Decision Report

Application for Licence

Division 3, Part V *Environmental Protection Act 1986*

Licence Number	L9036/2017/1
Licence Holder	Altura Lithium Operations Pty Ltd
ACN	095 384 491
File Number	DER2017/000279
Premises	Pilgangoora Lithium Project M45/1230 and M45/1231 MARBLE BAR WA 6760
Date of Report	11 September 2018
Status of Report	Final

Table of Contents

1. Definitions of terms and acronyms

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

Table 1: Definitions

Term	Definition
ACN	Australian Company Number
AEP	Annual Exceedance Probability
Annual Period	means a 12 month period commencing from 1 July until 30 June in the following year
ARI	Average Recurrence Interval
ADWG	Australian Drinking Water Guideline
Bq/g	Becquerel per gram
Category/ Categories/ Cat.	categories of Prescribed Premises as set out in Schedule 1 of the EP Regulations
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 is responsible for the administration of Part V, Division 3 of the EP Act
DER	Department of Environment Regulation
DMIRS	Department of Mines, Industry Regulation and Safety
DMS	Dense Media Separation
DoW	Department of Water
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.
EC	Electrical Conductivity
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)

Term	Definition
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EP Regulations	*Environmental Protection Regulations 1987* (WA)
FT	Flotation-Tailings
g/t	grams per tonne
HDPE	High Density Polyethylene
HPGR	High Pressure Grinding Rolls
Issued Licence	The licence issued under Part V, Division 3 of the EP Act following finalisation of this assessment
Licence Holder	Altura Lithium Operations Pty Ltd
LIMS	Low Intensity Magnetic Separator
mbgl	metres below ground level
Mt	million tonnes
Mtpa	million tonnes per annum
PDWSA	Public Drinking Water Source Area proclaimed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*
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	is defined in the Guidance Statement: *Risk Assessments* to include the primary activities which fall within the description of the category of prescribed premises in Schedule 1 to the EP Regulations
Risk Event	as described in Guidance Statement*: Risk Assessments*
RiWI Act	*Rights in Water and Irrigation Act 1914*
RL	Reduced Level
ROM	Run of Mine
SMDD	Standard Maximum Dry Density
TSF	Tailings Storage Facility
TDS	Total Dissolved Solids
UDR	*Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA)

Term	Definition
WRL	Waste Rock Landforms
WHIMS	Wet High Intensity Magnetic Separator
µg/L	micrograms per litre
µm	micrometres
µS/cm	microSiemens per centimetre

2. Purpose and scope of assessment

Altura Lithium Operations Pty Ltd (Licence Holder) submitted an application (Preston Consulting, 2017a) on 15 February 2017 to the former Department of Environment Regulation (DER) for a Licence under the *Environmental Protection Act 1986* (EP Act). The application is to develop an open pit, waste rock landforms (WRL) Tailing Storage Facility (TSF), process plant and supporting infrastructure at the Pilgangoora Lithium Project (Premises) for the mining and processing of 1.4 million tonnes (Mt) per annum (Mtpa) of ore to produce approximately 220,000 tonnes of lithium spodumene concentrate per annum.

Works Approval W6036/2017/1 was issued on 7 July 2017 for the construction of the process plant, TSF and mobile crushing facility (construction purposes only). Compliance documentation was received on 13 June 2018 (TSF Compliance Report, W6036 Compliance, 2018a) and 26 June 2018 (W6036 Compliance, 2018b).

The Premises is located approximately 90 kilometres (km) south of Port Hedland in the Pilbara region of Western Australia. Spodumene concentrate is hauled from the Premises via road train to Port Hedland for export by ship to lithium producers, predominately in China for further processing into a wide range of lithium chemicals, including lithium carbonate, lithium hydroxide, lithium metal and lithium chloride.

This Decision Report assesses emissions and discharges associated with the operation of the following:

- Process plant; and
- TSF including tailings pipeline infrastructure.

This assessment has resulted in the Department of Water and Environmental Regulation (DWER) issuing Licence L9036/2017/1 (Issued Licence) 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
• Application form for a concurrent works approval and licence; and • Pilgangoora Lithium Project Works Approval Application Supporting Document.	15 February 2017

Pilgangoora Lithium Project Mining Proposal M45/1230, M45/1231, L45/400 & L45/404 (ALT-COR-BUS-DOC-0035 Rev 0) including: • Appendix 1: Mine Closure Plan; • Appendix 2: Spatial Files (DXF Format) of the Disturbance Envelope; • Appendix 3: Environmental Management System Manual; • Appendix 4: Aboriginal Heritage Survey Reports; • Appendix 5: TSF Design Report; • Appendix 6: Shire Approval of Road Upgrades; • Appendix 7: Materials Characterisation Reports; • Appendix 8: Environmental Risk Register; • Appendix 9: Groundwater Reports and Monitoring Plan; and • Appendix 10: Surface Water Reports.	15 February 2017
Pilgangoora Lithium Project Revised Mining Proposal M45/1230, M45/1231, L45/400 & L45/404 (ALT-COR-BUS-DOC-0035 Rev 1).	24 February 2017

3. Background

The application relates to category 5 activities at the Premises as defined in Schedule 1 of the *Environmental Protection Regulations 1987* (EP Regulations) and listed in Table 3.

Table 3: Prescribed Premises Category

Classification of Premises	Description	Approved Premises production or design capacity or throughput
Category 5	Processing or beneficiation of metallic or non-metallic ore: premises on which — (a) metallic or non-metallic ore is crushed, ground, milled or otherwise processed; or (b) tailings from metallic or non-metallic ore are reprocessed; or (c) tailings or residue from metallic or non-metallic ore are discharged into a containment cell or dam.	Process plant - 1,400,000 tonnes per Annual Period TSF - 770,000 tonnes of tailings per Annual Period

4. Overview of Premises

4.1 Operational aspects

The operational aspects as defined within Preston Consulting, 2017a are detailed below.

Process plant

Crushing and Dry Screening Circuit

The process plant is a vendor supplied modular package, with primary and secondary crushing with dry screening in a closed circuit. The process plant flow diagram is shown in Figure 1.

A front end loader feeds ore to the crushing plant via the Run of Mine (ROM) bin. Particles <90 millimetres (mm) discharge to the grizzly feeder and particles >90 mm are extracted off and fed through the jaw crusher. Both streams then report to primary screening. Ore >28 mm size is fed to the secondary crusher, while ore <28 mm is fed to the crushed ore stockpile.

High Pressure Grinding Rolls (HPGR)

Ore is reclaimed from the crushed ore stockpile and fed into the HPGR. HPGR product then discharges onto a return conveyor feeding the primary wet screen. Wet screen oversize (>6 mm) reports back to the HPGR feed conveyor closing the circuit. HPGR discharge is conveyed to the secondary screen for wet screening at 6 mm. Screen undersize reports to the tertiary screen cutting at 1 mm, this is then collected and pumped to the flotation classification area. The screen oversize is conveyed to the Dense Media Separation (DMS) classifier feed bin.

A vibrating feeder extracts ore from the classifier feed bin into the DMS classifier. Fluidisation water is fed into the bottom of the classifier to create an upward velocity that lifts the mica and fine quartz particles to the unit overflow while the heavy spodumene and coarse gangue settles to the underflow. DMS classifier overflow is gravity fed to a linear screen. The mica and fine quartz reports from the linear screen oversize into the dewatering circuit to be dewatered and conveyed to the coarse rejects bin. The DMS classifier underflow is dewatered on a horizontal vibrating screen and conveyed to the DMS feed bins.

DMS Circuit

Two primary DMS modules process prepared DMS feed to remove the majority of light gangue to rejects. A common rejects conveyor collects the floats reject from both modules and conveys to the coarse reject handling area. The sinks from both primary DMS modules are collected and conveyed to the secondary DMS. Floats from the secondary DMS (middlings) are conveyed to the Mill Feed Bin to be fed into the milling and flotation circuit and the sinks product are conveyed to the coarse product stockpiling area.

Milling and Flotation

Middlings generated in the DMS circuit report to the mill feed chute. Fines from the classifer underflow surge tank are pumped into the mill discharge tank and pumped to the mill classification cyclones. Cyclone underflow reports back to the mill feed chute and cyclone overflow reports to the attritioning tank via a trash screen. Diluted dispersant reagent is added into the attritioning tank, which once attritioned, the slurry is pumped to deslime cyclones. Cyclone overflow containing slimes reports to the flotation tailings thickener and cyclone underflow is sampled and reports to the flotation conditioning tank and flotation circuit.

Concentrate from each flotation stage (rougher flotation, cleaner flotation and re-cleaner flotation) is flushed into a concentrate tank and pumped to a conditioning tank for further reagent addition. Final concentrate from the re-cleaner is pumped to the product upgrade circuit while flotation tailings is pumped to the flotation tailings thickener.

Final Product Processing

Flotation concentrate is pumped through a final treatment stage to be subjected to low and high intensity magnetic separation. Flotation concentrate is pumped into a feed tank to pass through a Low Intensity Magnetic Separator (LIMS) to remove highly magnetic material. The LIMS non-magnetic fraction is gravity fed into a Wet High Intensity Magnetic Separator (WHIMS). Impurities with low magnetic susceptibility are removed from the concentrate and washed from the electromagnetic ring into the magnetics tank with the LIMS magnetic fraction. Magnetics

from the LIMS and WHIMS are then pumped to the flotation tailings tank. Non-magnetics from the WHIMS are pumped to the concentrate thickener for dewatering.

Fines Tailings Handling

There are two tailings thickeners dedicated respectively to flotation and the DMS water circuits. The DMS tailings thickener is fed via the tailings streams within the DMS and the mica removal circuits. The flotation tailings thickener is fed from reject streams within the milling, flotation and the concentrate upgrade areas. The thickener overflows report to separate process water tanks. Both thickener underflow tailings are pumped to the tailings tank and TSF. A return pump and toe drain pump recovers and transfers the TSF decant water back to the DMS process water tank.

Process reagents

The process plant reagents and proposed annual consumption (Mining Proposal, 2017) is provided in Table 4.

Table 4: Process plant reagents and consumption rate

Reagent	**Unit Consumption**	**Usage (tonnes per annum)**
DMS Reagents (consumption based on grams per tonne (g/t) DMS fee)		
Ferrosilicon DMS 1	350	240
Ferrosilicon DMS 2	200	55
Shutdown Losses	-	25
Sodium Nitrate (powder)	-	0.25
Lime (powder)	-	0.25
Flotation reagents (consumption based on g/t flotation feed)		
Flotinor 7801 (@100%)	2,100	1,400
Sodium Carbonate (@30%)	300	200
Lignin Sulphonate (@100%)	55	25
Sodium Silicate (@30%)	300	200
Hydrochloric Acid (@30%)	20	15
Thickening Reagents (consumption based on g/t thickener feed)		
Flocculant (Flotation Concentrate Thickener)	20	4
Flocculant (Flotation Tails Thickener)	20	12
Flocculant (DMS Tails Thickener)	90	10

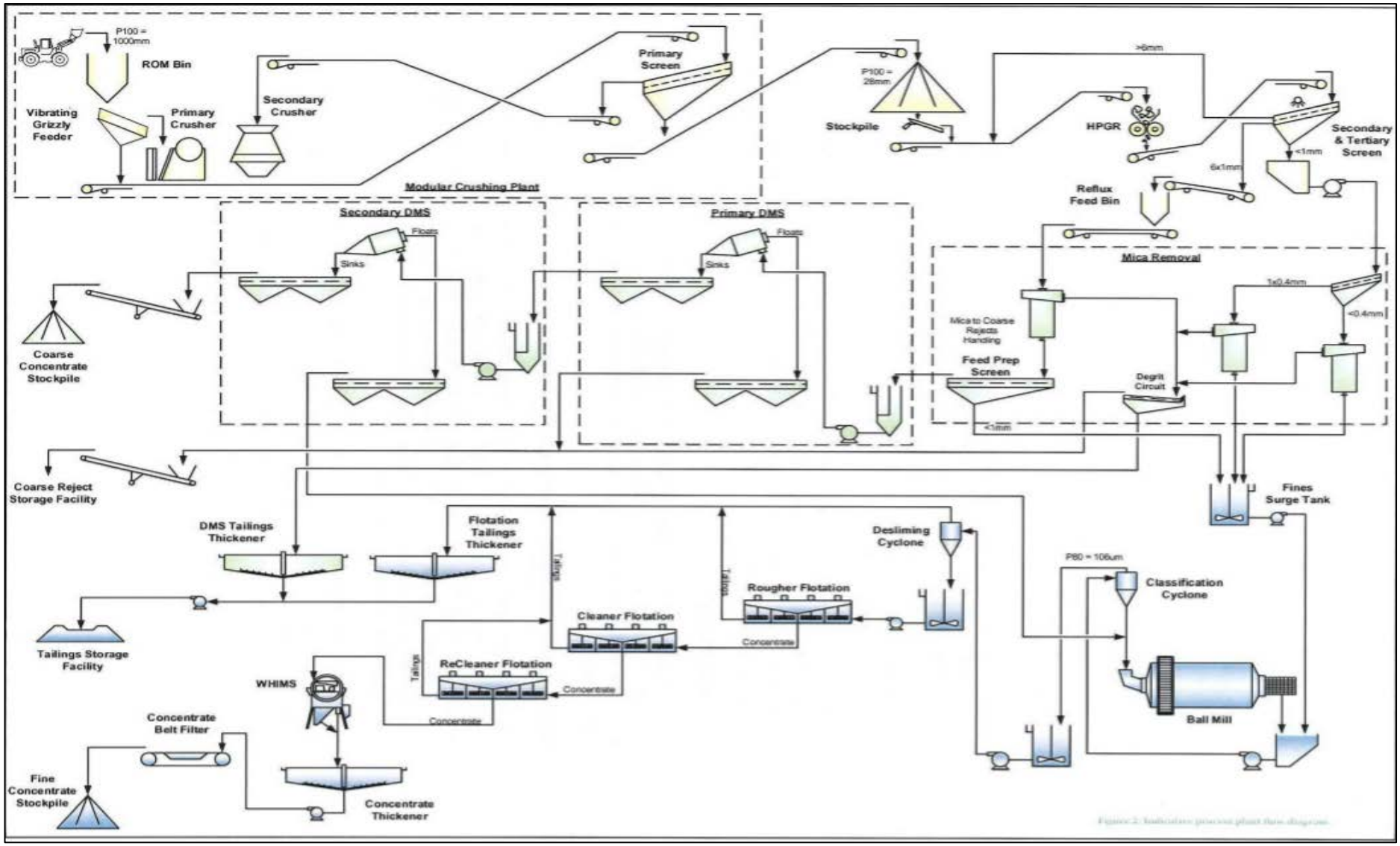

Figure 1: Process plant flow diagram

TSF

The *TSF Design Report* states that the *"TSF will be located adjacent to the west side of the waste dump and comprise a semi-circular embankment with a final basin footprint area of approximately 29 ha"*.

Over the life of the mine (14 years), a total of approximately 10 Mt of tailings is expected to be produced (770,000 tonnes per year). The tailings has a particle size of approximately 80 percent passing 92 micrometres (µm) and is transferred via a slurry pipeline at a range of 50-60 percent solids from the process plant to the TSF.

Tailings are discharged to the TSF by sub-aerial deposition methods, using a combination of spigots at regularly spaced intervals along the embankment. Supernatant water and rainfall runoff from the tailings surface will be pumped back to the process plant (DMS tank) by pumps located in the decant tower.

The TSF is to be built in stages. The Issued Licence is for stage two to embankment level of 186 m Reduced Level (RL) only as shown in Table 5 and Figure 2.

Table 5: Staged embankment construction (TSF Compliance Report and TSF Design Report)

Stage	Tailings Storage (Cumulative) (tonnes)	TSF Embankment Elevation[*1] (mRL)	Max Raise Height (m)	Maximum TSF Embankment Height (m)
2	1,561,000	186	1.9	9.7

*1 Embankment crest elevations include a minimum freeboard and stormwater capacity for 100 year Annual Recurrence Interval (ARI) 72 hour storm event occurring on an average conditions pond.

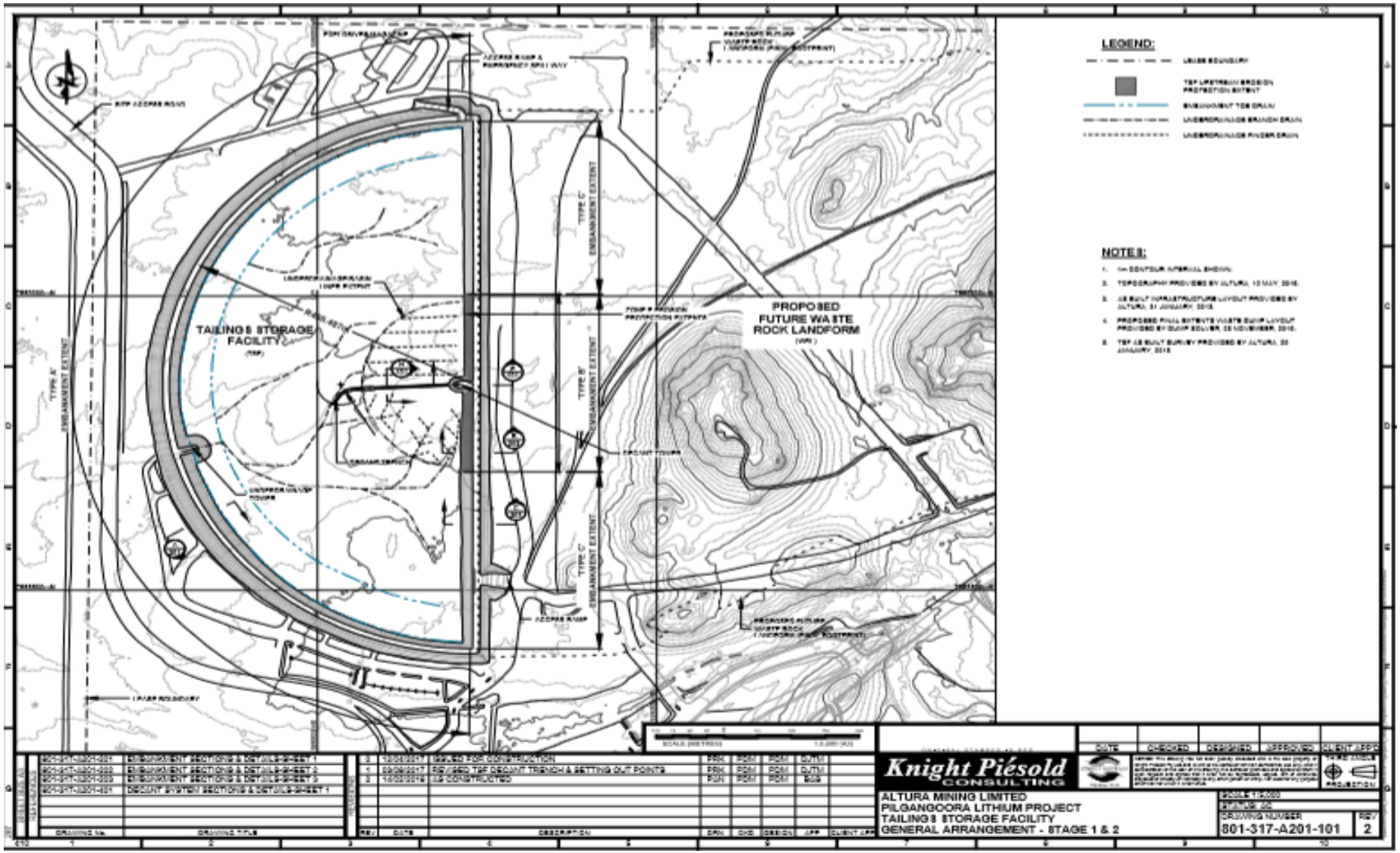

Figure 2: TSF general arrangement for Stage 2

4.2 Infrastructure

The Premises infrastructure, as it relates to category 5 activities, is detailed in Table 6 with reference to the Site Plans (Figures 3 and 4).

Table 6: Premises infrastructure

	Infrastructure	Site Plan Reference
	Prescribed Activity Category 5	
The process plant is designed to process 1.4 Mtpa of lithium ore, beneficiating ROM ore to a 6 percent lithium concentrate. The process plant employs two stages of crushing followed by HPGR Machine which reduces the ROM material down to <6.0 mm. The crushing circuit is followed by two stages of DMS to produce coarse (>0.5 mm) lithium concentrate. The fines material (<0.5 mm) and the DMS middlings are milled and beneficiated with flotation to achieve a fine lithium product. Tailings is thickened and pumped to the TSF (approximately 770,000 tonnes per year) where solids settle out.		
1	ROM pad	Figures 3 and 4: ROM pad
2	Primary and secondary crushing station	Figure 3: Mine Operations and Processing Centre; and Figure 4: Processing Plant
3	HPGR Machine	
4	DMS station – 3 separate modular plants (two for primary separation and a single module for secondary separation)	
5	Coarse product stockpile	
6	Coarse rejects bin	
7	Milling and flotation station (three stages of upgrading: rougher, cleaning and re-cleaning circuit)	
8	Concentrate thickener and filter station (Magnetic separation – LIMS and WHIMS)	
9	Tailings thickener	
10	Product stockpile	
11	Associated conveyors and pipelines	
12	WRL TSF (including embankments, cut-off trench, underdrainage, decant and pumps)	Figure 3: Tailings Storage Facility
13	TSF pipelines (tailings delivery pipeline and distribution pipeline and decant return pipeline)	
14	Process plant reagents (DMS reagents, flotation reagents and thickening reagents)	Figure 4: Reagents
15	Process water dam	Figure 3: Process Water Dam
16	Stormwater sediment basins	Not shown

	Infrastructure	Site Plan Reference
	Other infrastructure	
1	Workshop	Figure 3: Mine Offices, Store & Workshop
2	Power plant	Not shown
3	Concrete batching plant	
4	Bioremediation facility	Figure 3: Bioremediation Pad
5	Fuel storage areas	Figure 4: MOC Diesel Tank Farm and Process Plant Diesel Tank Farm
6	Reverse Osmosis (RO) plant	Figure 4: Water Treatment

Figure 3: Site Plan 1

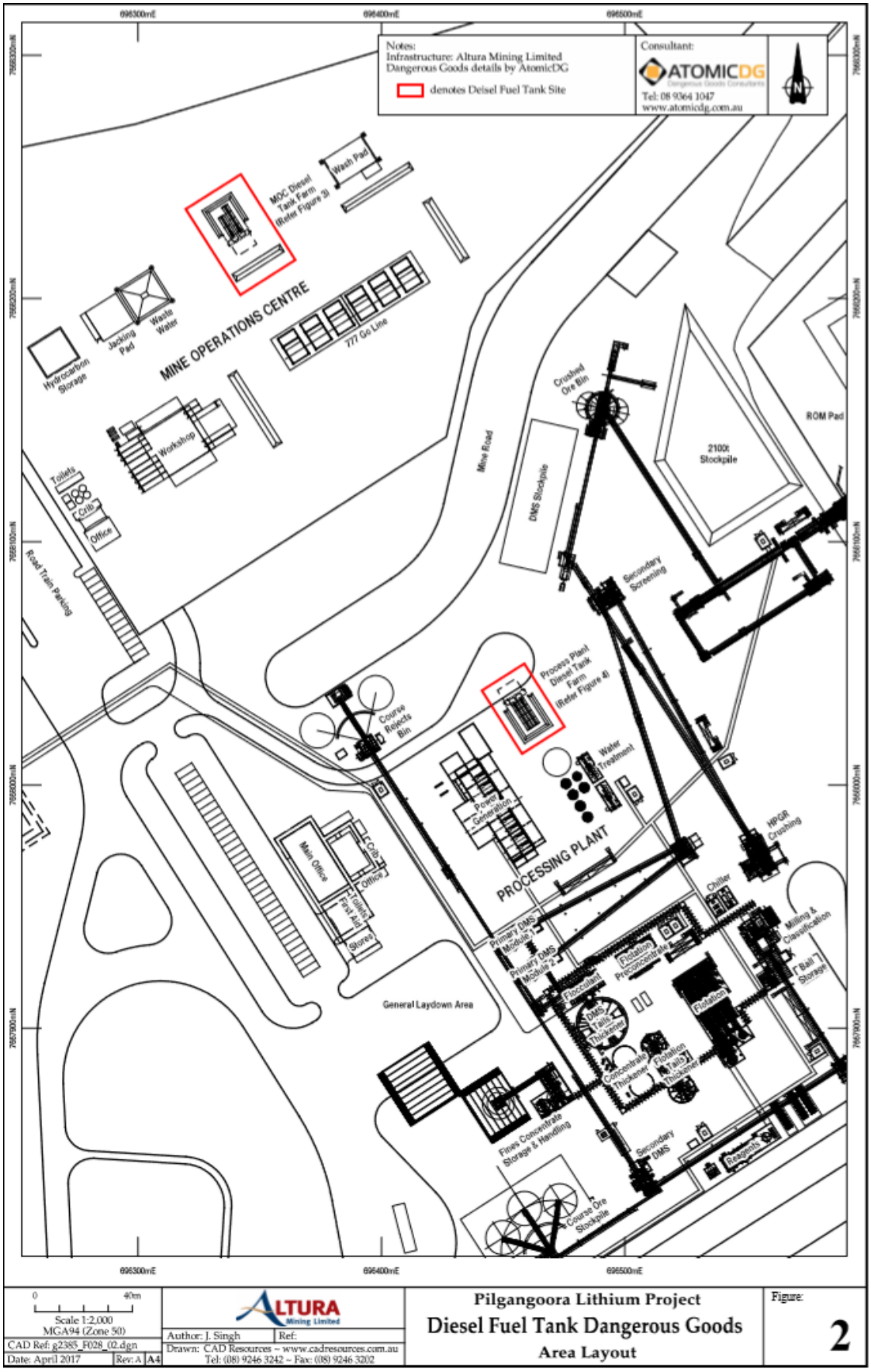

Figure 4: Site Plan 2

4.3 Exclusions to the Premises

The following activities/infrastructure will be occurring/located at the Premises which are not included in the scope of this assessment:

- Mining ore from open pits.
- Abstraction of groundwater is regulated under the *Rights in Water and Irrigation Act 1914* (RiWI Act).
- A concrete batching plant with a capacity of 40 cubic metres (m^3) – 50 m^3 per. This activity is not regulated by DWER as it does not trigger category 77 under the EP Regulations, as the material is not being taken offsite.
- Power plant (consisting of multiple gen-sets with a capacity of 8 megawatts). This activity is not regulated by DWER as it does not trigger category 52 or 84 of the EP Regulations.
- Bioremediation facility - as the facility does not receive liquid waste from other Premises, it does not trigger category 61 under the EP Regulations. The Licence Holder should note that the discharge of hydrocarbons to the environment is an unauthorised discharge under the *Environmental Protection (Unauthorised Discharges) Regulations 2004 (UDR)* and the facility should be operated to comply with the *Assessment and management of contaminated sites* and the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (ASC NEPM).
- Fuel storage area (diesel fuel stored at the Mine Operations Centre, process plant and power plant) with a total capacity of 385 kilolitres, which is below the category 73 threshold. The Licence Holder should note that the general provisions of the EP Act and UDR apply, as does the *Dangerous Goods Safety Act 2004* and associated Regulations.
- RO plant. The Licence Holder has stated that "*A RO plant will be installed near the process plant once it has been constructed. Altura will not discharge brine produced from this RO plant to the environment*" (Altura, 2017a).
- Workshop and Offices.
- Raw water dam.
- Laydown area.
- Core yard.
- Borefield – dewatering, production and monitoring bores.
- Magazine and explosives facility.
- Haul and access roads.
- Borrow pits and stockpiles.

5. Legislative context

Table 7 summarises approvals relevant to the assessment.

Table 7: Relevant approvals and tenure

Legislation	Number	Subsidiary	Approval
Mining Act (WA) 1978	Reg ID 68576	Altura Mining Limited	Mine Closure Plan, Pilgangoora Lithium Project M45/1230, M415/1231, L45/400, L45/401, L45/404, L45/409 & L45/416 (ALT-PRO-CS-LET-0061), Version 4, Altura Mining Limited, 2 August 2017.
	Reg ID 63674		Pilgangoora Lithium Project, Revised Mining Proposal M45/1230, M45/1231, L45/400 & L45/404 (ALT-COR-BUS-DOC-0035), Rev 1, prepared by Preston Consulting Pty Ltd for Altura Mining Limited, 15 February 2017.
Granted under section 51E of the EP Act	Purpose Permit number 7246/1, approved in November 2016	Altura Exploration Pty Ltd	Clearing Permit – not more than 374.58 hectares of native vegetation.
RiWI Act	GWL182856	Altura Lithium Operations Pty Ltd	Groundwater abstraction for water supply and mine dewatering borefield systems - 1,270,000 kilolitres per annum.

5.1 Part IV of the EP Act

The Licence Holder has stated that the Premises has not been referred to the Environmental Protection Authority (EPA) under Part IV of the EP Act, as it was not considered to have a significant impact on the environment.

5.2 Other relevant approvals

5.2.1 Radiation Management

The Licence Holder engaged Radiation Professionals to prepare a preliminary assessment of the predicted uranium and thorium radioactivity concentrations within the ore and the waste products.

In Western Australia the primary legislation relating to radiation management is the *Radiation Safety Act 1975* and subsidiary legislation. In general, mining operations are mandated to comply with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Code of Practice & Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing – Radiation Protection Series No. 9 (the Code).

Within the Code it is stated that the International Atomic Energy Agency (IAEA, RS-G-1.7) sets exclusion levels for naturally occurring radioactivity in bulk materials at 1 Becquerel per gram (Bq/g) head-of-chain activity for the uranium and thorium decay chain radionuclides. The activity concentration of 1 Bq/g is currently the internationally-accepted level for defining the scope of regulation for naturally occurring materials containing uranium or thorium.

Radiation Professionals, 2016 state that "*uranium and thorium mass concentrations in the ore, product and waste streams were determined using the results from mass concentration data"* supplied by the Licence Holder. "*Based on the radioactivity calculations, the uranium-238 and the thorium-232 concentrations in the ore, beneficiation and waste rock streams are not expected to exceed the exemption levels. However, there are indications of some mobile uranium in the leachate samples from the flotation tailings solids and although general concentrations are below the regulatory limits, there are noticeable variations depending on the location of the samples taken*".

Transport of radioactive material in Western Australia is legislated by the *Radiation Safety (Transport of Radioactive Substances) Regulations 2002*, made under the *Radiation Safety Act 1975*.

The regulations commit Western Australia to regulating the transport of radioactive materials as per the requirements of the ARPANSA Code of Practice for the Safe Transport of Radioactive Material – Radiation Protection Series No. 2 (Transport Code). Under the Transport Code (Section IV, Table 1. *Basic Radionuclide Values*) the exemption limit for materials or ores containing natural uranium and thorium is 1 (1 x 10^0) Bq/g head-of-chain. However, under an additional clause, paragraph 107(e) of the Transport Code states, "*natural material and ores containing naturally occurring radionuclides that are either in their natural state, or have been processed only for purposes other than for the extraction of the radionuclides, and that are not intended to be processed for use of these radionuclides, provided that the activity concentration of the material does not exceed 10 times the values specified in para. 401(b), or calculated in accordance with paras 402-406*".

Based on the additional clause, paragraph 107(e) of the Transport Code, the limit for transport of materials or ores containing natural uranium and thorium is 10 Bq/g head-of-chain.

Radiation Professionals, 2016 states that "*Based on the current assessment, the product will have a total radioactivity concentration of << 10 Bq/g and would not be subject to the Transport Code. Should any of the process or waste products approach or exceed 10 Bq/g, the Transport Code will apply*".

Due to the overall low uranium and thorium level details as provided in the application, the requirements of the Code "*are not applicable*" to the Premises. "*It is not anticipated that any pre-operational baseline or radiation management actions is needed*".

5.3 Part V of the EP Act

5.3.1 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: *Setting Conditions (October 2015);*
- Guidance Statement: *Licence Duration (August 2016);*
- Guidance Statement: *Decision Making (February 2017);*
- Guidance Statement*: Risk Assessments (February 2017);* and

- Guidance Statement: *Environmental Siting (November 2016).*

5.3.2 Works approval history

Table 8 summarises the works approval history for the Premises.

Table 8: Works approval and licence history

Instrument	Issued	Nature and extent of works approval, licence or amendment
W6036/2017/1	7/07/2017	New works approval for category 5 (process plant and TSF) and category 12 (mobile crushing facility to be used for construction purposes only).

5.3.3 Clearing

The clearing of native vegetation is not approved under the Issued Licence. Refer to Table 7 for information on known clearing approvals for the Premises.

6. Consultation

The application was advertised in the West Australian on 20 March 2017 for a comment period ending on 10 April 2017. No comments were received.

A letter inviting comment was sent to the Shire of East Pilbara on 16 March 2017. No comments were received from the Shire of East Pilbara.

7. Location and siting

7.1 Siting context

The Premises is located on M45/1230 and M45/1231, which is owned and managed by the Licence Holder. The Premises is located approximately 90 km south-east and 90 km north-west of the towns of Port Hedland and Marble Bar respectively as shown in Figure 5. The Wodgina Mine (operated by Wodgina Lithium Pty Ltd) and the Lynas Find Mine (now closed) are 25 km south-west and 1.5 km respectively from the Premises. The Premises is located on Wallareenya Pastoral Lease, an active cattle grazing property and the homestead is located approximately 35 km north of the Premises.

The workforce for the Premises is accommodated at the Roy Hill Infrastructure Rail Construction Camp 2 located approximately 18 km south-west of the Premises. This Camp is operated by the Licence Holder and as such the Camp is not considered a sensitive land use or receptor.

Pilbara Minerals Limited is currently constructing a mining operation (Pilgangoora Lithium-Tantalum Project) for category 5, 52, 64, 70, 73 and 85 activities adjacent to the Premises. The workforce for the Pilgangoora Lithium-Tantalum Project will be located at their onsite accommodation camp, which is approximately 5 km to the north-east of the Licence Holder's TSF.

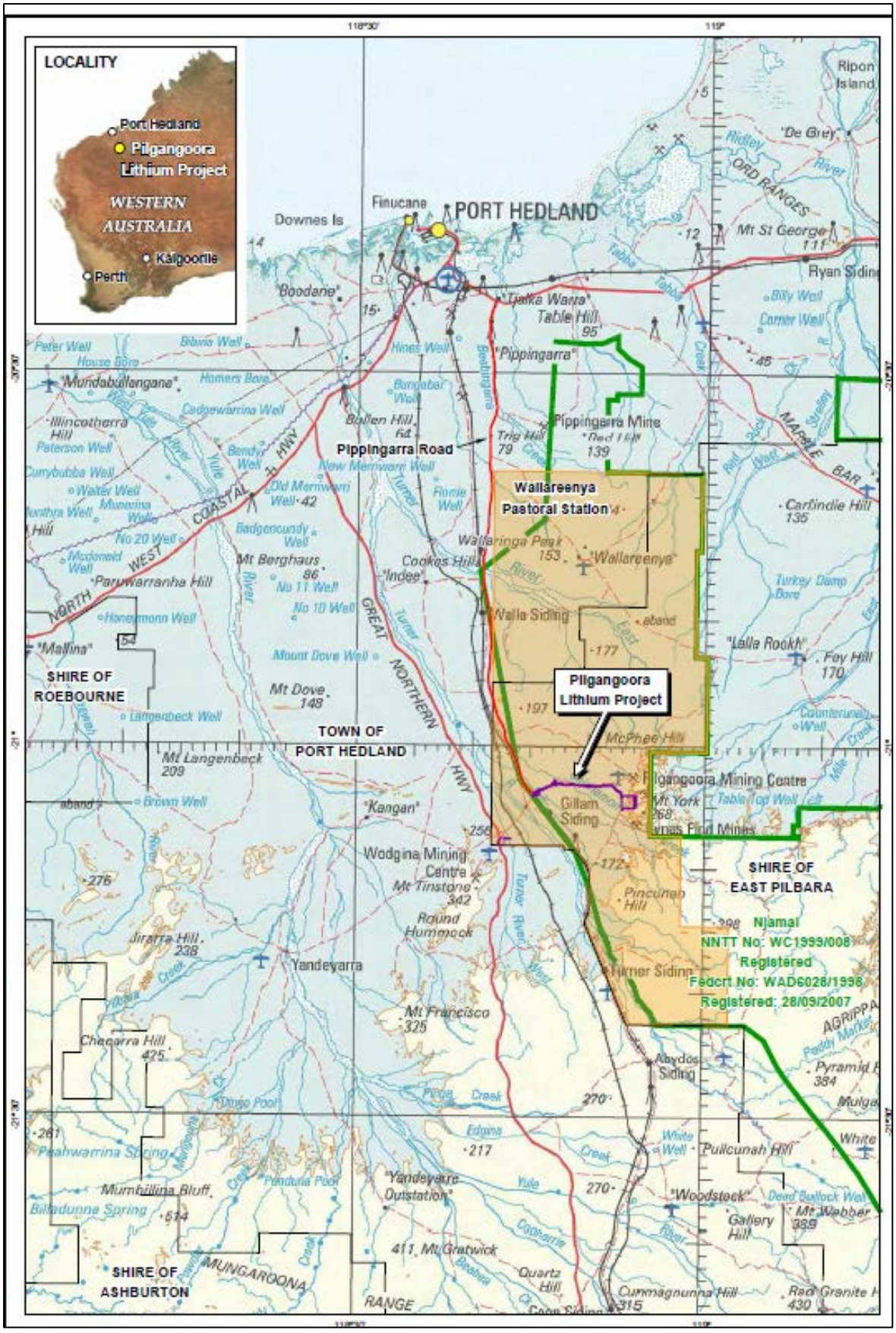

Figure 5: Regional location

7.2 Residential and sensitive Premises

The distances to residential and sensitive receptors are detailed in Table 9.

Table 9: Receptors and distance from activity boundary

Sensitive Land Uses	Distance from Prescribed Activity
Closest residential zoned premises (zoned residential Town of Port Hedland Planning Scheme No. 5)	The residential area of South Hedland is approximately 75 km north-west of the TSF and process plant.
Accommodation camp at the Pilgangoora Lithium-Tantalum Project	Approximately 5 km to the north-east of the TSF.
Wallareenya Homestead	Approximately 35 km north of the Premises.
Wodgina Mine Camp	Approximately 30 km south-west of the Premises.

7.3 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 10. Table 10 also identifies the distances to other relevant ecosystem values which do not fit the definition of a specified ecosystem.

The table has also been modified to align with the *Guidance Statement: Environmental Siting.*

Table 10: Environmental values

Specified ecosystems	Distance from the Premises*
Department of Biodiversity, Conservation and Attractions - Managed Lands and Waters	Mungaroona Range Nature Reserve boundary is located approximately 80 km south-west of the Premises.
Ramsar Sites in Western Australia	The Fortescue Marshes is located approximately 140 km south of the Premises.
Declared Rare Flora	There are no Declared Rare Flora within or in a 30 km radius of the Premises.
Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs)	There are no TECs or PECs within or in a 30 km radius of the Premises.
Biological component	**Distance from the Premises**
Threatened or Priority Flora	The 2016 field flora and vegetation survey did not identify any threatened or priority flora (Mining Proposal, 2017).
Threatened or Priority Fauna	A Level 2 vertebrate fauna assessment was conducted by Natural Area Consulting Pty Ltd in May 2016 which found the following: • The presence of the Rainbow Bee-eater (*Merops ornata*), which is listed as a Migratory species under the *Environment Protection and*

	*Biodiversity Conservation Act 1999 (*EPBC Act). The species is considered a seasonal visitor to the area as the rocky ground is suitable for construction of nesting burrows and it was found near the water bore. • Two active mounds of the Priority 4-listed Western Pebble-mound Mouse (*Pseudomys chapmani*) were observed in the stony plains to the north-west of the site although no individuals were observed.

*DWER's GIS database

7.4 Groundwater and water sources

The distances to groundwater and water sources are shown in Table 11.

Table 11: Groundwater and water sources

Groundwater and water sources	Distance from Premises	Environmental value
Public Drinking Water Source Area (PDWSA)	The Priority 1 Yule River Water Reserve is approximately 50 km north-west of the Premises.	Water is supplied to the town of Port Hedland from bores in the semi-confined deposits of the Yule River.
Major watercourses/waterbodies	The Premises is located within the Chinnamon Creek sub-catchment of the Turner River catchment and ephemeral creeks are common. On a local scale, a number of minor ephemeral creeks occur throughout the Premises. The two most prominent creeklines occurring within the Premises are SE Creek and Western Creek. SE Creek flows into the Premises from the south-east corner. Western Creek joins SE Creek by the proposed stockpile location. Chinnamon Creek and McPhee Creek are approximately 2.5 km south and 8 km south-east of the Premises respectively.	Local internal drainage is generally westward, but with some flow to the north and south. Chinnamon Creek joins the Turner River approximately 20 km to the north-west of the Premises. The Turner River discharges to the sea in tidal flats to the west of Port Hedland.
Groundwater and groundwater salinity	The Premises is located within the Proclaimed Pilbara Groundwater and Surface Water Area. Water depths from existing boreholes constructed by the Licence Holder in the vicinity of the TSF recorded water from a depth of between 14 to 31 m (TSF Design Report).	Groundwater salinity (Total Dissolved Solids (TDS)) is 500-1,000 mg/L which is considered marginal (Salinity status classifications). Groundwater is used for beneficial use and recharge of groundwater is from surface water runoff and flooding events.

Groundwater and water sources	Distance from Premises	Environmental value
	GDS, 2016 states the following: • to the west of the Premises, "*production bores are constructed along the Turner River, which has significant recharge. To the south, groundwater occurs in fractured bedrock associated with the Breccia borefield and fairly significant recharge from Chinnamon Creek*"; and • "*the water supply to Wodgina is sourced from the Breccia borefield, located approximately 3 km to the south of the Altura tenements*" and "*the only other users within a 10 km radius are pastoral bores*".	

7.5 Groundwater Chemistry

GDS, 2016a states that groundwater in the Port Hedland and Pilgangoora region is generally unconfined and occurs in weathered fractured bedrock aquifers comprising granite and greenstone. Recharge occurs mostly from river flow and the most important areas for groundwater resources are in the vicinity of major surface water courses. To the west of the Premises, production bores are constructed along the Turner River, which has significant recharge. To the south, groundwater occurs in fractured bedrock associated with the Breccia borefield and fairly significant recharge from Chinnamon Creek.

The area around the Premises is a bedrock aquifer system with varying degrees of localised fracturing and only small local steam channels providing recharge. Compared to the bores along the Turner River to the east or within the Breccia borefield to the south, the groundwater potential at Pilgangoora can be considered to be poor to moderate.

The local hydrogeology of the project area can be summarised as follows:

- Aquifer type (Fractured rock);
- Water Levels (approximately 20 to 30 metres below ground level (mbgl);
- Direction of groundwater flow (predominantly to the west); and
- Direction of surface water flow (predominantly to the west).

Four monitoring bores (Obs1, Obs2, Obs3 and Obs4) were constructed in the mine area in 2014 and a single pastoral bore (Coppin Bore) is located within the mining area.

Four production bores (PB1, PB2, PB3 and PB4) were constructed at the Premises in May/June 2016 with the purpose of assessing potential inflows into the pit area and to test the prospectivity of the mine area for the development of mine water supply (GDS, 2016a). Figure 6 shows the location of the four test production bores, six monitoring bores and the pastoral bore. These bore details are summarised in Table 12.

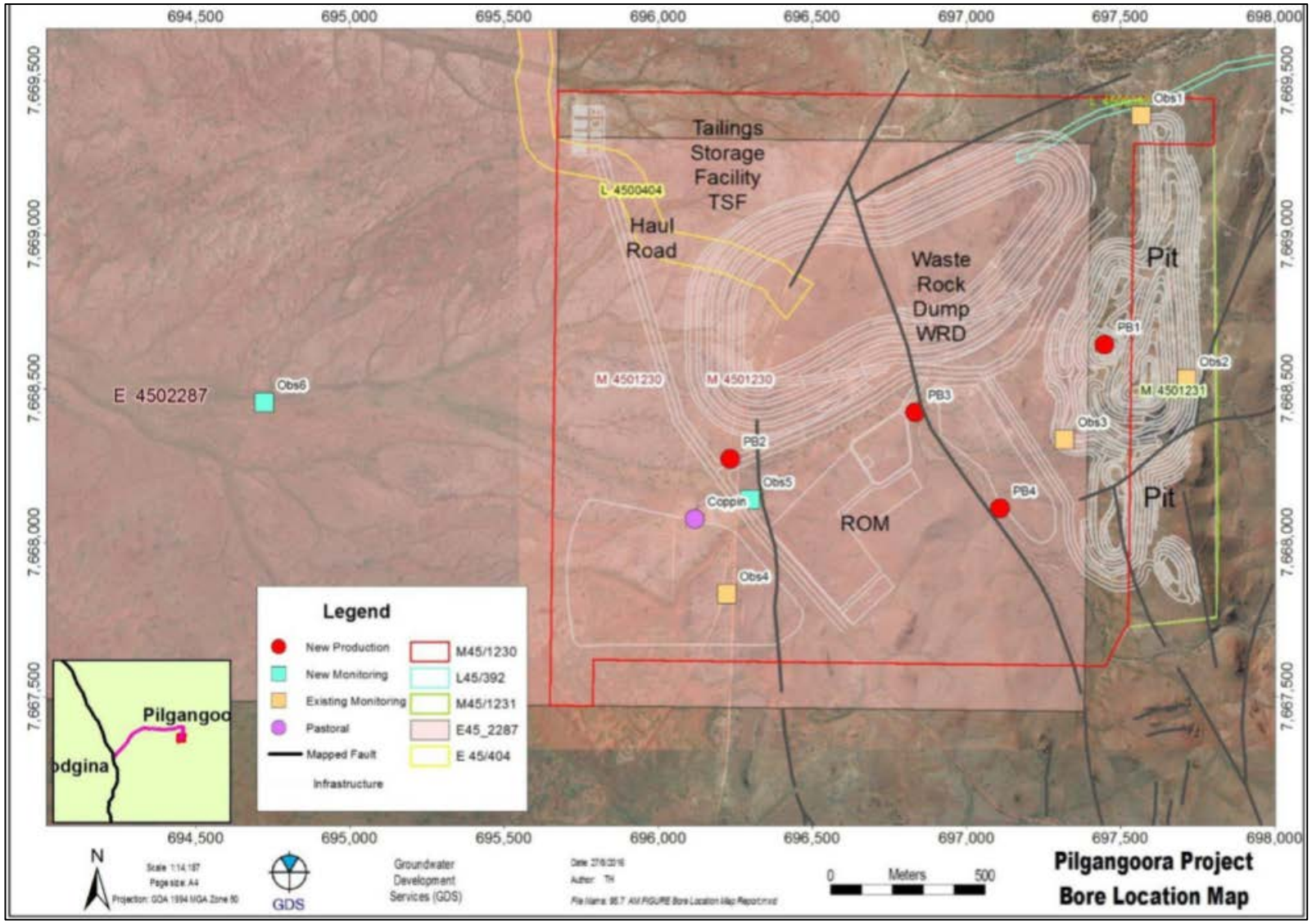

Figure 6: Bore location map

Table 12: Premises production, monitoring and pastoral bore details

HoleID	Easting	Northing	Ground Elevation mAHD	Casing Depth (mbgl)	pH	EC (mS/cm)	SWL (mbTOC)
PB1	697449	7668643	195	100	7.85	1.52	23.77
PB2	696242	7668299	185	83.2	8.06	1.20	15.27
PB3	696830	7668427	196	93.5	7.74	0.75	15.24
PB4	697110	7668111	189	66.5	7.73	1.28	17.74
Obs5	696300	766840	185	Open hole[1]	7.87	0.87	15.61
Obs6	694698	7668464	173	Open hole[2]	N/A	N/A	19.02
HoleID	**Easting**	**Northing**	**Ground Elevation mAHD (GPS)**	**Casing Depth (mbgl)**	**TDS (mg/L)**	**SWL (mbTOC)**	
Obs1	697567	7669387	183	70	1,809	12.34	
Obs2	697715	7668532	202	40	1,825	22.01	
Obs3	697320	7668335	190	40	1,662	17.83	
Obs4	696224	7667834	181	50	1,303	15.21	
Coppin Bore	696119	7668078	181	30-40	-	15.43	

1 Reverse circulation (RC) hole WX15 was converted to an open hole monitoring bore (Obs5) with concrete pad, 6-inch steel surface casing and locking cap.

2 RC hole WX9A was converted to an open hole monitoring bore (Obs5) with a concrete pad, 6-inch steel surface casing and locking cap.

Hydraulic testing of the four production bores was undertaken by Resource Water Group between 27 July and 14 August 2016. Samples were collected at the end of the test pump for the four production bores and submitted for comprehensive chemical analysis (physical parameters, major ions and trace metals). Table 13 provides a summary of the groundwater quality analysis results with a comparison against the *ANZECC, 2000 Livestock; Australian & New Zealand Guidelines for Fresh & Marine Water Quality;* and Australian Drinking Water Guidelines (ADWG) for the purpose of risk assessment review.

Table 13: Summary of Groundwater Quality Analysis Results

Analyte	Units	*Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater* (mg/L)	*ANZECC, 2000 Livestock* (mg/L)	ADWG Health (mg/L)	PB1* 2/11/2016	PB2 2/11/2016	PB2 9/08/2017	PB3 2/11/2016	PB3 9/08/2017	PB4 2/11/2016	PB4 9/08/2017
pH	pH Units	6 to 9	NE	IDH	7.9	7.9	8.2	7.8	8.2	7.9	8.3
Electrical Conductivity @ 25ºC	µS/cm	NE	NE	-	1,600	1,300	1,300	1,100	1,500	1,400	1,300
Total Dissolved Solids Dried @ 175-185ºC	mg/L	NE	<5,000	NN	870	730	710	600	810	770	710
Total Suspended Solids Dried at 103-105 ºC	mg/L	NE	NE	-	<5	<5	<5	<5	<5	<5	<5
Carbonate Alkalinity as CO_3	mg/L	NE	NE	-	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as HCO_3	mg/L	NE	NE	-	630	550	580	410	600	590	600
Total Alkalinity as $CaCO_3$	mg/L	NE	NE	-	510	450	470	340	500	480	490
Total Hardness by Calculation	mg $CaCO_3$/L	NE	NE	NN	590	580	520	490	580	640	600
Fluoride by ISE	mg/L	NE	2.0	1.5	0.7	0.6	0.6	0.3	0.6	0.4	0.4
Silicon, Si	mg/L	NE	NE	-	33	36	28	29	28	42	36

Analyte	Units	*Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater* (mg/L)	*ANZECC, 2000 Livestock* (mg/L)	ADWG Health (mg/L)	PB1* 2/11/2016	PB2 2/11/2016	PB2 9/08/2017	PB3 2/11/2016	PB3 9/08/2017	PB4 2/11/2016	PB4 9/08/2017
Sulfate as SO_4	mg/L	NE	1,000	IDH	37	22	25	19	29	23	23
Chloride, Cl	mg/L	NE	NE	IDH	220	170	160	160	200	190	160
Calcium, Ca	mg/L	NE	1,000	-	51	52	48	70	69	61	58
Magnesium, Mg	mg/L	ND	<600	-	110	110	97	77	98	120	110
Sodium, Na	mg/L	NE	NE	NN	120	73	77	50	89	63	65
Potassium, K	mg/L	NE	NE	-	1.3	2.5	2.1	1.7	1.7	1.2	1.2
Nitrate Nitrogen, NO_3 as N	mg/L	NE	400	50	<0.05	<0.05	2.2	<0.05	1.8	<0.05	1.1
Aluminium, Al	mg/L	0.055	5.0	IDH	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic, As	mg/L	0.013 As V 0.024 As III	0.5 to 5.0[1]	0.01	0.03	0.13	0.075	0.027	0.042	0.051	0.050
Barium, Ba	mg/L	NE	NE	2.0	0.025	0.06	0.061	0.68	0.49	0.034	0.032
Beryllium, Be	mg/L		ND	0.06	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, B	mg/L	0.37	5.0	4.0	0.51	0.36	0.54	0.24	0.55	0.35	0.43
Cadmium, Cd	mg/L	0.0002	0.01	0.002	<0.0001	<0.0001	0.0001	0.0012	0.0012	<0.0001	<0.0001
Cobalt, Co	mg/L	ID	1.0	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Analyte	Units	*Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater* (mg/L)	*ANZECC, 2000 Livestock* (mg/L)	ADWG Health (mg/L)	PB1* 2/11/2016	PB2 2/11/2016	PB2 9/08/2017	PB3 2/11/2016	PB3 9/08/2017	PB4 2/11/2016	PB4 9/08/2017
Chromium as CrVI	mg/L	0.0004	1.0	0.05	<0.001	0.002	0.001	<0.001	0.002	<0.001	<0.001
Copper, Cu	mg/L	0.0014	1.0	2.0	<0.001	<0.001	0.001	0.002	0.002	<0.001	<0.001
Lead, Pb	mg/L	0.0034	0.1	0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese, Mn	mg/L	NE	NT	0.5	<0.001	0.002	<0.001	0.006	<0.001	0.002	<0.001
Molybdenum, Mo	mg/L	ID	0.15	0.05	<0.001	0.001	0.001	<0.001	0.002	<0.001	<0.001
Nickel, Ni	mg/L	0.011	1.0	0.02	0.006	0.006	0.003	0.008	0.006	<0.001	0.002
Zinc, Zn -	mg/L	0.008	20	IDH	0.007	0.006	0.006	0.04	0.042	<0.005	0.006
Iron, Fe	mg/L	ID	ID	IDH	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Antimony, Sb	mg/L	ID	NE	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Se	mg/L	0.011	0.02	0.01	0.003	0.002	0.003	0.002	0.004	0.002	0.003
Tin, Sn	mg/L	ID	NE	NN	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium, V	mg/L	ID	ND	-	0.097	0.059	-	0.020	-	0.064	-
Mercury, Hg	mg/L	0.0006 (inorganic)	0.02	0.001	<0.00005	<0.00005	-	<0.00005	-	<0.00005	-

*PB1 has been decommissioned (blasted in pit area) and is no longer being used.

Note 1: May be tolerated if not provided as a food additive and natural levels in the diet are low (*ANZECC, 2000 Livestock*).

ND = Not determined. Insufficient background data to calculate (*ANZECC, 2000 Livestock*)

NT = Not sufficiently toxic (*ANZECC, 2000 Livestock*)

NE = Not established (*ANZECC, 2000 Livestock*)
ID = Insufficient data to derive a reliable trigger value (*Australian & New Zealand Guidelines for Fresh & Marine Water Quality - 95% level of species protection for freshwater*)
NN = Not necessary (*ADWG - Health*)
IDH = Insufficient data to set a guideline value based on health considerations (*ADWG - Health*)

Red highlight indicates an exceedance of the *ADWG* - Health and *Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater*.

Purple highlight indicates an exceedance of the *Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater*.

TSF Compliance Report states that monitoring bores were installed at four locations around the TSF. In each location two bores were drilled, one shallow (approximately 10 m depth) and one deep (extending 25 m below the water table). The shallow bore is intended to detect any seepage from the TSF flowing within the surface sediment, whilst the deep bore will monitor the chemical composition of the groundwater.

Monitoring bore locations are provided in Figure 7 and the results from a suite of groundwater monitoring (5 August 2018) is provided in Table 14 (Altura, 2018a).

Table 14: TSF monitoring bore locations

Bore ID	Easting	Northing	mRL	Water Depth (m)	EC (mS/cm)	pH	Temp
MB-01-1	695866	7668375	178.69	-	-	-	-
MB-01-2	695857	7668377	178.77	14.17	1.24	8.0	29.5
MB-02-1	695676	7668667	176.54	14.92	2.00	7.51	29.1
MB-02-2	695676	7668674	176.35	-	-	-	-
MB-03-1	695679	7669010	178.57	-	-	-	-
MB-03-2	695680	7669017	178.69	17.42	1.15	7.60	29.5
MB-04-1	695884	7669284	179.92	17.33	1.20	7.80	28.7
MB-04-2	695883	7669290	178.75	-	-	-	-

No baseline samples have been provided by the Licence Holder for the ability to compare data. The Licence Holder has committed to a TSF monitoring program as shown in Table 28 (section 8.5.5).

Figure 7: TSF monitoring bore locations

7.6 Tailings characterisation

GCA, 2016 states that a programme of static-testing (i.e. 'whole-rock' analyses and tests) and kinetic-testing (i.e. weathering testing via humidity-cells operated at 30ºC) was completed for representative samples of:

- Flotation-Tailings (FT); and
- DMS-solids.

Three FT and one DMS-solids samples were provided to Graeme Campbell & Associates Pty Ltd in December 2015 and April 2016. A geochemical characterization of the FT and DMS-solids was completed, which assessed options for managing the FT and DMS-solids streams either individually, or as a 'combined-stream'.

Key FT geochemistry findings (Preston Consulting, 2017a):

- All samples are classified as Non-Acid Forming (NAF), due to negligible amounts of sulphide-minerals (viz. Total-S values less than 0.01%); and
- Multi-element composition and mineralogy shows that enrichments are not marked, and correspond to forms that are biogeochemically 'fixed' (i.e. incorporated within the crystal-lattices of silicates, oxides, etc.).

The multi-element-analysis results for process-stream-solids samples are shown in Table 15. *DER, 2016* states that tailings solids appear to be enriched in numerous metals, in particular lithium (Li), arsenic (As), chromium (Cr), lead (Pb), zinc (Zn), thallium (Tl), bismuth (Bi), tin (Sn) and tantalum (Ta).

Leachates from columns of tailings materials were analysed with the results presented in Tables 16 and 17:

- The leachate-pH values were ca. 7-8, and the leachate-EC values swiftly dropped to less than 100 µS/cm, due to rapid, quantitative 'wash-out' of solutes. The leachate-alkalinities remained fairly constant in the low-tens-of-mg/L (as $CaCO_3$) range, and likely reflects contributions from 'minute-calcites';
- Geochemically, the weathering and solubility behaviour exhibited by the FT- solids sample were consistent with the basic geochemistry and mineralogy of the FT-solids sample, i.e. 'zero-sulphides' in a 'gutless-gangue' devoid of even carbonate-minerals; and modest enrichments in a few minor-elements that are lattice-bound' (i.e. 'fixed');
- A wide range of minor-elements exhibited solubilities which were either consistently 'non-detects', or close to the respective detection-limits (viz. typically 0.1 - 10 µg/L range);
- In terms of drinking-water quality, the FT-solids-leachates were essentially potable: the leachate-As concentrations ranged up to the Australian guideline value of 10 µg/L for drinking-water (NHMRC, 2015); and
- The leachate-Li concentrations swiftly reached a steady-stage value within range of 10 - 100 µg/L, and attests to the stability of the Total-Li of ca. 800 mg/kg in the FT-solids sample.

Table 15: Multi-Element-Analysis Results for Process-Stream-Solids, Samples (GCA, 2016)

		S	Ca	Mg	Na	K	Al	Fe	Li	As	Sb	Se	Mo	B	F	Ni	Cr	Co	Cu	Zn	Cd	Pb	Hg
		%							mg/kg	mg/kg						mg/kg							
GCA11429	Flotation-Tailings-[HG]-Solids (Dec'15)	<0.005	<0.1	0.02	3.12	1.99	6.39	0.42	828.3	0.6	0.11	<0.01	0.3	<50	872	4	456	0.3	3	94	0.21	7.0	<0.01
GCA11437	Flotation-Tailings-[LG]-Solids (Dec. '15)	<0.005	0.2	0.02	4.08	2.03	6.80	0.15	256.2	20.4	<0.05	<0.01	0.3	<50	307	2	<50	0.2	<1	37	<0.02	7.8	<0.01
GCA11534	Flotation-Tailings-Solids (April '16)	<0.005	0.1	0.05	3.30	2.23	6.61	0.30	1,145.9	0.6	0.35	<0.01	5.9	<50	740	31	<50	0.8	7	68	0.05	8.8	<0.01
GCA11430	Dense-Media-Separation-Solids	<0.005	<0.1	0.02	3.04	2.46	6.79	0.18	1,167.4	0.6	0.16	<0.01	<0.1	<50	560	<1	<50	0.1	<1	64	0.31	10.5	<0.01
	Average-Crustal Abundance (Bowen 1979)								20	1.5	0.2	0.05	1.5	10	950	80	100	20	50	75	0.11	14	0.05

		Ag	Tl	Ba	Sr	Bi	P	Mn	Sn	Ta	V	Th	U
		mg/kg											
GCA11429	Flotation-Tailings-[HG]-Solids (Dec'15)	<0.05	13.55	12.3	9.29	3.11	98	371	52.5	18.38	<1	0.54	1.52
GCA11437	Flotation-Tailings-[LG]-Solids (Dec. '15)	<0.05	12.59	5.6	12.73	0.09	143	95	23.7	15.22	1	0.33	0.74
GCA11534	Flotation-Tailings-Solids (April '16)	0.08	12.69	36.0	15.69	3.96	115	310	43.7	20.79	<1	1.04	1.66
GCA11430	Dense-Media-Separation-Solids	0.08	15.26	10.1	11.63	9.87	283	261	34.5	28.48	<1	2.15	2.74
	Average-Crustal Abundance (Bowen 1979)	0.07	0.6	500	370	0.05	1,000	950	2.2	2	160	12	2.4

Highlighted Assays:

signifies element content 10-100 times average-crustal abundance

signifies element content 100+ times average-crustal abundance

Table 16: Leachate-analysis results for Humidity-Cells (FT-solids)

PARAMETER / ELEMENT	INITIAL PRE-RINSE-CYCLE 'Week-0'	WEEKS OF WEATHERING @ 30 oC (GWC = 3-8 % [w/w])			
		2	4	6	12
pH, Salinity & Alkalinity					
pH	7.6 (7.6)	7.5 (7.5)	7.7	7.3 (7.3)	7.3
pH (GCA)	8.3	7.9	7.8	7.6	7.9
EC (µS/cm)	377 (377)	95 (96)	66	55 (55)	60
EC (GCA, µS/cm)	330	99	79	64	57
HCO3 (mg/L CaCO3)	86 (86)	43 (43)	36	31 (28)	27
HCO3 (GCA, mg/L CaCO3)	78	39	32	25	27
Major-Ion Chemistry					
Ca (mg/L)	5.26	3.63	4.58	4.66	5.00
Mg (mg/L)	4.66	2.67	3.21	3.01	2.59
K (mg/L)	5.4	3.1	2.2	1.5	1.5
Na (mg/L)	67.4	13.0	4.3	1.9	2.0
Cl (mg/L)	55 (52)	5 (6)	<2	<2 (<2)	<2
SO4 (mg/L)	7	<1	<1	<1	<1
F (mg/L)	1.1 (1.1)	0.2 (0.3)	0.1	<0.1 (<0.1)	0.2
Al (mg/L)	0.08	0.12	0.02	0.02	0.17
Fe (mg/L)	0.02	0.03	0.02	<0.01	0.01
Si (mg/L)	7.47	9.79	8.62	8.48	8.60
Minor-Element Chemistry					
Li (µg/L)	399.48	135.6	76.92	48.00	64.36
Rb (µg/L)	116.56	60.75	52.97	42.90	40.18
Cs (µg/L)	2.9	1.3	1.2	1.1	2.0
Ta (µg/L)	<0.01	0.05	0.01	<0.01	0.02
As (µg/L)	13.9	9.0	6.2	5.4	10.4
Sb (µg/L)	1.85	0.95	0.64	0.54	1.38
B (µg/L)	320	90	90	80	170
Mo (µg/L)	5.66	0.96	0.47	0.32	1.14
Se (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5
P (µg/L)	<100	<100	<100	<100	<100
Cu (µg/L)	10	<10	<10	<10	<10
Zn (µg/L)	<10	<10	<10	<10	10
Cd (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5
Pb (µg/L)	3	<2	<2	<2	<2
Ni (µg/L)	<10	<10	<10	<10	<10
Cr (µg/L)	<10	<10	<10	<10	<10
Co (µg/L)	0.4	0.1	<0.1	<0.1	<0.1
Hg (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1
Mn (µg/L)	90	70	110	120	70
Sn (µg/L)	<0.1	<0.1	<0.1	<0.1	0.2
Ag (µg/L)	0.01	0.01	0.02	0.03	0.10
Ba (µg/L)	6.94	4.39	1.89	1.80	2.92
Sr (µg/L)	39.23	20.75	22.47	20.55	22.54
Bi (µg/L)	0.047	0.162	0.051	0.022	0.043
Tl (µg/L)	0.23	0.13	0.11	0.11	0.13
Th (µg/L)	0.007	0.034	0.011	<0.005	0.013
U (µg/L)	24.725	1.032	0.728	0.525	3.240
V (µg/L)	<10	<0.1	<10	<10	<10
Leachate Wt (kg)	0.43	0.32	0.33	0.36	0.36

Notes: EC = Electrical-Conductivity; values in parentheses represent duplicate determinations.
GWC = Gravimetric-Water Content

Table 17: Leachate-analysis results for Humidity-Cells (DMS-solids)

PARAMETER / ELEMENT	INITIAL PRE-RINSE-CYCLE 'Week-0'	WEEKS OF WEATHERING @ 30 oC (GWC = 3-8 % [w/w])			
		2	4	6	12
pH, Salinity & Alkalinity					
pH	6.3	6.8	7.2 (7.2)	6.7	6.7 (6.7)
pH (GCA)	6.8	7.2	7.2	6.9	7.3
EC (µS/cm)	113	37	25 (25)	11	30 (30)
EC (GCA, µS/cm)	110	40	27	14	26
HCO3 (mg/L CaCO3)	6	13	12 (12)	6	11 (12)
HCO3 (GCA, mg/L CaCO3)	5	12	10	7	9
Major-Ion Chemistry					
Ca (mg/L)	2.70	1.35	1.51 (1.52)	0.69	1.91
Mg (mg/L)	1.86	0.97	1.03 (1.04)	0.45	1.10
K (mg/L)	2.0	1.3	0.9 (0.9)	0.6	0.8
Na (mg/L)	14.9	4.2	1.6 (1.6)	0.6	0.7
Cl (mg/L)	12	2	<2 (<2)	<2	<2 (<2)
SO4 (mg/L)	12	2	<1	<1	1
F (mg/L)	0.4	0.7	0.8 (0.8)	0.4	0.8 (0.8)
Al (mg/L)	0.10	0.04	0.02 (0.02)	0.03	0.06
Fe (mg/L)	<0.01	<0.01	0.01 (<0.01)	<0.01	<0.01
Si (mg/L)	0.33	1.48	0.99	0.30	0.89
Minor-Element Chemistry					
Li (µg/L)	43.80	24.06	12.71 (12.96)	5.24	13.15
Rb (µg/L)	21.49	11.94	11.29 (11.56)	6.91	10.77
Cs (µg/L)	2.0	1.2	1.8 (1.8)	0.9	2.0
Ta (µg/L)	<0.01	<0.01	<0.01 (<0.01)	<0.01	0.02
As (µg/L)	2.9	4.6	3.0 (3.1)	1.7	3.6
Sb (µg/L)	0.19	1.72	1.05 (1.07)	0.29	1.00
B (µg/L)	40	60	50 (60)	40	100
Mo (µg/L)	0.39	0.46	0.11 (0.14)	0.07	0.21
Se (µg/L)	<0.5	<0.5	<0.5 (<0.5)	<0.5	<0.5
P (µg/L)	<100	<100	<100 (<100)	<100	<100
Cu (µg/L)	<10	<10	<10 (<10)	<10	<10
Zn (µg/L)	<10	<10	10 (<10)	<10	<10
Cd (µg/L)	<0.5	<0.5	<0.5 (<0.5)	<0.5	<0.5
Pb (µg/L)	<2	<2	<2 (<2)	<2	<2
Ni (µg/L)	<10	<10	<10 (<10)	<10	<10
Cr (µg/L)	<10	<10	<10 (<10)	<10	<10
Co (µg/L)	0.5	<0.1	<0.1 (<0.1)	<0.1	<0.1
Hg (µg/L)	<0.1	<0.1	<0.1 (<0.1)	<0.1	<0.1
Mn (µg/L)	20	10	10 (10)	<10	10
Sn (µg/L)	<0.1	<0.1	<0.1 (<0.1)	<0.1	<0.1
Ag (µg/L)	<0.01	<0.01	0.01 (0.02)	0.01	0.01
Ba (µg/L)	6.22	2.18	1.71 (1.65)	0.79	2.14
Sr (µg/L)	19.18	7.96	8.13 (8.48)	3.56	10.09
Bi (µg/L)	0.171	0.044	0.039 (0.043)	0.094	0.094
Tl (µg/L)	0.12	0.06	0.07 (0.07)	0.03	0.06
Th (µg/L)	<0.005	<0.005	<0.005 (<0.005)	<0.005	<0.005
U (µg/L)	0.243	11.986	12.946 (12.893)	5.844	22.216
V (µg/L)	<10	<10	<10 (<10)	<10	<10
Leachate Wt (kg)	0.63	0.77	0.74	0.76	0.77

Note: **1.50 kg dry-solids** flushed with **1.00 kg** HPDW.

Tailings slurry water (Table 18):

- The sample had a pH value of 7 -8, and TDS value of 400 - 500 mg/L;
- The recorded Fe and Al concentrations within the near-mg/L range indicate colloidal-sized minerals that passed through the 0.45 µm-membrane during filtration. Part of the recorded Si concentration also reflects such colloidal forms;
- In terms of drinking-water quality, the tailings-slurry-water was essentially potable (NHMRC 2015);
- The Li concentration was ca. 400 µg/L;
- The sample was analysed for a wide range of 'organics' (viz, recoverable hydrocarbons of different chain lengths from C6 to C40, volatile hydrocarbons, polycyclic aromatic hydrocarbons [PAHs], etc.). The C10-C14 and C15-C28 fractions with concentrations of 2.9 - 3.3 mg/L and 0.81 - 0.91 mg/L, respectively, likely reflect residual oleic acid employed in flotation; and
- All analyses for volatile hydrocarbons, PAHs, etc. resulted in 'non-detects'.

Table 18: Analysis results for FT-slurry-water sample

ELEMENT/ PARAMETER	FT-Slurry-Water (GCA11535)	ELEMENT/ PARAMETER	FT-Slurry-Water (GCA11535)
Major-Parameters		***Minor-Ions (µg/L)***	
pH	7.7 (7.7)	Li	428.43 (394.18)
pH (GCA)	8.0	Ta	0.70 (0.72)
EC (µS/cm)	800 (810)	Cu	<10 (<10)
EC (GCA, µS/cm)	785	Ni	<10 (<10)
TDS-(grav.) [mg/L]	455 (457)	Zn	10 (10)
alkalinity (mg/L CaCO3)	93 (92)	Co	<0.1 (<0.1)
alkalinity (GCA, mg/L CaCO3)	89	Cd	<0.5 (<0.5)
		Pb	2 (<2)
Major-Ions (mg/L)		Cr	<10 (<10)
		Hg	<0.1 (<0.1)
Na	144.5 (140.9)	As	8.6 (8.2)
K	8.2 (8.2)	Sb	0.35 (0.32)
Mg	3.64 (3.68)	Bi	1.683 (1.580)
Ca	4.57 (4.63)	Se	<0.5 (<0.5)
Cl	189 (190)	B	0.34 (0.34)
SO_4	20 (21)	Mo	4.66 (4.62)
F	1.3 (1.3)	P	<100 (<100)
		Ag	0.03 (0.03)
Al	**0.75 (0.80)**	Ba	11.73 (11.37)
Fe	**0.49 (0.50)**	Sr	39.36 (38.04)
Si	**18.78 (18.92)**	Tl	0.62 (0.60)
		V	<10 (<10)
		Sn	0.9 (0.9)
		U	4.211 (4.078)
		Th	0.215 (0.219)
		Mn	90 (90)

Notes:
EC = Electrical-Conductivity; TDS-(grav.) = Total-Dissolved-Solids-(gravimetric).
Values in parentheses represent duplicate determinations.

The Licence Holder has committed to sampling the TSF slurry water annually over the life of the mine.

DMS-solids geochemistry findings:

- The sample is classified as NAF, due to negligible amounts of sulphide-minerals (viz. Total-S less than 0.01%);
- The sample had element contents below, or close to, those typically recorded for soils, regoliths and bedrocks free from mineralisation influences;
- The sample comprised chiefly albites, muscovites, K-feldspars and quartz, with subordinate spodumene; and
- In essence, compositionally and mineralogically, the DMS-solids and FT-solids were identical.

Preston Consulting, 2017a states that "*(From all geochemical viewpoints, the FT and DMS solids streams are inert with 'near-zero' risk for water-quality impacts where left in a free-draining state. This affords considerable 'degrees- of-freedom' in options for the management of these process-streamsGCA 2016a)".*

DWER considers that while the leaching tests carried out to date are reasonable, and indicate a relatively low risk in regard to initial leachate water quality. DWER believes that the conclusion by *GCA, 2016* that the FT and DMS-solids streams are "inert with 'near-zero' risk for water quality impacts where left in a free-draining state" has far overreached the scope of the tests carried out.

DER, 2016 states that "*It is significant to note that the concentrations of uranium measured in the initial pre-rinse cycle for flotation-tailings solids (24.7 µg/L), and in the 12 week cycle for the dense-media separation solids (22.2 µg/L), exceeded Australian Drinking Water Guideline values (17 µg/L), so it is incorrect to assert that "the FT-solids-leachates were essentially potable…*".

DER, 2016 also states that "*Humidity cell testing did not reveal concentrations of trace metals at levels posing any environmental concern*".

The Licence Holder has provided (Table 19) information on analytes that were elevated in crustal abundance including a comparison against the *ADWG*.

Table 19: Tailings characterisation results – comparison with *ADWG*

Analyte of concern to DER	Maximum concentration or limit of reporting in tailings leachate testing (µg/L)	ADWG level (µg/L)	Assessment
Lithium	135	Not listed	Lithium levels of 70 – 170 µg/L are common in water supply schemes
Arsenic	10.4	10	This was expected given the elevated Arsenic concentrations in the underlying groundwater (~10-13 µg/L)
Chromium	10	50	Below ADWG
Lead	2	10	Below ADWG
Zinc	10	3,000	Below ADWG
Thallium	0.13	Not listed	Not listed in the ADWG however average concentrations in US water supply are 0.89 µg/L, indicating that Thallium is not a concern
Bismuth	0.162	Not listed	Generally considered to be non-toxic
Tin	0.2	Listed as "not necessary"	ADWG state that Tin is one of the least toxic metals
Tantalum	0.05	Not listed	Generally considered to be non-toxic
Uranium	3.24	17	Well below ADWG. Also see below assessment for Thorium
Thorium	0.034	Not listed	Radiation testing has confirmed that material on site is non-radioactive (i.e. is generally low in Uranium and Thorium) – see Radionuclide report attached to Mining Proposal in Attachment 9 for more information.

7.7 Soil type

DWER's GIS dataset identifies that soil types within the Premises are generally shallow and stony and there are large areas without soil cover: chief soils are brown loams (Um6.23) along with significant areas of earthy loam (Um5.51) soils. (Dr2.33) soils occur on lower slopes with (Uf6.71) and (Ug5.37) soils on valley floors. In some areas of the Premises the chief soils are hard alkaline red soils (Dr2.33) and (Dr2.43). There are more areas of (Um5.11) soils on calcrete (kunkar) than in unit Oc62 and some (Uc5.11) and (Uc1.22) soils occur along creeks (Northcote, 1960-68).

Soil materials were investigated by Significant Environmental Services in 2016. Chemical analysis indicated the soils to be (Mining Proposal, 2017):

- Mildly to strongly alkaline (pH 7.6 – 8.8);
- Non-saline (i.e. low EC);
- Non-sodic (i.e. low in exchangeable sodium);
- Low in organic matter and mineral nutrients (except for phosphorus); and

- Have a balanced to high calcium/magnesium ratio, and moderate to high cation-exchange capacity.

7.8 Meteorology

7.8.1 Regional climatic aspects

The region experiences a semi-desert tropical climate characterised by hot days and sporadic rainfall, often associated with cyclonic events (Mining Proposal, 2017). The climate at the Premises is classified as arid-tropical with two distinct seasons, hot summers from October to April and mild winters from May to September.

7.8.2 Rainfall and temperature

DWER's GIS dataset indicates the Premises lies between evaporation isopleths 3,400 mm per year (mm/year) and 3,600 mm/year. The Mining Proposal, 2017 states the annual pan evaporation at Port Hedland and Marble Bar is 3,600 mm (6.6-12.9 mm per day) and 3,300 mm respectively, varying from 5.5-12.5 mm per day winter to summer.

The Bureau of Meteorology provides the ARI for the Premises as shown in Figure 8. Figure 9 provides the mean rainfall and maximum temperatures for Marble Bar (mean maximum temperature 2000-2017 and mean rainfall 2000-2017).

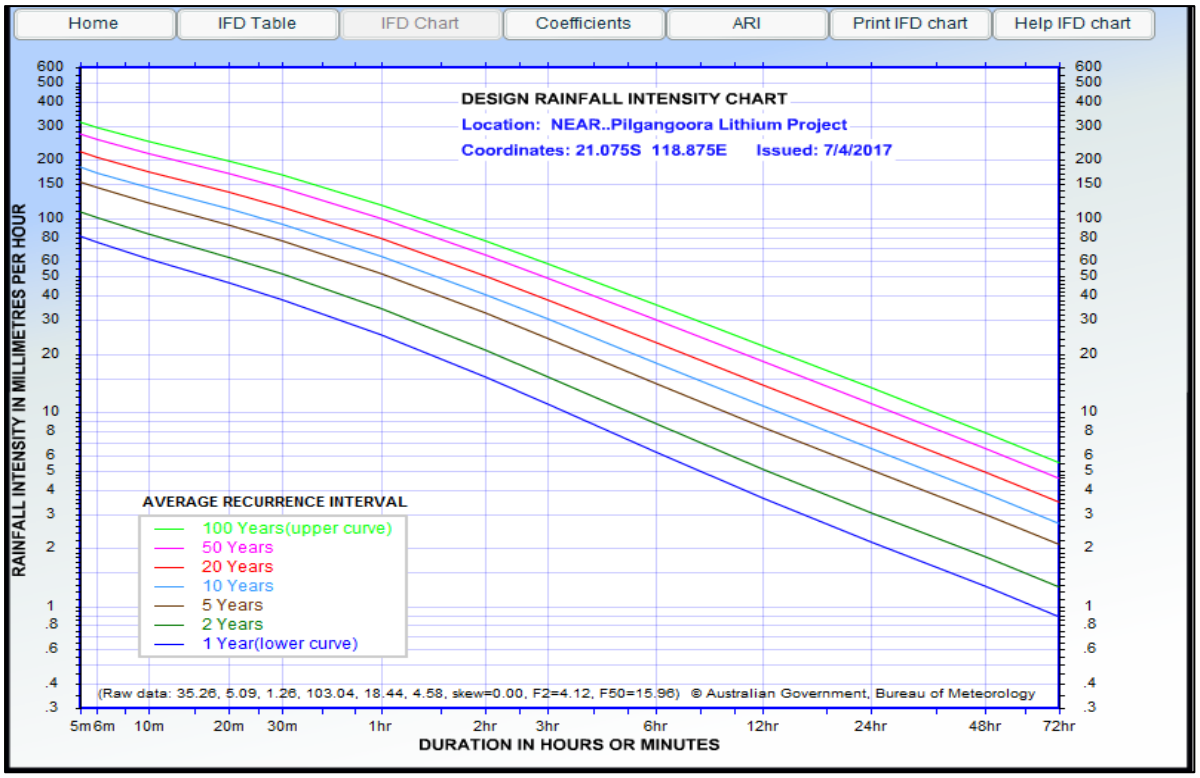

Figure 8: Design Rainfall Intensity Chart

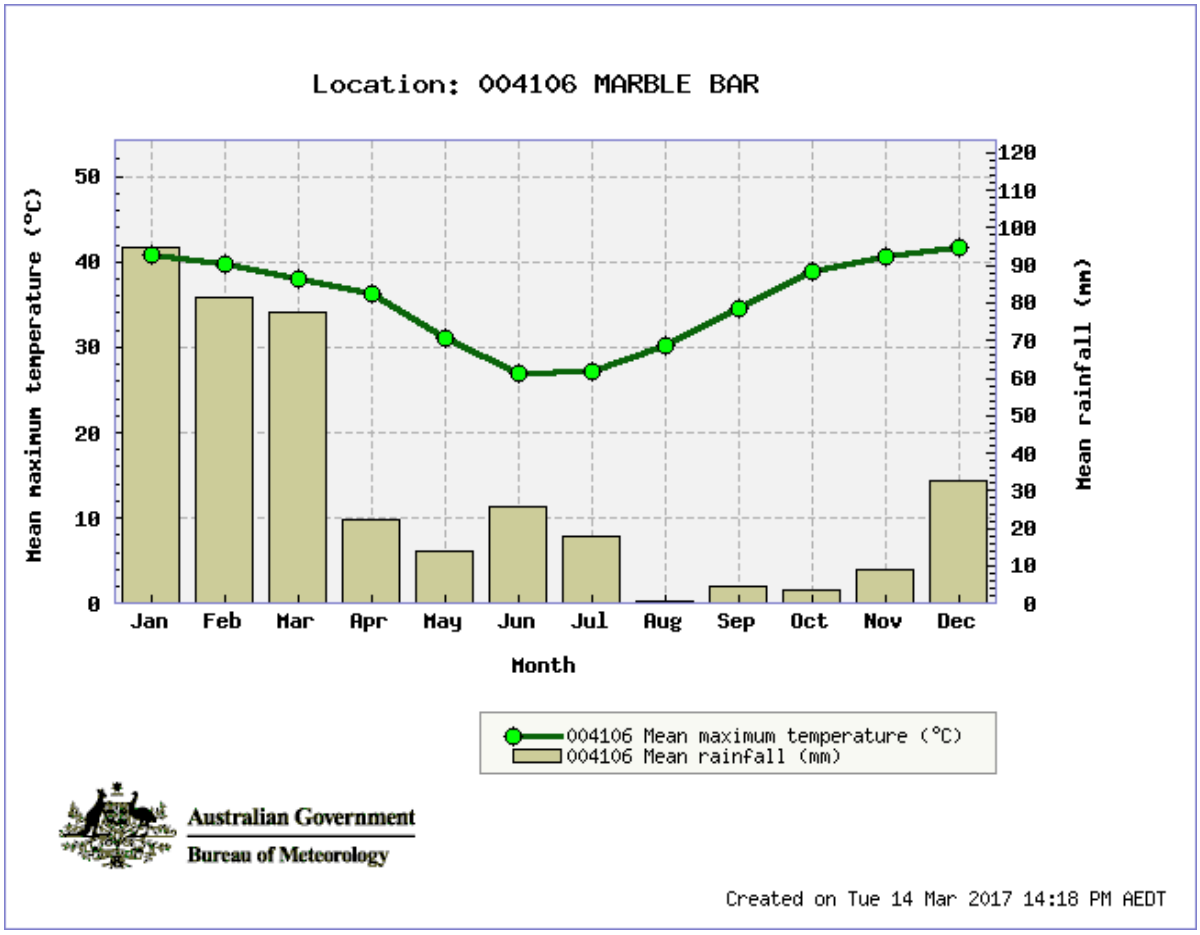

Figure 9: Mean temperatures and rainfall, Marble Bar

8. Risk assessment

8.1 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 20.

The identification of the sources, pathways and receptors to determine Risk Events is set out in Table 20 below.

Table 20: Identification of emissions, pathway and receptors during operation

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Processing or beneficiation of metallic or non-metallic ore	Operation of process plant, movement of ore through crushing and screening circuit, ROM pad, stockpiles and conveyors	Dust	No residences in proximity	Air / wind dispersion	None	No	No receptor present.
			Adjacent vegetation		Potential suppression of photosynthetic and respiratory functions	No	Limited impact on vegetation (dust impacts are temporary). There are no Declared Rare Flora, TECs or PECs within or in a 30 km radius of the Premises.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
	Wet processing (classification cyclone, flotation circuit, LIMS, WHIMS, tailings thickeners)	Slurry with diluted dispersant reagents	Terrestrial ecosystems and drainage lines adjacent to where the spillage has occurred	Pipeline failure or tank/bund overflow causing spill to ground; flow to vegetation and drainage lines dependent on size	Death or adverse impact to adjacent vegetation Soil contamination	No	The Licence Holder has implemented the following controls: • The process plant is located outside major known drainage lines; • The process plant is located on concrete footing and the wet processing area is bunded retaining all spillages; and • Processing reagents are stored in accordance with *Australian Standard 1940-2004 The Storage and Handling of Flammable and Combustible Liquids*. The Delegated Officer considers the application of the following sufficient in terms of regulatory controls: • General provisions of the EP Act; • *Environmental Protection (Unauthorised Discharges) Regulations 2004;* and • *Dangerous Goods Safety Act 2004* and associated Regulations.
	Process water dam and associated pump and piping system	Process plant runoff and some water from the process plant circuit (before the reagents and thickeners are added)	Terrestrial ecosystems adjacent to the pond	Overflow from Process water pond Seepage through liner	Soil contamination	Yes – Refer to section 8.4	Potential to cause soil contamination if overflows or leaks occur.
	All processing activities	Noise	No residences or other sensitive receptors in proximity	Air / wind dispersion	None	No	No receptor present.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
		Contaminated stormwater	Drainage lines Riparian vegetation	Stormwater runoff Gravity flow overland	Contamination of drainage lines with sediment and metals in sediment Loss of riparian vegetation	No	The Licence Holder has implemented the following controls: • Surface water is managed in accordance with *EMP, 2017*; • *"The process plant is located on concrete footing and surface water run-off is captured and diverted away from the dry circuit using a combination of diversion drains and culverts into a designated low catchment pond / v drain located near the side of the road into site"* (Altura, 2018b); • *"General collector and diversion drains redirect surface water flows from major infrastructure locations and into ephemeral drainage lines*" (W6036 Compliance Report, 2018a); • Sedimentation basins (designed for 5-10 year ARI flow event) have been fitted with control outlets at low points to treat surface water flows prior to discharge; and • Flood protection of infrastructure provided at the 50-100 year protection level based on a 15 year life-of-mine. The Delegated Officer considers the general provisions of the EP Act and *Environmental Protection (Unauthorised Discharges) Regulations 2004* sufficient in terms of regulatory controls.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
		Leaks and spills of hydrocarbons and chemicals	Terrestrial ecosystems adjacent to where the spillage has occurred	Spill to ground or leak, overflow during filling or leak from pipework	Soil and/or groundwater contamination	No	Managed under Dangerous Goods Site Licence number DGS022272. The general provisions of the EP Act and *Environmental Protection (Unauthorised Discharges) Regulations 2004* apply, as does the *Dangerous Goods Safety Act 2004* and associated Regulations.
	TSF	Tailings overflows from the TSF	Terrestrial ecosystems adjacent to the TSF	Direct discharges to land and infiltration to soil	Soil contamination inhibiting vegetation growth and survival	Yes – Refer to section 8.5	Potential to cause soil contamination if overflows occur.
		Discharge of tailings through TSF embankment failure	Drainage lines in pathway of tailings Soil and vegetation	Direct discharges to land and infiltration to soil	Death or adverse impact to adjacent vegetation Soil contamination	No	Managed by DMIRS under the *Mining Act 1978*.
		Tailings seepage	Soil Subterranean fauna Adjacent vegetation Groundwater	Seepage to groundwater adjacent to the TSF and seepage from the base of the TSF with infiltration into soils	Groundwater mounding Inundation of vegetation root zones, resulting in poor vegetation health or death Groundwater contamination Soil contamination inhibiting vegetation growth and survival	Yes – Refer to section 8.5	Potential to cause groundwater mounding inundating root zones of vegetation, groundwater and soil contamination.

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
		Dust from surface of TSF containing tailing contaminants	No residences or other sensitive receptors in proximity	Air / wind dispersion	Potential to be deposited on vegetation and may prevent photosynthesis and plant respiration	No	The Delegated Officer considers the natural dust tolerance of vegetation species should prevent vegetation impacts. There are also no Declared Rare Flora, TECs or PECs within or in a 30 km radius of the Premises.
		Spillage of tailings and/ or supernatant through leaks, pipeline ruptures or failure	Terrestrial ecosystems adjacent to the process plant, TSF and pipelines	Direct discharge to land and infiltration to soil	Soil contamination inhibiting vegetation growth and survival	Yes – Refer to section 8.5	Potential for soil contamination through release of tailings slurry/tailings supernatant.

8.2 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 21 below.

Table 21: 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 22 below.

Table 22: 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.

8.3 Acceptability and treatment of Risk Event

DWER will determine the acceptability and treatment of Risk Events in accordance with the risk treatment table 23 below:

Table 23: 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.

8.4 Risk Assessment - Leaks or overflows from the process water dam

8.4.1 Description of leaks/overflows from the process water dam

A high density polyethylene (HDPE) lined process water dam (turkeys nest) stores naturally occurring groundwater, process plant runoff and some water from the process plant circuit (before the reagents and thickeners are added) (Altura, 2017b). Releases to the environment may occur through overflows due to poor process controls (i.e. pump failure or liner leaks) or extreme rainfall events.

8.4.2 Identification and general characterisation of emission

Process plant runoff is stored within the process water dam.

8.4.3 Description of potential adverse impact from the emission

Process water discharged to ground has the potential to inundate vegetation and contaminate terrestrial ecosystems.

The Licensee took samples from the process water dam on the 9 August 2017 with the results shown in Table 24. The quality of these results are consistent with the groundwater quality of bores PB1 to PB4 (Table 13 - section 7.5).

Table 24: Process Water Dam Water Quality Analysis Results

Analyte	Units	*Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater* (mg/L)	*ANZECC, 2000 Livestock* (mg/L)	ADWG Health (mg/L)	Process water dam 9/08/2017
pH	pH Units	6 to 9	NE	IDH	8.4
Electrical Conductivity @ 25ºC	µS/cm	NE	NE	-	1,200
Total Dissolved Solids Dried @ 175-185ºC	mg/L	NE	<5,000	NN	680
Total Suspended Solids Dried at 103-105 ºC	mg/L	NE	NE	-	26
Carbonate Alkalinity as $CaCO_3$	mg/L	NE	NE	-	7
Bicarbonate Alkalinity as HCO_3	mg/L	NE	NE	-	450
Total Alkalinity as $CaCO_3$	mg/L	NE	NE	-	380
Total Hardness by Calculation	mg $CaCO_3$/L	NE	NE	NN	440
Fluoride by ISE	mg/L	NE	2.0	1.5	0.3
Silicon, Si	mg/L	NE	NE	-	25
Sulfate as SO_4	mg/L	NE	1,000	IDH	49
Chloride, Cl	mg/L	NE	NE	IDH	160
Calcium, Ca	mg/L	NE	1,000	-	44
Magnesium, Mg	mg/L	ND	<600	-	80
Sodium, Na	mg/L	NE	NE	NN	90
Potassium, K	mg/L	NE	NE	-	2.7
Nitrate Nitrogen, NO_3 as N	mg/L	NE	400	50	1.3
Aluminium, Al	mg/L	0.055	5.0	IDH	<0.005
Arsenic, As	mg/L	0.013 As V	0.5 to 5.0[1]	0.01	0.026

Analyte	Units	*Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater* (mg/L)	*ANZECC, 2000 Livestock* (mg/L)	ADWG Health (mg/L)	Process water dam 9/08/2017
		0.024 As III			
Barium, Ba	mg/L	NE	NE	2.0	0.11
Beryllium, Be	mg/L	-	ND	0.06	<0.001
Boron, B	mg/L	0.37	5.0	4.0	0.042
Cadmium, Cd	mg/L	0.0002	0.01	0.002	0.0002
Cobalt, Co	mg/L	ID	1.0	-	<0.001
Chromium as CrVI	mg/L	0.0004	1.0	0.05	<0.001
Copper, Cu	mg/L	0.0014	1.0	2.0	<0.001
Lead, Pb	mg/L	0.0034	0.1	0.01	<0.001
Manganese, Mn	mg/L	NE	NT	0.5	<0.001
Molybdenum, Mo	mg/L	ID	0.15	0.05	0.001
Nickel, Ni	mg/L	0.011	1.0	0.02	0.001
Zinc, Zn -	mg/L	0.008	20	IDH	0.005
Iron, Fe	mg/L	ID	ID	IDH	<0.005
Antimony, Sb	mg/L	ID	NE	0.003	<0.001
Selenium, Se	mg/L	0.011	0.02	0.01	0.002
Tin, Sn	mg/L	ID	NE	NN	<0.001
Vanadium, V	mg/L	ID	ND	-	-
Mercury, Hg	mg/L	0.0006 (inorganic)	0.02	0.001	-

Note 1: May be tolerated if not provided as a food additive and natural levels in the diet are low (*ANZECC, 2000 Livestock*).

Red highlight indicates an exceedance of the *ADWG* - Health and *Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwate*r.

Purple highlight indicates an exceedance of the *Australian & New Zealand Guidelines for Fresh & Marine Water Quality 95% level of species protection for freshwater*.

8.4.4 Criteria for assessment

Australian & New Zealand Guidelines for Fresh & Marine Water Quality provide recommended trigger values for freshwater quality; and *Assessment and management of contaminated sites* and *ASC NEPM* provides ecological and human health assessment levels for soil.

8.4.5 Licence Holder's controls

The process water dam has the following controls:

- HDPE lined;
- Freeboard marker installed; and
- Freeboard of 300 mm maintained.

8.4.6 Consequence

The water quality of the water stored within the process water dam is shown within Table 24. Arsenic was the only parameter to exceed the *ADWG* and *Australian & New Zealand Guidelines for Fresh & Marine Water Quality* (consistent with background levels – Table 13). Therefore, if the process water dam was to overflow and discharge to the environment, the water quality criteria would be met. The consequence has been determined as **slight**.

8.4.7 Likelihood of Risk Event

Based upon the Licence Holder's controls, the likelihood of leaks or overflows from the process water dam will probably not occur in most circumstances. Therefore, the likelihood of the consequence is **unlikely**.

8.4.8 Overall rating of leaks or overflows from the process water dam

Comparison of consequence and likelihood ratings described above with the risk rating matrix (Table 21) determines the overall rating of risk for leaks or overflows from the process water dam to be **low**.

8.5 Risk Assessment – TSF pipeline ruptures, overtopping and seepage

8.5.1 Description of TSF pipeline ruptures, overtopping and seepage

Over the life of the mine (14 years), a total of approximately 10 Mt of tailings is expected to be produced (770,000 tonnes per year). Noting that the Issued Licence is for Stage 2 of the TSF only, being 1.56 Mt of tailings.

Tailings is transferred via a HDPE slurry pipeline at a range of 50-60 percent solids from the process plant to the TSF. The TSF will allow the solids to settle out with decant water reclaimed and returned to the process plant (DMS tank) for reuse.

8.5.2 Identification and general characterisation of emission

The physical and chemical properties of the tailings materials to be discharged to the TSF have been characterised by *GCA, 2016* and is detailed in section 7.6. The tailings are enriched in numerous metals, in particular lithium, arsenic, chromium, lead, zinc, thallium, bismuth, tin and tantalum. Uranium and thorium are also generally associated with lithium deposits. Decant has the potential to become concentrated as it is recycled through the process.

8.5.3 Description of potential adverse impact from the emission

Discharge of tailings or decant through pipeline failure or embankment overtopping will impact upon adjacent vegetation through toxicity and physical smothering as well as sedimentation and contamination of surface water systems.

Lateral movement of seepage through ground may contaminate soil and impact vegetation in the path of the seepage through inundation and toxicity of contaminants. Leaching of tailing contaminants through soil into local groundwater may impact on beneficial uses of groundwater.

Evidence from mines in rare-element pegmatites elsewhere in Western Australia and internationally indicates that significant amounts of lithium, caesium and rubidium can be leached from mine wastes that can lead to contamination of surface water and groundwater. Some of the lithium is released into solution during the milling of spodumene ore (Bradley et al., 2010), and significant concentrations of this element can accumulate within mine processing water and can seep into groundwater through tailings disposal sites.

For example, lithium concentrations of up to 13 mg/L have been recorded in groundwater at a spodumene milling site at a site in the USA (Bradley et al., 2010), a level that greatly exceeds the interim US EPA drinking water limit of 0.7 mg/L. Elevated concentrations of lithium (>1 mg/L) and caesium in drinking water are associated with adverse impacts on thyroid function (Broberg et al., 2011). It is likely that elevated lithium concentrations in drinking water would have a similar effect on livestock or wildlife, although there is currently no ANZECC water quality guideline value for livestock water supplies for lithium, caesium and rubidium.

A monovalent cation, lithium is easily displaced by other cations in soil solution and is relatively mobile, meaning mobile in solution and thereby increasing its ability to be transferred to receiving environments more readily (i.e. groundwater transfer and surface water runoff).

A seepage analysis program was used to assess order of magnitude seepage losses and drainage volume from the TSF, as well as the location of the phreatic surface through the tailings and embankment. Seepage modelling was undertaken at the TSF and Table 25 shows the results for Stage 2 (end of the downstream construction phase) for two ponds (Pond A – average pond under average climatic conditions (radius 150m); and Pond C – extreme pond) (TSF Design Report, 2016).

Table 25: Estimated seepage loss

			Estimated Flow To Drains (m^3/h)	Estimated Seepage Loss To Ground (m^3/h)	Estimated Seepage Loss To Ground (kl/Ha/day)
Stage 2	Pond A	Full Basin Underdrainage	0.8	5.5	18.2
		No Drains	0	5.6	18.9
	Pond C	Full Basin Underdrainage	7.9	26.6	3.8
		Finger Drains Only	3.7	27.7	3.8
		Toe Drain Only	4.2	26.6	18.2
		No Drains	0	27.7	18.9

"*The modelling results show that the underdrainage system help reduces the seepage loss through the facility*". "*Observation and monitoring during operation is recommended to ensure*

the underdrainage system is maintained in an operating condition" (TSF Design Report, 2016).

The Licence Holder has stated (Altura, 2018c), that "*seepage analysis will be verified in the annual audit using monitoring data*".

8.5.4 Criteria for assessment

The TSF is operated according to the *Code of Practice: Tailings storage facilities in Western Australia* and *TSF Operating Manual, 2018.* The TSF design criteria and parameters are shown in Table 26.

Table 26: TSF design criteria and parameters (TSF Operating Manual, 2018)

TSF DESIGN	
Tailings Production	770,000 tonnes per year. Permeability of the base less than 1 x 10^{-8} m/s.
Storage Capacity	
- Stage 2	1.56 Mt (26 months).
- Stage (Final)	10.08 Mt (14 years).
Embankment Freeboard	0.3 metres (m) minimum to embankment crest for tailings elevation. 0.5 m minimum to embankment crest (or spillway invert for average pond plus design storm (1 percent Average Exceedance Probability (AEP) 72 hour).
Stormwater Capacity	
- Short duration	1 percent AEP 72 hour duration storm event superimposed over average conditions operating pond volume.
- Long duration	Average conditions. 1 percent AEP, 1 year wet sequence.
Spillway	
- Intermediate Stages	Probable Maximum Flood storm event.
- Final Stage	Probable Maximum Flood storm event.
- Closure spillway	Probable Maximum Flood storm event.
Earthquake Loading	
- Operating	Operating Basis Earthquake.
- Final	Maximum Design Earthquake.
- Closure	Maximum Credible Earthquake.
Factors of Safety (target values)	
- Long-term drained	1.5
- Short-term drained (potential loss of containment)	1.5
- Short-term undrained (no potential loss of containment)	1.3
- Post-seismic	1.0 – 1.2

TSF OPERATION	
Slurry Characteristics	60 percent solids by weight. Tailings beach slope = 100H:1V (horizontal distance to vertical change). Maximum Density = 1.3 tonnes per m^3.
TSF REHABILITATION	
Final Embankment Slopes	External to waste dump – 3.0H:1V (overall), with 5 m horizontal benches at 10 m height increments.
Cover Profile	Generally shaped to achieve dry closure with no ponding (water shedding).
Capping	Mine waste (nominal 0.3 m thickness), covered with topsoil (0.2 m), re-vegetation.
Closure spillway	Probable Maximum Flood storm event.

8.5.5 Licence Holder's controls

The Licence Holder's controls for the TSF are set out in Table 27 below.

Table 27: Licence Holder's controls for the TSF (refer to Figures 7, 10, 11, 12 and 13)

Site Infrastructure	Operation details
TSF general (refer to Figure 10)	Multi-zoned, downstream profile embankment, single cell configuration. Stage 2 – Embankment level of 186 mRL. A total freeboard of 500 mm maintained.
Cut-off trench (refer to Figure 10)	Located beneath the entire length of the embankment.
Tailings Underdrainage System (refer to Figures 10 to 13)	The TSF underdrainage system consists of an embankment toe drain, branch drains and finger drains. The underdrainage system flows by gravity to a collection sump at the lowest elevation point in the TSF. Underdrainage water collected in the sump is pumped to the crest and directed back to the supernatant pond. Supernatant water and rainfall runoff is removed from the TSF by pumps located in the decant tower and returned to the process plant.
Decant System (refer to Figure 14)	Decant tower situated on the eastern embankment of the TSF. Decant trench runs from the central area of the basin to the decant tower structure. Supernatant and rainfall is removed from the TSF by pumps located in the decant tower and returned to the process plant by the HDPE decant return pipeline. The supernatant pond is controlled by managed spigotting from the perimeter embankment so that it is located at the centre of the eastern embankment.

Site Infrastructure	Operation details
Tailings deposition	Tailings is discharged into the TSF by sub-aerial deposition methods, using a combination of spigots located at 25 m intervals along the embankment crest. The active beach will be regularly rotated around the TSF.
Process pipelines (tailings delivery, distribution and decant return)	Constructed of HDPE. Fitted with flow and leak detection sensors. If the two sensors are outside the accuracy of the flow meters there is an alarm which indicates a leak.
Tailings delivery and decant return pipelines	Contained within a pipeline containment trench suitably sized to capture a localised spill and situated adjacent to the access road.
Ambient groundwater monitoring (refer to Figure 7 – MB-01 to MB-04)	Four groundwater monitoring stations were installed downstream of the TSF perimeter embankment to facilitate early detection of changes in the groundwater level and/or quality. Each monitoring bore station consists of one shallow and one deep bore (refer also to section 7.5). Refer also to Table 28.
Monitoring instrumentation	Four vibrating wire piezometers (100 m length) were installed in the Stage 1 TSF embankment to monitor phreatic surface. Embankment settlement pins installed at 250 m intervals to monitor movement of the embankment.

Table 28 also shows the TSF monitoring program which the Licence Holder committed to in the *TSF Design Report, 2016*.

Table 28: TSF monitoring program

Monitoring Point reference	Parameter	Units	Frequency
MB-01 MB-02 MB-03 MB-04 PZ-01 PZ-02 PZ-03 PZ-04	Standing Water Level	mbgl	Monthly
	pH	pH units	Quarterly
	Electrical Conductivity	µS/cm	
	Total Dissolved Solids, Hardness, Hydroxide, Silicon dioxide, Carbonate, Biocarbonate, Potassium, Calcium, Magnesium, Chloride, Sulfate, Nitrate, Aluminium, Arsenic, Boron, Barium, Beryllium, Mercury, Molybdenum, Lead, Selenium, Antimony, Strontium, Zinc, Chromium VI, Copper, Iron, Manganese, Nickel, Sodium, Fluoride, Cadmium, Cobalt, Tin, Vanadium, Lithium	mg/L	

8.5.6 Key findings

The Delegated Officer has reviewed the information regarding operation of the TSF and has found:

1. The Issued Licence is for Stage 2 of the TSF only. For any raises beyond 186 mRL, it is the Licence Holder's responsibility to ensure they have all relevant approvals.
2. The results for the multi-element-analysis for process-stream-solids samples indicate elevated concentrations of lithium, arsenic, chromium, lead, zinc, thallium, bismuth, tin and tantalum. It is noted that lithium does not a trigger value for freshwater ecosystem protection, however advice (Broberg et al., 2011) indicates values of >1 mg/L are considered of concern.
3. There is currently no ANZECC water quality guideline value for livestock water supplies for lithium, caesium and rubidium. DWER acknowledges this information gap and that further updates/ amendments may be required as information becomes available.
4. No ambient groundwater samples have been provided for the TSF (MB-01 to MB-04) for the ability to compare data. The Delegated Officer considers the requirement on the Licence to undertake fortnightly sampling for a 6 month period from the issue of the Licence will provide adequate baseline data.

8.5.7 Consequence

The vegetation impact of TSF pipeline ruptures and overtopping could result in mid-level on-site impacts. Therefore, the consequence is **moderate**.

The Premises should be managed so as to ensure that groundwater quality is maintained at its baseline level. Groundwater quality should therefore be protected to ensure that groundwater remains suitable for its highest beneficial use. Based upon the potential contaminants in tailings leachate, and that no samples have been provided by the Licence Holder for the TSF monitoring bores (refer to section 7.5) it is unknown if the *ADWG* will be met. Therefore, the consequence is **moderate**.

8.5.8 Likelihood of Risk Event

Based upon the Licence Holder's controls, distance to nearest receptors and specified ecosystems, an environmental impact from TSF pipeline ruptures and overtopping will occur in exceptional circumstances. Therefore, the likelihood of the consequence is **rare**.

The tailings are enriched in numerous metals, in particular lithium, arsenic, chromium, lead, zinc, thallium, bismuth, tin and tantalum. The Delegated Officer recognises that some analytes may become present at concentrations that indicate potential for concern if tailings decant is concentrated through evaporation or process cycling, or if tailings chemistry is affected by changes in redox chemistry within the tailings mass.

To monitor this, the Delegated Officer has determined that the following parameters will be included on the Issued Licence as part of the ambient groundwater quality monitoring program for the TSF: Total Alkalinity as $CaCO_3$; Fluoride by ISE; Fluoride by PC Titrator; Nitrite; Phosphorus; Total Phosphorus; Total Nitrogen; Copper; Silicon; Uranium; Thorium; Bismuth; Nobium; Thallium; Caesium; Rubidium; Radium-266; and Radium-228.

Based upon the Licence Holder's controls including the ambient groundwater monitoring program (listed above and in Table 28), an environmental impact from seepage will probably not occur in most circumstances. Therefore, the likelihood of the consequence is **unlikely**.

8.5.9 Overall rating of TSF pipeline ruptures, overtopping and seepage

Comparison of the consequence and likelihood ratings described above with the risk rating matrix (Table 21) determines the overall rating of risk for TSF pipeline ruptures, overtopping and seepage to be **medium**.

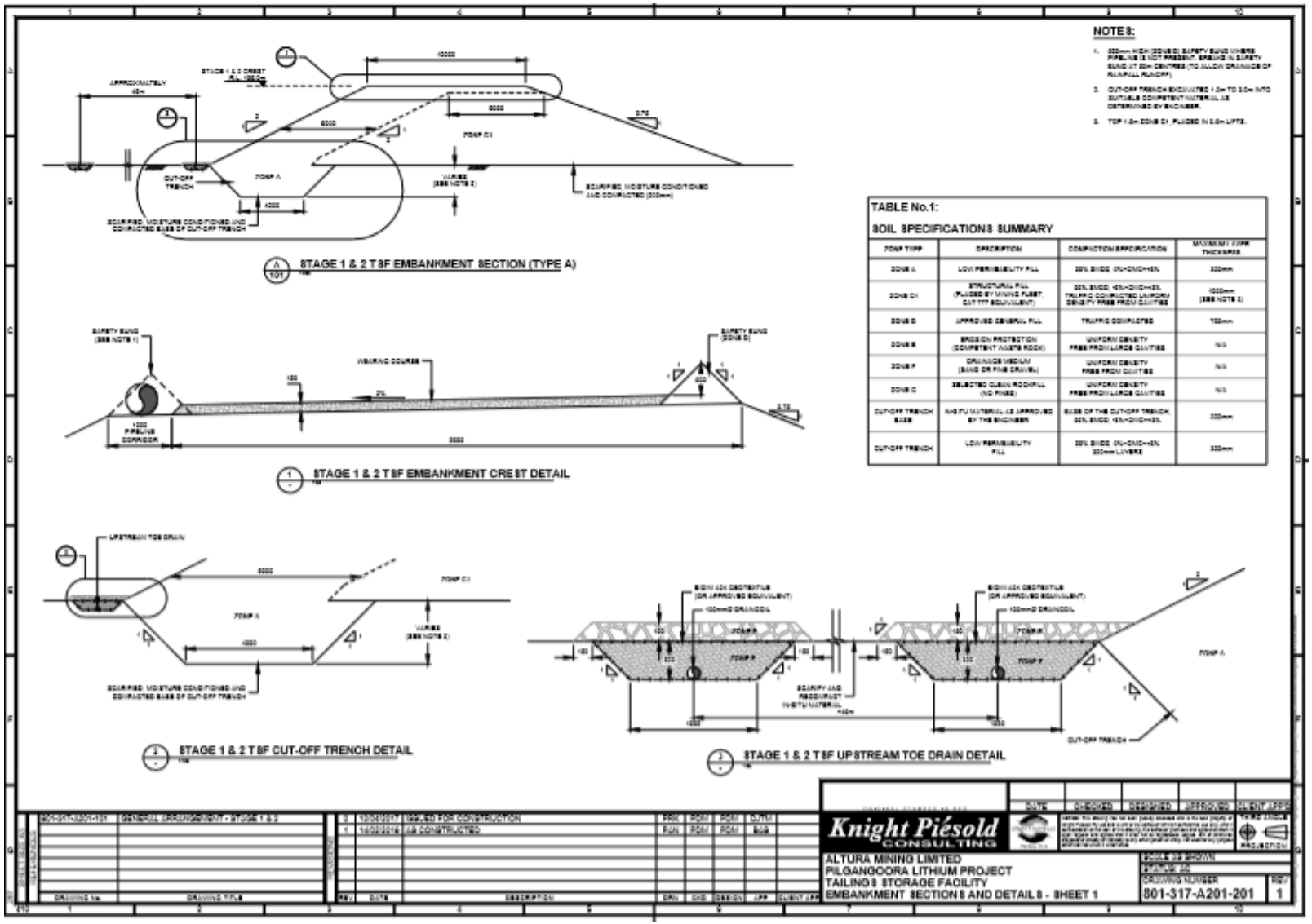

Figure 10: Embankment, cut-off trench and toes drain detail

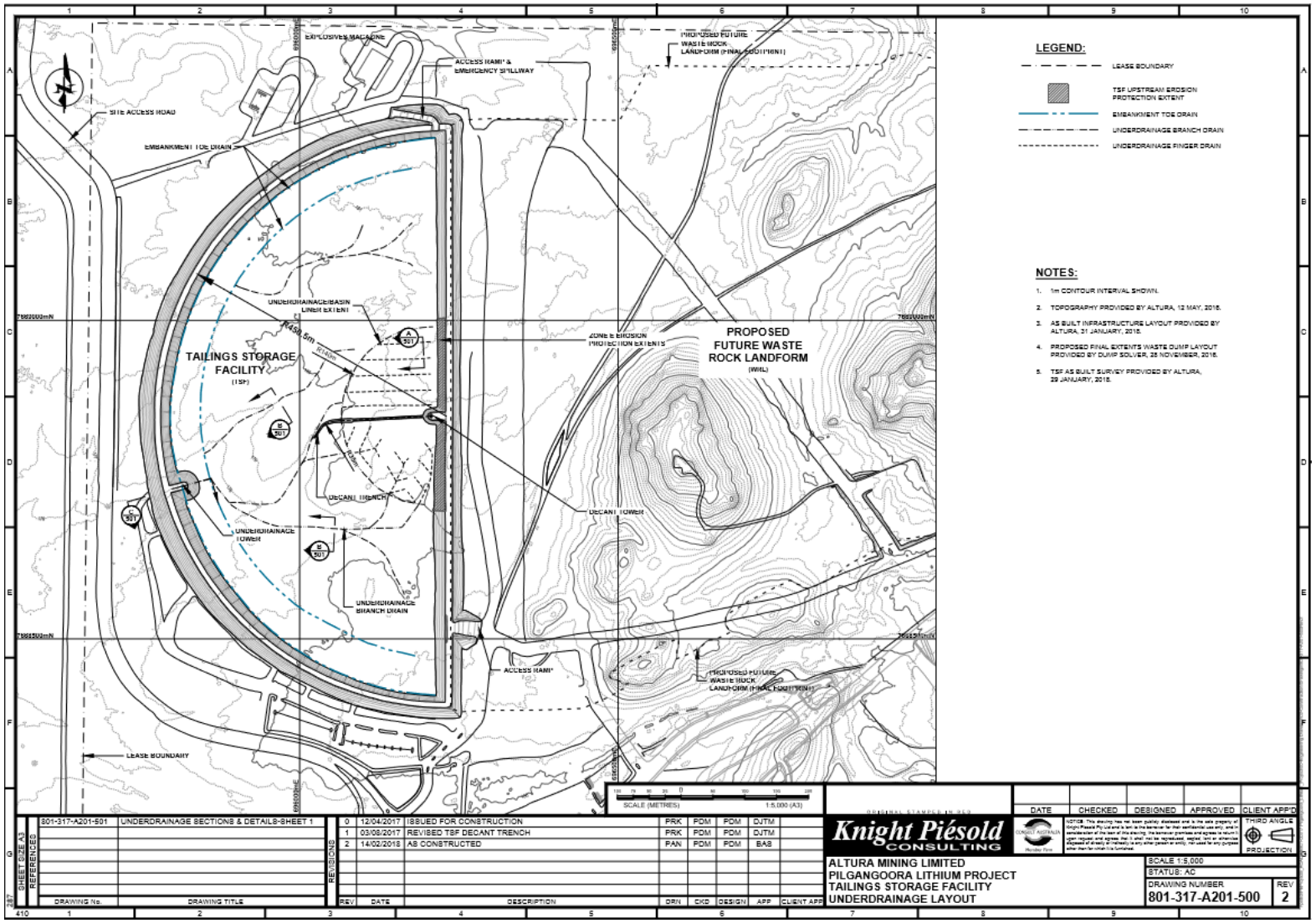

Figure 11: TSF underdrainage layout

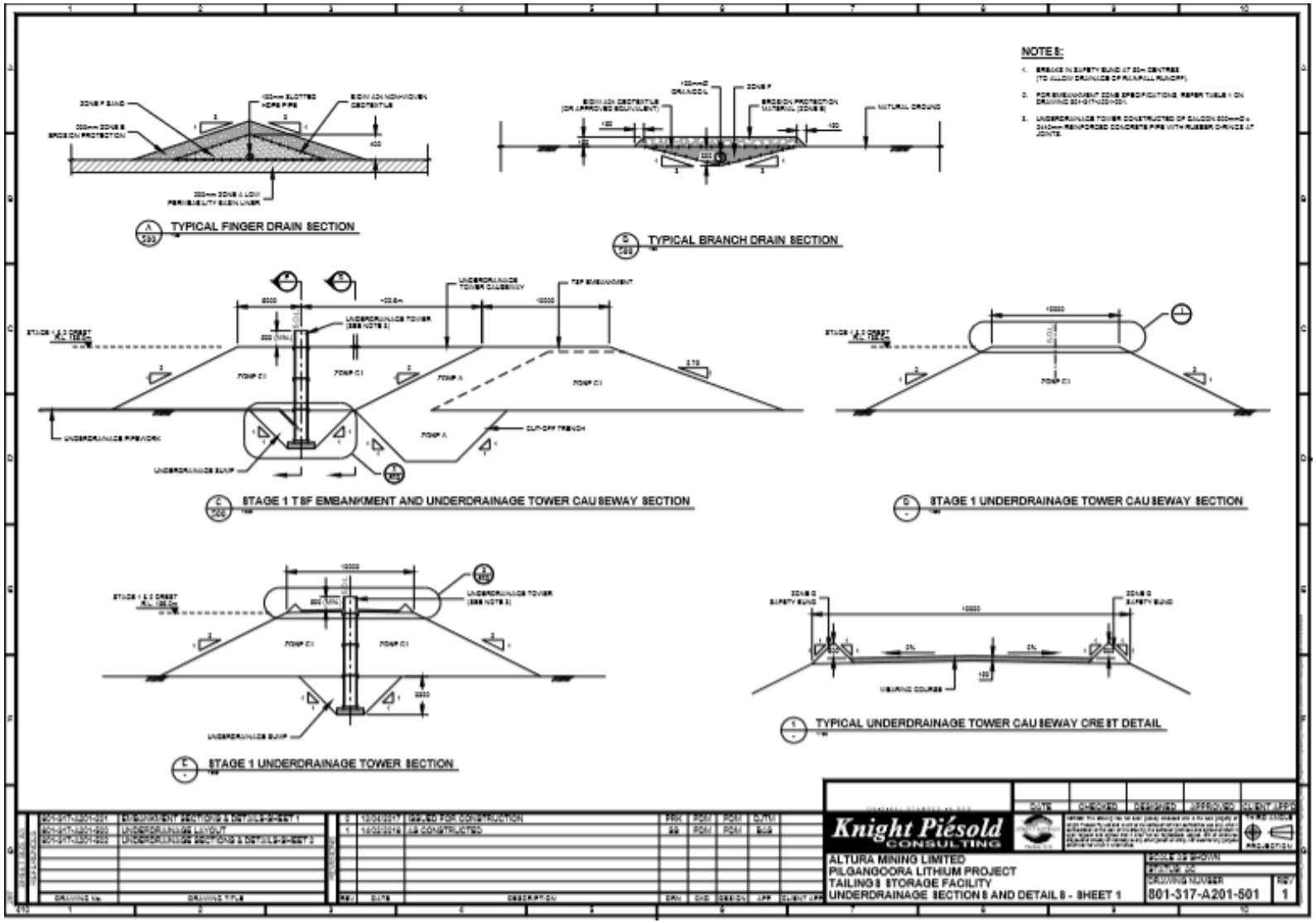

Figure 12: TSF underdrainage section 1

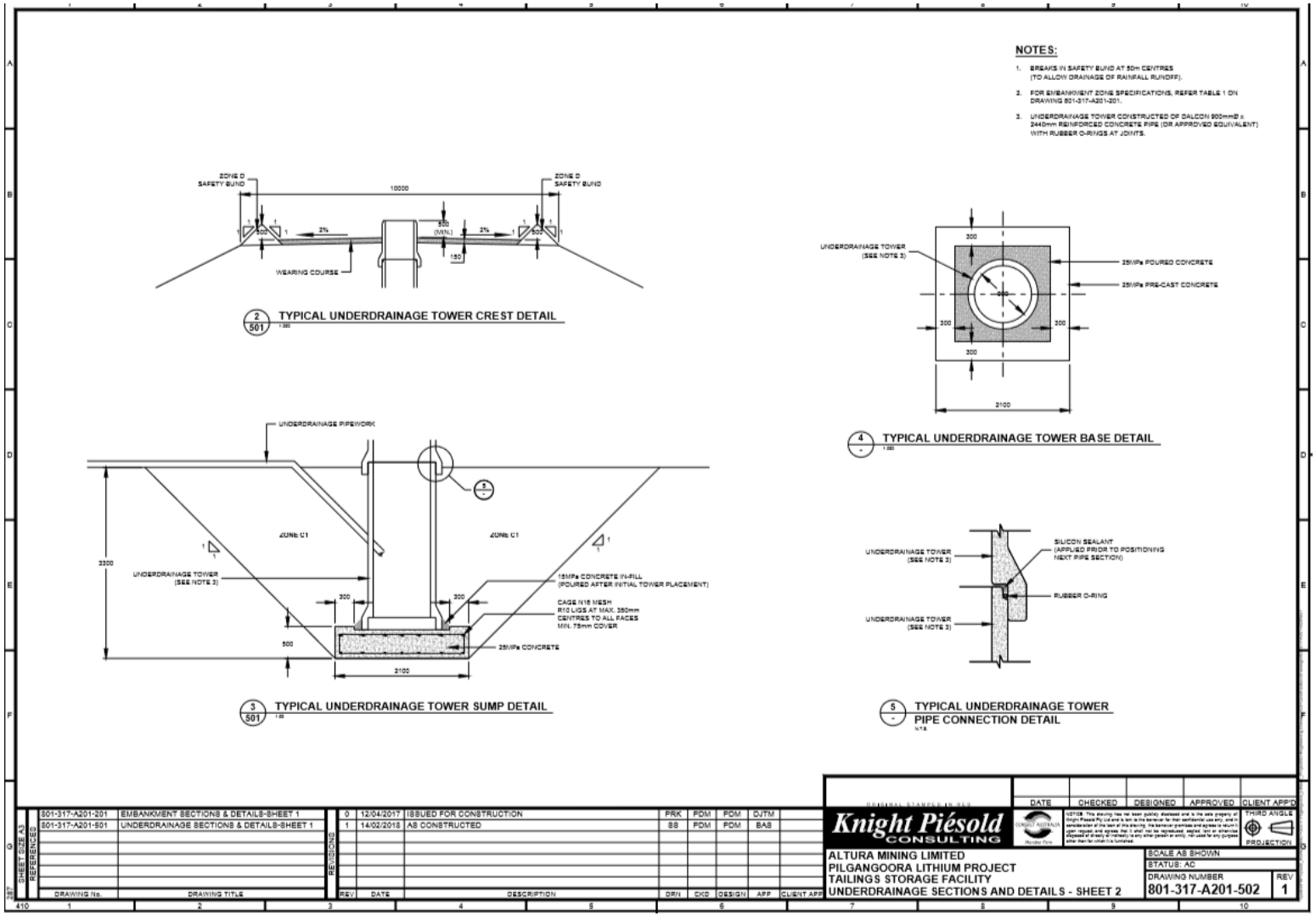

Figure 13: TSF underdrainage section 2

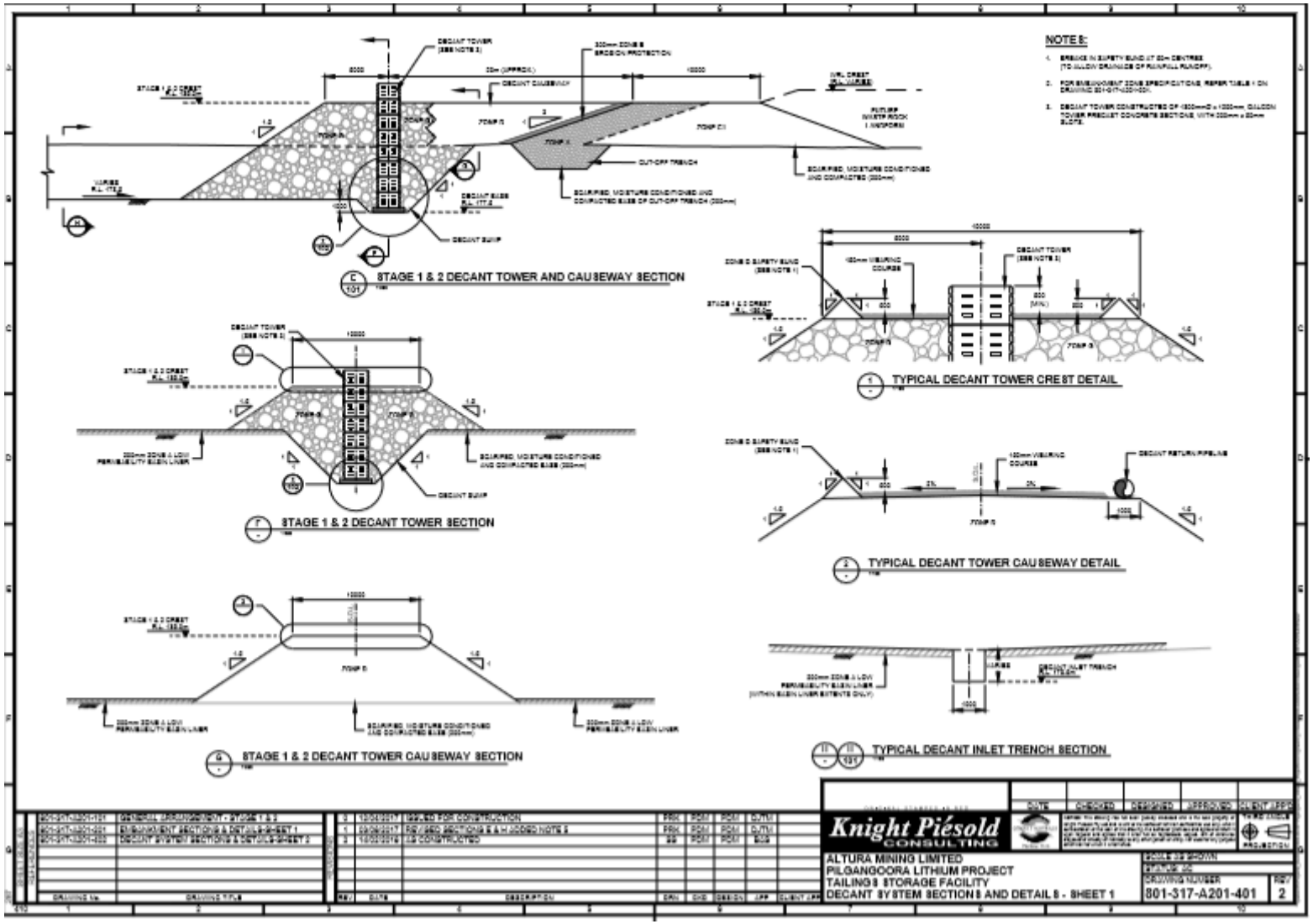

Figure 14: TSF decant system

8.6 Summary of acceptability and treatment of Risk Events

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 29 below. Controls are described further in section 9.

Table 29: Risk assessment summary

	Description of Risk Event			Licence Holder's controls	Risk rating	Acceptability with controls (conditions on instrument)
	Emission	**Source**	**Pathway/ Receptor (Impact)**			
1	Leaks or overflows from the process water dam	Process water dam breaches	Overflow or leak to land causing poor vegetation health and localised soil contamination	• HDPE lined; • Freeboard marker installed; and • 300 m freeboard maintained.	Slight consequence Unlikely likelihood **Low Risk**	Acceptable, subject to Licence Holder's operational controls conditioned. Subject to the general provisions of the EP Act and the *Environmental Protection (Unauthorised Discharges) Regulations 2004*.
2(a)	TSF pipeline ruptures and overtopping	Rupture of pipelines (tailings delivery, distribution and decant return) Overflow of TSF tailings	Direct discharge to land potentially causing soil contamination inhibiting vegetation growth and survival Inundation of vegetation rooting zone	Refer to Licence Holder's controls as detailed in section 8.5.5.	Moderate consequence Rare likelihood **Medium Risk**	Acceptable, subject to Licence Holder's operational controls conditioned. Infrastructure and monitoring requirements on the Licence.
2(b)	TSF seepage	Seepage from TSF	Groundwater contamination with impacts to beneficial uses		Moderate consequence Unlikely likelihood **Medium Risk**	

9. Regulatory controls

A summary of regulatory controls determined to be appropriate for the Risk Event follows in this section. Controls are set with regard to the adequacy of controls proposed by the Licence Holder. The conditions of the Issued Licence are set to give effect to the determined regulatory controls.

9.1 Licence controls

9.1.1 Process water dam

The following environmental controls, infrastructure and equipment should be maintained at the process water dam to manage the risk of emissions at the Premises:

- HDPE liner maintained.
- Freeboard of 300 mm to be maintained.

9.1.2 TSF and TSF pipelines (tailings delivery and decant return)

The following environmental controls, infrastructure and equipment should be maintained and operated onsite for the TSF and tailings delivery and decant return pipeline management:

- A total freeboard of 500 mm maintained on the TSF.
- Daily inspections of the TSF and pipelines' integrity.
- Flow and leak detection sensor maintained.
- Pipeline containment trench maintained.

9.1.3 Monitoring requirements for the TSF

Ambient groundwater monitoring requirements have been placed on the Issued Licence. The requirement for an annual water balance is also a condition of the Issued Licence.

9.1.4 Licence reporting

An Annual Audit Compliance Report is required to be submitted as a condition of the Issued Licence.

10. Determination of Licence conditions

The conditions in the Issued Licence in Attachment 1 have been determined in accordance with the *Guidance Statement: Setting Conditions*.

The *Guidance Statement: Licence Duration* has been applied. The expiry date for M45/1230 and M45/1231 is 25 August 2037. The Issued Licence will expire on 25 August 2037.

Table 30 provides a summary of the conditions to be applied to the Licence. Licence conditions may be subject to change following site inspections by DWER.

Table 30: Summary of conditions to be applied

Condition Ref	Grounds
Emissions Condition 1	This condition is valid, risk-based and consistent with the EP Act.
Infrastructure and equipment Condition 2	This condition is valid, risk-based and contains appropriate controls.
Emission Limits Condition 3	This condition is valid, risk-based and consistent with the EP Act.
Monitoring Conditions 4 to 9	These conditions are valid, risk-based and contain appropriate controls.
Record-keeping Conditions 10 to 14	These conditions are valid and are necessary administration and reporting requirements to ensure compliance.

DWER notes that it may review the appropriateness and adequacy of controls at any time and that, following a review, DWER may initiate amendments to the Issued Licence under the EP Act.

11. Licence Holder's comments

The Licence Holder was provided with the draft Decision Report and draft Licence on 4 September 2018. The Licence Holder provided comments on 5 September 2018 (Altura, 2018c) which are summarised, along with DWER's response, in Appendix 2.

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 Issued Licence 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	Assessment and management of contaminated sites, Contaminated sites guidelines, Department of Environment Regulation, December 2014	Assessment and management of contaminated sites	accessed at http://www.der.wa.gov.au
2	Australian Radiation Protection and Nuclear Safety Agency, Code of Practice for Safe Transport of Radioactive Material – Radiation Protection Series, No. 2, 2008 Edition	Transport Code	accessed at http://www.arpansa.gov.au
3	Australian Radiation Protection and Nuclear Safety Agency, Code of Practice & Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing – Radiation Protection Series Publication No. 9, August 2005	the Code	accessed at http://www.arpansa.gov.au
4	Bradley, D.C., McCauley, A.D. and Stillings, L.M., 2010. Mineral-Deposit Model for Lithium-Cesium-Tantalum Pegmatites. US Geological Survey, Scientific investigations Report 201050700-O	Bradley et. al, 2010	available at https://pubs.er.usgs.gov/publication/sir20105070O
5	Broberg, K., Concha, G., Engström, K., Lindvall, M., Grandér, M. and Vahter, M., 2011. Lithium in drinking water and thyroid function. Environmental Health Perspectives, 119(6), 827-830	Broberg, et al, 2011	available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3114818/pdf/ehp-119-827.pdf
6	Code of Practice: Tailings storage facilities in Western Australia, Department of Mines and Petroleum, 2013	Code of Practice: Tailings storage facilities in Western Australia	accessed at http://www.dmp.wa.gov.au
7	Guidance Statement*: Regulatory principles*, Department of Environment Regulation, July 2015	Guidance Statement*: Regulatory principles*	accessed at http://www.der.wa.gov.au
8	Guidance Statement: *Setting Conditions*, Department of Environment Regulation, October 2015	Guidance Statement: *Setting Conditions*	
9	Guidance Statement: *Licence duration*, Department of Environment Regulation,	Guidance Statement:	

	Document Title	In text ref	Availability
	August 2016	*Licence duration*	
10	Guidance Statement: *Risk Assessments,* Department of Environment Regulation, February 2017	Guidance Statement: *Risk Assessments*	
11	Guidance Statement: *Decision Making,* Department of Environment Regulation, February 2017	Guidance Statement: *Decision Making*	
12	IAEA Safety Standards Series, Application of the Concepts of Exclusion, Exemption and Clearance, Safety Guide No. RS-G-1.7, International Atomic Energy Agency, 2004	IAEA, RS-G-1.7	accessed at http://www-pub.iaea.org
13	National Environment Protection (Assessment of Site Contamination) Measure 1999	ASC NEPM	accessed at http://www.nepc.gov.au
14	National Water Quality Management Strategy: Australian Drinking Water Guidelines 6 2011, Version 3.4, National Health and Medical Research Council and Natural Resource Management Ministerial Council, updated October 2017	ADWG	accessed at http://www.nhmrc.gov.au
15	Australian & New Zealand Guidelines for Fresh & Marine Water Quality, Australian and New Zealand Governments, and Australian state and territory governments, 2018	Australian & New Zealand Guidelines for Fresh & Marine Water Quality	accessed at http://www.waterquality.gov.au
16	National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Paper No. 4, Volume 3) Primary Industries – Rationale and Background Information, Australian and New Zealand and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, October 2000	ANZECC, 2000 Livestock	
17	Northcote,K.H. with Beckmann,G.G., Bettenay,E., Churchward,H.M., Van Dijk,D.C., Dimmock,G.M., Hubble,G.D., Isbell,R.F., McArthur,W.M., Murtha,G.G., Nicolls K.D., Paton,T.R., Thompson,C.H., Webb,A.A. and Wright,M.J. (1960-1968). Atlas of Australian Soils, Sheets 1 to 10. With explanatory data (CSIRO Aust. and Melbourne University Press: Melbourne)	Northcote, 1960-68	accessed at http://www.asris.csiro.au
18	Pilgangoora Lithium Project Environmental Management Plan (AJM-HSEOP-PLN-006-1), Altura Lithium	EMP, 2017	DWER records (A1712752)

	Document Title	In text ref	Availability
	Operations Pty Ltd, 30 October 2017		
19	Pilgangoora Lithium Project Revised Mining Proposal M45/1230, M45/1231, L45/400 & L45/404 (ALT-COR-BUS-DOC-0035 Rev 1), prepared by Preston Consulting Pty Ltd for Altura Mining Limited, 15 February 2017	Mining Proposal, 2017	DWER records (A1383409)
20	Pilgangoora Lithium Project Site Water Operating Strategy - Revision 3, Altura Lithium Operations Pty Ltd, 20 February 2018	Site Water Operating Strategy	DWER records (DWERDT44118)
21	Pilgangoora Lithium Project Tailings Storage Facility Final Design Report, prepared by Knight Piésol Pty Ltd for Altura Mining Limited, PE801-00317/07, Rev 0, December 2016	TSF Design Report	DWER records (A1377473)
22	Pilgangoora Lithium Project Works Approval Application Supporting Document prepared by Preston Consulting Pty Ltd for Altura Lithium Operations Pty Ltd, 14 February 2017	Preston Consulting, 2017a	DWER records (A1377466)
23	Pilgangoora Project, Geochemical Characterisation of Flotation-Tailings and Dense-Media-Separation-Solids Samples, Implications for Process-Stream Management, prepared by Graeme Campbell and Associates Pty Ltd for Altura Mining Limited, July 2016	GCA, 2016	DWER records (A1377473)
24	Pilgangoora Project Drilling Investigations Hydrogeologic Report, prepared by Groundwater Development Services (GDS) Pty Ltd for Altura Mining Limited, SHS010-GWS-Doc142, Rev 5, 14 December 2016	GDS, 2016a	DWER records (A1377473)
25	Pilgangoora Project Groundwater Monitoring Strategy, prepared by Groundwater Development Services Pty Ltd for Altura Mining Limited, SHS021-GWS-Doc181, 14 December 2016	GDS, 2016b	DWER records (A1377473)
26	Pilgangoora Surface Water Assessment, prepared by RPS Group for Altura Mining Limited, 2000B/003f, 6 December 2016	RPS, 2016	DWER records (A1377473)
27	Preliminary Assessment of the Radionuclide Mass Balance and Regulatory Impact for the Altura Exploration Pty Ltd Pilgangoora Lithium Project, prepared by Radiation Professional, AJM161109 Rev 0, 24	Radiation Professionals, 2016	DWER records (A1377473)

	Document Title	In text ref	Availability
	November 2016		
28	RE: Altura licence L9036 for comment, received from Stephen Danti (Altura), 5 September 2018	Altura, 2018c	DWER records (A1717232)
29	RE: Altura works approval_licence questions, received from Stephen Danti (Altura), 11 April 2017	Altura, 2017a	DWER records (A1410893)
30	RE: Licence application L9039 – Pilgangoora Lithium Project, received from Stephen Danti (Altura), 16 August 2018	Altura, 2018a	DWER records (A1712089)
31	RE: L9036 management plans, received from Stephen Danti (Altura), 20 August 2018	Altura, 2018b	DWER records (A1712779)
32	RE: Partial Compliance Report_W6036/2017/1, received from Stephen Danti (Altura), 13 June 2018 including Appendix 1 Part 1_KP_TSF Construction and Compliance Report_FINAL	TSF Compliance Report	DWER records (A1690683)
33	RE: Partial Compliance Report_W6036/2017/1, received from Stephen Danti (Altura), 13 June 2018 including Appendix 2_Dangerous Goods Site Licence – Diesel Storage – DGS022272; and Appendix 3_Pilgangoora DG Licence Application_FINAL	W6036 Compliance, 2018a	DWER records (A1690436, A1690374 and A1690377)
34	RE: Partial Compliance Report_W6036/2017/1, received from Stephen Danti (Altura), 26 June 2018	W6036 Compliance, 2018b	DWER records (A1697628)
35	RE: Process water dam, received from Stephen Danti (Altura), 4 July 2017	Altura, 2017b	DWER records (A1466436)
36	Request for Technical Advice – Altura Pilgangoora Lithium Project, received from Dr Bill Richmond (Department of Environment Regulation), dated 11 November 2016	DER, 2016	DWER records (A1194792)
37	Tailings Storage Facility Operating Manual, prepared by Knight Piésol Pty Ltd for Altura Mining Limited, PE801-00317/17, Rev A, April 2018	TSF Operating Manual	DWER records (A1712754)
38	Understanding-salinity – Salinity status classifications, by total salt concentration table, Department of Water	Salinity status classification	accessed at http://www.water.wa.gov.au/water-topics/water-quality/managing-water-

	Document Title	In text ref	Availability
			quality/understanding-salinity
39	Works Approval W6036/2017/1, Pilgangoora Lithium Project, issued 7 July 2017	W6036/2017/1	accessed at www.dwer.wa.gov.au

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

Condition	Summary of Licence Holder's comment	DWER response
Licence		
Condition 8 – Table 4 for the process water dam	The Licence Holder has stated that "*This water dam contains naturally occurring groundwater only. There is no return water from the process plant or TSF into this dam therefore no potential for contamination*". The Licence Holder has requested that this monitoring requirement be removed.	DWER has removed the requirement to monitor the process water dam under the Licence.
Condition 8 – Table 4 for the TSF	The Licence requires the Licence Holder to sample Standing Water Level, pH and Electrical Conductivity and pH fortnightly from the issue of this Licence for the first 6 months and then monthly. The Licence Holder has stated "*This monitoring frequency seems onerous for these water quality parameters. Can this please be changed to monthly to align with TSF Operating Manual and our current DWER approved groundwater sampling regime*".	As stated in section 8.5.6 no ambient groundwater samples have been provided for the TSF (MB-01 to MB-04) for the ability to compare data. The Delegated Officer considers the requirement on the Licence to undertake fortnightly sampling for a 6 month period from the issue of the Licence will provide adequate baseline data. After this period, the requirement to monitor Standing Water Level will go to monthly sampling; and sampling for pH and Electrical Conductivity will be quarterly, which is consistent with the *TSF Design Report, 2016* and Table 28. Whilst it is acknowledged that the Licence Holder has developed a *Site Water Operating Strategy,* this document does not include the TSF monitoring bores. These bores have been included on the Licence to identify potential impacts to ambient groundwater

Condition	Summary of Licence Holder's comment	DWER response
		quality as a result of seepage from the TSF.
	The Licence requires the Licence Holder to sample the remaining parameters fortnightly from the issue of this Licence for the first 6 months and then quarterly. The Licence Holder has stated that the monitoring frequency seems onerous for these water quality parameters. "*These parameters should be quarterly and then annually to align with the TSF Operating Manual and our current approved DWER groundwater sampling regime*".	As stated in section 8.5.6 no ambient groundwater samples have been provided for the TSF (MB-01 to MB-04) for the ability to compare data. The Delegated Officer considers the requirement on the Licence to undertake fortnightly sampling for a 6 month period from the issue of the Licence will provide adequate baseline data. After this period, the requirement to monitor pH, Electrical Conductivity and remaining parameters will go to quarterly sampling. This is consistent with the *TSF Design Report, 2016* and Table 28. Based on the results provided, at the next amendment this frequency may change. An annual sampling frequency does not take into account seasonal variation, so will generally not be applied.
	The Licence requires the Licence Holder to sample Radium-266 and 228 monthly from the issue of this Licence for the first 6 months and then six monthly thereafter. The Licence Holder has requested that this be changed to annually. Stating that "*Lab timeframes won't allow for monthly and our current approved water quality regime is annually*".	DWER has changed the frequency to "*Within 60 days of the issue of this Licence and then six monthly thereafter*". This will ensure that a baseline level is known which can be provided to DWER. As above an annual sampling frequency does not take into account seasonal variation, so will generally not be applied.
Decision Report		
Section 7.5	DWER requested that the Licence Holder check the pH data for MB-01 to MB-04. As the pH in these bores was recorded as being quite acidic (approx. 4). The Licensee responded stating that the "*pH data has been re-*	DWER updated Table 14 with the new pH results.

Condition	Summary of Licence Holder's comment	DWER response
	measured and is as follows: MB01 – 8.00, MB02, 7.51, MB02 7.60 & MB04, 7.80". The original data was due to faulty probe.	
Section 7.6 under Tailings slurry water	DWER asked the Licence Holder if it was just one sample and whether there were plans to verify the initial results and ongoing as mining continues to ensure any risk remains managed/ concentrates further – sample decant etc.). The Licence Holder stated that it was three tailings samples and that they would sample the TSF slurry water over the life of mine.	DWER has added the following statement to section 7.6 "*The Licence Holder has committed to sampling the TSF slurry water annually over the life of the mine*".
Section 7.6 under DMS-solids geochemistry findings	DWER asked the Licence Holder if any further testing had been considered or would be undertaken? The Licence Holder stated *"No further sampling as yet but we are aware of this and will monitor*".	DWER notes this. No change was made to the Decision Report.
Section 8.5.3	DWER asked the Licence Holder if the verified modelling of the seepage analysis program was ongoing? The Licence Holder stated that the "*seepage analysis will be verified in the annual audit using monitoring data*".	DWER has added the following statement to section 8.5.3 "*The Licence Holder has stated (Altura, 2018c), that seepage analysis will be verified in the annual audit using monitoring data*".

Attachment 1: Issued Licence L9036/2017/1