF cells will be in the upstream direction. The maximum final height of the facility will be approximately 37 m.

The estimated remaining storage capacity of NMTSF Cell 1 is between 430,000m^3 and 1,090,000m^3 depending on the beach slope achieved.

The tailings will be discharged at an average rate of 308 tph from the perimeter embankments as slurry at ~55% solids by mass into the paddock-type tailings storage cells. The initial starter embankment of Cell 1 has previously been constructed in the southern part of the NMTSF.

Cell 2 cannot be constructed until the buried sodium oxalate is relocated (this will be subject to a further Works Approval), consequently Cell 3 will be constructed on the northern side of the facility during the first year of mill operation and will share a common embankment with the future Cell 2 to be located in the centre of the facility. Prior to the construction of Cell 3 stage 1, a diversion drain will be excavated around the NMTSF to re-route runoff from the southern portion of the catchment to the valley located to the west and east of the proposed facility. Figure 5 shows the general arrangement of Windimurra NMTSF Stage 1.

The new NMTSF cells are planned to be constructed predominantly over the top of the existing valley NMTSF tailings beaches. A geotechnical investigation of the foundation conditions was performed by ATCW in 2018. The foundations consist of dense pre-deposited tailings underlain by weathered rock.

The perimeter embankments will predominantly be constructed from tailings sourced from the adjacent beaches to create a low permeability zone. Fresh, durable waste rock will be used for erosion protection on the downstream slopes and to construct the decant causeways.

Two seepage interception trenches are planned to be constructed on either side of the Cell 3 embankments: one within Cell 2, one 10m downstream of the external cross-valley embankment. The downstream seepage trench will have a maximum depth of 3m and is designed to collect near surface seepage (ACTW 2018 in Umwelt, June 2019).

The adopted geometry and material requirements of the NMTSF design are presented in Table 5.

An operating beach freeboard of 0.3 m and a limiting height of 1.6 m between the lowest point on the tailings beach and each stage crest elevation have been included in the design. For the design beach slope of 1.5%, a minimum expected height difference between the tailings at the centre of the cell and the embankment of 3.4 m occurs at the end of Cell 1 deposition.

Seepage Analysis

A two-dimensional seepage analysis has been carried out using the finite element program SEEP/W. The geometry developed for the SEEP/W model is based on the proposed embankment configuration and existing stratigraphy. Foundation units encountered during

previous geotechnical investigations were idealized by assigning representative hydraulic conductivities (k values), thicknesses, and elevations. Each of the main embankment zones along with the foundation soil and rock layers were modelled separately.

Seepage analyses increments were modelled for each successive stage raise, with the respective pond elevation superimposed on the tailings surfaces as a constant head boundary condition.

Table 5: NMTSF extension embankment geometry

Containing Embankments	**Specification**
Crest width	6m
Downstream slope	3.75:1 (H:V)
Upstream slope	2:1 (H:V)
Final safety windrow height	0.5m (x 2)
Embankment raise	2.5m to 3m in height
Embankment material	compacted, low permeability tailings with waste rock for erosion protection
Decant Structure	**Specification**
Causeway crest width	6m
Filter zone crest diameter	10 m (including decant tower)
Side slopes	1.5:1 (H:V)
Decant tower	18 slot, 1,800 mm dimeter, 96 mm thick,1,220 mm high slotted precast concrete rings
Cut-off trench (where required)	**Specification**
Base width	3m
Depth	Varies (nominal 1.5 m)
Side slopes	1:1 (H:V)
Seepage collection trenches	**Specification**
Base width	3m
Depth	Varies
Side slopes	0.5:1 (H:V)

The hydraulic conductivity properties of materials used were assigned based on the geotechnical investigations carried out by ATCW in 2018. The values adopted are presented in Table 6.

Table 6: Hydraulic conductivities used in the SEEP/W model

Materials	**Hydraulic Conductivity Kv (m/s)**	**Comment**
Laterite	2.19×10^{-6}	Obtained from in-situ testing during geotechnical investigation
Mafic Saprolite	1.67×10^{-7}	
Existing Tailings	6.26×10^{-9}	Average obtained from CPTu dissipation tests and in-situ laboratory tests
Existing Embankment Clay	3.98×10^{-9}	Obtained from Laboratory test results of BH05
Existing Embankment Tailings	1.35×10^{-9}	Obtained from Laboratory Test Results from BH07
New Tailings	1×10^{-7}	Obtained from tailings testing of fresh and oxide tailings
New Embankment	5.34×10^{-9}	Obtained inside proposed borrow area from laboratory tests of TP09 and TP11
Waste Rock	1×10^{-5}	Typical waste rock permeability

The estimated magnitude of seepage passing through the tailings / natural ground interface is approximately 50m^3/d for the initial six months of operation of each cell, reducing to less than 20m^3/d thereafter. This is equivalent to an average decant pond loss of approximately 0.5mm/d.

4.2 Category 7 – Calcine TSF (CTSF) extension

Calcine tailings are produced as a result of water leaching of sodium vanadate from the kiln product in the Processing Plant leach vats. The liquid phase is pumped from the vats to the refinery. The solid component is classified as calcine tailings. The calcined tailings are excavated from the vats and disposed of in the Calcine TSF (CTSF).

The CTSF is approximately 14.7 hectares (ha) in size has been constructed in two stages with a 1mm High Density Polyethylene (HDPE) liner (Umwelt, November 2019). The CTSF functions as a heap leach, draining leachate and rainwater into a HDPE lined collection pond from which liquor is pumped and sprayed back over the stockpile to further leach soluble vanadium. Concentrated liquor is eventually returned to the Processing Plant for vanadium recovery.

A previously constructed extension area (part of what is referred to as stage 2) to the CTSF is planned to be operated following installation of a dual geosynthetic clay liner/ HDPE liner over the area. An approximate 1.7ha area will be lined (area shown in yellow in Figure 6 below). The extension area represents a further two years' capacity based on a production rate of 0.8 Mtpa calcine tailings. A further extension to the CTSF will be subject to a separate works approval application.

Leachate and stormwater runoff from the expanded lined calcine tailings disposal area will be directed to the existing leachate pond. Prior to commencement of works on the CTSF the volume of the existing leachate pond will be confirmed to ensure capacity is available to capture a 1% AEP rainfall event over 72 hours. It is possible that the pond will require further works to ensure this capacity is available (Umwelt, November 2019).

Additionally some overspill of existing tailings into the unlined extension area has occurred in the past and to address the potential soil contamination, a soil contamination investigation is planned, with any contaminated material to be removed back to the main CTSF (Umwelt, November 2019).

The project will generate 0.7 – 0.8 million tonnes of calcine tailings per year.

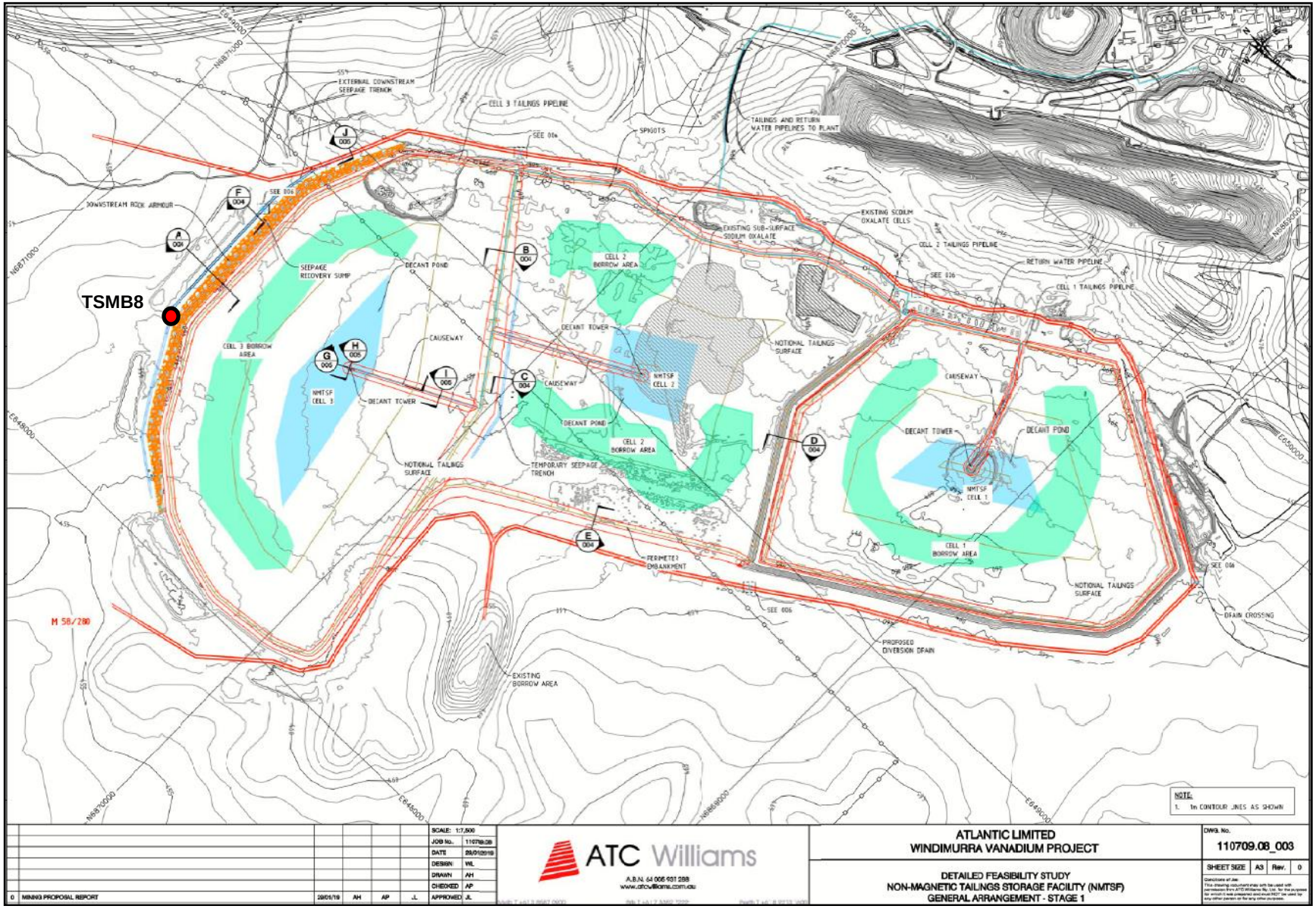


Figure 5: Windimurra Vanadium NMTSF Stage 1 - general arrangement

Figure 6: Aerial view of the CTSF showing the extension area in yellow planned for GCL and HDPE liner installation (Umwelt, November 2019)

4.3 Category 44 – Metal smelting or refining

Refinery

The new process will retain the capability to produce vanadium oxide (V_2O_3) powder, but a new vanadium pentoxide (V_2O_5) flake production circuit will be installed. The key items of new equipment to be installed are:

- Deammoniation kiln and off-gas scrubbing system
- V_2O_5 fusion furnace
- off gas venturi scrubbing system
- bag house filter system
- V_2O_5 flaking wheel
- V_2O_5 packaging plant

The V_2O_5 production area takes material from the Ammonium Meta-Vanadate (AMV) precipitation area, dries the cake and oxidises it at 550°C in the deammoniation kiln, producing ammonia (NH_3) gas and V_2O_5 powder. The off gas (also containing trace amounts of V_2O_5 powder) is treated via a wet venturi scrubber to remove particulates, followed by a dilute acid scrubber to remove the ammonia. V_2O_5 powder produced from the deammoniator is then transferred to a storage bin from where it is fed into the gas fired refractory lined fusion furnace, which operates at approximately 700°C to produce a molten V_2O_5 stream. This molten product exits the fusion furnace onto a water cooled rotating flaking wheel which solidifies the molten stream into a fused flake product. Cooled flake from the flaking wheel is transferred to a storage bin from which it is then packaged into either 205 L drums or 1,000 kg bulka bags. Fugitive dust from the fusion furnace and packing operations will be captured in the baghouse filter system.

All of the new infrastructure will be located in or next to the existing V_2O_3 reduction kiln area. The general layout of the new V_2O_5 facility is shown in Figure 7.

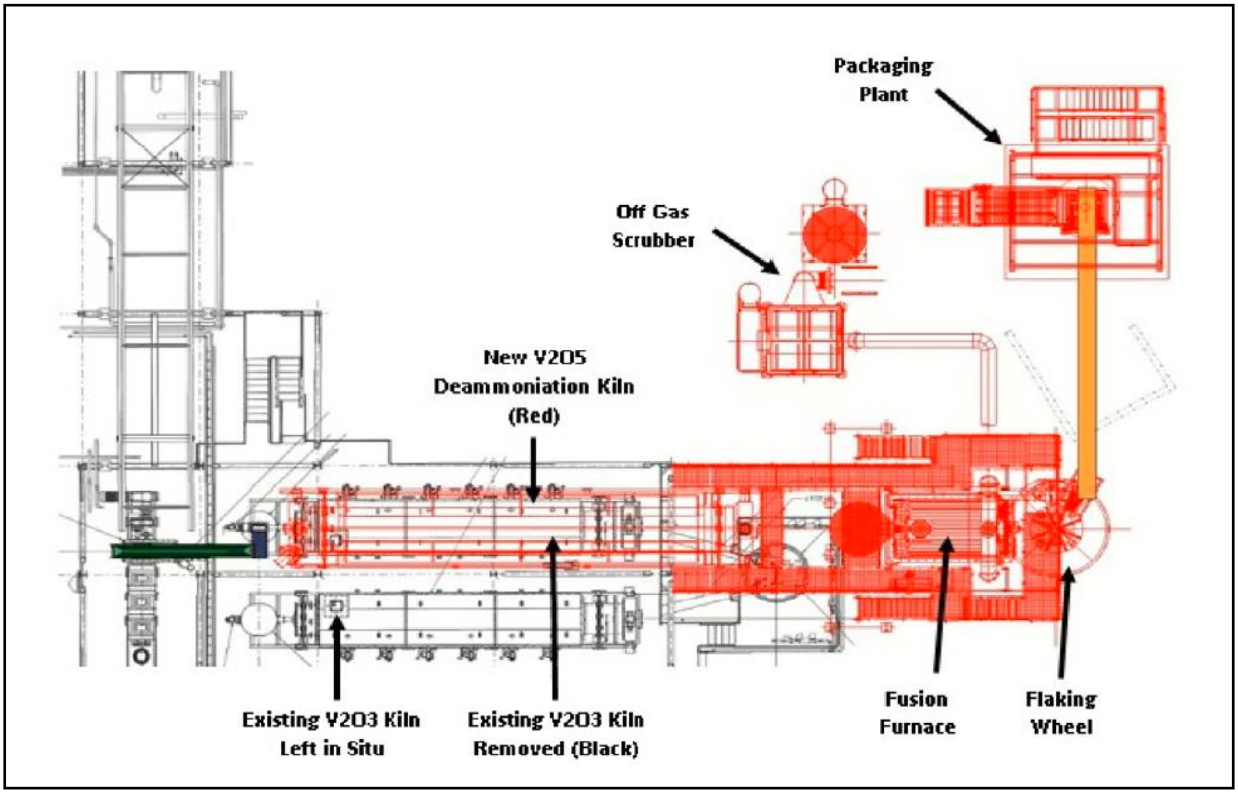


Figure 7: Vanadium pentoxide production facility layout

4.4 Category 63 – Class I inert landfill

It is proposed that an inert waste dump be constructed at the base of the existing waste rock stockpile 2 (WRS 2) for the disposal of waste produced during demolition and construction. An area of 50 m x 50 m will be used to store waste in a pile up to 2 m high, a total potential capacity of 5,000m^3 for this facility. Figure 8 shows the location of the proposed inert landfill.

Wastes will include inert material, such as concrete, plastic piping and wooden crates produced from demolition of the existing CMB circuit within the Processing Plant. Steel will be returned to Perth for recycling.

Waste will be laid along the toe of WRS 2. A site-specific risk-based procedure for the management of demolition and construction waste will be established to ensure that materials with a high risk of containing environmentally hazardous materials are either treated or compliantly disposed of elsewhere to minimise the risk of environmental contamination.

Once demolition and construction are completed, waste rock will be dumped from the top of WRS 2 encapsulating the inert waste. The waste dump will be progressed during the first twelve months of operation and the landfill will be covered to a depth of over 20 m once the waste dump reaches its design capacity. Embankment angles and the waste rock material that is dumped will be managed to ensure stability is achieved.

Other wastes (non inert) that are generated during construction activities will be disposed of in the site landfill or in accordance with compliance requirements.

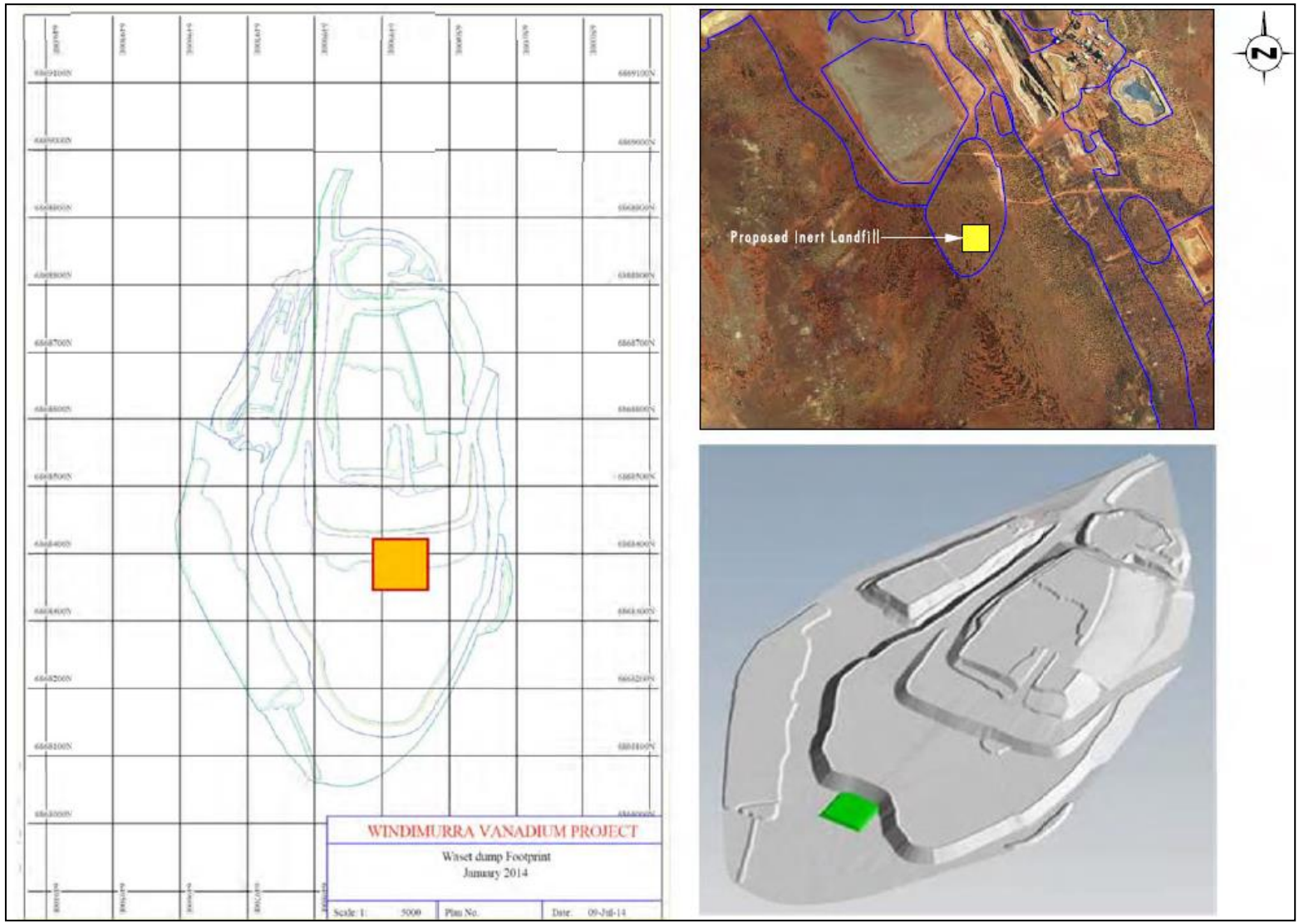


Figure 8: Proposed Inert Landfill location

4.5 Category 54 – Sewage facility

4.4.1 Wastewater treatment plants

The primary wastewater treatment plant (WWTP) is situated to the north of the accommodation village. This facility is approved under licence L8314/2008/3 and has a production capacity of 62 cubic metres per day (m^3/d) based on 200 persons in full residence with a sewage generation rate of 310 L/person/day.

Atlantic Vanadium proposes to increase the total WWTP production capacity to 128 m^3/day, with a temporary WWTP contributing 66 m^3/day production capacity. The temporary WWTP is planned to be used for a maximum of six months. The temporary WWTP will be installed adjacent to the existing WWTP.

The temporary WWTP will be operated in parallel with the existing WWTP, with sewage distributed to each system through a balance tank. Each WWTP will run an independent disposal system for treated wastewater, which will be irrigated into two separate sprayfield areas (Umwelt, November 2019) as shown on Figure 9.

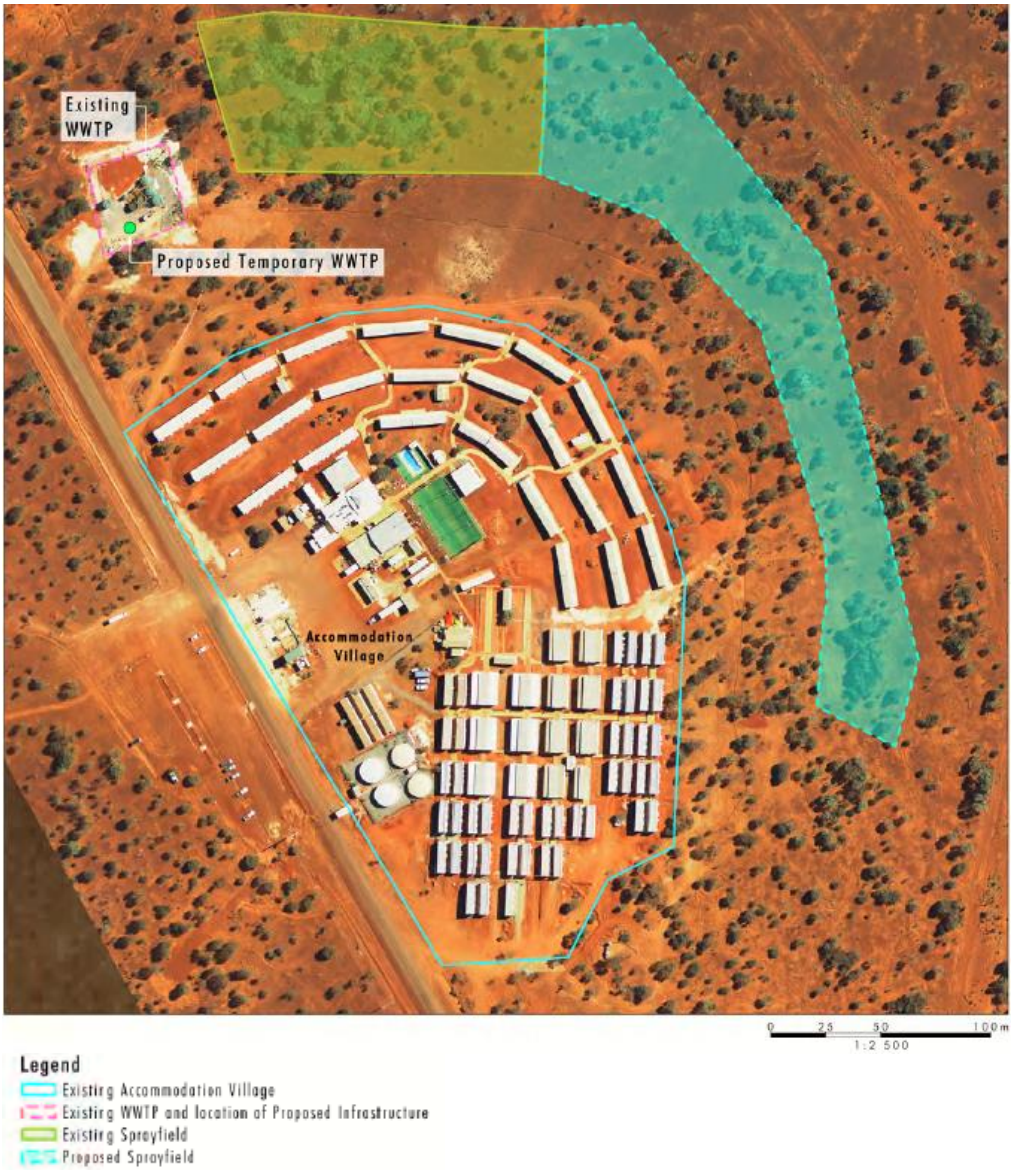


Figure 9: Proposed location for a temporary WWTP and additional irrigation field

The sprinklers will be ground mounted and appropriately sited within the proposed sprayfield so that all treated effluent is sprayed within the designated area.

4.6 Infrastructure

The Premises facility infrastructure, as it relates to Categories 5, 7, 44, 63 and 54 activities for this Works Approval, is detailed in Table 7 and with reference to the Site Plan (attached in the Works Approval).Table 7 lists infrastructure associated with each prescribed premises category.

Table 7: Windimurra Vanadium project facility Categories 5, 7, 44, 63 and 54 infrastructure

	Infrastructure	Site Plan Reference
Prescribed Activity Category 5		
Ore Process plant with design throughput of 4,500,000 tonnes per annum		
1	8 MW SAG Mill	Figure 9
2	2.5 MW Ball Mill	
3	Magnetite Thickener	
Non-Magnetic Tailings Storage Facility (NMTSF)		
1	Three cells above ground paddock style facility	Figure 5
Prescribed Activity Category 7		
Calcine Tailings Storage Facility		
1	Installation of a dual liner (geosynthetic clay liner overlain by primary 1.5mm HDPE liner) placed over previously constructed CTSF extension area (1.7 ha of stage 2 CTSF extension)	Figure 6
Prescribed Activity Category 44		
Refinery		
1	Deammoniation kiln	Figure 9
2	Off gas venturi scrubbing system	
3	Fusion furnace	
4	Flaking wheel	
5	Bag house filter system	
6	Packaging plant	
Prescribed Activity Category 63		
Inert Landfill at Waste Rock Dump 2		
1	50 x 50 cell, 2m high	Figure 7

	Infrastructure	Site Plan Reference
Prescribed Activity Category 54		
Temporary WWTP 66m^3/day		
1	Sequencing Batch Reactor (SBR) with capacity 66m^3/day production capacity	Figure 13
	Pipelines and pumps to transfer effluent to new irrigation area	

4.7 Exclusions to the Premises

The following infrastructure associated with the Premises are not included in this assessment:

- camp accommodation;
- administration buildings;
- mining contractor workshop;
- laydown yards;
- power plant and associated supply infrastructure;
- putrescible landfill;
- removal of sodium oxalate from NMTSF; and
- rehabilitation and closure of BLP1 (Barren Liquor Pond 1).

Data Source: Minnovo (Oct 2019)
Note: Not For Construction - PRELIMINARY

Figure 10: Windimurra Vanadium infrastructure location

5. Location and siting

5.1 Siting context

The Premises sits within mining leases M58/178, M58/279, and M58/280, as depicted in Figure 1, and is located within the Windimurra Pastoral Lease (LPL N049896). It is approximately 600 kilometres north-east of Perth and 70km south-east of the town of Mount Magnet, located in the Gascoyne region of WA.

5.2 Residential and sensitive Premises

The distances to residential and sensitive receptors are detailed in Table 8.

Table 8: Receptors and distance from activity boundary

Sensitive Land Uses	Distance from Prescribed Activity
Windimurra Pastoral Station	The Premises is wholly located within the pastoral lease. Windimurra Homestead no longer exists, and the pastoral lease was acquired by the neighbouring Challa station. The local area has a beneficial use as pastoral land for stock animals, which are not restricted to exclusively near the homestead.
Challa Homestead	Approximately 22.5 km to the west of the TSFs. Cattle grazing property actively managed.
Mount Magnet town site	Approximately 68km to the west of the TSFs

5.3 Specified ecosystems

Specified ecosystems are areas of high conservation value and special significance that may be impacted as a result of activities at or emissions and discharges from the Premises. The distances to specified ecosystems are shown in Table 9. Table 9 also identifies the distances to other relevant ecosystem values which do not fit the definition of a specified ecosystem. The general locations of these ecological receptors relative to Premises boundary are depicted in Figure 11.

Table 9: Environmental values

Specified Ecosystems	Distance from the Premises
Threatened and Priority Fauna	At least one example of Threatened Fauna was identified approximately 400m east of the premises boundary. Several other instances of Priority Fauna were also identified.
Biological Components	**Distance from the Premises**
Threatened and Priority Flora	One Priority 1 flora identified near the WWTP spray area; an additional instance is located near the Premises, approximately 1.1kms south of the premises boundary. Several other instances of Priority Flora (specifically P3 and P4) were also identified within the premises boundary.
Threatened Ecological Communities and Priority Ecological Communities	Priority Ecological Community (Priority 1) located within and adjacent to a large portion of the Premises. Stygofauna identified within this TEC/PEC area.

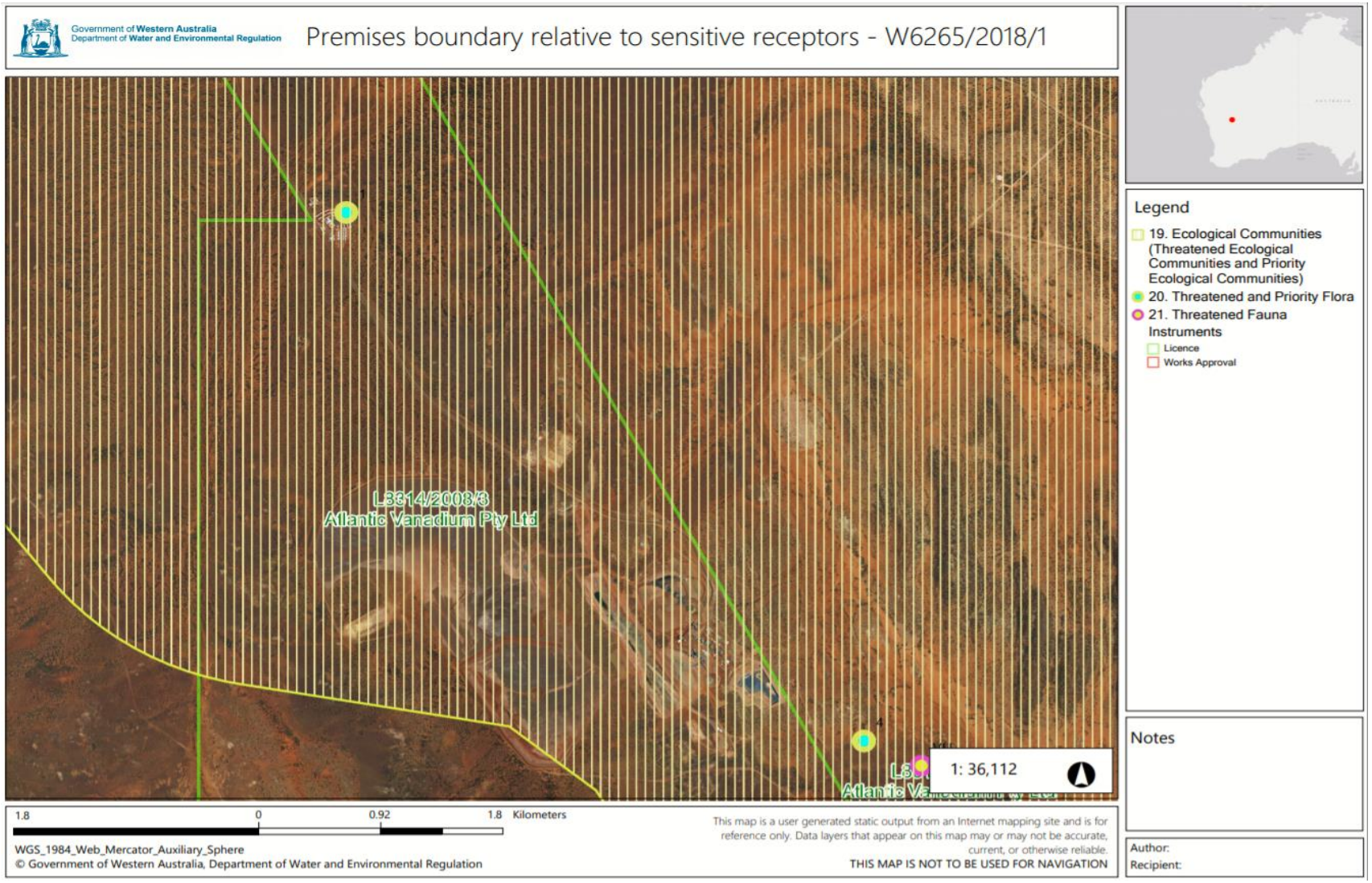


Figure 11: Specified sensitive ecological receptors in the vicinity of the Premises

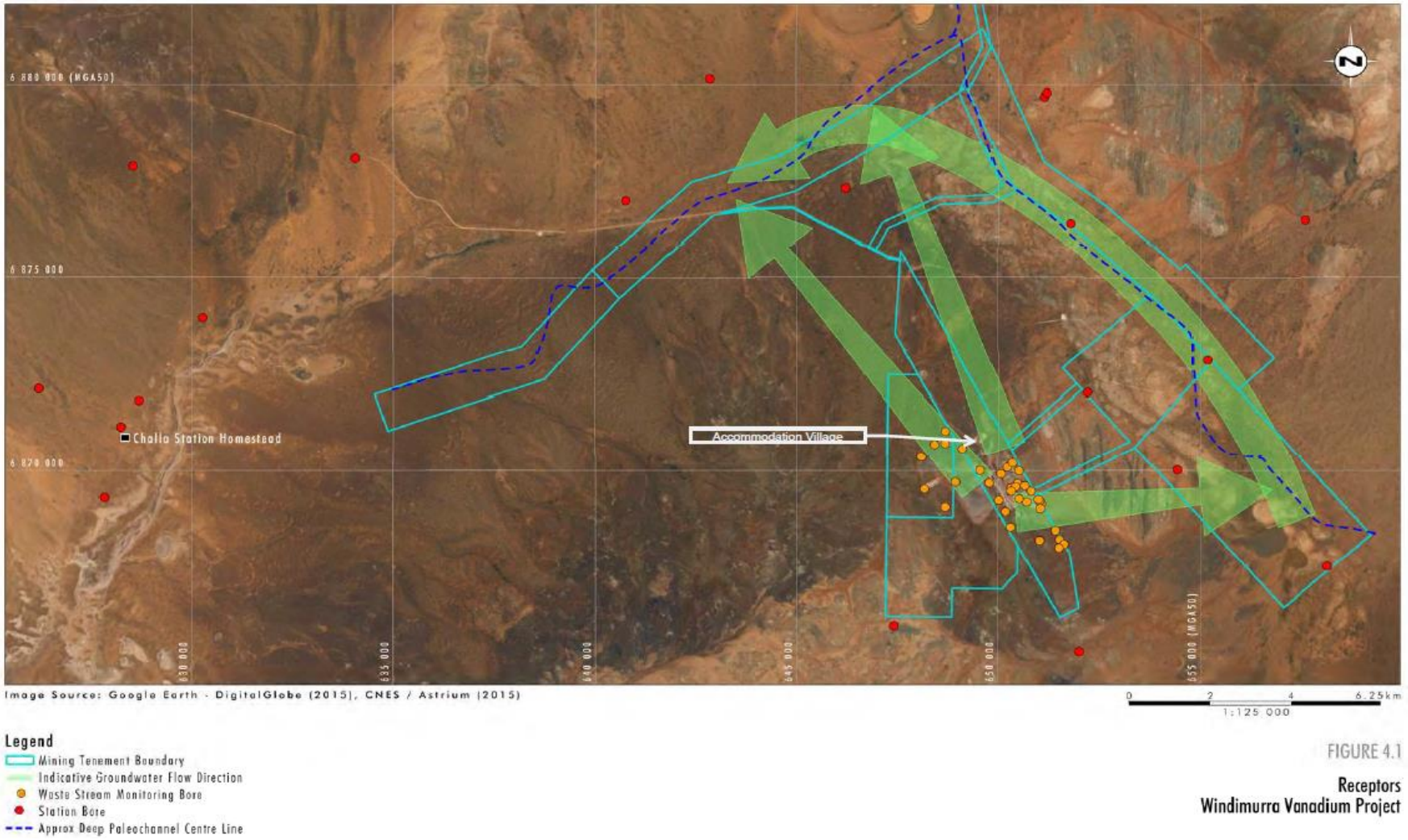


Figure 12: Location of groundwater receptors (pastoral bores in red) and direction of groundwater flow (in green) from Premises (Umwelt 2019)

5.4 Groundwater and water sources

The distances to groundwater and water sources are shown in Table 10. Figure 13 shows the locations of identified receivers.

Table 10: Groundwater and water sources

Groundwater and water sources	Distance from Premises	Environmental Value
Drinking Water Source Areas	None within 30kms of the Premises.	N/A
East Murchison Groundwater Area	Covers the entirety of the Premises, and a large area beyond that.	Unknown
Potable drinking water for mine site	4.6km	*The groundwater is treated through an RO plant*
Challa Homestead	20km north west of the Premises	Drinking water at Challa Station is sourced from rainwater, with other water used sourced from bore located 20.7km away from the Premises
Brailia Well	8.5km north of the Premises	Pastoral Station bore / well used for cattle drinking water
Garden Well	10.5km north of the Premises	Pastoral Station bore / well used for cattle drinking water
Stag Well	6.5km northeast of the Premises	Pastoral Station bore / well used for cattle drinking water
Sandie Well	9km southeast of the Premises	Pastoral Station bore / well used for cattle drinking water
Bundlejinnie Well	24km northwest of the Premises	Pastoral Station bore / well used for cattle drinking water
“Near” 34 Mile Bore (34 Mile destroyed)	10.5km northwest of the Premises	Pastoral Station bore / well used for cattle drinking water

The Premises is mostly within an area that has been assessed as having a groundwater salt content level of 1,000-3,000mg/L (DWER’s Geocortex), but does overlap the boundary between this zone and one with a salt content level of 3,000-7,000mg/L. The average Total Dissolved Solids (TDS) at the Premises range from 1,500mg/L to 3,900mg/L (Umwelt, April 2017).

5.4.1 Regional climatic aspects

The area surrounding Mount Magnet is located in the eastern part of the Gascoyne region of Western Australia. In general, its climate is relatively arid, with a somewhat rainy season during the summer months.

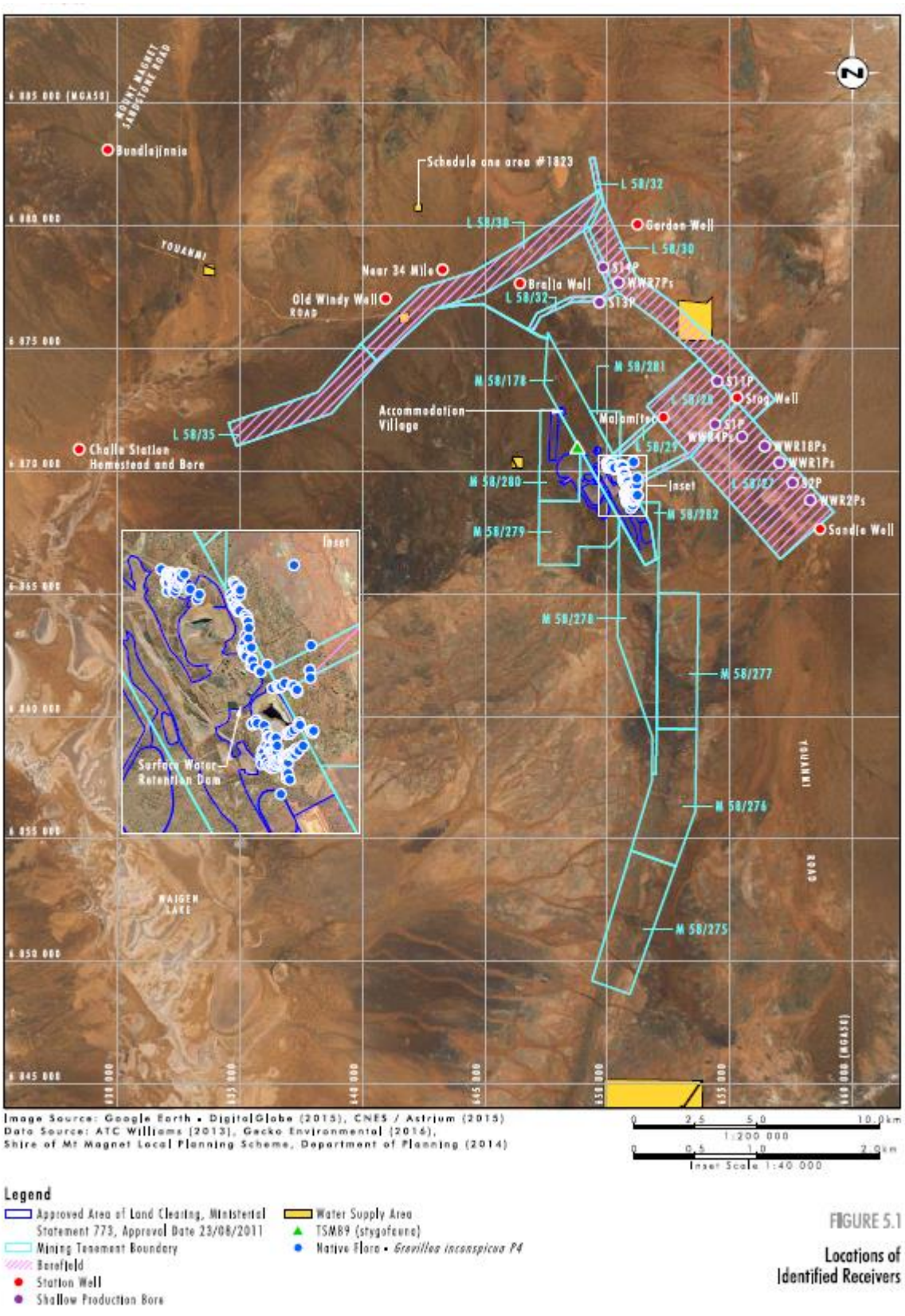


Figure 13: Locations of Identified Receivers

Figure 14: Groundwater monitoring bores on Licence L8314/2008/3 (Umwelt, December 2018).

6. Legislative context

Table 11 summarises approvals relevant to the assessment.

Table 11: Relevant approvals and tenure

Legislation	Number	Approval
Rights in Water and Irrigation Act 1914 (WA)	GWL161706(3)	3.5GL/a water extraction from the East Murchison GWA for dust suppression, mineral processing, and mining camp purposes (DoW, 2011; Umwelt, April 2017)
	GWL161714(3)	
Mining Act 1978	File No. 2342/98	*"Windimurra Vanadium Project – Tailings Storage Facilities Notice of Intent"*, 18 February 1999 (DMP, May 2017)
	NOI 3136 File No. 2429/99	*"Letter of Intent Windimurra Vanadium Project – Proposed Location of Groundwater Monitoring Bores at the Plant Site"*, 18 August 1999 (DMP, May 2017)
	MP 20464	*"Windimurra Vanadium Project Mining of Vanadium Ore Mining Proposal: Stage 1 Recommencement of Mining at Windimurra Vanadium Project, Mining Leases 58/178, 58/279 and 58/280, Miscellaneous Licences 58/27, 58/28, 58/29, 58/30 and 58/32"*, 25 September 2008 (DMP, May 2017)
	MP 21210	*"Windimurra Vanadium Project Mining of Vanadium Ore Mining Proposal: Stage 2 Revision 4 Recommencement of Mining at Windimurra Vanadium Project. Mining Leases 58/178, 58/279 and 58/280 Miscellaneous Licences 58/27, 58/28, 58/29, 58/30 and 58/32"*, 6 February 2009 (DMP, May 2017)
	Reg ID 30623 MP-30623	*"Notification of proposed iron ore fines customer samples at Windimurra Vanadium Project – M58/178"*, 27 April 2011 (DMP, May 2017)
	Reg. ID 31207 MP-31207	*"Mining Proposal Stage 1 to include airstrip (M58/280) and minor changes to other site infrastructure (M58/178); and - Mining Proposal Stage 2 to include iron ore production (M58/178) June 2011"*, 7 June 2011 (DMP, May 2017)
	Reg ID: 32687	*"Windimurra Vanadium Project Decommissioning and Closure Plan May 2012"*, 24 October 2012 (DMP, May 2017)
Part IV of the EP Act (WA)	MS 481	- Total production capacity of 10,515 tonnes per annum; - 610 hectares of clearing permitted; - 176,000 kilolitres per annum of carbon dioxide emissions; - 3,200,000 tonnes per annum of inert non-magnetic tailings; - 1,040,000 tonnes per annum calcine tailings; and - 65 truck movements per day.
	MS 565	- Limits on nitrous oxides to be regulated under Part V of the EP Act.
	MS 773	- Additional 300 hectares of cleared land - Mining operations to a maximum of 90m in depth
Part V of the EP Act (WA)	L8314/2008/3	Existing Licence

6.1 Contaminated Sites Act

The Windimurra Vanadium mining tenements M58/178 and M58/208 have been classified under the *Contaminated Sites Act 2003* as “contaminated – remediation required”. The classification quotes a number of reasons including the storage and potential contamination of the site (including groundwater) by sodium oxalate.

In addition to the sodium oxalate issue, the classification mentions other reasons including elevated metal concentrations associated with process tailings within the Calcine Tailings Storage Facility (CTSF), Non-Magnetic Tailings Storage Facility (NMTSF) and the two Barren Liquor Ponds (BLP1 and BLP2) in addition to high salinity groundwater beneath the plant area.

Atlantic Vanadium has prepared a sodium oxalate management plant and it will be the basis for removal and management of sodium oxalate stored in the NMTSF, and closure of BLP1. A subsequent works approval application will be prepared and submitted for assessment of these actions.

6.2 Part V of the EP Act

6.2.1 Applicable regulations, standards and guidelines

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

The guidance statements which inform this assessment are:

- *Guidance Statement: Regulatory Principles (July 2015)*
- *Guidance Statement: Decision Making (June 2019)*
- *Guidance Statement: Risk Assessments (February 2017)*
- *Guidance Statement: Environmental Siting (November 2016)*

6.2.2 Works approval and licence history

Table 12 summarises the works approval and licence history for the premises.

Table 12: Works approval history

Instrument	Issued	Nature and extent of works approval, licence or amendment
W5556/2013/1		Category 5
W2600/1998/1	08/12/1998	Categories 5, 44, 52, 58
W2729/1998/1	08/06/1999	Categories 5, 44, 52, 58
W3438/1998/1	19/06/2001	Category 5
W4403/2007/1	27/03/2008	Categories 5, 7, 31, 44, 52, 85, 89
W4428/2008/1	21/08/2008	Category 5
W5029/2011/1	06/10/2011	Category 5
W6265/2019/1	24/03/2020	Categories 5, 7, 44, 63, 85

7. Modelling and monitoring data

7.1 Groundwater Monitoring

The potential contaminants that monitoring has previously recorded as exceeding ANZECC guidelines have been identified below in Table 13, along with their respective potential adverse impacts. The contaminants have also been evaluated based on a "relative degree of concern" to indicate which contaminants the Delegated Officer has determined would cause the worst consequence if they were to be leached to the groundwater/environment and then transmitted to receptors.

A high rating was used for any contaminants known to have potential bioaccumulative properties as these would not only constitute a threat to the stock animal receptors, but also to humans who may later consume beef from those animals. Sodium oxalate was also rated as high due to its extremely corrosive nature and its solubility. An additional factor was the quantities stored at the Premises, calculated to be approximately 7,400 tonnes in total. A medium rating was then used for non-bioaccumulative potential contaminants that nonetheless had some severely adverse side-effects of ingestion, and the remainder were designated to be of relatively low (but still noteworthy) concern.

Figure 14 above shows the location of current Windimurra groundwater monitoring bores (Licence L8314/2008/3).

Table 13: Contaminants of concern in leachate

Parameter	Highest detected level in groundwater waste stream bores (location, year)	Assessment level under ANZECC	Relative degree of concern
Arsenic	0.008mg/L (Plant Area, 2018)	0.5mg/L	Medium
Boron	9.9mg/L (Plant Area, 2016)	5mg/L	Low
Cadmium	<0.001mg/L (BLP 1, 2007)	0.01mg/L	High
Calcium	4,100mg/L (BLP 1, 2018)	1,000mg/L	Low
Chromium	0.01mg/L (NMTSF, 2018)	1mg/L	Medium
Magnesium	1,300mg/L (CTSF, 2018)	1,000mg/L	Low
Mercury	0.032mg/L (BLP 1, 2005)	0.002mg/L	High
Molybdenum	0.07mg/L (Plant Area, 2016)	0.15mg/L	High
Selenium	0.1mg/L (Plant Area, 2017)	0.02mg/L	High

Parameter	Highest detected level in groundwater waste stream bores (location, year)	Assessment level under ANZECC	Relative degree of concern
Sodium oxalate (soluble only)	N/A	N/A	High
Sulfate	3,000mg/L (Plant Area, 2018)	1,000mg/L	Low
Total dissolved solids (TDS)	29,000mg/L (Plant Area, 2018)	4,000 to 5,000mg/L	Medium
Vanadium	37mg/L (Plant Area, 2018)	1mg/L	Low

8. Consultation

The application was referred to DMIRS, the Local Government Authority (LGA) and Challa Station for comments. No comments were submitted on the application.

9. Risk Assessment

9.1 Determination of emission, pathway and receptor

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

To establish a Risk Event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission. Where there is no actual or likely pathway and/or no receptor, the emission will be screened out and will not be considered as a Risk Event. In addition, where an emission has an actual or likely pathway and a receptor which may be adversely impacted, but that emission is regulated through other mechanisms such as Part IV of the EP Act, that emission will not be risk assessed further and will be screened out through Table 14 and Table 15.

The identification of the sources, pathways and receptors to determine Risk Events are set out in Table 14 and Table 15 below.

Table 14. Identification of emissions, pathway and receptors during construction

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Construction, mobilisation and positioning of infrastructure	Vehicle movements on unsealed access roads	Noise	No residences or other sensitive receptors in proximity as the Challa Station residence is approximately 20 km west of the Processing Plant	Air / wind dispersion	Health and amenity impacts	No	No receptors present. Noise will be managed in accordance with the *Mines Safety and Inspection Act 1994*, *Mines Safety and Inspection Regulations 1995* and *Environmental Protection (Noise) Regulations 1997*.
		Dust			Health and amenity impacts	No	No receptors present. Use water trucks to suppress dust from roads or cleared areas as required. Maintain incident reporting system to identify recurring issues.
	Construction of new buildings, plant and infrastructure	Noise	No residences or other sensitive receptors in proximity as the Challa Station residence is approximately 20 km west of the Processing Plant	Air / wind dispersion	Health and amenity impacts	No	No receptors present. Noise will be managed in accordance with the *Mines Safety and Inspection Act 1994*, *Mines Safety and Inspection Regulations 1995* and *Environmental Protection (Noise) Regulations 1997*.
		Dust			Health and amenity impacts	No	No receptors present. Use water trucks to suppress dust from roads or cleared areas as required. Maintain incident reporting system to identify recurring issues.

Table 15: Identification of emissions, pathway and receptors during commissioning

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Processing Plant	Ore crushing, transfer of processed ore, feed ore stockpile	Dust (PM_{10}) emissions from crushing, grinding and screening of ore	No residences or other sensitive receptors in proximity. Nearest sensitive land users are 22.5km away	Air / wind dispersion	Health/amenity	No	No receptors present. No further assessment.
			Priority flora/ adjacent native vegetation		Chronic impacts to adjacent vegetation impacting	No	Vegetation in an arid environment may have natural dust tolerance which is likely to prevent vegetation impacts. No further assessment required.
	All Processing Plant areas	Processing water leaks / spills (saline, contaminated) Solution leaks / spills	Soils, vegetation, groundwater	Direct discharge	Contamination of soils and potential seepage to groundwater. Degradation of vegetation.	No	All existing and new plant areas (aside from areas under pipe racks and conveyors) will be contained within concrete slabs and bunds with sump pumps to return process fluids back into the process. The bunds will be sized to accommodate 110% of the volume of the largest vessel within the bund or 25% of the total volume of all vessels within the bund, whichever is larger (as per *Australian Standards 1940:2017 The storage and handling of flammable and combustible liquids*). Process spills outside the bunded areas will be removed immediately and disposed of appropriately. Stormwater will be prevented from entering bunded areas with the following controls: • All stormwater that falls within bunded process areas is prevented from discharge to the environment; • Non-process areas (administration,

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
							roads, hardstand and other areas not containing environmentally hazardous materials) within the plant area are drained by grading earthworks to encourage overland flow of water. Pipe drainage is minimised; • All unsealed areas will be graded so that stormwater is directed into a network of swale drains that have been designed to accommodate 1 in 100 year, 15 minute flood events as a minimum; • The swale drains will deliver stormwater to a 1,000 m^3 sediment settling basin to the north-west and a 4,000 m^3 sediment settling basin to the south-west; • The swale drains have a controlled outfall, which is designed to contain up to a 1 in 5 year, 12 hour storm event, and allow maximum discharge of up to a 1 in 50 year storm event without overtopping the remainder of the swale embankment; and • The swale drains will be inspected weekly and cleaned out as required to maintain performance Groundwater monitoring network already in place, which includes PSMB1, 4, 7, 8 in the Processing Plant area.
	Process Water Tank	Contaminated wastewater generated from the CMB area, bunding and production bores water	Native vegetation in the vicinity of the CMB Circuit.	Direct discharge	Contamination of adjacent soils and vegetation	No	A new process water tank with 1,000m^3 capacity will replace the old one. The process water tank is within the CMB Circuit bunded area. The available capacity of this tank prior to severe weather events will be managed by restricting or ceasing input from the bores to ensure that there is sufficient available

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
							volume. The tank will be equipped with a duty/standby pump arrangement and alarms to protect against overflows. Excess water can be removed from the system by adjusting the water being sent to the NMTSF.
	Deammoniation Kiln	Ammonia (NH_3) emissions	Priority Flora / Native Vegetation	Point source emission to air	Chronic impacts to vegetation health	Yes	See Section 9.4
		Nitrogen Oxides (NOx) emissions			Acute and chronic impacts to vegetation health Acid generation degrading water quality	Yes	See Section 9.4
		Hydrogen chloride emissions			Impacts to vegetation health	Yes	See Section 9.4
		Particulate (PM_{10}) emissions from stacks			Potential suppression of vegetation photosynthetic and respiratory functions	No	Vegetation in an arid environment may have natural dust tolerance which is likely to prevent vegetation impacts. No further assessment required
	Fusion Furnace Flaking Wheel Packaging Plant	Vanadium pentoxide (V_2O_5) emissions	Pastoral station groundwater bores	Point source emission to air deposition to soil, leaching to groundwater	Adverse impact to groundwater quality	Yes	See Section 9.5

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
			Priority Flora / Native Vegetation	Point source emissions to air	Potential suppression of vegetation photosynthetic and respiratory functions	Yes	
		Particulate (PM_{10}) emissions from stacks	Priority Flora / Native Vegetation	Point source emissions to air	Potential suppression of vegetation photosynthetic and respiratory functions	No	Vegetation in an arid environment may have natural dust tolerance which is likely to prevent vegetation impacts. No further assessment required
	Kiln area	Contaminated stormwater Process solution leaks / spills	Soils, vegetation, groundwater	Direct discharge	Contamination of soils and potential seepage to groundwater. Degradation of vegetation.	No	Kiln area run-off channel will be relined with new HDPE liner to prevent ingress of contaminated water. This will be conditioned in the Works Approval. As part of regular workplace inspections, daily visual inspections will be carried out to check the integrity and capacity of containment structures and pipelines and for any evidence of over-topping or leaks. Quarterly groundwater quality monitoring to detect any possible leakage into groundwater. These Applicant controls will be conditioned.
Calcine TSF	Tailings surface	Dust	No residences or other sensitive receptors in proximity. Nearest sensitive land users are 22.5km away Vegetation	Air / wind dispersion	Potential suppression of vegetation photosynthetic and respiratory functions	No	Water trucks will be used to suppress dust from access tracks and other cleared areas as required. Vegetation in an arid environment may have natural dust tolerance which is likely to prevent vegetation impacts. No further assessment required.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
	Tailings storage cells	Overtopping of the tailings cells, discharging tailings	Vegetation adjacent to tailings cells	Direct discharge	Soil contamination inhibiting vegetation growth and survival	Yes	See Section 9.6
	Seepage	Leachate to groundwater	Groundwater dependent ecosystems	Infiltration through soils and groundwater	Groundwater mounding	Yes	See Section 9.7
			Groundwater dependent ecosystems, beneficial uses (stock watering)		Groundwater contamination	Yes	See Section 9.7
Non-metallic TSF	Tailings surface	Dust	Vegetation	Air / wind dispersion	Potential suppression of vegetation photosynthetic and respiratory functions	No	No receptors present No further assessment required.
	Tailings pipelines	Rupture of pipelines causing tailings to discharge to land	Vegetation adjacent to tailings pipeline alignment	Direct discharge	Soil contamination inhibiting vegetation growth and survival	Yes	See Section 9.8
	Tailings storage cells	Overtopping of the tailings cells, discharging tailings	Vegetation adjacent to tailings cells	Direct discharge	Soil contamination inhibiting vegetation growth and survival	Yes	See Section 9.8
	Seepage	Leachate to groundwater	Groundwater dependent ecosystems	Infiltration through soils	Groundwater mounding	Yes	See Section 9.9

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
			Groundwater dependent ecosystems, beneficial uses (stock watering)	and groundwater	Groundwater contamination	Yes	See Section 9.9
WRS 2 Inert Landfill	Equipment movement over unsealed areas	Dust	No residences or other sensitive receptors in proximity. Nearest sensitive land users are 22.5km away Vegetation	Air / wind dispersion	Health / amenity Potential suppression of vegetation photosynthetic and respiratory functions	No	No nearby receptor present. Dust emissions at the landfill are not expected to be significant as it will be used only during the period of demolition and construction period of the project and no trenches are to be dug. No further assessment required
	Equipment movement in waste deposition	Noise	No residences or other sensitive receptors in proximity. Nearest sensitive land users are 22.5km away	Air / wind dispersion	Health / amenity	No	No nearby receptor present and the WRS 2 Inert Landfill will only be used during the construction period of this Works Approval. The Applicant will manage noise to meet the requirements of the *Environmental Protection (Noise) Regulations 1997*

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
	Deposited waste that is not yet covered	Windblown waste	Surrounding terrestrial environment (flora, fauna)	Air / wind dispersion	Fauna attraction / entrapment / entanglement Flora covering affecting photosynthesis	No	Landfill is only to be used during the demolition and construction period of the project. No fencing around the facility as it is within an existing waste rock dump and the dumping area is enclosed by large boulders making it inaccessible to stock animals in the area. As the WRS 2 is in an active area of the project, flora and fauna are not expected to be common in this area. Materials to be placed in the facility are heavy and bulky and are not susceptible to becoming windblown. Regular covering is not proposed by the Applicant. The Applicant is proposing to cover the landfill to a depth of over 20 m once the waste dump reaches its design capacity. Embankment angles and the waste rock material that is dumped will be managed to ensure the required level of stockpile stability is achieved.
	Deposited waste in the WRS 2	Leachate	Soils and groundwater	Infiltration, particularly during rainfall events	Contamination to groundwater	No	Groundwater is estimated to be approximately 20 – 40 mbgl and underlying geology is expected to be gabbro, with few fractures and low hydraulic conductivity. The tipping face used to dispose of materials into the landfill area will have a bund built along its length to prevent stormwater flows from the catchment above entering the landfill facility.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
New Village Temporary Aerobic WWTP 62m^3/day	Treatment of sewage	Odour	No residences or other sensitive receptors in proximity. Nearest sensitive land users are 22.5km away	Air / wind dispersion	None	No	No nearby receptor present
	Sewage pipes and holding tanks	Rupture of pipes / overtopping of holding tanks resulting in sewage discharge to land	Vegetation adjacent to discharge area	Direct discharge	Soil contamination inhibiting vegetation growth and survival	Yes	See Section 9.10
	Irrigation of treated effluent to the existing Village WWTP irrigation area	Treated effluent to land (potentially elevated in Total Nitrogen, Total Phosphorus, *E.coli*, TSS, BOD)	Native flora, fauna, and stock	Direct discharge	Impacts to the health of native flora, fauna, and stock	Yes	See Section 9.11

9.2 Consequence and likelihood of risk events

A risk rating will be determined for risk events in accordance with the risk rating matrix set out in Table 16 below.

Table 16: Risk rating matrix

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

DWER will undertake an assessment of the consequence and likelihood of the Risk Event in accordance with Table 17 below.

Table 17: Risk criteria table

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

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

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

"onsite" means within the Prescribed Premises boundary.

9.3 Acceptability and treatment of Risk Event

DWER will determine the acceptability and treatment of Risk Events in accordance with the Risk treatment Table 18 below:

Table 18: Risk treatment table

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

9.4 Risk Assessment – Emissions from the Deammoniation Kiln

9.4.1 Description of Emissions from the Deammoniation Kiln

Ammonia, NOx, vanadium pentoxide and trace concentrations of hydrogen chloride are produced in the V_2O_5 Deammoniator that processes Ammonium Meta-Vanadate (AMV) precipitation solids in the deammoniation kiln, oxidising AMV at 550^{o}C. The AMV decomposes, driving off the ammonia gas, leaving a V_2O_5 powder product. Hydrogen chloride is also generated in the kiln from reaction with remaining ammonia chloride in the AMV feed. Gas combustion generates NOx emissions.

9.4.2 Description of potential adverse impact from the emission

Potential health impacts associated with ammonia exposure include irrigation to eyes, throat and nose, breathing difficulties and chest pain.

NOx emissions may cause acute and chronic impacts on vegetation, creating acidic conditions.

Vanadium particulates may impact on vegetation health, bioaccumulate in plants and thereby impact on grazing animals (Aihemaiti, A., *et al,* 2017). Plants in metal-enriched soil take up metal ions to varying degrees; this uptake is highly plant specific and largely influenced by metal bioavailability (e.g. soil pH, cation exchange capacity, organic matter content).

The geochemistry of vanadium is complex. Vanadium has a high affinity to oxygen and forms both stable oxyanions and oxycations (Wright, M.T., *et al* 2014). Vanadium emissions deposited in soils can migrate to groundwater table after rainfall events affecting groundwater quality (Mejia, J.A., *et al* 2007).

9.4.3 Identification of the expected emissions and criteria for assessment

Relevant reference criteria is as listed in Table 19 below. Modelling conducted in 2007 has been utilised as a guide in the absence of any current emissions data and was based on a flowsheet similar to that proposed in the current works approval application (previously used at Windimurra from 1999 – 2003; Umwelt, November 2019) with the exception of vanadium, which is an estimate based on soluble concentrations in TSP monitored in the period 2011 - 2013. It should be noted that the current proposal has an increased processing throughput of 4.45Mtpa, from 3.9Mtpa.

Table 19: Relevant DWER Air Emissions Guideline Criteria (Draft) (DWER 2019)

Emission	Draft Ambient Air Concentration Guideline Value (DWER 2019) at 0°C	Averaging period	Modelled concentrations converted to the averaging period (SKM 2007 in Umwelt, June 2019)
NH_3	330 µg/m^3	1 hour	26 µg/m^3
NO_x	246 µg/m^3	1 hour	42 µg/m^3
Vanadium	1 µg/m^3	24 hours	0.02 µg/m^3 [1]
Hydrogen chloride	140 µg/m^3	1 hour	1.3 µg/m^3

Note 1: Vanadium estimate taken from soluble vanadium analysed from ambient TSP particulate monitored at the accommodation village during 2011 – 2013. Unlikely to be directly relevant to expected emission rates.

9.4.4 Applicant controls

Two scrubbers will treat the offgas from the kiln: a venturi scrubber to collect the particulate (including vanadium), and a dilute acid (sulphuric) scrubber with pH measurement and control to collect the NH_3. The scrubbers will be designed to emit <30 mg/Nm^3 particulates and <100mg/Nm^3 NH_3 (Umwelt, November 2019).

The Applicant has also committed to undertaking an air quality assessment as part of the detailed design for the project. A screening analysis will be completed for all criteria pollutants and if deemed necessary dispersion modelling will be completed to determine the expected ground level ambient concentrations for both normal and upset operating conditions (Umwelt, November 2019). A monitoring verification program will be conducted during the commissioning phase to check that the emissions are as per the air quality assessment and that gas cleaning systems are functioning as designed (Umwelt, November 2019).

9.4.5 Consequence and Likelihood

The results from the Air Quality Assessment (SKM, 2007) data for NH_3 emissions from the deammoniator kiln (1.04 g/s emitted at a 35m stack height) for an averaging period of 3 minutes. From the Victoria EPA, the ambient air quality criteria for ammonia is 600µg/m^3. The area of greatest concentration is located near the stacks. In this area, the maximum concentration is seen to be approximately 326µg/m^3 which is approximately 54% of the air quality criteria concentration contours for ammonia, thus is well below the criteria.

Noting the lack of current data as to the expected emission, but considering that the off gas cleaning system will be designed as per the criteria, the consequence of the air emissions from the Deammoniation Kiln impacting on vegetation is as follows:

- NH_3**: minor and unlikely**
- NO_x: **minor and unlikely**

- Vanadium: **slight and unlikely**
- Hydrogen chloride: **slight and unlikely**

Following revision and update of the modelling information during the works approval construction period, these risk ratings may be revised.

9.4.6 Overall rating of Emissions from the Deammoniation Kiln

The preliminary (subject to further confirmation in the works approval detailed design and construction period) overall ratings for the risk of emissions from the Deammoniation Kiln is as follows:

- NH_3: **medium**
- NO_x: **medium**
- Vanadium: **low**
- Hydrogen chloride: **low**.

9.5 Risk Assessment – Vanadium pentoxide emissions from the Fusion Furnace, Flaking Wheel and Product Packaging

9.5.1 Description of emissions

V_2O_5 powder produced from the deammoniation kiln is transferred to a storage bin and fed into the gas fired refractory lined Fusion Furnace, which operates at approximately 700^oC to produce molten V_2O_5. The molten product exits the Fusion Furnace onto a water cooled rotating Flaking Wheel, which solidifies the molten stream into a fused flake product. The cooled flake is transferred to a storage bin and is packaged into either 205L drums or 1,000 kg bulka bags. V_2O_5 emissions may be generated from the Fusion Furnace, Flaking Wheel and packing operations.

9.5.2 Identification and general characterisation of emission

No specific data on expected emission rates from the fusion furnace, flaking wheel or packing operations were provided as part of the application.

Soluble vanadium in total suspended particulate (TSP) emissions recorded at the accommodation village during previous operations in 2011-2012 and 2012-2013 annual environmental reporting periods recorded a maximum concentration of 0.02 µg/m^3 (Umwelt, November 2019). It is noted that this data was based on a process plant configuration that included two reduction kilns and may not be directly applicable to the revised flowsheet, which is more similar to the configuration used by Xstrata from 1999 – 2003. Air dispersion modelling of the expected emissions from the Xstrata flowsheet did not include vanadium pentoxide (Umwelt, June 2019).

9.5.3 Description of potential adverse impact from the emission

Vanadium has toxic effects on humans, vegetation and fauna. Vanadium particulates may be deposited to soil and dependent on the extent of the contamination, leachate to groundwater may result in adverse groundwater quality (Mejia, J.A., *et al* 2007).

For soils, it has been known that vanadium inhibits soil microbiota at high concentrations, for example by inhibiting nitrogen mineralisation and nitrification at a V dose of approximately 250 mg V kg^{-1}. As for plants, early studies showed that ecotoxic effects usually started to appear at soil solution concentrations of 1–10 mg V L^{-1}, which is much higher than the dissolved V concentrations that usually occur in natural soils. Vanadium mainly accumulates in the roots, and there is a linear relationship between soil labile V and the root V concentration (Gustafsson, J.P.,

2019).

9.5.4 Criteria for assessment

The draft DWER Guideline: Air Emissions quotes an ambient air concentration guideline value of 1 µg/m^3 for vanadium, averaged over 24 hours (DWER 2019).

9.5.5 Applicant controls

The Applicant stated that there will be one baghouse servicing the fusion furnace, flaking wheel and product packaging station. The baghouse is an existing facility on site. The design efficiency for the baghouses is 99.9% removal of solids from the offgas (Umwelt, November 2019).

The Applicant has also committed to undertaking an air quality assessment as part of the detailed design for the project. A screening analysis will be completed for all criteria pollutants and if required, dispersion modelling will be completed to determine the expected ground level ambient concentrations for both normal and upset operating conditions (Umwelt, November 2019). A monitoring verification program will be conducted during the commissioning phase to check that the emissions are as per the air quality assessment and that gas cleaning systems are functioning as designed (Umwelt, November 2019).

9.5.6 Consequence

The consequence of Vanadium V_2O_5 particulate emissions on vegetation and cattle is considered to be **moderate**.

The consequence of V_2O_5 particulate emissions on groundwater is considered to be **minor**.

9.5.7 Likelihood of Risk Event

The likelihood of vanadium pentoxide impacting on vegetation and cattle is considered **rare**.

The likelihood of vanadium pentoxide impacting groundwater is considered **rare.**

9.5.8 Overall rating of Vanadium V_2O_5 emissions from the Refinery

The overall rating for the risk of vanadium V_2O_5 emissions impacting on vegetation and cattle is **medium**.

The overall rating for the risk of vanadium V_2O_5 emissions impacting on groundwater is **low.**

9.6 Risk Assessment –Overtopping of the CTSF, CTSF leachate pond or calcine storage reticulation sump

9.6.1 Description of Overtopping of the CTSF, CTSF leachate pond or calcine storage reticulation sump

Calcine tailings are produced as a result of water leaching of sodium vanadate from the kiln product in the Processing Plant Leach Vats. The liquid phase is pumped from the Leach Vats to the Refinery zone, leaving the solid phase, the calcine tailings. The tailings are excavated from the Leach Vats and disposed of in the CTSF. Calcine tailings are transferred from the Processing Plant Leach Vats via haul trucks so there are no pipelines involved. Calcine tailings are then paddock-dumped in the HDPE lined CTSF storage area where it is spread by a front-end loader.

The CTSF functions in a similar fashion to a heap leach with the calcine solids placed over the HDPE liner. Water is applied via rainfall and the CTSF dust suppression spray system. Solution that permeates through the stockpile is drained out and collected in a HDPE lined leachate pond from which it is pumped by collection pumps to the CTSF reticulation pond / sump. The solution

is re-utilised by spraying it back over the CTSF via the CTSF dust suppression system. This continuous wetting of the stockpile is undertaken to avoid wind dispersion of dust. The circulating solution is periodically analysed for vanadium content and, when the concentration is sufficiently high, the solution is pumped back to the leach vats for recovery of the vanadium through the refinery. Both storages are lined with 1mm HDPE, installed in 1999.

Due an updated rainfall amount for the 1% AEP, 72 hour rainfall event since the time of the original design (187mm compared to the original design of 165mm) there is potential for both the CTSF leachate pond and calcine storage reticulation sump to overtop in extreme rainfall events (Umwelt, November 2019).

9.6.2 Identification and general characterisation of emission

CSTF leachate pond results for 2017/2018 are presented in Table 20. The elements shown in red - Arsenic, Boron, Chromium, Fluoride, Molybdenum, pH, Selenium, Sulfate, TDS, Uranium and Vanadium exceeded ANZECC Livestock drinking water quality guidelines. It is also important to note that oxalate levels range from 75 to 180mg/L.

Table 20: CTSF Leachate pond Waste Liquids Quality extracted from 2017/2018 AER

Parameter	Date of monitoring and analyte concentration (mg/L)				ANZECC Livestock guidelines (mg/L)
	31/10/2017	22/01/2018	30/04/2018	23/07/2018	
Aluminium	<2.5	1,000	<1	<1	5
Arsenic	39	18	24	19	0.5
Bicarbonate	<5	<5	<5	17,000	600
Boron	420	220	320	190	5
Calcium	<100	26	26	12	1,000
Chloride	110,000	6,700	-	100,000	4,800
Chromium	<0.5	13	<0.2	0.53	1
Cobalt	<0.5	<0.2	<0.2	<0.2	1
Copper	<0.5	-	-	<0.2	1
Fluoride	120	24	110	130	2
Iron	3.1	1.6	2.4	1.8	0.3
Lead	-	-	-	-	0.1
Magnesium	<50	<5	<10	<5	2,000
Manganese	<0.5	<0.2	<0.2	<0.2	5
Molybdenum	110	50	73	64	0.15
Nickel	<0.5	<0.2	<0.2	<0.2	1
Oxalate	180	75	120	130	-
Potassium	590	320	520	320	130
Selenium	3.3	1.4	2.4	2.1	0.02
Sodium	150,000	100,000	140,000	130,000	2,400
Sulfate	35,000	49,000	66,000	40,000	1,000
TDS	500,000	290,000	460,000	360,000	5,000
Uranium	<0.5	1.4	0.9	1.5	0.017
Vanadium	100,000	42,000	90,000	47,000	1.87
Zinc	<2.5	37.000	<1	<1	20

9.6.3 Criteria for assessment

Livestock animals and stygofauna found in the shallow aquifer are the closest receptors. The most appropriate assessment criteria is the ANZECC/ARMCANZ *Primary Industries – Rationale and Background Information* guidelines (ANZECC, 2000), which provides guidance for suitable drinking water qualities for livestock. In the absence of an ANZECC livestock guideline value for vanadium, South African guidelines (referenced in the ANZECC explanatory text) were used.

9.6.4 Applicant controls

This assessment has reviewed the controls set out in Table 21 below.

Table 21: Applicant's proposed controls for CTSF Pipeline Spills or CTSF Overtopping

Site infrastructure	Description	Operation details
CTSF Leachate Pond Calcine Storage Reticulation Sump	Stormwater runoff	Designed to contain run-off from a 72 hour duration, 1% AEP rainfall event; however November 2019 review of pond capacity has determined that the leachate pond may not have sufficient capacity to store this event (Umwelt November 2019).
	Freeboard	The CTSF stage 2 will be operated to maintain with a freeboard of 0.5m.
	Inspections	Daily inspections of embankment freeboards visually to confirm required freeboard capacity is available
	Integrity	Annual independent geotechnical audit

9.6.5 Consequence

If CTSF leachate pond overtopping occurs, then the Delegated Officer has determined that the impact of the discharge of parameters of high and medium concern according to Table 13 (Vanadium, Molybdenum, Selenium, Arsenic and TDS) will be mid-level onsite impacts (soil contamination with potential for groundwater contamination), with low level offsite impacts. Therefore, the consequence of overtopping of the CTSF and its ponds is considered to be **moderate**.

9.6.6 Likelihood of Risk Event

The likelihood of the CTSF and its ponds overtopping, resulting in soil/groundwater contamination will probably not occur in most circumstances. Therefore, the likelihood of overtopping of the CTSF to be **unlikely**.

9.6.7 Overall rating of CTSF and CTSF Ponds Overtopping

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 16) and determined that the overall rating for the risk of CTSF and its ponds overtopping is **medium**.

9.7 Risk Assessment – CTSF Seepage

9.7.1 Description of CTSF Seepage

As noted in Section 9.6 above, calcine tailings are produced as a result of water leaching of sodium vanadate from the kiln product in the Processing Plant Leach Vats and the CTSF functions as a heap leach to further leach soluble vanadium.

Although the facility is lined with a 1mm HDPE liner and the extended section included as part of this Works Approval will be lined with a dual GCL / 1.5 mm HDPE liner, the groundwater monitoring data in the vicinity of the CTSF is inconsistent with the assertion that the existing liner is providing an effective barrier. The CTSF monitoring bores have recorded increased concentrations of metals (selenium and vanadium) and salts (calcium, chloride, magnesium, sodium and sulphate) compared to baseline levels.

Table 22 shows the ambient groundwater monitoring in the vicinity of the CTSF from the 2017/2018 AER. Analytes above the ANZECC guideline for lifestock drinking water quality are shown in red. The main contaminants of concern are chloride, selenium, sulfate, TDS and vanadium. As mentioned previously, the average TDS at the Premises ranges from 1,500mg/L to 3,900mg/L (Umwelt, April 2017). The average TDS concentrations at CTMB2 and CTMB3 are 16,000mg/L and 10,000mg/L respectively. The results also indicate higher concentrations at CTMB2 and decreasing towards CTMB3, but lower at CTMB4.

Atlantic has indicated that groundwater flow from the plant area is the source of decreased groundwater quality detected at the CTSF (Umwelt, November 2019). However, based on monitoring bores location and results, this statement cannot be endorsed because if so, it would follow that CTMB4 should have higher salt concentrations than at CTMB3 and CTMB2.

Atlantic has stated that there have been minimal changes in surface water level underlying the HDPE lined waste CTSF, indicating that the HDPE liner continues to provide an effective barrier to water movement out of the containment facilities (Umwelt, April 2017). However, the facility has not been operational for a number of years and further assurance of the integrity of the liner is required.

9.7.2 Identification and general characterisation of emission

As noted in Section 9.6, the 2017/2018 AER provides data on the waste liquids onsite, including the CTSF Leachate pond. Parameters that are most elevated in the leachate are vanadium (maximum 100,000mg/L), TDS (maximum 500,000mg/L), sulfate (maximum 66,000mg/L), selenium (maximum 3.3mg/L), molybdenum (maximum 110,000mg/L), arsenic (maximum 39mg/L), boron (maximum 420mg/L), fluoride (maximum 130 mg/L) as shown in Table 20.

9.7.3 Description of potential adverse impact from the emission

Deterioration of groundwater quality. Parameters of concern are molybdenum, selenium, arsenic and TDS.

9.7.4 Criteria for assessment

Stock animals and stygofauna found in the shallow aquifer are the closest receptors. The most appropriate assessment criteria is the ANZECC/ARMCANZ *Primary Industries – Rationale and Background Information* guidelines (ANZECC, 2000), which provides guidance for suitable drinking water qualities for stock animals. It should be noted though that the ANZECC guidelines themselves do not set stock drinking water guidelines around Vanadium concentrations; for this, South African guidelines referenced in the ANZECC explanatory text were used instead.

Table 22: CTSF Ambient Groundwater Monitoring Results extracted from 2017/2018 AER

Parameter	Date of monitoring and result (mg/L)																Livestock guidelines (mg/L)
	CTMB1				CTMB2				CTMB3				CTMB4				
	31/10/17	22/01/18	30/04/18	23/07/18	31/10/17	22/01/18	30/04/18	23/07/18	31/10/17	22/01/18	30/04/18	23/07/18	31/10/17	22/01/18	30/04/18	23/07/18	
Aluminium	<0.025	0.048	<0.025	<0.01	<0.025	<0.025	<0.025	<0.025	0.005	<0.025	<0.025	<0.005	<0.005	0.028	<0.005	0.005	5
Arsenic	<0.005	<0.001	<0.005	<0.002	<0.005	<0.005	<0.005	<0.005	0.003	<0.005	<0.005	0.003	0.002	0.001	0.001	0.001	0.5
Bicarbonate	140	140	140	130	200	210	210	190	220	230	230	220	240	240	230	220	600
Boron	1.9	1.9	1.7	1.7	2.8	2.5	1.8	1.9	2.0	1.5	1.3	1.4	0.7	1.3	0.98	0.99	5
Calcium	1,100	670	1,200	1,200	3,300	3,900	2,600	2,700	1,800	2,100	1,700	1,700	1,100	1,100	950	920	1,000
Chloride	4,000	3,300	3,700	3,500	9,300	9,500	8,400	8,800	5,100	4,700	4,700	4,400	2,900	2,900	2,800	2,800	4,800
Chromium	<0.005	0.002	<0.005	0.003	<0.005	<0.005	<0.005	<0.005	0.001	<0.005	<0.005	0.001	0.005	<0.001	<0.001	<0.001	1
Cobalt	<0.005	<0.001	<0.005	<0.002	<0.005	<0.005	<0.005	<0.005	<0.001	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	1
Copper	<0.005	0.002	<0.005	<0.002	<0.005	<0.005	<0.005	<0.005	0.004	<0.005	<0.005	0.004	0.016	0.002	0.002	0.002	1
Fluoride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	2
Iron	<0.025	0.006	<0.025	<0.01	<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.025	<0.005	2.9	<0.005	<0.005	<0.005	0.3
Lead	<0.005	<0.001	<0.005	-	<0.005	<0.005	<0.005	-	<0.001	<0.005	<0.005	-	0.002	<0.001	<0.001	-	0.1
Magnesium	510	340	590	590	1,300	1,200	1,100	1,100	620	620	600	580	420	380	340	330	2,000
Manganese	<0.005	<0.001	0.008	<0.002	0.054	0.069	0.013	0.070	0.002	<0.005	<0.005	0.001	0.041	0.004	0.007	0.015	5
Molybdenum	<0.005	0.002	0.016	<0.002	0.019	0.018	0.022	0.015	0.009	0.007	0.007	0.011	<0.001	0.001	0.001	0.001	0.15

Nickel	0.007	0.009	0.012	0.008	0.079	0.075	0.043	0.084	0.007	0.008	0.007	0.006	0.043	0.052	0.040	0.040	1
Parameter	**Date of monitoring and result (mg/L)**																**Livestock guidelines (mg/L)**
	CTMB1				**CTMB2**				**CTMB3**				**CTMB4**				
	31/10/17	**22/01/18**	**30/04/18**	**23/07/18**	**31/10/17**	**22/01/18**	**30/04/18**	**23/07/18**	**31/10/17**	**22/01/18**	**30/04/18**	**23/07/18**	**31/10/17**	**22/01/18**	**30/04/18**	**23/07/18**	
Oxalate	<1.0	<1.0	<0.1	-	<1.0	<1.0	<0.1	-	<1.0	<1.0	<0.1	-	<1.0	<1.0	<0.1	-	-
Potassium	7.20	6.50	8.00	7.60	7.50	7.20	7.30	6.70	7.60	7.20	7.60	7.50	5.80	5.50	5.60	5.20	130
Selenium	0.024	0.015	0.026	0.025	0.024	0.024	0.022	0.023	0.012	0.015	0.014	0.013	0.010	0.008	0.010	0.009	0.02
Silicon	18	17	18.00	-	39	36	37.00	-	35	36	37.00	-	31	29	29.00	-	
Sodium	1,000	640	1,100	1,100	690	620	570	580	470	410	450	470	300	290	290	280	2,400
Sulfate	1,700	1,100	1,700	1,800	1,900	1,800	1,700	1,700	1,100	1,100	1,100	1,100	870	7701	740	710	1,000
TDS	8,500	5,700	10,000	11,000	17,000	17,000	16,000	15,000	10,000	10,000	10,000	9,200	6,400	6,100	5,600	4,700	5,000
Uranium	<0.005	0.002	<0.005	<0.002	0.006	0.007	0.006	<0.005	0.009	0.008	0.007	0.007	0.010	0.009	0.008	0.007	0.017
Vanadium	0.037	0.087	0.190	0.037	1.000	1.200	1.000	0.900	2.000	2.100	1.800	2.000	0.033	0.041	0.042	0.026	1.87
Zinc	<0.025	0.010	<0.025	<0.01	<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.025	<0.005	0.049	<0.005	0.025	<0.005	20
pH	7.47	7.31	7.16	6.95	7.24	6.82	7.08	6.75	6.98	6.58	6.83	6.65	7.30	6.81	7.08	7.06	-

9.7.5 Applicant controls

This assessment has reviewed the controls set out in Table 23 below.

Table 23: Applicant's proposed controls for CTSF Seepage

Site infrastructure	Description	Operation details
CTSF	Existing lining	Lined to achieve a permeability of 10^{-9} metres per second or less - facility has a 1 mm HDPE liner.
	New lining	Lined to achieve a permeability of 10^{-9} metres per second or less - extension to facility will have a secondary geosynthetic clay liner (GCL) overlain by a primary 1.5 mm HDPE liner. Baseline soil sampling to be taken prior to installation of the new lining. Any contaminated soil detected outside of the lined CTSF will be removed and placed into the lined CTSF.
	Groundwater monitoring	Groundwater monitoring is conducted in the vicinity of the CTSF at groundwater monitoring bores CTMB1, CTMB2, CTMB3 and CTMB4

9.7.6 Key findings

The Delegated Officer has reviewed the information regarding CTSF Seepage and has found:

1. *The information provided to date does not confirm integrity of the existing liner.*

9.7.7 Consequence

If CTSF seepage occurs, then the Delegated Officer has determined that the impact of the discharge of parameters of high and medium concern according to Table 13 (molybdenum, selenium, arsenic and TDS) will be mid-level onsite impacts, with low level offsite impacts. Therefore, the Delegated Officer considers the consequence of CTSF seepage to be **moderate**.

9.7.8 Likelihood of Risk Event

The Delegated Officer has determined that CTSF seepage could probably occur at some time. Therefore, the Delegated Officer considers the likelihood of CTSF seepage to be **possible**.

9.7.9 Overall rating of CTSF Seepage

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 16) and determined that the overall rating for the risk of CTSF seepage is **medium**.

9.8 Risk Assessment – Pipeline Spills and Overtopping of the NMTSF

9.8.1 Description of NMTSF Pipeline Spills or Overtopping of the NMTSF

Non-magnetic tailings are produced as waste from the beneficiation process and are

transported to the NMTSF via tailings pipelines (Umwelt, June 2019). Table 24 shows the historical characterisation of the NMTSF leachate composition.

Table 24: Indicative Properties of Water Extracts from NMTSF Tailings

Parameter	Water extracts from NMTSF solids – 2005 (mg/L)	Tailings Pond 1 – 2007 (mg/L)
Aluminium	0.14	0.13
Antimony	0.00002	-
Arsenic	0.0032	<0.1
Barium	0.012	-
Bicarbonate	30	240
Bismuth	0.000044	-
Boron	0.25	37
Cadmium	-	<0.005
Calcium	99	2,200
Carbonate	-	<1
Chloride	670	139,000
Chromium	-	<0.001
Cobalt	0.0003	-
Copper	-	0.075
Fluoride	0.5	-
Iron	0.46	<0.05
Lead	-	<0.1
Magnesium	46	7,200
Manganese	0.02	-
Molybdenum	0.00084	<0.03
Nickel	-	0.013
Nitrate	1.4	<4
pH	7.6	-
Phosphorus	0.1	-
Potassium	6.8	1,500

Selenium	0.011	<0.1
Silver	0.00008	-
Sodium	370	68,000
Strontium	0.44	-
Sulfate	340	8,600
Thallium	0.00001	-
Thorium	0.000027	-
TDS	1,600	232,000
Uranium	0.000029	-
Vanadium	0.02	0.56
Zinc	-	0.21

9.8.2 Description of potential adverse impact from the emission

A release of tailings to ground outside containment will result in soil contamination and potentially deterioration of groundwater quality, depending on the scale of the release. The parameters of concern are boron, sulfate, selenium and TDS.

9.8.3 Criteria for assessment

Livestock animals and stygofauna found in the shallow aquifer are the closest receptors. The most appropriate assessment criteria is the ANZECC/ARMCANZ *Primary Industries – Rationale and Background Information* guidelines (ANZECC, 2000), which provides guidance for suitable drinking water qualities for livestock. In the absence of an ANZECC guideline value for vanadium the South African guidelines (referenced in the ANZECC explanatory text) are used.

9.8.4 Applicant controls

This assessment has reviewed the controls set out in Table 25 below.

Table 25: Applicant's proposed controls for loss of containment of the NMTSF or tailings pipelines

Site infrastructure	Description	Operation details
NMTSF (Cells 1 -3)	Stormwater runoff	Designed to contain run-off from a 72 hour duration, 100 year rainfall event.
	Freeboard	A total freeboard of 0.5 m and a limiting height of 1.6 m between the lowest point on the tailings beach and each stage crest elevation have been included in the design.
	Inspections	Daily inspections of embankment freeboards visually to confirm required freeboards capacity is available
	Integrity	Annual independent geotechnical audit.

Site infrastructure	Description	Operation details
Pipelines	Inspections	Daily inspections of tailings pipelines and facility features for visual integrity
	Sensors	Equipped with telemetry systems and pressure sensors along pipelines to allow the detection of leaks and failures Equipped with automatic cut-outs in the event of a pipe failure Provided with secondary containment sufficient to contain any spill for a period equal to the time between inspections.

9.8.5 Consequence

If the NMTSF's freeboard is breached and overtopping occurs, then the impact of the tailings discharge with elevated concentrations of contaminants (boron, selenium, sulfate and TDS) will be mid-level onsite impacts, with low-level offsite impacts. Therefore, the consequence of NMTSF overtopping is considered to be **moderate**.

If the NMTSF tailings delivery or return pipelines fail such that tailings are released outside containment the consequence will be mid-level onsite impacts, with low-level offsite impacts, **moderate** consequence.

9.8.6 Likelihood of Risk Event

The Delegated Officer has determined that the likelihood of overtopping of the NMTSF resulting in groundwater quality deterioration occurring will probably not occur in most circumstances. Therefore, the likelihood of overtopping of the NMTSF to be **unlikely**.

The likelihood of pipeline failures resulting in spills that cause a decrease in groundwater quality is **unlikely**.

9.8.7 Overall rating of NMTSF Leaks and Spills or Overtopping

Given the consequence and likelihood ratings described above, the overall rating for the risk of NMTSF overtopping is **medium** and that of pipeline spills is **medium**.

9.9 Risk Assessment – NMTSF Seepage

9.9.1 Description of NMTSF Seepage

Existing evidence shows that seepage was encountered at the downstream area of Cell 3 at commencement of deposition from the valley embankment. Seepage can also be confirmed by groundwater monitoring results presented in AERs from 2000 to 2018.

The analysis of the predominant ions that contribute to total dissolved solids (TDS) in groundwater around NMTSF show that monitoring bore TSMB8 has TDS ten times above the surrounding bores. In quarter 1 (Q1) 2000, the TDS value in TSMB8 was 1,600mg/L, all the other bores around the NMTSF had TDS values between 350 to 2,100mg/L. After Q3 2001, TDS values in TSMB8 started to increase but TDS concentration in the other bores did not change. From Q1 2000 to Q2 2018 TDS concentration in TSMB8 increased from 1,600 to 14,000mg/L. All the other bores remained almost constant below 4,000mg/L (Figure 15). When operations started in 1999, TDS in groundwater around the site ranged from 400 to 2,400mg/L. It indicates that the NMTSF lining system close to TSMB8 is compromised.

Other elements are also much higher at TSFMB8 (calcium, chloride, magnesium, selenium and

sulfate) when compared to other monitoring bores around the NMTSF. Sulfate in TSMB8 has increased 20 times since operation started.

Figure 15 and 16 present TDS and sulfate concentration at NMTSF monitoring bores (TSMB1 to TSMB10) between year 2000 and 2018.

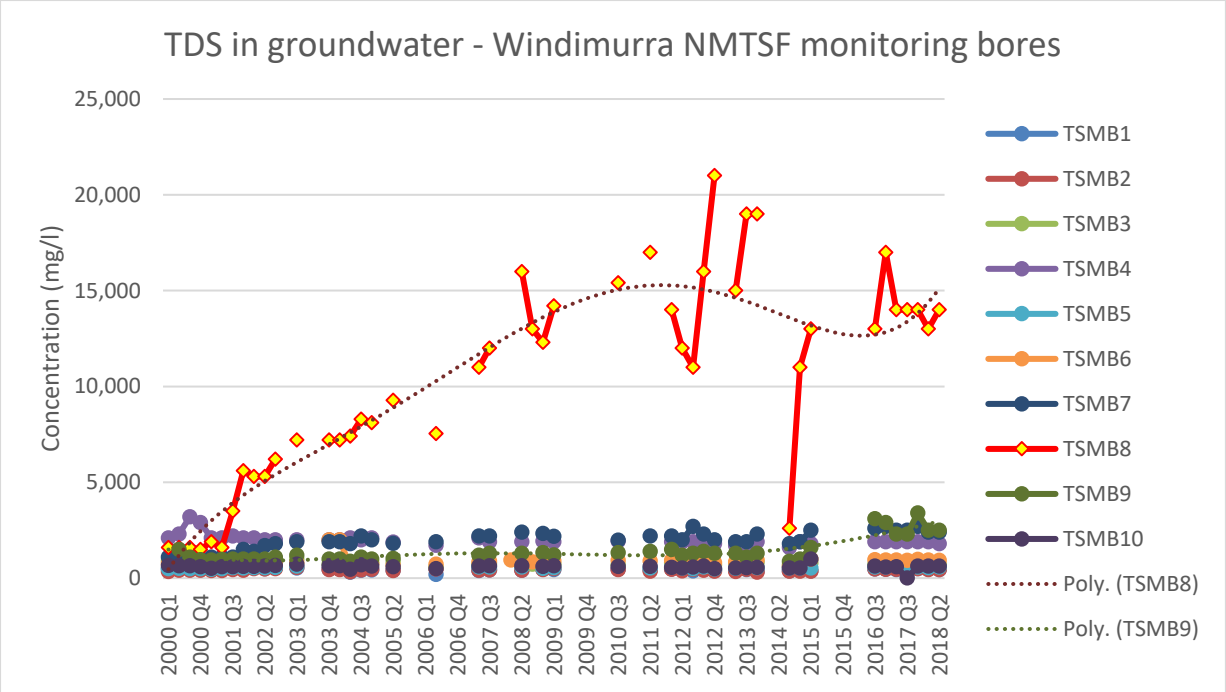


Figure 15: TDS concentration on NMTSF monitoring bores between 2000 and 2018.

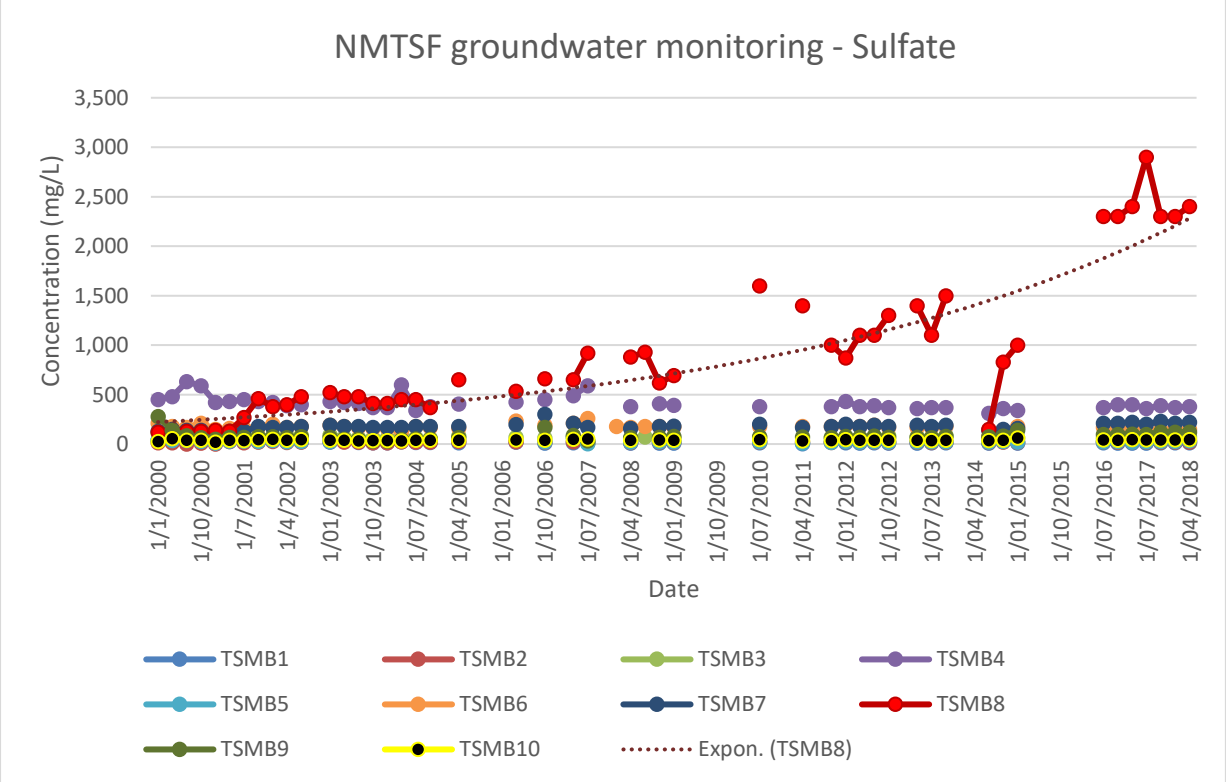


Figure 16: Sulfate concentration on NMTSF monitoring bores between 2000 and 2018.

Leaching Environmental Assessment Framework (LEAF) tests have been conducted on samples representative of the non-magnetic tailings and the metals that are present at relatively high abundance in the tailings using leaching solution between pH 4 – 10.5. The test was performed with the 0.3mm fraction of the tailings. The fine fraction of the tailings, more than 50% of the particle size distribution (Table 26), was not tested.

Table 26: Tailings geotechnical characterisation

Test item	Oxide Tailings	Fresh Tailings	50/50 Blend
Solids concentration for slurry preparation (%)	42.1 - 44.1	66.3 - 68.3	-
Particle Size - <% 600 µm	98.7	95.7	
- <% 200 µm	86	65	
- <% 75 µm	77.4	46.3	-
- <% 2 µm	32	8.7	
- P_{80}	100µm	500µm	

The results indicate that the coarse fraction of the oxide and blend tailings have higher leaching potential than fresh rock tailings. Tailings exposed to acidic conditions (pH <4) will release cobalt, iron, aluminium and manganese. When the test sample was exposed to alkaline conditions (pH >10.5), vanadium, selenium and aluminium were present in the leachate (Umwelt, June 2019).

9.9.2 Identification and general characterisation of emission

Selenium, sulfate, TDS and Vanadium are the contaminants of concern relevant to the non-magnetic tailings waste stream.

9.9.3 Description of potential adverse impact from the emission

Deterioration of groundwater quality if deposition recommences in the proposed Cell 3.

9.9.4 Criteria for assessment

ANZECC Guidelines – Livestock drinking water quality.

9.9.5 Applicant controls

This assessment has reviewed the controls set out in Table 27 below.

Table 27: Applicant's proposed controls for NMTSF Seepage

Site infrastructure	Description	Operation details
NMTSF	Permanent seepage trenches	Seepage interception trench downstream of the cross-valley embankment Cell 3 with a maximum depth of 3m.
	Temporary seepage trench	Prior to tailings deposition into Cell 2, a Temporary seepage trench will be constructed within Cell 2, at the north eastern end, approximately 150m away from the sodium oxalate discharge area and trench. This will enable any seepage that may occur during the initial deposition of tailings into Cell 3 to be captured. It will intercept any seepage so that it doesn't interact with the sodium oxalate material recovery process. The Temporary seepage trench will not be required once Cell 2 becomes operational and will be covered

Site infrastructure	Description	Operation details
		with tailings as they are discharged.
	Groundwater monitoring	Groundwater monitoring is conducted in the vicinity of the NMTSF at groundwater monitoring bores TSMB1, TSMB7, TSMB8 and GETB4

9.9.6 Key findings

The Delegated Officer has reviewed the information regarding NMTSF Seepage and has found:

1. *The other monitoring bores around the NMTSF show TDS values 10 times lower than at TSMB8.*
2. *Elevated levels of TDS at TSMB8 indicate that the NMTSF close to proposed Cell 3 is not performing as designed.*
3. *The NMTSF Cell 3 does not currently provide adequate containment and additional works will not collect the main seepage flow at the cross-valley embankment (only near surface seepage) adjacent to TSMB8.*

9.9.7 Consequence

The impact of NMTSF seepage on groundwater quality due to the discharge of parameters of high concern according to Table 22 (Selenium and TDS) will be **moderate**.

9.9.8 Likelihood of Risk Event

The Delegated Officer has determined that NMTSF seepage such that groundwater quality is adversely affected could occur. Therefore, the likelihood of NMTSF seepage is considered to be **possible**.

9.9.9 Overall rating of NMTSF Seepage

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 16) and determined that the overall rating for the risk of NMTSF seepage is **medium**.

9.10 Risk Assessment – Leaks and Spills from the New Village Temporary WWTP Pipelines and Tanks

9.10.1 Description of WWTP Leaks and Spills

The existing WWTP onsite is 62m^3/day aerobic system is designed for 200 persons in full residence and an effluent generation rate of 310L/person/day. Treated wastewater is irrigated to a sprayfield on a campaign or batch basis, with a design average total residence time at maximum capacity, of 24 hours.

An additional Temporary WWTP of 66m^3/day capacity is proposed by the Applicant to be used during the construction phase, for approximately six months. The Temporary WWTP will be installed adjacent to the existing WWTP and operated in parallel with the Existing WWTP. Sewage will be distributed to each WWTP through a balance tank.

9.10.2 Identification and general characterisation of emission

Wastewater at several stages of treatment has the potential to be discharged. This may be influent and/or effluent.

Table 28 shows the effluent quality at the Existing WWTP and the expected effluent quality at the Temporary WWTP. All parameters, meet the relevant criteria *National Water Quality Management Strategy Australian Guidelines for Sewerage Systems Effluent Management, 1997,* aside from the TSS, which is slightly elevated over the guidelines. The Applicant is not proposing to monitor *E.coli*.

9.10.1 Description of potential adverse impact from the emission

Adverse impacts to vegetation and soils could potentially occur in the direct vicinity of the where leaks or spills have occurred from the increased nutrient-rich water. This may include increased growth of vegetation and invasive week species.

The nearest ephemeral floodway is 100 m away so impacts to surface water are not expected.

The estimated depth to groundwater at the accommodation village and irrigation areas is 20 – 25 mbgl; hence infiltration and contamination of groundwater is not expected.

9.10.2 Criteria for assessment

National Water Quality Management Strategy Australian Guidelines for Sewerage Systems Effluent Management, 1997.

Table 28: Existing WWTP and Temporary WWTP Effluent Quality

Parameter	Monitored from existing licensed WWTP, typical range during operations	Proposed standards for short-term increase to production capacity for WWTP (Temporary WWTP)	National Water Quality Management Strategy Australian Guidelines for Sewerage Systems Effluent Management, 1997.	Proposed monitoring program
Treatment process	Aerobic treatment unit with sequencing batch reactor form of extended aeration activated sludge with separate anoxic denitrification zone	Minimum secondary treatment process with disinfection	Secondary Treatment	Daily operational check and log sheet, including checking for leaks, activated alarms and tank levels. Weekly operational check including inspection for pooling of water and check of sludge volumes.
Discharge volume	10 – 50 m^3/day	152 m^3/day (total)	-	Flow totaliser, daily readings
Biochemical oxygen demand (BOD)	8 – 180 mg/L Average <25 mg/L	10 – 30 mg/L	20 - 30 mg/L	Quarterly using on-site field kit, as not practical to meet holding time requirements for lab analysis
Total suspended solids (TSS)	10 – 830 mg/L Average <100 mg/L	22 – 60 mg/L	25 - 40 mg/L	Quarterly sample for laboratory analysis at a NATA accredited lab
Total nitrogen	5 – 50 mg/L Average <30 mg/L	10 – 30 mg/L	20 – 50 mg/L	Quarterly sample for laboratory analysis at a NATA accredited lab
Total phosphorus	0.1 – 7.6 mg/L Average <5 mg/L	1 – 8 mg/L	6 – 12 mg/L	Quarterly sample for laboratory analysis at a NATA accredited lab
E. coli	<1 – 370,000 cfu/100mL Average <10 cfu/100mL	< 100 cfu/100mL	10^5 – 10^6 org/100mL	Not required as low risk of human access. Not practical to meet short holding time requirements and no onsite test kit. Chlorination level monitored to ensure sufficient disinfection.
Chlorination level	8 – 20 mg/L	0.2 – 2.0 mg/L (minimum)	-	Quarterly using on-site field kit, as residual (free) chlorine dissipates rapidly and is required to be tested in the field.

9.10.3 Applicant controls

This assessment has reviewed the controls set out in Table 29 below.

Table 29: Applicant's proposed controls for WWTP Leaks and Spills

Site infrastructure	Description	Operation details
Temporary WWTP	• Located 100 metres from the ephemeral floodway; • Situated above ground on skids or a trailer or similar, which will prevent inflow of clean stormwater to the temporary WWTP; • Include an alarm system, which includes audible alarms and flashing lights for high tank levels and pump faults. The alarm system will be similar to the existing WWTP • Tanks will be sized so that recirculating anoxic buffer tank is only 40% full in typical operating conditions. The residual volume of the tank provides a buffer for digestion and settlement of material as well as a buffer to retain material in the event of abnormal operating conditions. The total tank volume is likely to be approximately 32 m^3, providing approximately 0.25 days contingency storage if operated at peak capacity.	• The waste liquor is pumped from the anoxic buffer tank to the aeration/decant tank. The aeration/decant tank has a sensor to detect changes in volume. If a rising volume is detected in the aeration/decant tank prior to a preset "peak flow period", an additional settle/decant sequence is initiated in time to finish before the beginning of the designated peak inflow period; • Daily operational inspections will be undertaken to check for leaks, activated alarms and tank levels. Any leaks will be controlled and cleaned up as soon as practicable after they are detected. • Sludge volume is minimised in the WWTP design through extended aeration. Sludge levels are checked as part of the weekly inspection. When desludging is required, a tanker truck is brought to site and settled sludge is withdrawn from the Kamlock fittings on the tanks. The sludge will be removed and disposed only by a suitably licensed contractor.

9.10.4 Consequence

If WWTP leaks and spills occurs, then the Delegated Officer has determined that the impact of influent and/or effluent could result in mid-level onsite impacts, low level offsite impacts and the Specific Consequence Criteria for the environment are at risk of not being met. Therefore, the Delegated Officer considers the consequence of leaks and spills from the New Village Temporary Aerobic WWTP to be **moderate**.

9.10.5 Likelihood of Risk Event

The Delegated Officer has determined that the likelihood of leaks and spills from the Temporary Aerobic WWTP could occur at some time. The Applicant has also stated the no secondary bunding is proposed to be installed for the Temporary WWTP. Therefore, the Delegated Officer considers the likelihood of WWTP leaks and spills to be **possible**.

9.10.6 Overall rating of WWTP Leaks and Spills

The Delegated Officer has compared the consequence and likelihood ratings described above

with the risk rating matrix (Table 16) and determined that the overall rating for the risk of WWTP leaks and spills is **medium**.

9.11 Risk Assessment – Effluent Discharge to the Existing Village WWTP Irrigation Area from the New Village Temporary WWTP

9.11.1 Description of Effluent Discharge to the Existing Village WWTP Irrigation Area from the New Village Temporary Aerobic WWTP

The existing irrigation area onsite is approximately 0.9 hectares and consists of eight irrigation sprinklers in a fenced area, 70m from the accommodation village at the closest point. Each WWTP will then operate independently of each other and effluent discharged to two separate irrigation areas (the Existing WWTP will dispose of treated effluent to the existing irrigation area of 0.9ha).

The Temporary WWTP treated effluent will be discharged to a new extended irrigation area of 1.7ha. Treated wastewater will be irrigated to this sprayfield on a campaign or batch basis, with design average total residence time at maximum capacity of 24 hours.

The additional sprayfield will be located in a similar vegetation community to the existing sprayfield ("mulga scrub on plains).However, one priority species has been recorded in the vicinity of Accommodation Village (Figure 11). The soil type in this area has been described as red sandy loams to loamy sands, with patches of ironstone and calcrete pebbles. The closest known pastoral station well is approximately 4 km away. A floodway is located approximately 40 – 70 m away from the current sprayfield.

9.11.2 Identification and general characterisation of emission

Table 30 shows the effluent quality at the existing WWTP and the expected effluent quality at the Temporary WWTP. All parameters, meet the relevant criteria *National Water Quality Management Strategy Australian Guidelines for Sewerage Systems Effluent Management, 1997,* aside from the TSS, which is slightly elevated over the guidelines. The Applicant is not proposing to monitor *E.coli*.

Table 30 shows the loading rates of Total Nitrogen and Total Phosphorus for the Existing WWTP and the Temporary WWTP. The new Temporary WWTP will meet the preferred loading rates guidelines.

Table 30: Nutrient Loadings of Total Nitrogen and Total Phosphorus

Parameter	**Existing WWTP** **0.9 hectares** **62 m^3/day capacity**	**Temporary WWTP** **1.7 hectares** **66 m^3/day**	***Water Quality Protection Note 22, Irrigation with nutrient-rich wastewater, July 2008, Risk Category D***
Total Nitrogen kg/ha/yr	754.33	425.12	480
Total Phosphorus kg/ha/yr	201.16	113.36	120

9.11.3 Description of potential adverse impact from the emission

Adverse impacts to vegetation and soils could potentially occur in the direct vicinity of the irrigation area from the increased nutrient-rich water supply. This may include:

- poor health of priority 1 flora specimen

- soil saturation and nutrient overload;

- increased growth of vegetation and invasive week species; and/or

- attraction of fauna to pooling water.

The nearest ephemeral floodway is 100 m away so impacts to surface water are not expected.

The estimated depth to groundwater at the accommodation village and irrigation areas 20 - 25 metres below ground level. Thus, infiltration and contamination of groundwater is not expected.

9.11.4 Criteria for assessment

National Water Quality Management Strategy Australian Guidelines for Sewerage Systems Effluent Management, 1997 and Water Quality Protection Note 22, Irrigation with nutrient-rich wastewater, July 2008.

9.11.5 Applicant controls

This assessment has reviewed the controls set out in Table 31 below.

Table 31: Applicant's proposed controls for Effluent Discharge to the Existing Village WWTP Irrigation Area from the New Village Temporary Aerobic WWTP

Site infrastructure	Description	Operation details
Irrigation Area	• The additional sprayfield will be located at least 40 m away from the floodway (as with the current sprayfield) and the ground level in the sprayfield will be at least 1 m above the predicted water level in a 1 in 100 year, 72 hour flood event; • additional sprayfield will be located outside of the 25 m exclusion zone for the gas pipeline; • distance from the additional sprayfield to the accommodation village will be no closer than the current sprayfield, which is 70 m; • additional sprayfield will be sized at a minimum 1.7 ha; • additional sprayfield will be fenced and sign-posted to prevent direct access from personnel, unless required for maintenance and inspection purposes; and irrigation sprayfield will be located on flat land, with a gradient of less than 1:10.	• Irrigation to the sprayfield will typically be on a campaign basis to allow sufficient resident time in the WWTP for treatment.

9.11.6 Key findings

The Delegated Officer has reviewed the information regarding Effluent Discharge to the new irrigation area from the temporary WWTP and has found:

1. *The location of the priority 1 flora species is approximately 100m from the spray filed*

9.11.7 Consequence

If impacts from effluent discharge to the new temporary irrigation area affect Priority 1 Flora occurs the consequence **minor**.

9.11.8 Likelihood of Risk Event

The Delegated Officer has determined that the likelihood of impacts from effluent discharged to the new irrigation area will probably not occur in most circumstances. Therefore, the Delegated Officer considers the likelihood of effluent discharge to the new irrigation area to be **unlikely**.

9.11.9 Overall rating of effluent discharge for the new irrigation area

The Delegated Officer has compared the consequence and likelihood ratings described above with the risk rating matrix (Table 16) and determined that the overall rating for the risk of effluent discharge to the new irrigation area is **medium**.

10. Summary of acceptability and treatment of Risk Events, including Regulatory Controls

A summary of the risk assessment and the acceptability or unacceptability of the risk events set out above, with the appropriate treatment and control, are set out in Table 32 below.

Table 32: Risk assessment summary

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
1.a	Ammonia (NH_3)	Deammoniation Kiln	Direct to air deposition/contact with native vegetation including priority flora Chronic impacts to vegetation health	Two stage scrubbing system to collect particulate (vanadium) and ammonia emissions. No specific treatment system for NOx or HCl, however 2007 model indicated very low HCl emission concentrations (1% of criteria). NOx estimated to Revised air quality assessment model to be completed prior to commissioning to confirm ambient air ground level concentrations are less or similar to those estimated in 2007 model. Emission testing completed during commissioning phase to confirm that stack emissions meet design criteria	Minor consequence Unlikely likelihood **Medium risk**	Acceptable subject to regulatory and applicant controls	Works Approval: • A revised ambient air dispersion model will be required to be submitted prior to commissioning of the deammoniation kiln • Stack height and design criteria to meet the particulate emission concentration of 50 mg/m3 and an ammonia concentration of 0.6 mg/m3 over a 3 minute average • Sampling port to be installed on the exit stack compliant to AS4323.1 • Stack emissions testing shall be completed during environmental commissioning to verify compliance with design criteria Licence: • Ongoing monitoring of emissions will be required by
1.b	Nitrogen oxides (NOx)				Minor consequence Unlikely likelihood **Medium risk**	Acceptable subject to regulatory and applicant controls	
1 c	Vanadium pentoxide (V_2O_5)				Slight consequence Unlikely likelihood **Low risk**	Acceptable subject to regulatory and applicant controls	

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
							the licence; frequency and parameters to be determined following commissioning stack testing program
1.d	Hydrogen chloride (HCl) emissions				Slight consequence Unlikely likelihood **Low risk**	Acceptable	• Stack emissions testing shall be completed during environmental commissioning to verify compliance with design criteria Pending results, no further regulatory controls may be required.
2.a	Vanadium pentoxide emissions	Fusion Furnace, Flaking Wheel and Product Packaging	Point source emission to air resulting in deposition to soil, leaching to groundwater. Pastoral station groundwater bores	Fugitive dust collected Revised air quality assessment model to be completed prior to commissioning to confirm ambient air ground level concentrations are less or similar to those estimated in 2007 model.	Minor consequence Rare likelihood **Low risk**	Acceptable	• Stack emissions testing shall be completed during environmental commissioning to verify compliance with design criteria Pending results, no further regulatory controls may be required.

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
2.b			Point source emissions to air impacting on priority flora native vegetation	Emission testing completed during commissioning phase to confirm that stack emissions meet design criteria	Moderate consequence Rare likelihood **Medium risk**	Acceptable subject to proponent controls conditioned / outcomes based controls	Works Approval: As per risk events 1a – 1c.
3.	Calcine tailings, calcine tailings leachate elevated in metal(loid)s	Calcine TSF	Overtopping of the CTSF leachate pond or calcine storage reticulation pond during an extreme rainfall event; or Calcine tailings spillage during disposal to the CTSF; windblown tailings; and All resulting in soil/ groundwater contamination	Leachate ponds originally designed to contain run-off from a 72 hour duration, 100 year rainfall event (165mm event) however whether the ponds can contain the revised amount of 187mm is not known. The Applicant has committed to assessing the ponds capacity prior to recommissioning. The CTSF is designed with a freeboard of 0.5m Daily inspections of embankment freeboards visually to confirm required freeboards capacity is available Annual independent geotechnical audit	Moderate consequence Unlikely likelihood **Medium risk**	Acceptable with regulatory and applicant controls conditioned.	Works Approval: • Capacity of the leachate pond and calcine storage reticulation pond to be calculated and a maximum operating pond level determined to ensure that the both ponds can contain the expanded CTSF catchment and are operated with capacity to contain a 1% AEP rainfall event over 72 hours (187mm). • Pumping system for transferring leachate from the leachate pond to the process plant via the calcine storage reticulation sump tested and automatic pump operation activated by level controls for both the CTSF leachate pond and CTSF calcine storage reticulation sump. • Critical Containment Infrastructure report requirement.

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
							Licence: • Current freeboard and inspection conditions (1.2.4 and 1.2.5)
4.	Seepage/ leachate from calcine tailings	Calcine TSF including the CTSF leachate pond and calcine storage reticulation pond	Leak through HDPE liner resulting in soil/ groundwater contamination	Existing area (including 2 ponds) lined with a 1 mm HDPE liner installed in 1999 and 2008. New area to be lined to achieve a permeability of 10^{-9} m/s or less - extension to facility will have a secondary geosynthetic clay liner (GCL) overlain by a primary 1.5 mm HDPE liner. Baseline soil sampling to be taken prior to installation of the new lining. Any contaminated soil detected outside of the lined CTSF will be removed and placed into the lined CTSF. Groundwater monitoring is conducted in the vicinity of the CTSF at groundwater monitoring bores CTMB1, CTMB2, CTMB3 and CTMB4 Annual independent geotechnical audit of facility	Moderate consequence Possible likelihood **Medium risk**	Acceptable with regulatory and applicant controls conditioned.	Works Approval: • Both the leachate pond and calcine storage reticulation sump to be drained and the integrity of the HDPE liner tested. Any holes or tears to be repaired • Dual liner installation of GCL overlain with a 1.5mm HDPE. Post installation assessment of liner integrity reported to CEO. Licence: • Existing groundwater monitoring program including bores CTMB1 – CTMB4 maintained and reported in AER. • Add to conditions to include a summary of Geotechnical Audit findings and recommendations in the AER
5.a	Non-magnetic tailings	Overtopping of the NMTSF Cell 1 (during an extreme rainfall event or during deposition)	Direct to ground causing soil/groundwater contamination; impact to stygofauna and livestock water	Cell capacity to contain stormwater from a 72 hour duration, 100 year rainfall event. A total freeboard of 0.5 m and a limiting height of 1.6 m between the lowest point on the tailings	Moderate consequence Unlikely likelihood **Medium risk**	Acceptable with regulatory and applicant controls conditioned.	Licence: • Current freeboard and inspection conditions (1.2.4 and 1.2.5) • Add to conditions to include a

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
				beach and each stage crest elevation have been included in the design. Daily inspections of embankment freeboards visually to confirm required freeboards capacity is available Annual independent geotechnical audit.			summary of Geotechnical Audit findings and recommendations in the AER
5.b	Non-magnetic tailings	Tailings delivery or return pipeline failure spilling tailings outside containment	Direct to ground causing soil/groundwater contamination; impact to stygofauna and livestock water	Daily inspections of tailings pipelines and facility features for visual integrity Equipped with telemetry systems and pressure sensors along pipelines to allow the detection of leaks and failures Equipped with automatic cut-outs in the event of a pipe failure Provided with secondary containment sufficient to contain any spill for a period equal to the time between inspections.	Moderate consequence Unlikely likelihood **Medium risk**	Acceptable with existing controls	Works Approval: • No additional works proposed as part of the works approval. Licence: • Current inspection conditions (1.2.4 and 1.2.5) • Pipelines to be located within secondary containment and equipped with automatic cut-outs in the event of a pipe failure
6	Seepage from non-magnetic tailings	Deposition of tailings to the NMTSF Cell 1 and Cell 3	Seepage to soil and groundwater resulting in poor groundwater quality; impact to stygofauna and livestock water	Permanent seepage trenches	Moderate consequence Possible likelihood **Medium risk**	Tailings deposition to NMTSF Cell 3 is not authorised at this time as there are no additional works planned to collect seepage at the cross-valley embankment near TSMB8 with the exception of the near	Works Approval: • Construction of Cell 1 embankments authorised as part of this works approval and installation of Cell 1 decant and decant causeway • Critical Containment Infrastructure report

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
						surface seepage trench. The depth of this trench is insufficient to collect the dominant seepage flow (located at approximately 21 mbgl). NMTSF Cell 1 works are acceptable	requirement. Licence: • Operation of Cell 3 not authorised at this time • Operation of Cell 1 authorised pending compliance.
7.	Untreated and treated wastewater	Release of wastewater from treatment plant pipelines and tanks due to pipeline failure, tank overflows from new 66m^3/d sewage plant	Direct to ground; soil contamination	• Located 100 metres from the ephemeral floodway; • Situated above ground on skids or a trailer or similar, which will prevent inflow of clean stormwater to the temporary WWTP; • Include an alarm system, which includes audible alarms and flashing lights for high tank levels and pump faults. The alarm system will be similar to the existing WWTP • Tanks will be sized so that recirculating anoxic buffer tank is only 40% full in typical operating conditions. The residual volume of the tank provides a buffer for digestion and settlement of material as well as a buffer to retain material in the event of abnormal operating conditions. The total tank volume is likely to	Moderate consequence Possible likelihood **Medium risk**	Acceptable subject to regulatory and applicant controls conditioned.	Works Approval: • Condition the location, proposed above ground construction and process control systems • Time limited operations not authorised. Licence: • Quarterly monitoring of effluent quality already prescribed by condition 3.3.1. • Operation of new WWTP not authorised

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	**Source**	**Pathway/ Receptor (Impact)**				
				be approximately 32 m^3, providing approximately 0.25 days contingency storage if operated at peak capacity			
8.	Treated wastewater (effluent)	Discharge to land via an irrigation sprayfield	Impact to the health of Priority 1 flora located adjacent to the proposed sprayfield extension area	• The additional sprayfield will be located at least 40 m away from the floodway (as with the current sprayfield) and the ground level in the sprayfield will be at least 1 m above the predicted water level in a 1 in 100 year, 72 hour flood event; • additional sprayfield will be located outside of the 25 m exclusion zone for the gas pipeline; • distance from the additional sprayfield to the accommodation village will be no closer than the current sprayfield, which is 70 m; • additional sprayfield will be sized at a minimum 1.7 ha; • additional sprayfield will be fenced and sign-posted to prevent direct access from personnel, unless required	Minor consequence Unlikely likelihood **Medium risk**	Acceptable subject to regulatory and applicant controls conditioned.	Works Approval: • Condition the location, of spay field and control systems

	Description of Risk Event			Applicant controls	Risk rating	Acceptability with controls (conditions on instrument)	Resulting Regulatory Controls
	Emission	Source	Pathway/ Receptor (Impact)				
				for maintenance and inspection purposes; and • irrigation sprayfield will be located on flat land, with a gradient of less than 1:10			

10.1 Works Approval Controls – Commissioning duration

The Environmental Commissioning duration for the Windimurra Project components is listed in Table 33. The Applicant will be commissioning the newly installed equipment (SAG mill, Ball Mill, magnetic concentrate thickener and V_2O_5 production facility) and the existing infrastructure. The commissioning phases will include:

- *Pre-commissioning – comprising static checks on unpowered equipment to confirm that the infrastructure has been built according to specification and all required safety systems and interlocks are fully functional;*
- *Dry commissioning – comprising testing of 'empty' equipment and facilities without the addition of fuel, reagents, ore, water or compressed air. Diesel generators will provide power for the testing of equipment. Computer control systems and the components of the processing circuit they control will be tested for functionality. Equipment specifically for air production (compressors etc.) will be inspected and the controls will be tested prior to actually having pressurised air in them;*
- *Wet commissioning – comprising test operation of equipment and facilities with water (this will not commence until pre-commissioning and dry commissioning tests have been passed);* and
- *Ore commissioning – comprising test operation of equipment and facilities with reagents, ore and water.* (Umwelt, June 2019)

Table 33: Infrastructure components – environmental commissioning period

Infrastructure	Component	Environmental Commissioning Period
Crushing, milling and beneficiation circuit	8 MW SAG Mill	60 days
	2.5 MW Regrind Ball Mill	
	Magnetite Concentrate Thickener	
Process Water Tank		60 days
Refinery	Deammoniation Kiln	90 days
	Fusion Furnace	
	Flaking Wheel	
	Packaging Plant	
Calcine Tailings Storage Facility Extension Area		60 days
Non-Magnetic Tailings Storage Facility Expansion		60 days
Temporary Wastewater Treatment Plant and Irrigation Sprayfield		60 days
Inert Landfill		60 days

11. Applicant's comments

The Applicant was provided with a draft Decision Report and draft Works Approval on 23 December 2019. The Applicant provided comments which are summarised, along with DWER's response, in Appendix 2. A second draft was provided to the Applicant on 12 March 2020.

12. Conclusion

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

Based on this assessment, it has been determined that the Works Approval will be granted

subject to conditions commensurate with the determined controls and necessary for administration and reporting requirements.

Alana Kidd
Manager, Resource Industries
Delegated Officer
under section 20 of the *Environmental Protection Act 1986*

Appendix 1: Key documents

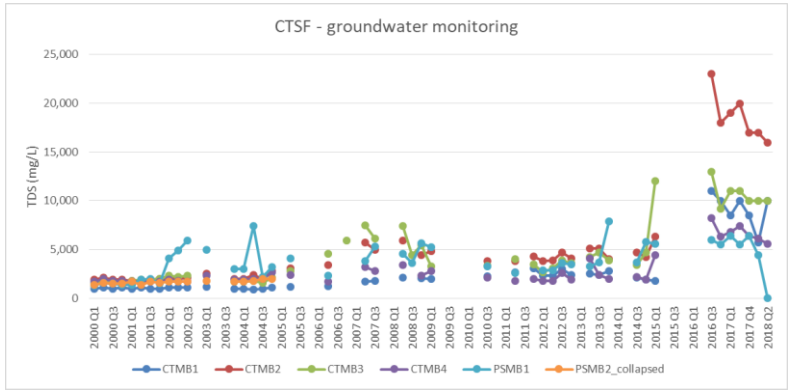
	Document title	In text ref	Availability
1.	Licence L8314/2008/3 – Windimurra Vanadium Project	L8314/2008/3	accessed at www.dwer.wa.gov.au
2.	DER, July 2015. *Guidance Statement: Regulatory principles.* Department of Environment Regulation, Perth.	N/A	accessed at www.dwer.wa.gov.au
3.	DER, October 2015. *Guidance Statement: Setting conditions.* Department of Environment Regulation, Perth.	N/A	
4.	DER, August 2016. *Guidance Statement: Licence duration.* Department of Environment Regulation, Perth.	N/A	
5.	DER, November 2016. *Guidance Statement: Risk Assessments*. Department of Environment Regulation, Perth.	N/A	
6.	DER, November 2016. *Guidance Statement: Decision Making*. Department of Environment Regulation, Perth.	N/A	
7.	Umwelt, Atlantic Vanadium Pty Ltd, Review of Salts and Metals Contaminants, Windimurra Vanadium Project, Final, April 2017	Umwelt, April 2017	DWER records (A1420703)
8.	Contaminated Sites technical advice for the Windimurra Vanadium Project – Groundwater Monitoring Results	N/A	DWER records (A1146671)
9.	Umwelt, Atlantic Vanadium Pty Ltd, Windimurra Vanadium Project, Works Approval Application Supporting Documentation – Resubmission, Final, June 2019	Umwelt, June 2019	DWER records (A1806290)
10.	SKM, Windimurra Vanadium Air Quality Assessment, Final Ver 5, May 2007.	SKM, 2007	DWER records (A1806290)

11.	Atlantic Ltd, Windimurra Vanadium Mine, Mt Magnet WA, NMTSF Expansion Design Report, February 2019	ATC Williams, February 2019	DWER records (Appendix B of A1806290)
12.	Umwelt, Atlantic Vanadium Pty Ltd Windimurra Vanadium Project Response to Works Approval Application Request for Further Information, November 2019	Umwelt, November 2019	DWER records (DWERDT219952)
13.	Aihemaiti, A., Jiang, J., Li, D., Li, T., Zhang, W., Ding, X., (2017) Toxic metal tolerance in native plant species grown in a vanadium mining area. *Environmental Science & Pollution Research,* **24,** pp. 26839 - 26850	Aihemaiti, A., *et al,* 2017	
14.	Mejia, J.A., Rodriguez, R., Armienta, A., Mata, E., & Fiorucci. A., (2007) Aquifer Vulnerability Zoning, an Indicator of Atmospheric Pollutants Input? Vanadium in the Salamanca Aquifer, Mexico. *Water Air Soil Pollution***, 185,** pp.95 -100	Mejia, J.A., *et al* 2007	
15.	DWER (2019*) Guideline: Air Emissions,* draft for public consultation, October 2019	DWER 2019	As accessed: www.dwer.wa.gov.au
16.	Paul Armstrong and Associates, Vegetation survey and rare flora research of the Windimurra Vanadium Mine Project, August 2007	Paul Armstrong, 2007	DWER records (A1862206)
17.	Gustafsson, J.P., (2019) Vanadium geochemistry in the biogeosphere – speciation, solid-solution interactions, and ecotoxicity. Applied Geochemistry, **102**, pp. 1-25	Gustafsson, J.P., 2019	
18.	Umwelt, Atlantic Vanadium Pty Ltd Windimurra Vanadium Project Response to Draft Works Approval Application, January 2020		DWER records (A1862206)
19.	Umwelt, Atlantic Vanadium Pty Ltd Windimurra Vanadium Project Response to Draft Works Approval Application Version 2, March 2020		DWER records (A1877025)

Appendix 2: Summary of applicant's comments on risk assessment and draft conditions

Condition	Summary of Licence Holder comment	DWER response
Decision Report Section 9.9	Table 27 incorrectly stated that the non-magnetic tailings storage facility (NMTSF) has an existing impenetrable liner of 1 mm high density polyethylene (HDPE).	Table 27 updated
Decision Report Section 9.9.1	It is acknowledged that DWER does not consider the proposed near-surface seepage collection trench to be sufficient to manage the known seepage from the northern portion of the NMTSF. AVPL will undertake further design work and propose an approach such as groundwater recovery bores installed north of the NMTSF. These bores would be used to pump out seepage, which would then be recirculated through the process water system for re-use in the plant. A works approval application will be submitted to DWER in the coming months for a revised NMTSF design.	Noted
Decision Report Section 9.11.8	Review consequence of priority flora impacts The priority 1 flora species *Ptilotus procumbens* has been recorded near the proposed new WWTP irrigation area. A specimen of this species was recorded in October 2006 adjacent to a sewage outflow at the accommodation village	The flora survey report (Paul Armstrong, 2007) stated that a single plant of *Ptilotus procumbens* (P1) was recorded in October 2006 from near the perimeter of the old accommodation village (648102E, 6872376N). The same area was searched again in December 2006 and July 2007 but no evidence of the plant could be located. Based on the coordinates of the P1 and new spray field location (approximately 100m from spray field), DWER has changed the risk to P1 and will allow WWTP effluent to be discharged in the proposed irrigation area.

Condition	Summary of Licence Holder comment	DWER response
Table 1 – Works Approval	**Tailings thickener bunding capacity** The existing tailings thickener is located within the beneficiation area of the plant (Figure 4.1) and is currently bunded; however, due to the size of the thickener tank, it is not reasonably practicable to install a bund with capacity to contain 110% of the volume of the tank.	L8314/2008/3 allows AVPL to operate with current equipment. DWER has been removed the requirement for 110% capacity bunding.
Table 1 – Works Approval	**Tailings thickener bunding integrity** AVPL has verified that there is no corrosion in the existing concrete bund as shown in the photographs presented in Figure 4.3 which were taken on 23 January 2020. We request that this requirement is removed as it is not relevant.	DWER will require a bunding integrity report, prepared by a qualified Civil Engineer, to be submitted to the CEO together with Commissioning Report. Removed from Table 1 and included in Specified Actions.
Decision Report **Section 9.11**	**CTSF seepage** High concentrations of metals (selenium and vanadium) and salts (calcium, chloride, magnesium, sodium and sulphate) in the bores referred to (CTMB2, 3 and 4) are not disputed, they do not reflect the characteristics of the concentrations measured in the leachate being stored in the CTSF. It is not clear why CTMB2 and CTMB3 are recording the higher concentrations of contaminants; however, the detailed hydrogeology pathways and linkages in this area are not known and do not necessarily reflect surface conditions or follow linear pathways.	A great number of ions present in the CTSF leachate (Table 20) show correlation with the CTSF monitoring bores (Table 22). DWER acknowledges that there are potentially other sources of contaminants from different areas of the site (e.g. plant, leachate pond, leach vats). For that reason, DWER has reviewed groundwater monitoring data around the CTSF between 2000 to current, including PSMB1 and PSMB2 that are located downstream of CTSF. The compiled data (shown below) shows that sulfate and TDS are lower at PSMB1 than CTMB2 and CTMBS3. PSMB1 is located downstream of the calcine reticulation pond.

Condition	Summary of Licence Holder comment	DWER response
		At this point, AVPL cannot provide assurance on the hydrology around the CTSF. Based on the monitoring results (from 2000 to 2018) and hydrogeological data provided (Figure 12), DWER concludes that the CTSF is the source of contamination. Therefore, the CTSF risk assessment remains the same.  DWER also noted that PSMB2 monitoring bore was destroyed. DWER will add to the Works Approval a requirement to replace PSMB2.
Condition 10 – Works Approval	AVPL agrees to carry out liner integrity test on the CTSF. However, we request that the draft works approval condition is worded to allow flexibility with the methodology used to undertake the test.	Condition amended.
Conditions 3, 5, 9, 10 – Works Approval and	It is requested that pre-commissioning, dry commissioning and wet commissioning, as previously described in Section 4.4.3 of Windimurra Vanadium Project Works Approval Application Supporting Documentation – Resubmission	Environmental commissioning does not mean that the equipment has to be tested to the nominal capacity. It allows specific testing to validate that equipment installed to regulate emissions to the environment, are adequately performing before

Condition	Summary of Licence Holder comment	DWER response
Decision Report **Section 10.1**	Umwelt (2019c), is permitted to be undertaken during the construction phase of the project. These activities are necessary for verification of functioning prior to ore commissioning, and to complete the Critical Containment Infrastructure Audit Compliance Report. It would take up to 18 months for the plant to ramp up to *design capacity* and achieve steady state operation. The complexity of commissioning the Windimurra plant means that a schedule with timeframes against itemised tasks cannot be produced.	operation. Partial commissioning can also occur as each piece of infrastructure is commissioned. Further information about Environmental Commissioning can be found in DWER Guideline: Industry Regulation Guide to Licensing, Section 4. The timeframe for Windimurra Environmental Commissioning is listed on Table 3. AVPL can continue to operate within the Works Approval under the Time Limited Operations Phase. Approval will be given for 180 days of Time Limited operation to allow for assessment of the Licence Amendment. Time limited operation is also outlined in DWER's Guide to Licensing. It is possible that several licence amendments may be required.
Decision Report **Table 32**	Table 32 lists a number of proposed works approval conditions including 'A revised model will be required to be submitted prior to construction to confirm compliance with ground level concentrations emission criteria'. It is requested that this condition is updated to clarify that the revised air emissions model is required *prior to construction of the deammoniation kiln only*, rather than prior to any construction commencing.	Table amended.
Decision Report **Section 9.4.5**	The draft Decision Report queries whether the modelled NH_3 emissions presented in the *Response to Works Approval Application Request for Further Information* (Umwelt, 2019a) are insignificant and whether the figure relates to	DWER has reviewed the Air Quality Assessment (SKM, 2007) and amended Section 9.4.5

Condition	Summary of Licence Holder comment	DWER response
	emissions before or after the treatment of off gas by the two stage scrubber.	
Decision Report **Section 9.5.5**	DWER has queried whether there are one or two baghouses within this section of the plant. There will be one baghouse servicing the fusion furnace, flaking wheel and product packaging station. This is an existing baghouse	Text amended
Condition 11 – Works Approval **Table 5**	Condition 11 of the draft Works Approval document contains Table 5 which sets out the air emissions monitoring that will be required during environmental commissioning. The table does not include the required frequency at which monitoring is to be undertaken. It is requested that this table is updated to include this information.	Table amended
Decision Report **Sections 9.4 .2**	• Clarify whether the concern is impacts to vegetation health or grazing cattle. • Clarify the pathway of impact from vanadium dust deposition to vegetation health. • Clarify the pathway of impact from vegetation health to grazing cattle.	Section 9.4.2 has been reviewed and amended.
Decision Report **Sections 9.5.3**	At bioavailable (soluble) concentrations of 30 mg/kg in soil, vanadium has been shown to cause toxicity and reduce plant biomass in soybeans.	Section 9.5.3 has been reviewed and amended. Additional scientific reference added.
Draft Works Approval, Condition 1, Table 1	The draft Works Approval requires all new components sited within concrete bunded compounds to meet AS1940 requirements. As no new components within the CMB or refinery bunding contain flammable or combustible liquids, AVPL requests that the reference to *AS 1940:2017* is removed	Reference to AS 1940:2017 removed

Condition	Summary of Licence Holder comment	DWER response
Draft Works Approval, Condition 13	It is requested that the Environmental Commissioning Reports are permitted to be provided separately for each of the four infrastructure items as listed in Table 3.	Text amended
Decision Report	It is noted that there are various inconsistencies in the information as presented in the draft Decision Report, that do not reflect the changes as made in the draft Works Approval.	Text and Tables amended

Attachment 1: Issued Works Approval W6265/2018/1