25 October 2021

TAILINGS STORAGE FACILITY 3 (TSF3)

MOOLART WELL GOLD PROJECT, WA

DESIGN REPORT

Regis Resources Limited

Ref. PER2021-0102AD Design Report Rev 4

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CERTIFICATION OF COMPLIANCE

Tailings Storage Facility Design Report

For and on behalf of CMW Geosciences Pty Ltd I, Christopher Hogg being a duly authorised officer of the above company and a qualified professional engineer and a member of Engineers Australia, IEAUST, do hereby certify and confirm that the Tailings Storage Facilities 3 (TSF3) at the Moolart Well Gold Project has been designed in accordance with the current edition of the Tailings storage facilities in Western Australia – code of practice issued by the Department of Mines and Petroleum, Western Australia and the design is referenced as Design Report, PER2021-0102AD Rev 3, dated 13 October 2021.

[redacted]

1 TSF PROPOSAL SUMMARY

This document presents the design details required by the Department of Mines, Industry, Regulation and Safety (DMIRS), formerly the Department of Mines and Petroleum (DMP), Western Australia, for the above-ground Tailings Storage Facility 3 (TSF3) at the Moolart Well Gold Project (MWGP). The MWGP is located in the locality of Bandya and forms part of the Regis Resources Limited (RRL) Duketon North Operation (DNO), approximately 130 km north of Laverton and 790 km northeast of Perth, Western Australia. The tenement plan is shown in Figure 1.

The MWGP is located on Mining Leases M38/354, M38/498, M38/499, M38/500, M38/589, M38/943 and the proposed TSF3 will be built on Mining Leases M38/498 and M38/499. The TSF has an approximate centre located at (MGA, Zone 51) coordinates 6,947,000 m North and 437,000 m East. The existing open pits, mill and camp are located at approximately 0.8 km to the west and southwest, 1.5 km to the south, and 2.5 km to the north of the proposed TSF3 location, respectively.

Regis Resources Limited (RRL) proposes to construct TSF3 in order to store processed tailings from the existing CIL/CIP plant located to the south of the existing Tailings Storage Facility 1 (TSF1). TSF3 has been designed as an irregular 'octagonal' conventional single paddock (cell) facility abutting TSF1 to the north. TSF3 is to store approximately 8.0 Mt of tailings over a 2-years and 8-months life assuming an ore processing rate of 3.0 Mtpa and tailings in-situ density of 1.4 t/m^3 (dry).

TSF3 has a storage footprint area of approximately 92.3 ha, a maximum embankment height of 15.0 m (final crest RL 555.0 m AHD). Embankment stability, embankment deformation, seepage, dam break and water balance analyses have been performed to support the design for a maximum crest embankment height of 15.0 m above the natural ground levels.

TSF3 will be constructed as part of DNO mining operations with the TSF being located partially within a waste dump. The embankment of TSF3 will be a zoned embankment comprising an upstream zone of low permeability roller compacted clayey mine waste and a waste dump downstream. The perimeter embankment will incorporate a cut-off trench 0.6 m (nominal) deep founded on a cemented Ferricrete layer in order to reduce seepage losses. TSF3 will be constructed in one stage (i.e. constructed in one stage prior to commissioning).

Surface water will be removed from the TSF by a pontoon-mounted decant pump located within a rock ring-type central decant structure. Return water will be pumped directly to the process plant for reuse. The water recovery system is designed to include the additional capacity to recover water from designed storm events.

The facility is classified, in accordance with Tables 1 and 2 of the DMP (2013) code, as hazard rating 'Category 2 – Medium'. The ANCOLD (2019) consequence rating is 'High C'. A dam break assessment has been performed and the hazard rating is based on this assessment.

The results of the design assessments for TSF3 indicate that the facility can be safely operated on the basis that:

- Liberated water is continually removed from the surface of the tailings.
- Tailings deposition is cycled around the facility to maximise tailings density and therefore the storage volume.
- The facility will be operated in accordance with the details contained in the Operations Manual.
- The safe operation of the storage relies upon the implementation of the tailings' operation, management inspection and maintenance procedures.

The closure objectives for TSF3 are to leave the facility in a safe, stable, erosion resistant and non-polluting state. These will be achieved through the following in the design:

- Downstream slopes of the TSF embankment will be rehabilitated. The maximum slope angle will be approximately 18º or 1:3 (v:h) with no intermediate bench.
- The decant system will be decommissioned and the decant area sealed.
- The tailings top surface will be covered with a layer of non-acid forming (NAF) clay/rock/mine waste with a minimum thickness of 0.5 m.
- Topsoil to suit local flora species will be applied once TSF3 is 'sealed'.

RRL as the operator of the project will have the following commitments to adhere to:

- TSF3 will be constructed, operated, maintained, rehabilitated, monitored and closed in accordance with the specifications and drawings, including where appropriate other studies made in consultation with relevant stakeholders.
- Construction will be supervised and monitored by personnel with experience in this type of construction. Details of construction will be provided in a construction report.
- All investigation and exploration drill holes within the TSF footprint are to be sealed prior to construction.
- TSF3 will be managed and operated in general accordance with the Operations Manual. Independent audits will be performed annually.

Figure 1: Tenement Plan of the Duketon Gold Project

The following figures and appendices complete this report:

- Appendix A – Tailings Storage Data Sheet (TSDS) and Explanatory Notes
- Appendix B – Drawings
- Appendix C – Geotechnical Investigation Report
- Appendix D – Tailings Testwork 2019
- Appendix E – Seepage Analyses
- Appendix F – Stability Analyses
- Appendix G – Deformation Estimate
- Appendix H – Water Balance Analyses
- Appendix I – Dam Break Assessment
- Appendix J – Scope of Works and Technical Specification Document
- Appendix K – Operations Manual

1.1 Location

TSF3 is located on mining tenements M38/498 and M38/499 in Bandya, WA. It is part of the RRL Duketon North Operation (DNO) which is located approximately 130 km north of Laverton and 790 km northeast of Perth, WA.

TSF3 has been designed as an irregular 'octagonal' conventional single paddock (cell) facility abutting TSF1 to the north. TSF3 is situated approximately 0.8 km east and northeast of the existing open pits, 1 5 km north of the mill and 2.5 km south of the camp. TSF2 is currently in use and comprises the Stirling Pit Tailings Storage Facility which is located approximately 1 km west of the mill. At the time of this report, the existing open pits at the MWGP include Blenheim Pit, Wallace Pit, Buckingham Pit, Wellington Pit, Beaufort North West Pit, Stirling Pit and Eindhoven Pit. The North and Central Waste Rock Landforms (WRL) are found between TSF3 and the two closest pits, Blenheim Pit and Buckingham Pit.

TSF3 will abut the decommissioned Tailings Storage Facility 1 (TSF1) and has an approximate centre located at (MGA, Zone 51) coordinates 6,947,000 m North and 437,000 m East. The location and layout of TSF3 have been selected based on an options study which considered three sites. The site selected was the preferred site as it was close to pits for supply of construction materials, not immediately upslope of the camp. The TSF3 site was developed to avoid heritage sites and avoid a major flood path identified by the Project Hydrologist. A layout plan showing the location of TSF3 in relation to the existing TSF1 is presented as Drawing PER2021-102-01.

1.2 Ownership

The project is owned and operated by Regis Resources Limited (RRL), a publicly listed company (ASX: RRL).

1.3 History

RRL carried out a bankable feasibility study with Newmont Australia for the MWGP from 2005 to 2009, when it acquired 100% of the Duketon Project from the latter. In 2010, RRL commenced the full construction of the MWGP and the commissioning of the gold processing plant occurred in July of the same year.

The MWGP delivered its first full year of gold production in 2012, which generated funds to develop the Garden Well Gold Mine located approximately 32 km to the south (Figure 1). By the end of 2013, RRL had established 10 Mtpa of processing capacity for its multiple mining operations across the Duketon Project.

RRL acquired tenure for the Duketon Greenstone Belt in 2019 that tripled its landholding, and in 2020, acquired from Stone Resources Australia a tenement package that has the potential to add further life to the Duketon Project.

Tailings storage at Moolart Well utilized TSF1 until December 2019. The Stirling In-pit TSF (TSF2) was commissioned in December 2019. It is expected that TSF2 will be operated to the end of 2023. TSF3 will then be required.

2 TAILINGS STORAGE FACILITY DESIGN CONSIDERATIONS

2.1 Introduction

Details contained in this report were compiled to DMIRS requirements and in accordance with the following guidelines:

- Department of Mines and Petroleum (2013), '*Code of practice: tailings storage facilities in Western Australia*'.
- Department of Mines and Petroleum (2015), *'Guide to the preparation of a design report for tailings storage facilities (TSFs)*'.

In addition to the DMIRS documents above, the design presented in this report has been undertaken using ANCOLD Guidelines (2019) *'Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure'*. The consequence category will determine the water management (e.g. freeboard and stormwater storage capacity required) and geotechnical embankment design requirements.

2.2 Storage Capacity

Factors that are considered in TSF3 design:

- Annual tailings production of 3.0 Mtpa.
- Total tailings production of approximately 8.0 Mt.
- Tailings density of 1.4 t/m^3 (dry).
- Tailings deposited at 45% solids.
- Tailings beach slope of 1.0%.
- Ore is processed using the Carbon-in-Leach / Carbon-in-Pulp (CIL/CIP) method.

Details of the storage characteristics are further discussed in Section 3.1.2.

2.3 Tenure and Site Conditions

TSF3 and the associated boundaries, as shown in Figure 2 below, fit within the tenement boundaries of the MWGP in Figure 1.

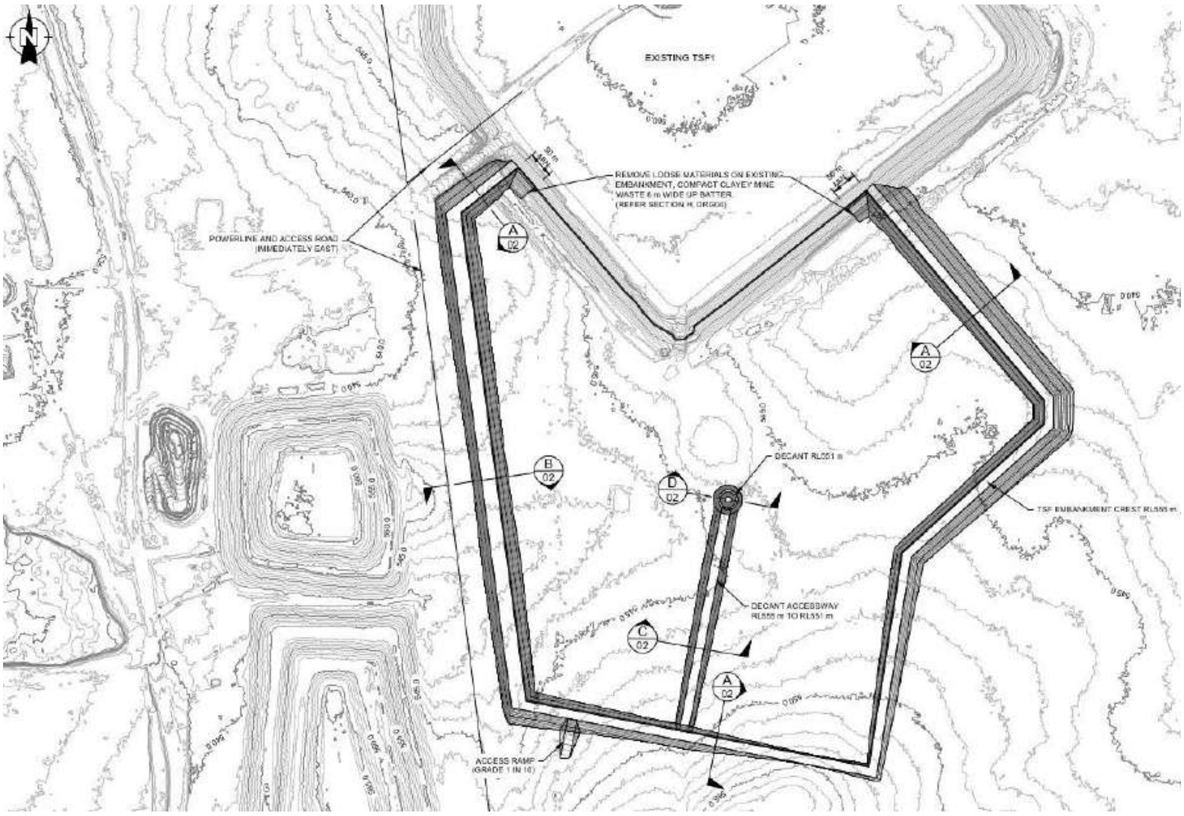

Figure 2: Proposed Extent of TSF3

2.3.1 Climate

The project area has a semi-arid climate with hot summers and mild to cool winters. The following data has been utilised in the design.

- Mean annual rainfall of 235.7 mm (BOM 2016 data for Laverton, WA Station 012045).
- Mean annual evaporation 3,746 mm (Luke et al 1987).
- Average annual evapotranspiration 1,350 mm (BOM 2005).
- 1:100 yr. Annual Exceedance Probability (AEP) event of 72 hr duration, 185 mm (BOM 2016 data for Latitude 27.5875 South and Longitude 122.3625 East).
- Probable Maximum Precipitation (PMP) storm event, 3-hour duration of 750 mm (BOM (2002) '*The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*').

2.3.2 Surface Topography

The topography of the TSF3 project area is characterised by minor topographical relief with grade across the site less than 3%. Areas with high elevation or low hills are encountered at the centre and south-southeast. The elevations range from approximately RL555 m on the south-southeast to RL540 m on the northeast and northwest. The lowest area in the TSF3 site is located in the north-west near the existing ramp to TSF1 that is currently at crest RL560.0 m.

Approximately 40 m and 130 m to the west of the proposed TSF3 western embankment alignment are an existing powerline and access road, and the north and central WRL (crest levels RL560.0 m and RL565.0 m), respectively. Three heritage-listed areas including a blowhole are located ≥50 m away to the northeast, east and south of the TSF3 site.

The TSF3 project area is predominantly a eucalypt open woodland with scattered scrub and mallee trees. There has been past disturbance at the site due to access roads, mining and exploration related activities.

2.3.3 Geology

Regionally, MWGP is located in the Duketon Greenstone Belt in the north-eastern sector of the Eastern Goldfields Super-terrane of the Yilgarn Craton. The Duketon Greenstone Belt is characterised by a metamorphosed succession of Archaean mafic, ultramafic, and felsic volcanic rocks with associated volcanogenic sedimentary rocks and thin units of banded chert and banded iron formation. Late-stage sills and dykes and associated small plutons intrude the sequence. These associations have been deformed into both N-S and NE-SW trending tight folds and strike slip thrust belts under mainly E-W stress. Subsequently, the sequence has been extensively sheared and elongated along the strike. Deep weathering occurs across the region.

Within the TSF3 project area, the near-surface regolith overlying the deeply weathered Archaean geology comprises relatively recent alluvium and colluvium deposits that have been reworked and cemented through the Tertiary and Quaternary Periods. A thin surface layer, typically less than 0.5 m thick, of red-brown silty sand soil overlies a cemented hardpan rock layer between 0.5 m to 3.0 m thick. The hardpan is fairly ubiquitous across the landscape and comprises a silcrete cemented layer developed within the Quaternary colluvium and alluvium deposits along drainage channels and/or within residual, extremely weathered bedrock material around the slightly elevated outcrop areas.

Geology in the pit areas comprises a laterite horizon overlying mafics, diorite and dolerite. Based on site observations, the geology is deeply weathered to at least 60 m. Based on tactile assessments, it is likely there will be ample clayey mine waste for use in integrated waste landform type construction.

2.3.4 Hydrology

Drainage in the area of the Moolart Well project area grades to the north and a salt lake system several kilometres to the north of the MWGP camp. There are three catchments in the TSF3 site area, with an eastern catchment that drains from a ridgeline near the plant and flows to the east of the existing TSF1, a central catchment that drains north from near the plant to the west of existing TSF1, and west of the camp. The main catchment in the area originates to the south of the pit area and is diverted to the west around the pit area and runs immediately to the east of the airport runway.

2.3.5 Hydrogeology

Two investigation bores constructed within the TSF1 area were measured prior to TSF1 development (ATC 2017). The stratigraphy in the investigation bores comprised surface soil at 1-5 m, Ferricrete at 1-5 m and weathered basement at 5-20+ m. Groundwater was inferred at depths of approximately 18 m to 20 m, hosted within fractured basement sequences.

The estimated permeability values of the encountered stratigraphy in TSF1 were $1x10^{-7}$ m/s (surface soil), $1x10^{-7}$ m/s (Ferricrete) and $9x10^{-7}$ m/s (weathered basement). Further drilling and permeability testing as part of the recent investigations for TSF3 indicated typical permeability values between 10^{-6} to 10^{-7} m/s for depths to 15 m below ground level (mbgl).

Groundwater salinity was measured at approximately 1,000 mg/L to 2,200 mg/L and was considered potable to brackish. Groundwater movement would typically be sympathetic with topography, flowing towards Lake Wells/Lake Carnegie.

2.3.6 Subsurface and Foundations

CMW carried out a geotechnical investigation of the proposed TSF3 site, including an option located to the west of TSF1 and north-west of the adopted site, in July 2021. The scope of fieldwork completed was as follows:

- A walkover survey of the site to assess the general landform and site conditions.
- Twelve (12) test pits, denoted TP2-01 to TP2-09 and TP2-10 to TP2-13, were excavated using a 55 tonne excavator within the footprint of the discarded TSF3 option (i.e. west of TSF1). Refusal depths on very dense/hard grounds ranged between 0.25 m to 1.3 m.
- Ten (10) test pits, denoted TP3-09 and TP3-14 to TP3-22, within the current proposed TSF3 site. Refusal (55 tonne excavator) depths on very dense/hard ground ranged between 0.2 m to 1.15 m.
- Sampling for subsequent laboratory testing.
- Eighteen (18) reverse circulation (RC) boreholes at six locations at both TSF3 site options for the purpose of permeability tests. Boreholes were drilled to 5 m, 10 m and 15 m at each location.

Engineering logs and photographs of the test pits are presented in the Geotechnical Investigation Report, included in Appendix C of this report.

At the current proposed TSF3 site, the encountered subsurface profiles can be generalised to the sequence of the following units:

SILTY GRAVELLY SAND (SM)	fine to coarse grained, angular to subangular, red-brown; gravel fine to coarse, subangular, blue-mottled red, lateritic; silt low plasticity; Colluvial.
or	
CLAYEY SILTY SAND (SM)	fine to coarse grained, angular to subangular, dark red; clay and silt low plasticity; with gravel fine to coarse grained, angular to subangular, grey; Colluvial.
Overlying	
FERRICRETE	recovered as Sandy Gravelly SILT; low plasticity, grey-patchy blue, lateritic; gravel fine to coarse, angular.

Saprolite layer underlies the Ferricrete layer from an averaged depth of 6 mbgl at the adjacent TSF1 site. Transitional layers and weathered basalt underlie the Saprolite layer.

It must be noted that not every unit is present in all locations.

Based on the results of the investigations, the following was adopted in design:

- Stripping to approximately 0.1 m depth.
- A cut-off trench, to nominally 0.6 m below ground level in the surficial colluvial layer has been included in the embankment design to reduce horizontal seepage losses.
- Seepage collection system comprising intersection trenches and collection trenches and manholes.

2.3.7 Seismicity

The project area is located in a region of low seismic risk. The Operating Basis Earthquake (OBE) of 0.09 g, as derived from AS 1170.4 (2007) for 1:475 year AEP of the 'High C' consequence category (refer Section 3.2), has been used in the seismic design of TSF3 embankment. The corresponding Maximum Design Earthquake (MDE) / Safety Evaluation Earthquake (SEE) is 0.16 g for 1:2,000 year AEP with a probability factor k_p of 1.7.

2.4 Retaining Structure Properties

The TSF3 embankments will be constructed out of mine waste from the mining operations at DNO with a waste dump forming the downstream zone. The embankment will be zoned with an upstream zone of roller compacted clayey mine waste and traffic compacted waste dump downstream zone.

The clayey mine waste materials to be used in the upstream zone should be predominantly sandy clay, clayey gravels and clayey saprolite materials from areas towards the top of the Blenheim Pit and Buckingham Pit at the MWGP. The materials are considered as stable and non-dispersive, and qualify as non-liquefiable under dynamic loadings or seismic activity. Materials description must be reviewed upon receipt of laboratory test results.

Mine waste should comprise of well graded clayey gravel with ≥20% to <70% fines content, and free of boulders. The mine waste shall be of non-acid forming (NAF) class. The physical properties of the mine waste should be confirmed by laboratory testing as part of construction.

Construction of TSF3 embankment should be integrated with the ongoing mine planning, to ensure that adequate volumes of construction materials are available and scheduled. It will also be necessary to ensure that the planning of upstream (or inner) zones is coordinated with planned downstream (or outer) waste dump construction as the latter has to be in place prior to the placement of any upstream (inner) zones materials.

Appendix J provides the technical specifications for the embankment construction materials.

2.5 Tailings Properties

2.5.1 Tailings Testwork

Tailings testwork was performed on a sample of mill tailings by a NATA registered laboratory in early 2019. The tailings sample was a non-plastic SANDY SILT (ML) with 73% fines (% passing 75 µm). The settling test results indicated moderate settling rates with the maximum dry density in the settling tests achieved in 5 to 7 days. The moderate rate of settling is due to the relatively high fines content of the tailings. It was noted that future tailings are expected to be coarser and hence settling should be more rapid and settled densities higher. The consolidation test indicated that consolidation will be relatively rapid.

The results of the tailings testwork are summarised below:

- Particle Size Distribution (PSD), 73% passing 75 micron, approximately 12% passing 3 micron.
- Undrained settled density, 0.92 t/m^3 (dry), with maximum density achieved in 5 days.
- Drained settled density, 1.10 t/m^3 (dry), with maximum density achieved in 5 days.
- Air drying test, final density 1.49 t/m^3 (dry) after 16 days.
- Consolidation test, final density 1.57 t/m^3 (dry) at 600 kPa. The laboratory recorded that the actual coefficient of consolidation and permeability from the test was unreliable due to drainage of the sample.

Tailings settling test results are presented in Appendix D.

2.5.2 Geotechnical Characteristics

The engineering properties of the tailings based on information provided by RRL in 2019, and that future tailings are expected to be coarser than those tested in 2019, are summarised below:

- Slurry density ex-plant approximately 45% solids.
- Initial and final tailings density 1.0 t/m³ (dry) and 1.4 t /m³ (dry), respectively.
- Specific gravity of approximately 2.7.
- Effective angle of internal friction, ϕ of 32º (assumed based on PSD testing).
- Particle size distribution (PSD) of 55% to 60% passing the 75 µm, and 85% to 90% passing the 300 µm.
- Tailings beach slope of 1%.
- Permeability, k of 10^{-7} to 10^{-8} m/s.
- Coefficient of Consolidation, C_v of 200 m^2/year to 1,000 m^2/year.

Based on the above parameters and traditional consolidation theory, a 15.0 m depth of tailings would likely consolidate over 1 to 2 years, assuming 1-way drainage. It is recommended that during deposition the tailings consolidation parameters are confirmed by testing. This confirmation should also be done as part of future closure planning.

2.5.3 Geochemistry and Mineralogy Characteristics

Geochemical characterisation has been undertaken of tailings samples at Moolart Well and other satellite ores processed at Moolart Well including Gloster, Dogbolter-Coopers and Petra. A summary of tailings classifications and observations from TSF1 and TSF2 Licence monitoring bores reported in the most recent Annual Environmental Report are presented below:

- The vast majority of tailings samples analysed across Moolart Well, Gloster, Dogbolter-Coopers and Petra have been classified as NAF.
- The only PAF tailings samples recorded have been one sample from Mitchell pit, which is the smallest active pit at Moolart Well, and one (out of five) tailings samples analysed from Petra, which has reached its life of mine.
- Licence monitoring bores have very low in WAD CN concentrations (less than 0.1 mg/L),
- With the exception of one outlier, salinities of Licence monitoring bores are generally brackish ranging from 1,300 mg/L to 5,100 mg/L.
- The pH of Licence monitoring bores have remained circum neutral ranging between 6.84 and 7.87.

TSF3 is therefore expected to contain almost entirely NAF tailings.

3 TAILINGS STORAGE FACILITY DESIGN

3.1 Introduction

The design objectives for this facility are:

- Optimising the removal of water from the facility and return to the plant for re-use in processing, which will assist in maximising the in-situ dry density of the deposited tailings.
- Optimising tailings storage capacity by maximising the deposited tailings density (i.e. undertaking cyclic tailings deposition between different locations of spigot) and reducing tailings drying time.
- Reducing environmental impact by maximising water recovery and minimising the potential for seepage losses.

Drawings PER2021-0102-01 to PER2021-0102-04 provide the general arrangements, and sections and details for the TSF3 design (refer to Appendix B). Scope of Works for the construction of TSF3 is included in Appendix J. Schedules of quantities for the staged construction of TSF3 are also included in Appendix J.

3.2 Hazard / Consequence Rating

Based on the DMP Code of Practice (2013), the hazard rating for the TSF has been assessed as ‘Category 2 – Medium’ based on the following:

- The potential for loss of human life due to the presence of infrastructure including the main access to the plant and the access between the camp and the mine along the western corridor of TSF3. A dam break is unlikely to inundate the plant due to the presence of drainage channel in between the two facilities, nor the camp due to the latter’s higher elevation and the presence of creeks to the east of TSF3.
- Limited impact on heritage value areas and on the natural environment, and effects on native flora and fauna downstream of TSF3. Damage would reasonably be expected to be concentrated in the ephemeral streams;
- Loss of TSF storage capacity, and permanent loss of assets including infrastructure. No loss of public infrastructure is expected;
- An ultimate embankment height of approximately 15.0 m.

Based on the above considerations and Table 1 of ANCOLD (2019), a ‘Medium’ damage is assigned. It is characterised by loss of infrastructure of the order \$10 M to \$100M significant impacts to business (i.e. the mine and plant), impact area 5 km^2 or less, impact duration less than 5 years and limited effects to heritage items and native flora and fauna. The consequence category for ‘Medium’ damage, based on Table 2 of ANCOLD (2019) and with an estimated PAR of ≥1 to <10, is ‘Significant’. For the purposes of design TSF3 has been assessed with a ‘High C’ consequence category to account for the potential of one or more lives being lost.

3.2.1 Drawings

The following design drawings are presented in Appendix B.

Table 2: Drawings	
Title	**Drawing No.**
Plan	PER2021-0102-01
Section and Details Sheet 1	PER2021-0102-02
Underdrainage and Instrumentation Plan	PER2021-0102-03
Section and Details Sheet 2	PER2021-0102-04
Instrumentation Details	PER2021-0102-05
Inundation Plan	PER2021-0102-06

3.2.2 TSF Storage Characteristics

TSF3 has been designed with a storage volume of 6.1 Mm^3. The storage capacity will be 8.0 Mt of tailings over a 2-years and 8-months life assuming an ore processing rate of 3.0 Mtpa, a tailings in-situ density of 1.4 t/m^3 (dry) and a beach slope of 1%.

3.2.3 Embankment Design

TSF3 will be a single cell irregular 'octagonal' facility constructed within a waste dump in a single stage. The total impoundment area will be approximately 96.8 ha.

The embankment will be zoned comprising an upstream zone of low permeability roller compacted clayey mine waste (Zone A) and a downstream zone (Zone B) of the waste dump. The decant accessway will be constructed using traffic compacted mine waste (Zone C) materials.

The materials will be internally sourced from the MWGP tenements (i.e. Blenheim and Buckingham Pits). A figure showing the general arrangement of the TSF is presented in Figure 3.

The maximum and averaged embankment heights will be approximately 15.0 m and 10.0 m, respectively. The embankment incorporates a cut-off trench excavated to a competent Ferricrete layer, 0.6 m nominal deep in order to reduce seepage losses.

The estimated volumes of materials required are summarised in Table 3.

Table 3: Estimated Volume of Materials	
Material Zone	**Estimated Volumes of Materials Required**
Zone A (1)	365,800
Zone B (2)	1,090,000
Zone C	80,000

(1) Include materials for cut-off trench and section through existing TSF1 batter (refer to drawings on Appendix B).

(2) Include materials for decant accessway (refer to drawings on Appendix B).

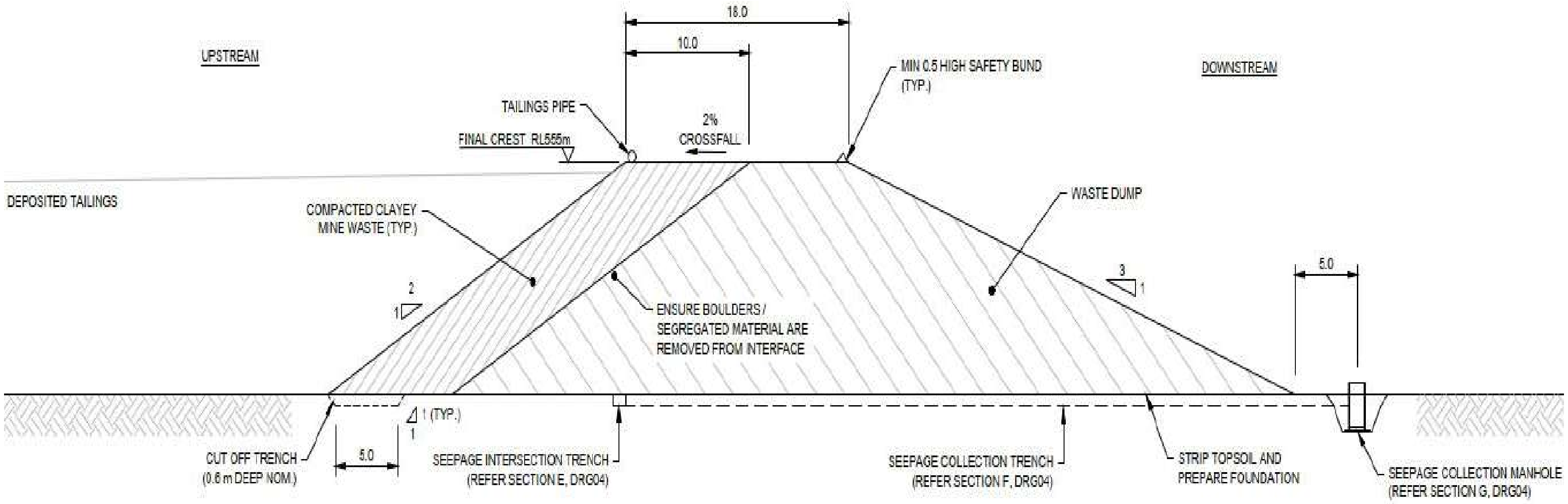

Figure 3: Typical Cross Section TSF Embankment *(not to scale*)

3.2.4 Embankment Geometry

TSF3 embankment will have design slopes of 1(V):2(H) upstream and 1(V):3(H) downstream, with a minimum crest width of 18.0 m.

Along the western corridor where an existing powerline and access road are located, the TSF3 embankment will have design slopes of 1(V):2(H) upstream and 1(V):1.5(H) downstream, with a minimum crest width of 29.0 m, during its operational life. The downstream slope will be battered back to 1(V):3(H) at closure. The designs have considered the required minimum clearances of 40.0 m and 15.0 m to the existing infrastructure during the life of TSF3 and at closure, respectively.

The embankment crest will have a 2% cross-fall towards the upstream side, 0.5 m (min.) high rock/mine waste windrow at the downstream crest, and above ground tailings pipeline at the upstream crest.

The decant accessway has design slopes of 1:1.5 (V: H), 18.0 m crest width, and a transversal slope of 1^0 from the embankment down to the rock-ring decant. The crest of the decant causeway will have 0.5 m (min.) high rock/mine windrows on both sides, with breaks in the windrow on the low side to allow surface water to run off. The rock-ring decant will be 30.0 m in diameter and has design slopes of 1:1 (V: H) and a crest width of 4.0 m.

A seepage collection system, comprising seepage intersection trenches, collection trenches and manholes will be constructed underneath parts of the embankment to reduce any potential seepage. The seepage intersection trenches will extend approximately 1.04 km underneath the northwest and west embankments, and approximately 0.59 km underneath the east and northeast alignments. The seepage intersection trenches are connected to collection manholes by three collection trenches that each extends approximately 63 m perpendicular to the embankments.

The design geometry of the proposed TSF3 construction is presented on Drawings PER2021-0102-01 to PER2021-0102-04 in Appendix B.

3.2.5 Water Recovery System

Surface water will be removed from TSF3 by a pontoon-mounted decant pump located within a rock-ring type central decant structure. Return water will be pumped directly to the process plant for reuse. The efficacy of the water return system is the key to achieving a high in-situ dry density within the tailings stack. The minimum capacity of the water recovery system should be not less than 420 tph including the additional capacity needed to recover water from design storm events.

3.3 Modelling and Design Studies

3.3.1 Structural Stability

3.3.1.1 Method of Analysis

Stability analyses were undertaken to assess the stability of the TSF embankment up to a maximum crest height of RL555.0 m (i.e. 15.0 m maximum embankment height). The analyses were undertaken in general accordance with ANCOLD (2019).

The computer software package 'Slide' was utilised to undertake the analyses. Slide is a two-dimensional slope stability program for evaluating the safety factor of circular and non-circular failure surfaces in soil and rock slopes. The stability of the slip surfaces for static and seismic loadings was assessed using vertical slice limit equilibrium methods. The simplified Bishop and GLE/Morgenstern-Price methods were used in the analyses of circular slip failures.

The design earthquake loads for the TSF embankment *(Safety Evaluation Earthquake, SEE (previously Maximum Design Earthquake or MDE), Operational Basis Earthquake, OBE and Maximum Credible Earthquake, MCE)* was determined by consideration of the consequence category of the tailings storage and are selected as earthquakes with given AEP. ANCOLD (2019) gives guidance in selecting the AEP of the OBE and SEE, and in calculating the MCE. This guidance considers 'defensive' earthquake design through the use of TSF principles.

Since the TSF is considered as a 'High C' consequence category storage, the OBE is 1:475 years AEP and SEE is 1:2,000 years AEP.

The following cases were examined in the stability analyses:

Case 1: Static Analysis – Downstream failure of TSF3 embankment with crest level of RL555.0 m (15.0 m maximum embankment height) under drained condition based on limit equilibrium method.

Case 2: Static Analysis – Upstream failure of TSF3 embankment with crest level of RL555.0 m (15.0 m maximum embankment height) under undrained condition based on limit equilibrium method.

Case 3*: Pseudo-Static Earthquake Case – As for Case 1, but under seismic loading of PGA of 0.09 g (OBE) corresponds to 1:475 year AEP.

Case 4*: Pseudo-Static Earthquake Case – As for Case 1, but under seismic loading of PGA of 0.16 g (MDE) corresponds to 1:2,000 year AEP.

Case 5: Post-Seismic Analysis – As for Case 1 utilising post-seismic strength parameters. Strength parameters in general were reduced by 20% for embankment materials and tailings are assumed to have liquefied (post liquefaction S_u/σ'_v).

In addition to the above, a further five cases denoted Case 1a to Case 5a were analysed to account for the western embankment downstream configurations during the operational life TSF3, as discussed in Section 3.2.4.

* ANCOLD (2019) requires deformation analysis and this is presented in Section 3.3.1.4. Analyses of Case 3 and Case 4 are presented for screening/completeness.

It should be noted that TSF3 embankment foundations are not liquefiable, however, post-seismic stability is made to account for tailings liquefaction based on the concept of MCE at the post-closure stage.

The phreatic surface adopted in all cases was based on the seepage analyses results, refer to Section 3.3.4. Seepage analyses have considered the scenario with a maximum pond level of 0.7 m below the final crest level, and where the phreatic level extends to the embankment toe (worst-case).

3.3.1.2 Parameters

The stability analyses of the embankment were carried out using the effective stress condition (c', φ') with pore pressure derived from the seepage analyses. The effective strength parameters were assumed, with a level of conservativism, based on the results of the geotechnical investigation by CMW and past investigations by Knight Piesold Pty Ltd for TSF1 discussed in ATC (2014) report, the subsequent laboratory test results and past experience with similar materials. Table 4 provides a summary of the strength parameters used in the stability analyses.

Table 4: Summary of Strength Parameters				
Material Type	**Bulk Density γ (kN/m³)**	**Effective Strength Parameter**		**Undrained Strength Parameter**
		Cohesion c' (kPa)	**Friction Angle φ' (degs)**	**Cohesion S_u (kPa)**
Deposited Tailings	14	0	32	0.25 σ'_v, min. 5 kPa
Deposited Tailings (liquefied)	14	-	-	0.05 σ'_v, min. 0 kPa
Compacted Clayey Mine Waste	15.5	10	25	200
Waste Dump	20	0	36	50
Foundation, surface (Clayey Silty Sand)	22	0	37	100
Foundation, upper (Ferricrete)	18	49	35	300
Foundation, lower (Saprolite)	18	25	25	250

3.3.1.3 Results of the Stability Analyses

The results of the stability analyses for the embankment at a maximum embankment height of 15 m, under the worst-case phreatic loadings where decant pond extends to the embankment, are summarised in Table 5. The graphical outputs of the analyses are presented in Appendix F.

Table 5: Results of Stability Analyses		
Case	**Factor of Safety (FoS)**	**Recommended Minimum FoS***
1	2.84	1.5
1a	2.65	
2	2.08	1.3
2a	2.07	
3	2.12	> 1.0
3a	1.96	
4	1.73	> 1.0
4a	1.62	
5	2.23	1.0 – 1.2
5a	2.01	

*Note: Recommended factors of safety in accordance with ANCOLD (2019).

The stability analyses indicate adequate factors of safety for the drained and undrained conditions when compared with the recommended minimum factors of safety in ANCOLD (2019). Pseudo-static analyses were presented as for completeness as a initial screen purpose (i.e. ANCOLD (2019) requires deformation analyses to assess earthquake loading.

3.3.1.4 Deformation Analyses

A preliminary assessment of embankment deformation due to an earthquake was estimated using the Swaisgood (2003) method. This method utilises an empirical formula based on observed crest settlement resulting from analysed 'real' earthquakes, with no liquefaction of foundation and embankment materials.

The permanent displacements and settlements expected for a 15.0 m high embankment were estimated under a magnitude 6.6 earthquake, corresponding with a PGA loading of 0.16 g for 1: 2,000 years AEP for the SEE event. The parameters were conservatively derived based on respectively the maximum earthquake magnitude on land recorded in Western Australia (Meckering) as gathered by Geoscience Australia, and the intensity measure as outlined in AS 1170.4 (2007). The nearest earthquake to the TSF3 site was a magnitude 2.0 recorded at approximately 30 km to the southeast in 1989.

From the analysis, it is concluded that for the highest embankment section, the deformation due to an MDE event is likely to be in the order of 6 mm. Such deformation is insignificant when compared with a minimum total freeboard of 0.7 m.

3.3.1.5 General Comments in Respect to Stability

TSF3 is a robust structure and the factors of safety, which are presented in Table 5, are above the required minimum and reflect this style of the structure.

Stability is significantly influenced by the position of the phreatic surface within the deposited tailings and confining embankment.

TSF3 has been designed to provide temporary water storage following extreme storm events. If water does extend to the embankment, which is considered very unlikely, it is anticipated this will be a temporary occurrence given continuous water removal from TSF3. The tailings storage should be operated in such a manner as to ensure that the `normal' supernatant pond is kept well away from the embankment at all times.

3.3.2 Design Acceptance Criteria

The design of TSF3 is based on the ANCOLD Guidelines (2019) *'Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure'*. The consequence category will determine the water management (e.g. freeboard and stormwater storage capacity required) and geotechnical embankment design requirements. Classification of TSF3, at its ultimate height, in accordance with Tables 1 and 2 of the DMP (2013) code results in a hazard rating of 'Category 2 – Medium' (Section 3.1). The ANCOLD (2019) consequence rating is 'High C' (refer to Tables 1 and 2 of ANCOLD (2019).

Embankment Design analysis should consider:

<u>Operations Phase</u>

- Operating Basis Earthquake (OBE) is 1 in 475 years annual exceedance probability (AEP).
- Safety Evaluation Earthquake (SEE) (previously MDE) is 1 in 2,000 years AEP.

<u>Post Closure</u>

- Maximum credible earthquake (MCE).

Freeboard and Water Management in accordance with ANCOLD guidelines (2019):

- Storage of 1:100 yr. AEP event of 72-hour duration, plus an allowance for wave run-up for 1:10 AEP and 0.5 m of additional freeboard.
- No spillway will be required during operations or at closure. Stormwater during operations will be largely re-used in the plant over several months. Stormwater from large storm events at closure will be disposed of on top-surface of TSF3 by evaporation.
- Minimum frequency of inspections of TSF in accordance with DMIRS guidelines.

The results of the design assessments for TSF3 indicate that the facility can be safely operated on the basis that:

- Liberated water is continually removed from the surface of the tailings.
- Tailings deposition is cycled around the facility to maximise tailings density and therefore the storage volume.
- The facility will be operated in accordance with the details contained in the Operations Manual.

- The safe operation of the storage relies upon the implementation of the tailings operation, management inspection and maintenance procedures.

The probability of major embankment failure during the life of TSF3 is assessed as being extremely low provided TSF3 is implemented (constructed and operated) within the intent of the design in accordance with the scope of works for the construction and operations manual.

3.3.2.1 Dam Break Assessment

3.3.2.1.1 Volume Released

If TSF3 embankment breach were to occur, tailings would only be partially released from the storage impoundment, as the majority of the tailings beaches would have dried back. In addition, remobilised tailings will behave as a thickened slurry, with some shear strength and therefore will not be as free flowing as water, which has no shear strength.

Under worst-case probable maximum precipitation (PMP) rainy day failure conditions:

- The storage capacity of TSF3 is estimated at 6,102,000 m³.
- PMP storm volume is estimated at a nominal 692,300 m³. This was based on a 3-hour probable maximum precipitation event (PMP) rainfall depth of 750 mm over TSF3 catchment of 92.3 ha.
- The tailings failure volume likely to be released from TSF3 at the maximum height of nominally 15.0 m, in the event of an embankment failure under PMP rainy day conditions, would be of the order 2.04 Mm³ i.e. approximately 33 % of the impounded storage capacity plus the PMP storm volume.
- Based on T MacDonald and J Langridge - Monopolis (1984), embankment breaches typically occur relatively quickly (typically 0.5 hour to 4 hours). Based on this methodology, it is estimated that the breach will occur over approximately 2 hours.

The calculation of breach characteristics is included in Appendix I.

The Rourke and Luppnow Method (ref: H Rourke, D Luppnow, 2015) for estimating volume released from the TSF was utilised to assess potential stored volume release. This method is based on a relation between the potential volume released from a TSF and the size of the decant pond. The greater the ratio of the pond area to the total area, the greater the ratio of release volume to stored volume. Table 6 presents a summary of case data used in the analyses taken from Table 1 of the referenced paper.

Table 6: Summary of Dam Break Case Study Data (ref: H Rourke, D Luppnow, 2015)

Name	Impoundment Storage Volume (Mm³)	Release Volume (m³)	Release Volume relative to Stored Volume (%)	Pool Area relative to Total Area (%)
Merriespruit	7.0	0.6	9	14
Bafokeng	13.0	3.0	23	30
Mount Polley	50.0	24.4	49	72
Kolontar	1.2	0.7	58	88
Stava	0.3	0.2	67	100

It was noted from Rourke and Luppnow analysis of past tailings storage facility (TSF) failures, that the release volume varies between 9% and 67% of stored volume. The 33% of TSF volume plus a PMP event, or approximately 2.04 Mm^3 scenario represents a likely maximum release from a relatively low embankment height TSF in a semi-arid region such as the northeast Goldfields region of WA (i.e. the water pond should not be this large as the water balance is a negative water gain and water should not accumulate on the facility).

The Rourke and Luppnow Method demonstrates that in order to mitigate the consequence of a dam-break, the pond volume and area should be minimised by the adoption of good operating practices.

3.3.2.1.2 Breach characteristics

Breach characteristics for a breach from TSF3 due to a dam break were assessed utilising published empirical (algebraic) methods. These methods are based on studies of past failures to provide relationships between release volume, breach development time and peak flow; and dam height and dam factor (height x stored volume).

For TSF failure, the method of Rico M, Beniti G, Diez-Herrero G (2008) was utilised to estimate peak flow. This study was based on examining historic tailings dam failures. The peak flows estimated by Rico M, Beniti G, Diez-Herrero G (2008) are skewed with the peak occurring quickly (i.e. less than the breach development time). For comparison, if a triangular hydrograph is assumed, the flow peak is not skewed and the peak is ‘normally’ distributed.

Tables 7 summarises the beach development time and estimated peak flows from a dam break utilising various methods.

Table 7: Results of Dam Break Analyses

Scenario	Peak Flow (m^3/s) Rico M, Beniti G, Diez-Herrero G 2008*	Peak Flow (m^3/s) triangular hydrograph**	Approx. Breach Development time (hrs)	Flood Volume (m^3)
Sunny Day	1,360	559	2	2,013,000
Worst-Case	1,539	751	2	2,705,300

*upper bound, **lower bound

3.3.2.1.3 Energy Methods

The sunny day case was examined by assessing a dam break using energy methods as referenced in K D Seddon (2010) and estimate tailings run-out distance. The method presented in the paper assumes the tailings and the embankment are assumed to liquefy and move as a block downstream.

The height of the block was assumed to be 15.0 m and the run-out distance a function of the residual shear strength and material density. For a residual shear strength of 1 kPa, the run-out distance was estimated to be 754 m.

Based on the analyses performed, the tailings from a sunny day dam break are not expected to reach the plant or the camp areas.

The calculations of the run-out distance for a sunny day case are presented in Appendix I.

3.3.2.1.4 Hydraulic modelling

The result from breach modelling indicates that the maximum (peak) run-out flow from a ‘dam break’ under ‘worst-case’ (PMP) rainy day conditions will be approximately 751 to 1,539 m^3/s over 2 hours. As drainage at TSF3 location is defined by the three catchments discussed in Section 2.3.4, the flow in the project area is expected to flow to the north via a channel on the eastern catchment, and to the west into the central catchment trending north. For example, the flows in Table 7 would be at least 350 m wide, with a maximum flow depth of approximately 1.4 m.

Flow towards the plant or the camp to the north and to the south, respectively, is considered highly unlikely. A flood from the western and most of the southern embankments would be diverted through low channels towards the west and into the pits. A flood from the east and southeast of TSF3 will flow east to a main creek channel that grades to the north, along the eastern side of TSF1. This flow is at least 800 m from the camp. Refer to the preliminary inundation plan in Appendix B.

The following consequences of a dam break are considered most likely:

- A dam break is unlikely to inundate the plant or the camp, however, there is potential for loss of life due to the presence of infrastructure along the western corridor of TSF3. For the purposes of stability analyses etc. a consequence category of 'High C' in accordance with ANCOLD (2019) has been used.
- No public infrastructure is likely to be affected.
- Economic loss from permanent loss of assets including infrastructure, repairs of damaged sections of TSF, damage to plant and local mine site roads.
- Limited impact on heritage value areas and on the natural environment, and effects on native flora and fauna downstream of TSF3. Damage would reasonably be expected to be concentrated in the ephemeral streams.
- Prolonged damage to the natural environment with potential for contamination of soils and vegetation distress requiring environmental 'clean-up', and permanent damage to heritage areas with remediation possible but difficult.

3.3.2.1.5 Controls

The conditions for TSF3 embankment failure to occur would be driven largely by the embankment mass and crest width adopted, the size and extent of the decant pond on the facility, and the magnitude of a trigger seismic event, embankment deformation, the grading of the tailings and saturation of the tailings adjacent to the embankment. Effective management of the decant pond to ensure excess water is continually removed from TSF3, will minimise the risk of a perimeter embankment breach and release of saturated tailings.

TSF embankment failure is not expected provided the facility is operated in accordance with the requirements set out in the TSF Operations Manual.

The water recovery system, pumps and piping must be designed for a minimum recovery of not less than 420 tph.

In the event that the TSF was in imminent danger of failure and breach, the Emergency Action Plan (EAP) would need to be enacted (see Section 4.4).

3.3.3 Erosion Control

The embankment has been designed with a downstream slope of approximately 18^{o} or 1:3 (v:h). The downstream slopes constructed at this angle with mine waste should be resistant to erosion. Further assessments will be required during mining on the erodibility of the materials to be included in the downstream batters of TSF3.

3.3.4 Seepage Analyses

3.3.4.1 Method of Analyses

Seepage analyses were undertaken to estimate the position of the phreatic surface for the embankment design at the crest RL555.0 m (15.0 m maximum embankment height). The analyses were undertaken using the groundwater module of the Slide software package. Slide uses a 2D finite element analysis to determine groundwater seepage for saturated, steady-state flow conditions. It should be noted that 2D modelling is a simplified approach, which does not consider 3D effects (e.g. seepage flow through geological structures such as joints).

3.3.4.2 Model Assumptions

The upstream boundary condition used in the analyses was determined based on a maximum water pond level of 0.5 m below the final crest level i.e. RL554.5 m. Models have been based on normal operating conditions where the decant pond is maintained well away (at least 150 m) from the embankment.

The downstream boundary condition was assumed based on the groundwater located at the ground surface level at the downstream toe of the embankment.

The material permeabilities used in the seepage analyses are based on values derived from CMW site geotechnical investigation and materials laboratory testing supplemented with assumed textbook values, appropriate to the materials. Table 8 provides a summary of the permeability used in the analyses.

Table 8: Permeability Values Adopted

Material Type	Permeability, K (m/s)
Deposited Tailings	1×10^{-7}
Compacted Clayey Mine Waste	1×10^{-9}
Traffic Compacted Mine Waste	1×10^{-7}
Waste Dump	1×10^{-6}
Foundation, surface (Clayey Silty Sand)	9.7×10^{-7}
Foundation, upper (Ferricrete)	6.6×10^{-7}
Foundation, lower (Saprolite)	3.4×10^{-7}

3.3.4.3 Results of Analyses

The seepage flow determinations from the analyses are summarised in Table 9, below.

Table 9: Results of Seepage Analyses

Scenario	Seepage Flow (m^3/day/m of embankment)	Approximate Embankment Length (m)	Estimated Seepage per day for embankment section (m^3/day)
Western* Embankment (Operational Life)	1.4×10^{-3}	960	2
Western Embankment (Post-Closure)	6.1×10^{-3}		6
Other Embankments	6.1×10^{-3}	2,245	14

* Western is highest embankment

Plots of the phreatic surfaces and distribution of pore pressures throughout the embankments are presented in Appendix E. The seepage from the facility as estimated in the table above is conservative and largely dependent on the hydraulic head and tailings permeability. The seepage analyses carried out indicated that there is only marginal benefit to seepage reduction by compacting the colluvium above the shallow Ferricrete. Please note, seepage recovery measures have been included in the design to reduce the impact of seepage.

3.3.5 Water Balance

A water balance analysis for the proposed TSF3 operation has been undertaken using a spreadsheet to examine expected TSF3 inflows and outflows.

Inflows and outflows for the facility were estimated on a monthly basis. Inflows include rainfall and slurry water. Outflows include evaporation, seepage losses and water retained in tailings (pore water). Water balance calculations are included in Appendix H.

Assumptions and other data adopted for the water balance are listed below:

- Climate data were obtained from the BOM website. Average monthly rainfall figures for Laverton, WA (recording period: 1899 to 2021) with an annual average of 235.7 mm/year, and average annual evaporation and evapotranspiration at approximately 3,746 mm/year and 1,350 mm/year, respectively.
- Tailings area of approx. 92.3 ha.
- A tailings runoff coefficient of 0.4 was assumed.
- Pool area equal to approximately 2% of tailings area (radius approx. 150 m).
- Running beaches equal to approximately 5% of the tailings area.
- Evaporation pan factor of 0.7.
- Average tailings residual moisture content of 35%.
- Tailings slurry density of 45% solids.
- Tailings production rate of 3.0 Mtpa.
- Seepage rate from seepage analyses of approximately 16 m^3/day.

The results of the analysis indicate potential annual average water returns of 68% of the tailings slurry water deposited into the facility can be expected under average climatic conditions.

The results also indicate that water recovery will vary according to the management of the facility, specifically the size of the pond and running beaches. The actual quantity of water available for return to the plant may vary from the figures presented based on the following factors:

- Variations in slurry density.
- Continuity of tailings discharge.
- Distance between the discharge point and decant pond.
- Size of the decant pond and running beaches from where evaporation is greatest.
- Climatic conditions at the time of operation.
- The efficiency of the decant system during operation.

The efficacy of the water return system is the key to achieving a higher in-situ tailings dry density within the TSF. The minimum capacity of the water recovery system should be not less than 420 tph including the additional capacity needed to recover water from design storm events.

3.4 Design and Construction Details

TSF3 will have a zoned embankment and be constructed in one stage prior to commissioning. Construction of the embankment is likely to utilise a mining contractor.

As part of preparation works, the footprint of the facility will be cleared of vegetation and its subgrade at the embankment foundation must be compacted. The topsoil from the footprint, nominally 0.1 m in thicknesses, will be stripped and stockpiled for use in rehabilitation. The vegetation and topsoil will be stockpiled separately. The subgrade must be compacted to achieve a minimum of 95% dry density ratio in accordance with AS1289.5.1.1.

The earthworks will comprise the construction of upstream (or inner) clayey mine waste (Zone A) and downstream (or outer) waste dump zone (Zone B). The estimated volumes required for each zone are shown in Table 3.

Construction of TSF3 embankment should be integrated with the ongoing mine planning, to ensure that adequate volumes of construction materials are available and scheduled.

It will also be necessary to ensure that the planning of the upstream Zone A construction is coordinated with the downstream Zone B construction as the waste dump (Zone B) must be in place prior to the placement of any upstream zones.

A decant accessway and central decant structure will be constructed. These will be constructed from traffic compacted mine waste (Zone C) and select filter rock (Zone D) materials, respectively. The decant accessway has a transversal slope of 1^0 from the embankment down to the rock-ring decant that reduces materials required for construction. The angle of 1^0 is designed to be consistent with the expected beach angles.

The embankment and decant accessway crests will be sheeted with a nominal 100 mm thickness of wearing course material obtained from a designated location. Safety windrows will be utilised during construction and on the final prepared crest. Gaps in the windrows will be placed intermittently to facilitate the shedding of rainfall runoff.

An underdrainage system comprising perforated pipe underdrainage lines in seepage intersection trenches grading to collection manholes via seepage collection trenches will be constructed along the northwest, west and northeast embankment alignments where the topographical lowest levels occur. The seepage interception trenches will be nominally 1 m wide and 0.6 m deep, with the seepage collection trenches having similar depths (dozer ripping etc may be required). The collection manholes will comprise a tower constructed using concrete well liners with a minimum depth of approximately 1.35 m below the levels of collection seepage trenches, including slab base.

3.5 Tailings Discharge and Water Management

The following operational considerations have been incorporated into the design:

- Tailings in the form of slurry will be discharged sub-aerially and cyclically into TSF3 in thin discrete layers, not exceeding 0.3 m thickness, in order to allow optimum density and strength gain by subjecting each layer to a drying cycle. Deposition will take place via multiple spigots located on the upstream perimeter embankment crest.
- Tailings deposition is to be carried out such that the supernatant pond is maintained within and around the rock ring decant. The pond is to be maintained away from the perimeter embankments at all times.
- Water will be removed from the facility and pumped back to the process plant via a decant pump located within the rock ring decant.

- The tailings storage area will assume the form of a truncated prism with a depressed cone on the top surface. The facility will have the capacity to store a considerable volume of water during a storm event. The minimum freeboard for the TSF under normal operating conditions is 0.7 m, which includes an allowance for the temporary storage of the 1:100 years or 1% average exceedance probability (AEP) storm event of 72-hour duration whilst maintaining the required total freeboard (Section 4.1.1).
- On eventual decommissioning, the facility will remain as a permanent feature of the landscape and drain to an increasingly stable mass. The top surface and batters will be stabilised and rehabilitated as described in Section 5.

3.6 Basin Preparation

No liners are proposed for TSF3. The reduction in permeability achieved through compaction of the sandy surface soils within the basin floor is marginal and therefore not justified from seepage modelling.

3.7 Quality Assurance

The Scope of Work and Technical Specification document is attached as Appendix J. This document specifies the responsibilities, procedures, and quality control tests which verify that TSF3 retaining structure has been constructed in accordance with the design intent.

4 OPERATIONAL REQUIREMENTS

4.1 Management of Tailings Deposition and Water

A summary of the operations design for TSF3 is presented in Section 3.2. An operations manual for TSF3 outlining the operating procedures, inspection criteria, monitoring requirements and log sheets for the facility has been compiled in Appendix K.

The following routine inspection and maintenance procedures are to be carried out for the various components of the system. A minimum of one inspection is to be undertaken during each shift by an operator or shift supervisor.

The inspections should cover:

- The pipelines (tailings delivery line and water return lines) to and from TSF3.
- Leak detection.
- Pumps.
- Valves.
- Discharge locations.
- Location and size of the decant pond.
- Decant and return water pumps.
- Seepage collection pipe flow and pumps.
- The general integrity of the embankment i.e. any new cracking (daily).
- Seepage downstream of TSF3.
- Any changes to existing cracking or seepage.

A monthly independent inspection should also be performed by senior site management. The operation, safety and environmental aspects should be periodically reviewed during an annual audit inspection by a suitably experienced and qualified engineer.

4.1.1 Freeboard

The following considerations were made regarding freeboard criteria and requirements for a 'High C' consequence category TSF (Section 3.2) based on ANCOLD (2019):

- The proposed TSF3 has been designed such that a 1:100 yr. AEP, 72-hour duration storm event can be temporarily stored on top of the facility. The design, however, assumes correct operational controls are adhered to and that water is continually removed from the facility, such that minimum freeboard allowances are maintained.
- Provision of a minimum of 0.7 m freeboard comprising minimum operational freeboard (vertical height between the tailings beach and embankment crest) of 0.3 m plus a minimum beach freeboard of 0.2 m and the allowance for the 1:100 yr. AEP 72-hour event of 0.2 m.

ANCOLD guidelines (2019) also recommend an allowance for wave run-up for 1:10 AEP wind for a 'High C' consequence category TSF (refer to Section 3.2). However, it is expected that with perimeter tailings deposition and an expected beach slope of 1.0 %, the separation distance between the perimeter embankments and design storm pond will be adequate to prevent wave action reaching the embankments.

Freeboard nomenclature is illustrated in Figure 4. Intensity-frequency-duration (IFD) data pertaining to the site is presented in Figure 5. From the chart presented in Figure 5, a 1:100 yr. AEP, 72-hour duration rainfall depth of 185 mm was adopted for the design. Temporary storage of a stormwater volume of approximately 170,800 m^3 (i.e. approx. 92.3 ha x 185 mm) on top of TSF was considered in the design. This stormwater volume will occupy approximately 10 % of the TSF basin. The TSF also has sufficient capacity to contain the probable maximum flood (PMF) of approximately 692,300 m^3 (i.e. 92.3 ha x 750 mm).

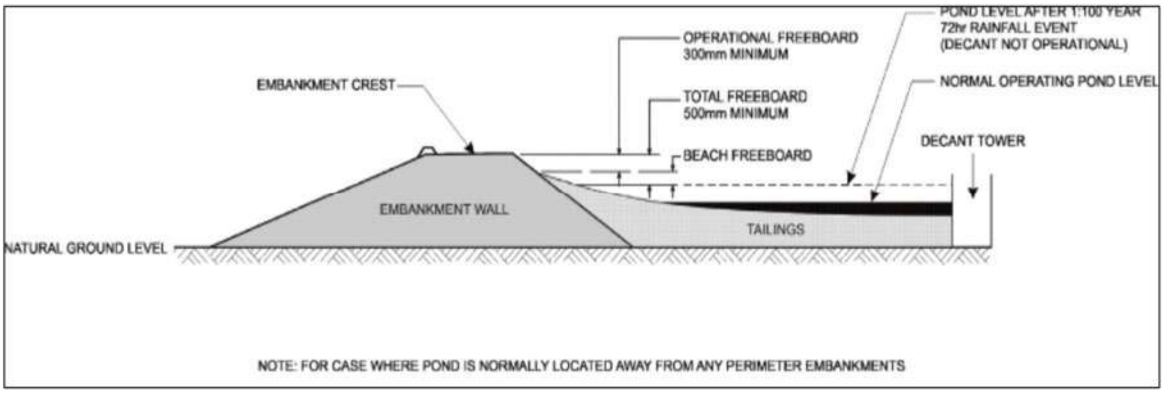

Figure 4: Freeboard Nomenclature

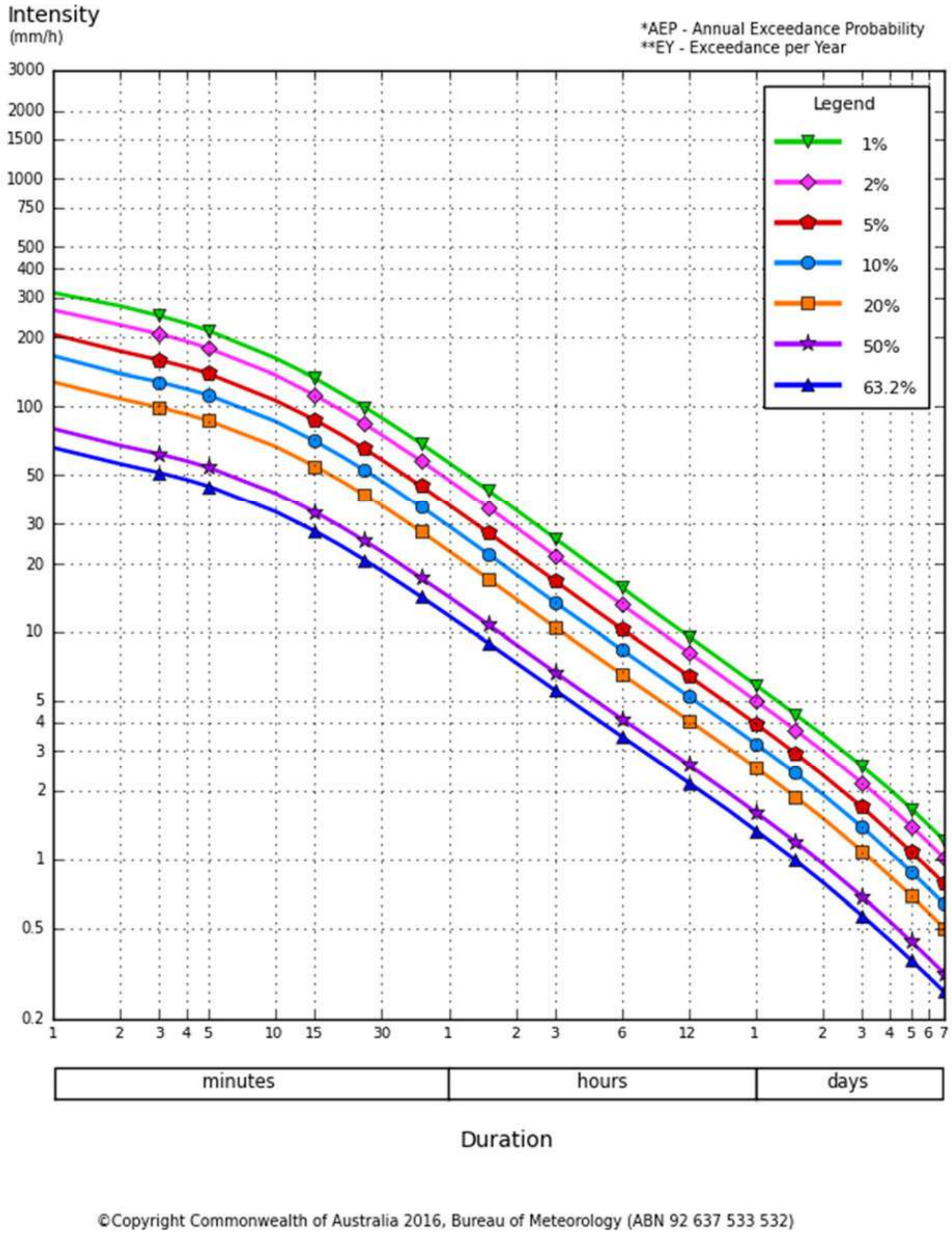

Figure 5: IFD Data

4.2 Dust Control

Provision for TSF3 construction works will include a water cart on location to provide dust suppression as required. This control measure will prevent dust from becoming airborne and subsequently being mobilised into the surrounding environment, from becoming a visibility issue, or from becoming a respiratory hazard for construction personnel.

Based on experience with TSF1, dust generation from the tailings beaches is not expected as the tailings are saline and a crust is likely to form on the beaches, binding the tailings surface and reducing the potential for dusting. If dust generation becomes an issue (i.e. in periods TSF3 may be inactive), the tailings beaches could be irrigated (i.e. with sprinklers or similar) or tailings deposition managed such that beach areas do not dry back to such that dust generation occurs.

4.3 Performance Monitoring and Instrumentation

4.3.1 Vibrating Wire Piezometers and Monitoring Bores

Groundwater monitoring bores (MB) (3 minimum) will be established around TSF3 perimeter. The geotechnical investigation carried out by CMW encountered no groundwater within the investigated depths of up to 1.3 m. Groundwater levels were interpolated from the water levels in existing production bores in the RRL (2014) TSF1 monitoring report, and inferred at between 22.8 m below ground level (mbgl) to 57.3 mbgl. For the purpose of performance monitoring, an allowance for three boreholes drilling to a depth of up to 45 mbgl should be made.

Installation of vibrating wire piezometers (VWP) will need to be developed internally within TSF3 to enable the phreatic surface within the TSF embankments to be monitored and stability analyses to be validated in the future. These VWPs will also give early warning of seepage from the TSF.

VWP are to be installed as part of the embankment construction. Allowance needs to be made for 3 pairs for a total of 6 VWP. Each pair will have VWP installed in a trench 0.5 m wide and 0.3 m deep, with one VWP installed at nominally 10 m away from the upstream toe of the TSF embankment, and another VWP at 1 m inside the upstream crest (i.e. downstream of the upstream embankment zone). Bentonite collars will be required to reduce the potential for the development of a seepage pathway. The read-out cables are to be installed in PVC electrical conduit to ensure they are not damaged during deposition.

A terminal box containing the data loggers is to be placed downstream of the final embankment toe to avoid vehicular damage and to allow future embankment raises. The loggers are to be downloaded periodically (typically monthly depending upon the variability of pore pressure responses) for analysis. The collected information should be reviewed regularly, acted upon as necessary, and reported in the annual audit.

The pore pressure readings collected from the VWP and the standing water levels recorded in the MB are also used if required to adjust the design phreatic surfaces used in the stability analysis models.

The positions of the proposed MB and VWP are detailed on drawings PER2021-0102-03 and PER2021-0102-05, and shown in Table 10 and Figure 6.

For both the MB and VWP, it is recommended that as a minimum:

- Groundwater level readings are taken monthly.
- Groundwater samples for laboratory analyses are taken quarterly.
- Water level readings from the piezometers are taken on a minimum monthly basis, with the readings plotted and graphed to allow an inferred phreatic surface within the facility to be modelled, and trends to be recognised.

The requirement for additional instrumentation (i.e. monitoring bores, piezometers) associated with TSF3 should be reviewed as part of the yearly audit.

Table 10: Locations of Monitoring Bores and Vibrating Wire Piezometers

Instrument Number	Easting (m)	Northing (m)	RL (m AHD, approx.)
MB01	437,349	6947,556	542
MB02	436,447	6946,842	541
MB03	436,377	6947,400	540
VWP01A	437,278	6947,468	541
VWP01B	437,312	6947,497	541
VWP02A	436,563	6946,878	542
VWP02B	436,521	6946,872	542
VWP03A	436,490	6947,436	541
VWP03B	436,445	6947,430	541

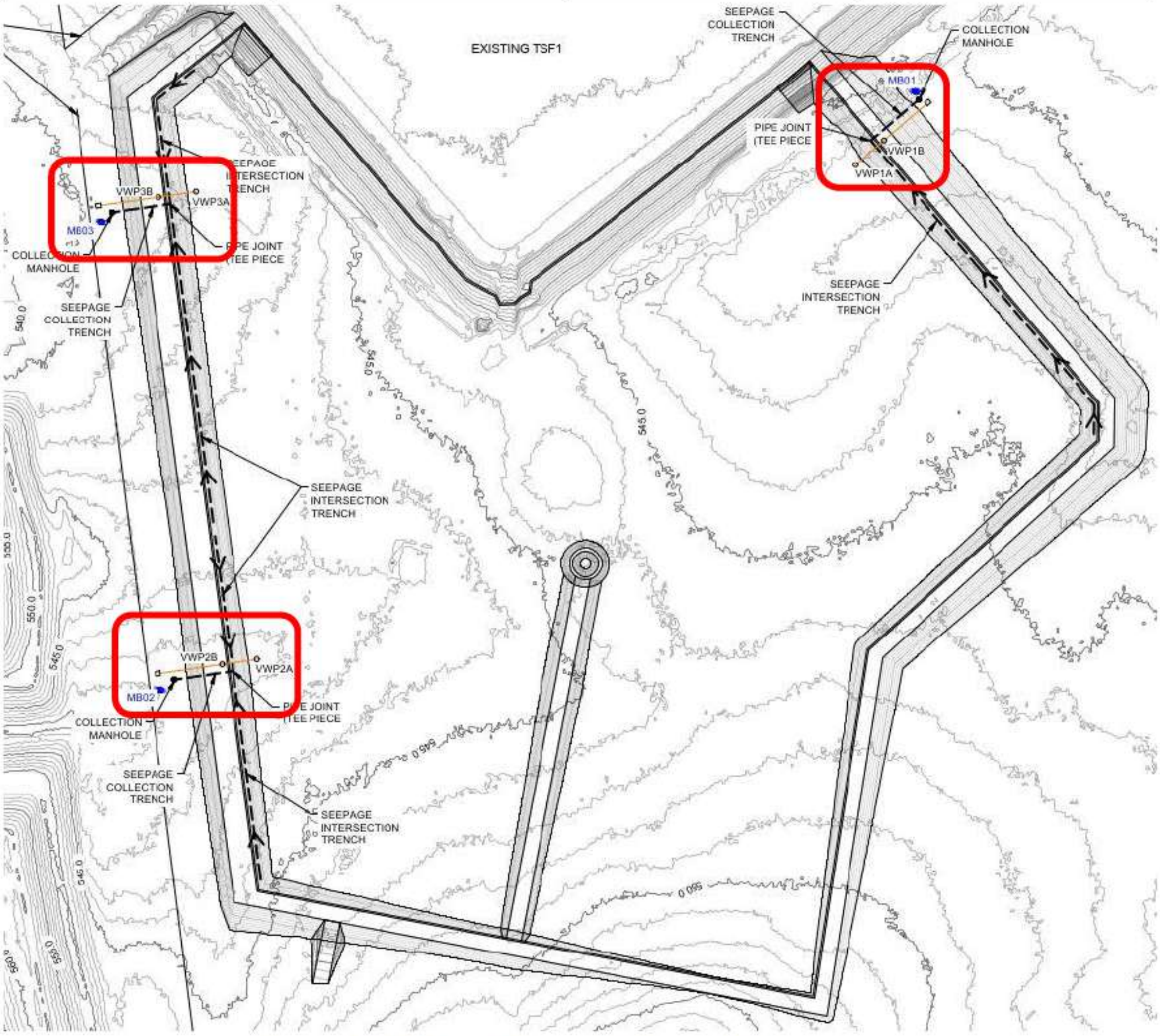

Figure 6: TSF Plan showing MB and VWP Locations

4.3.2 Displacement Monitoring

High-resolution surveys are conducted every 6 months from an unmanned aerial vehicle (UAV) or “drone”. These provide a detailed survey of the surface of TSF3 to +/- 100 mm resolution. Surveys are conducted every 4 to 6 months. Digital terrain models are prepared from the survey data and successive models can be compared to determine any deformation magnitude greater than the LIDAR limits of vertical accuracy of +/-100 mm.

4.3.3 Visual Inspections

Driving or walk-around inspections of TSF3 are to be undertaken to observe any irregularities in the normal configuration of the embankment, embankment toe areas, and tailings beach that may indicate internal erosion of the embankment or instability. In particular, any embankment cracking and damp or wet areas on batter slopes or toe areas are to be noted.

Informal inspections should be carried out daily, whilst documented independent inspections should be undertaken as part of an annual audit for submission to regulatory authorities.

4.4 Emergency Action Plan

TSF3 Operations Manual provides a description of the operating procedures for the facility and includes an Emergency Action Plan (EAP). The EAP for the plant site and pits should be updated based on the results of the dam break analyses presented in Section 3.3.2.1. The plan should be reviewed and updated as a minimum on a yearly basis.

The plan should include:

- Management responsibilities and emergency coordination.
- Muster points.
- Seeking specialist geotechnical advice.
- Emergency Plan Triggers:
    - Freeboard less than design values.
    - Elevated piezometer levels.
    - Significant embankment distress.
    - Imminent overtopping.
- Seepage from the embankment should be investigated and VWP installed to allow further assessment by a Geotechnical Engineer, as required.

5 CLOSURE CONSIDERATIONS

5.1 Overview

The closure objectives for TSF3 are to leave the facility in a safe, stable, erosion resistant and non-polluting state.

The top surface and batters will be stabilised and rehabilitated through cross ripping and topsoiling. The maximum slope angle will be 18^0, with no intermediate benches.

Once tailings deposition has been completed within TSF3 and the top surface of the tailings has gained adequate bearing capacity, it will be capped with a layer of NAF oxide or transition mine waste (0.5 m nominal thickness) to minimise dust generation from dried tailings and provide support for topsoil/growth medium for re-vegetation.

5.2 Rehabilitation

Upon completion of tailings placement within the facility, the surface will undergo a rehabilitation program. The rehabilitation program will include the identification of appropriate capping material and local flora species to revegetate the surface of the facility.

Prior to the commencement of the rehabilitation program, the tailings will need to be allowed to gain strength. Based on consolidation testing the tailings have moderate consolidation characteristics (an average C_v of 200 m^2/year to 1,000 m^2/year). The tailings (up to 15.0 m thick within TSF3) is expected to take approximately 1 to 2 years to consolidate. Hence in order to cover the top surface of the tailings within the TSF, several years will be required to allow a surface 'crust' to develop. Testing (e.g. Cone Penetration Test or CPT, and Dynamic Cone Penetrometer or DCP) will be required to assess trafficability for placement of cover over TSF3. The use of geotextiles and geogrids may assist trafficability in some areas to allow the construction of TSF3 cover to proceed.

Following the development of 'crust', a waste cover comprising uncompacted NAF oxide or transition mine waste will be pushed from the perimeter of the TSF out over the tailings towards the centre.

5.3 Performance Monitoring against Closure Criteria

Rehabilitation closure criteria for TSF3 including observations specific to the tailings and consolidation will be developed and progressed as part of a Mine Closure Plan. Details of the criteria will be documented in the Mine Closure Plan associated with the Mining Proposal.

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