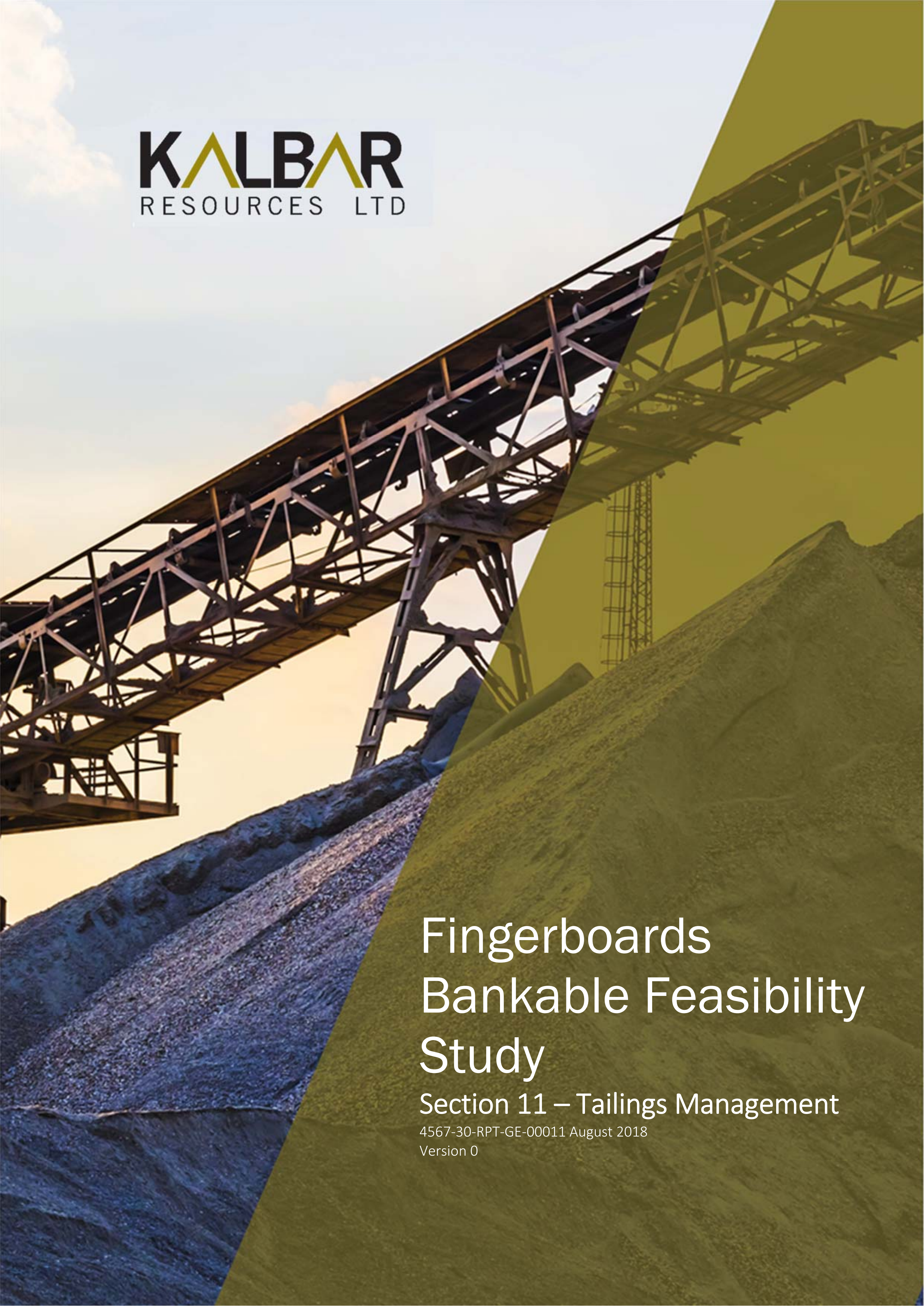

KALBAR RESOURCES LTD

Fingerboards Bankable Feasibility Study

Section 11 – Tailings Management

4567-30-RPT-GE-00011 August 2018

Version 0

KALBAR RESOURCES LTD

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11 Tailings Management

11.1 Section Summary

Mine waste disposal for the Project will consist of the disposal of the tailings from the Wet Concentrator Plant (WCP). The tailings that result from the wet separation process of the heavy mineral occurs in two distinct separation streams, namely fine tailings (also referred to as slimes) and coarse tailings (also referred to as sand tailings).

Fine tailings will be pumped from the WCP to the Temporary TSF situated Northwest of the WCP where it will be deposited in four Compartments consisting of perimeter earthfill embankments to contain supernatant and stormwater. The Temporary TSF, which are sized for the deposition of 5 years of fine tailings, will be constructed as required using a phased approach to defer Capital Expenditure over the life of the project. Once the tailings in the Temporary TSF have consolidated sufficiently, the fine tailings will be harvested and used as backfill in the pit and rehabilitation profile for the final. Fines deposition cells will then be developed in-pit for the remainder of the life of mine.

The fine tailings deposition will take place from the TSF perimeter embankments via spigot deposition. It is proposed to use spigot outlets at specified intervals. 'Mud Farming' or accelerated mechanical consolidation (AMC) is proposed for the Fingerboards Project to assist with the management of the tailings, maximizing water return to the WCP and to ensure adequate consolidation of the fine tailings material.

The design philosophy is to operate the fine TSFs so that tailings beaching will create a depression around the decant water collection points from where water will be returned to the WCP for re-use. The location of decant ponds will ensure water is kept away from the perimeter embankments. The TSF Compartments will be operated to have sufficient design storage allowance for a 1:100 year ARI, 72-hour storm even.

Sand tailings make up the bulk of the reject material from the WCP and will be pumped back to the mining void to be discharged, via cyclone stackers and will be shaped to design with dozers, which will also be required to move the stackers. The two sand tailings dewatering cyclone feed sumps each feed to a separate pipeline whereby the combined sand tailings are pumped overland to separate sand stacking cyclone clusters at the pit crest. The sand tailings cyclone underflow discharges directly in to the mine void at a pulp density of approximately 66% solids (w/w).

The concept for pit backfill with sand tailings is to stack the sand tailings without a downstream containment embankment allowing surface run-off and seepage to free-drain from the area, into a catchment dam. Surface water run-off and seepage water is therefore not allowed to pond against the sand stack areas.

Underdrainage is proposed to be installed in predetermined locations to assist with collection of seepage water from the sand tailing areas. Seepage from the underdrains will flow away from the stacked sand area and collected in a sump/dam.

Sand stacking during the start-up stages of the operations will be in the Perry Gully catchment. Surface water run-off from the Perry Gully catchment will be and seepage will be collected in a Catchment Dam. As silt collection pond is proposed between the sand tailings area and the dirty water dam. This will reduce the silt load in the water dam. The silt pond can be designed to allow cleaning by removal of silt from the pond during the dry months.

A Tailings Management Plan (TMP) will be developed for the project during the detailed design stage and will address the design, construction, operation and closure of the TSFs.

11.2 Background

11.2.1 Geological Setting

The area is located in the central-north portion of the Gippsland Basin, north of the Lake Wellington Depression. Depositional sequences within the Lake Wellington Depression comprise a thin sequence of the Latrobe Group (Traralgon Formation) overlain by a thick sequence (up to 800 m) of the Seaspray Group which in turn is unconformably overlain by the Sale Group.

The broader project area is characterised by plains and stepped terraces bordering the Mitchell River Valley, with plains typically consisting of widespread tallus, alluvial sheets and clays of quaternary sediments. Within the Mitchell River Valley there are east-northeast trending dunes and barrier sands of the marine sequences becoming more prevalent to the south through to the modern beach-barrier system that hosts the Gippsland Lakes.

Unconformably overlying the deposit in the southern part of the project area are wide expanses of Quaternary Haunted Hill Formation, consisting of mixed gravels with rounded cobbles and layers of gravelly sands and clays. Paleozoic basement underlies the Pliocene sands and is exposed in river cuttings a few kilometres to the north.

11.2.2 Climate

The site is located in an area with warm summers and cool damp winters. Rainfall occurs generally in every month of the year with higher evaporation from October through to March.

The nearest weather station recording a full suite of climate data is Bairnsdale Airport station (station number 085279) located approximately 25 km southeast of the site. The mean temperature records in this station range from 4°C in July to 26°C in January.

11.2.3 Hydrology

According to the annual rainfall records at Bairnsdale Airport Station, the area has experienced rainfalls of up to 904 mm (in 1992). Average annual rainfall is 650 mm and an annual average evaporation value of 1,110 mm can be expected at the mine site, see Figure 11.1.

The 1:100 AEP, 72-hr design rainfall is 243 mm which approximates to the average annual rainfall.

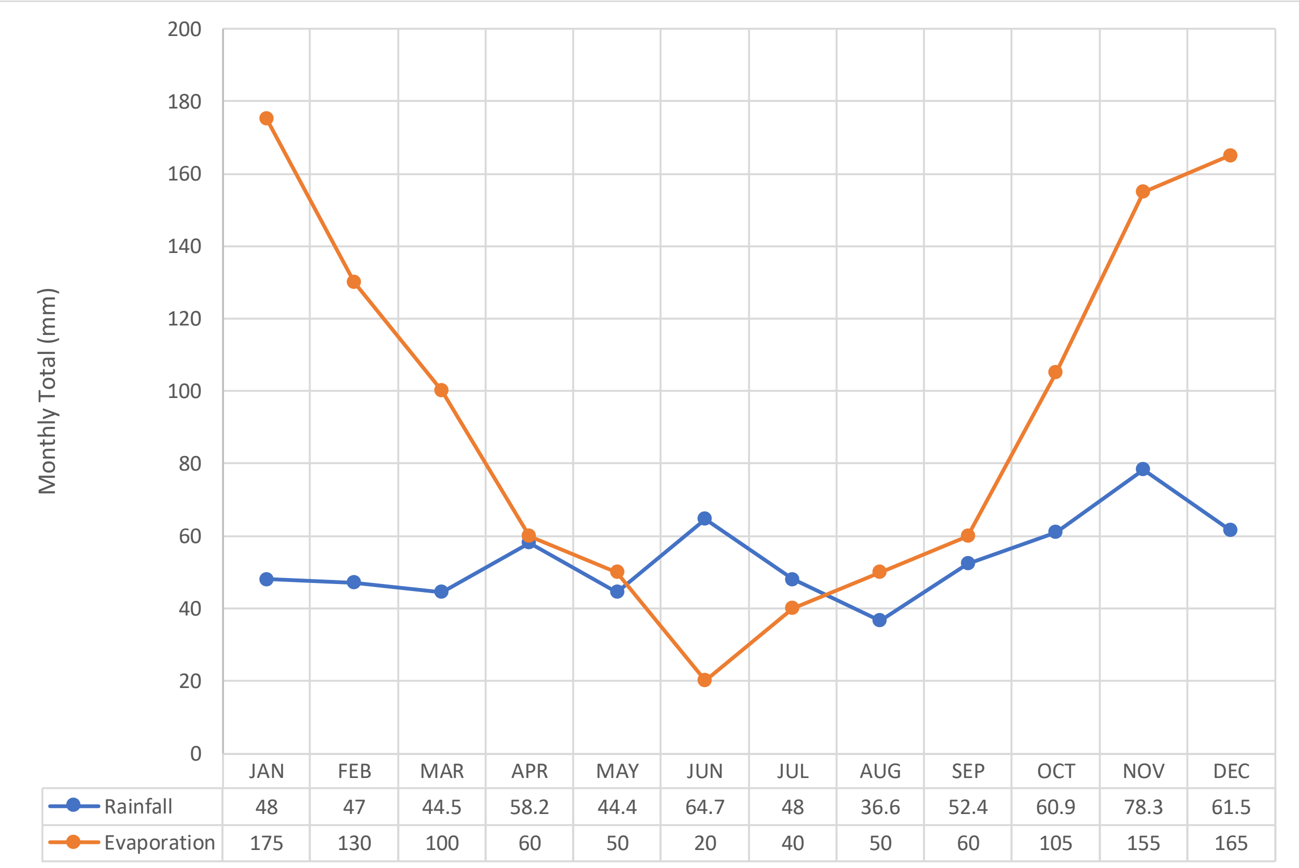


Figure 11.1 Monthly Rainfall and Evaporation Summary (BoM[1])

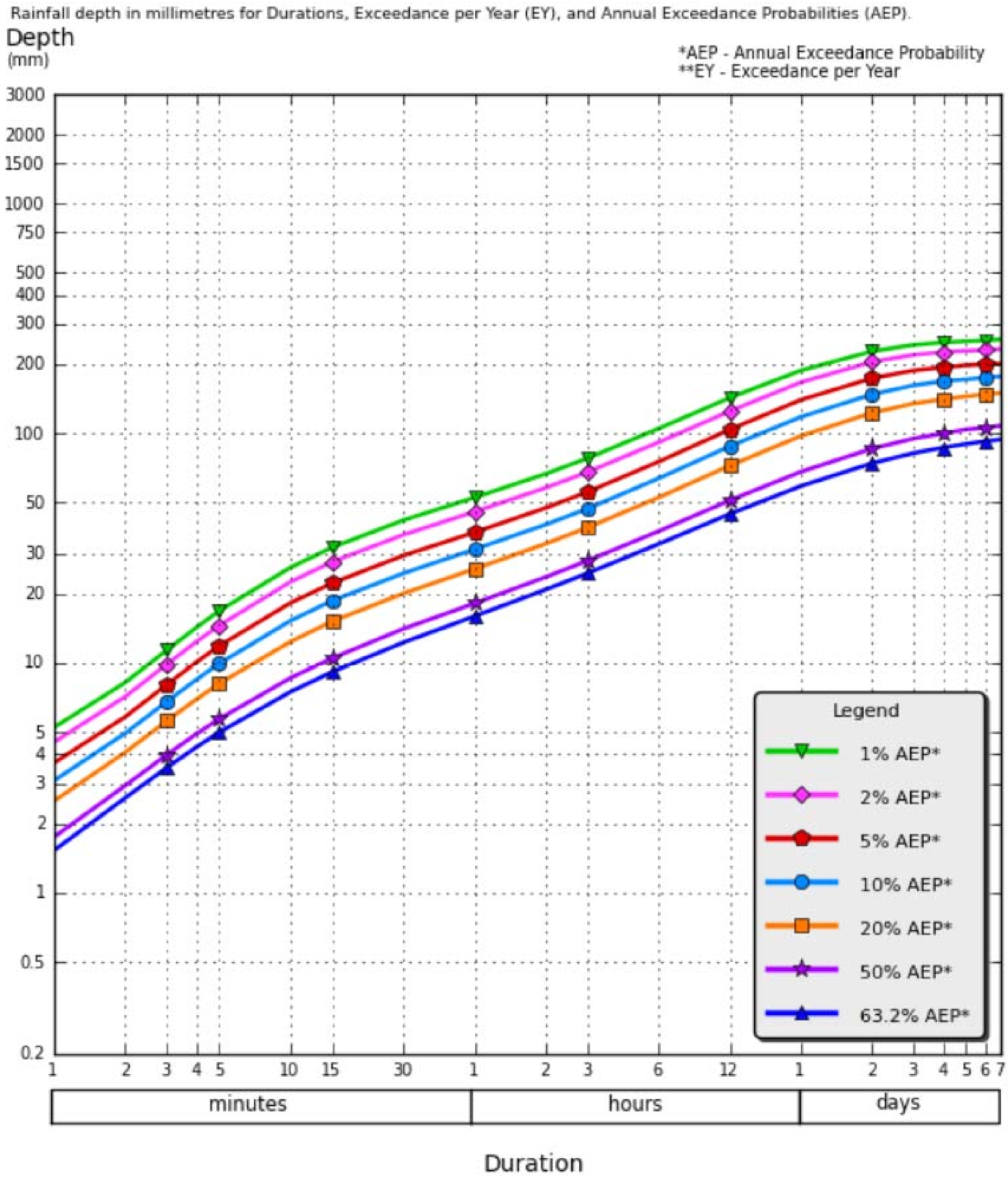
Short duration design rainfalls for the site were derived using the BoM's Computerised Design IFD Rainfall System, which allows automatic determination of a full set of intensity-frequency-duration (IFD) curves.

Table 11.1. IFD Design Rainfall Depth (mm)

Duration (min)	Annual Exceedance Probability (AEP)							Duration (hours)
	63.20%(1EY)	50%	20%	10%	5%	2%	1%	
5	5	5.72	8.15	9.96	11.9	14.6	16.9	5 min
10	7.5	8.62	12.4	15.3	18.3	22.6	26.1	10 mins
15	9.15	10.5	15.2	18.7	22.3	27.6	31.9	15 mins
30	12.3	14.1	20.1	24.6	29.4	36.2	41.9	30 mins
60	16	18.2	25.7	31.3	37.1	45.6	52.6	1 hours
120	20.9	23.7	33.1	40.1	47.4	58	66.7	2 hours
180	24.6	27.9	38.9	47	55.6	67.8	77.9	3 hours
360	33	37.5	52.6	63.7	75.3	91.5	105	6 hours

[1] Source: Australian Bureau of Meteorology (Rainfall - BAIRNSDALE AIRPORT Station No. 085279 records 1942 to 2018, Evaporation - http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp?period=an#maps)

Duration (min)	Annual Exceedance Probability (AEP)							Duration (hours)
	63.20%(1EY)	50%	20%	10%	5%	2%	1%	
720	44.6	51.1	72.4	87.9	104	125	143	12 hours
1440	59	68.1	97.5	118	140	167	188	24 hours
2880	74.2	85.9	123	148	174	205	228	48 hours
4320	82.1	95	135	162	188	220	243	72 hours



Latitude - 37° 42' 20"   Longitude - 147° 19' 16"   Latitude - 37.7125(S)   Longitude - 147.3125(E)

Figure 11.2   IFD Curve

11.2.4 Hydrogeology and Groundwater

The information used in this section of the BFS is a summary of the Fingerboards Groundwater Modelling Report (EMM, 2018).

The Fingerboards EES study area ('study domain') falls within the south-central region of both the West and East Gippsland CMAs. The CMAs are drained by a series of generally southward-flowing rivers from incised valleys in the exposed and elevated bedrock of the Great Dividing Range (GHD, 2010), across the coastal plain and out to the Tasman Sea and/or to the Gippsland Lakes system.

The Fingerboards project site is within the study domain which covers an area of approximately 50 by 50 km and encompasses the two main rivers in the area (Perry and Mitchell Rivers), the Gippsland Lakes system and the highly utilised Boisdale aquifer system, which supports thriving agricultural and horticultural industries.

The Gippsland CMA region lies on the southern flank of the Great Dividing Range, and the landform is characterised by: high elevation and high relief mountains and foothills, and the flatter coastal plain (GHD, 2010).

The coastal plain (between 535 km wide in a north-south direction) is generally wider to the west (near Gippsland Lakes and the lower Mitchell River valley), although it is also quite wide in the very east of the CMA region, around Mallacoota. The coastal plain comprises terrestrial and marine deposits overlying bedrock, up to an elevation of approximately 100 m AHD (GHD, 2010).

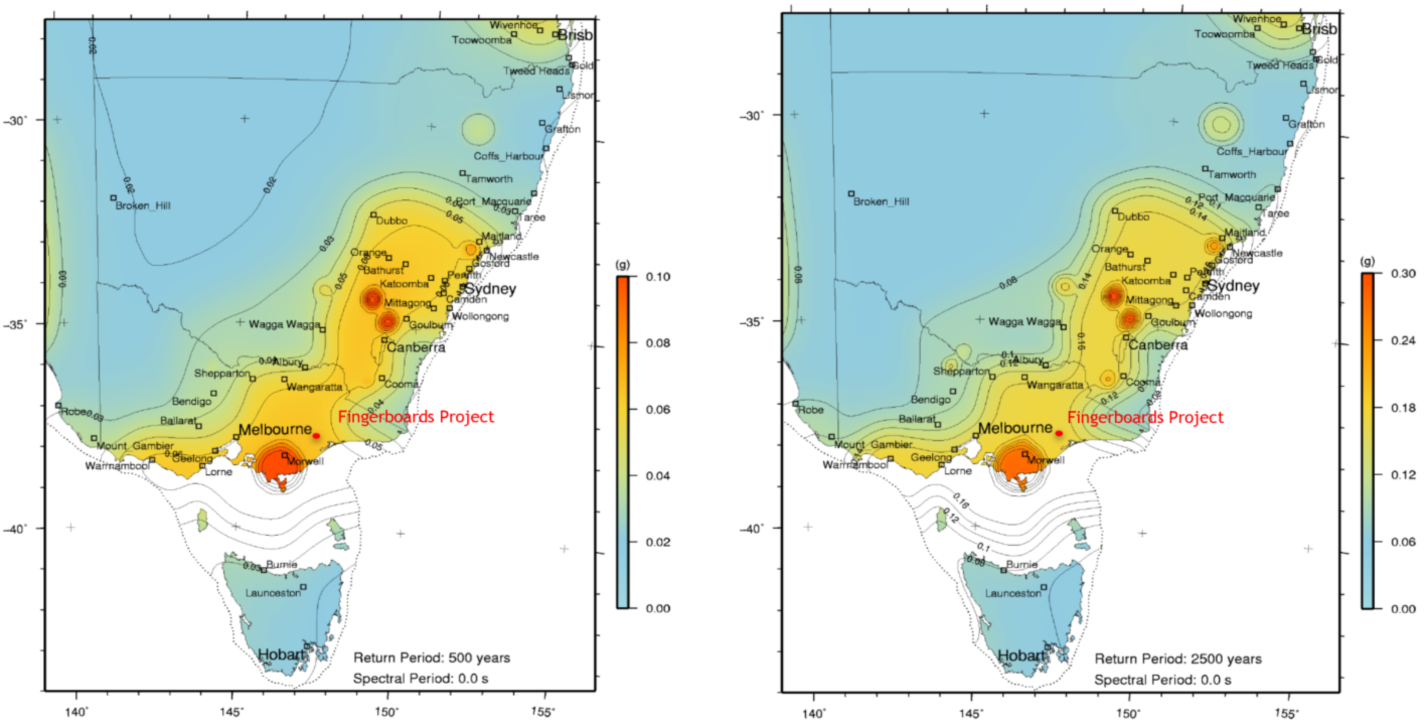
Within the Fingerboards study domain, surface topography ranges from approximately 1,200 m AHD in the north east, to near sea level towards the lakes system and the coast in the south. At the project site, the physiography is characterised by elevated plains reaching elevations of 130 m AHD, with incised gullies bordering the Mitchell River Valley, which has a typically surface elevation around 35 m AHD adjacent to the project site.

The groundwater levels and flows are described in detail in the Fingerboards Groundwater Modelling Report (EMM, 2018). A summary of this work is below:

- The water table measures from above 50 m AHD, north of the project site, to approximately sea level in the south eastern region towards the lakes system.
- Flow is generally from the north-west to the south-east.
- The groundwater gradient is steep in the northern region, a consequence of steeply dipping topography.
- The groundwater gradient decreases in the south eastern area of the coastal plain, likely resulting from the presence of the more permeable Boisdale Formation which underlies this region.
- The Mitchell River monitoring wells range from 28.6 m AHD adjacent to the project site, to 0.6 m AHD directly west of the township of Bairnsdale. The VAF water table contours in this region indicate that the Mitchell River is a strongly gaining system.
- The VAF groundwater contours have been updated within this area based on locally collected water level data from the Fingerboards baseline monitoring well network. The water table is hosted within the Coongulmerang Formation at the project site with groundwater levels ranging from above 45 m AHD in the north-western section of the project site to around 27 m AHD within the adjacent Mitchell River alluvium floodplain to the east. Groundwater flows from the west to north-west and is locally directed towards the east where the majority of groundwater discharges to the alluvium floodplain system.
- The measured groundwater levels within the Boisdale Formation are generally consistent with the constructed VAF groundwater contours.
- The Latrobe Group monitoring well labelled 47063 is located in the south-eastern section of the study domain, west of Lake King. The latest recorded groundwater level of -8.16 m AHD was recorded on the 10th of May 2017, which is up to 12 meters lower than the groundwater levels in the overlying Boisdale Formation based on the VAF groundwater contours within this area. The Latrobe Group has been depressurised over the last few decades as a result of various onshore and offshore mining activities.

11.2.5 Seismicity

The Fingerboards mine site is located in an area of low seismicity. This seismic acceleration is determined from the Earthquake Hazard Map of Victoria as shown in Figure 11.3. The horizontal Peak Ground Acceleration (PGA) coefficient applicable to the site is 0.06 g for a return period of 500 years and 0.16 g for a return period of 2500 years.



Annual probability of exceeding 1/500 and 1/2500 at an SA period of 0.0s (PGA)[2]).

Figure 11.3 Hazard Map of NSW, Victoria and Tasmania

11.3 Tailings Characterisation

The tailings that result from the wet separation process of the heavy mineral occurs in two distinct separation streams, namely fine tailings (also referred to as slimes) and coarse tailings (also referred to as sand tailings):

- sand tailings D_{50} ± 100 µm
- fine tailings D_{50} ± 10 µm and 100% < 45 µm
- fine and coarse tailings SG = 2.7.

11.3.1 Testing

ATC Williams (ATCW) carried out a laboratory testing program in May/June 2017 to review various tailings management options:

[2] Atlas of Seismic Hazard Maps of Australia (2013), Seismic hazard maps, hazard curves and hazard spectra, M. Leonard, D. Burbidge and M. Edwards

- Co-disposal of sands and slimes without pipehead flocculation (combined Slimes thickener U/F and the Sand cyclone U/F).
- Co-disposal as above with pipehead flocculation.
- Thickening of the combined Sand and Slimes stream and pumping to discharge without pipehead flocculation.

The ATCW testing program also included some classification testing of the fine and sands tailings and are summarised in Table 11.2.

ATCW carried out Particle Size Distribution (PSD) for fine (sample -45 µm) and sand tailings and Residue Solutions for fine tailings (sample -38 µm) and the PSDs are summarised in Figure 11.4.

Table 11.2. Tailings Material Characterisation Summary

Property	Fine Tailings	Sand Tailings
Particle Density (SG)	2.76	2.67
Atterberg Limits:		
▪ Liquid Limit (%)	34	-
▪ Plastic Limit (%)	21	-
▪ Plasticity Index (%)	13	-
Min/Max Dry Density (t/m3)	-	1.24/1.55
PSD D50 (µm)	12.9	110
PSD D80 (µm)	36.9	137
USCS Classification	ML/CL	SP

No permeability testing was undertaken on the fine tailings and sand tailings materials to date. ATCW (2017) did carry out a Rowe Cell consolidation on a unflocculated sand/fine tailings sample, measuring permeability values of 1 x 10-8 m/s to 5 x 10-9 m/s.

Based on the particle size distribution it is expected that the fine tailings will have a permeability of about 5×10^{-9} m/s to 1×10^{-9} m/s and the sand tailings of about 5×10^{-6} m/s to 1×10^{-5} m/s.

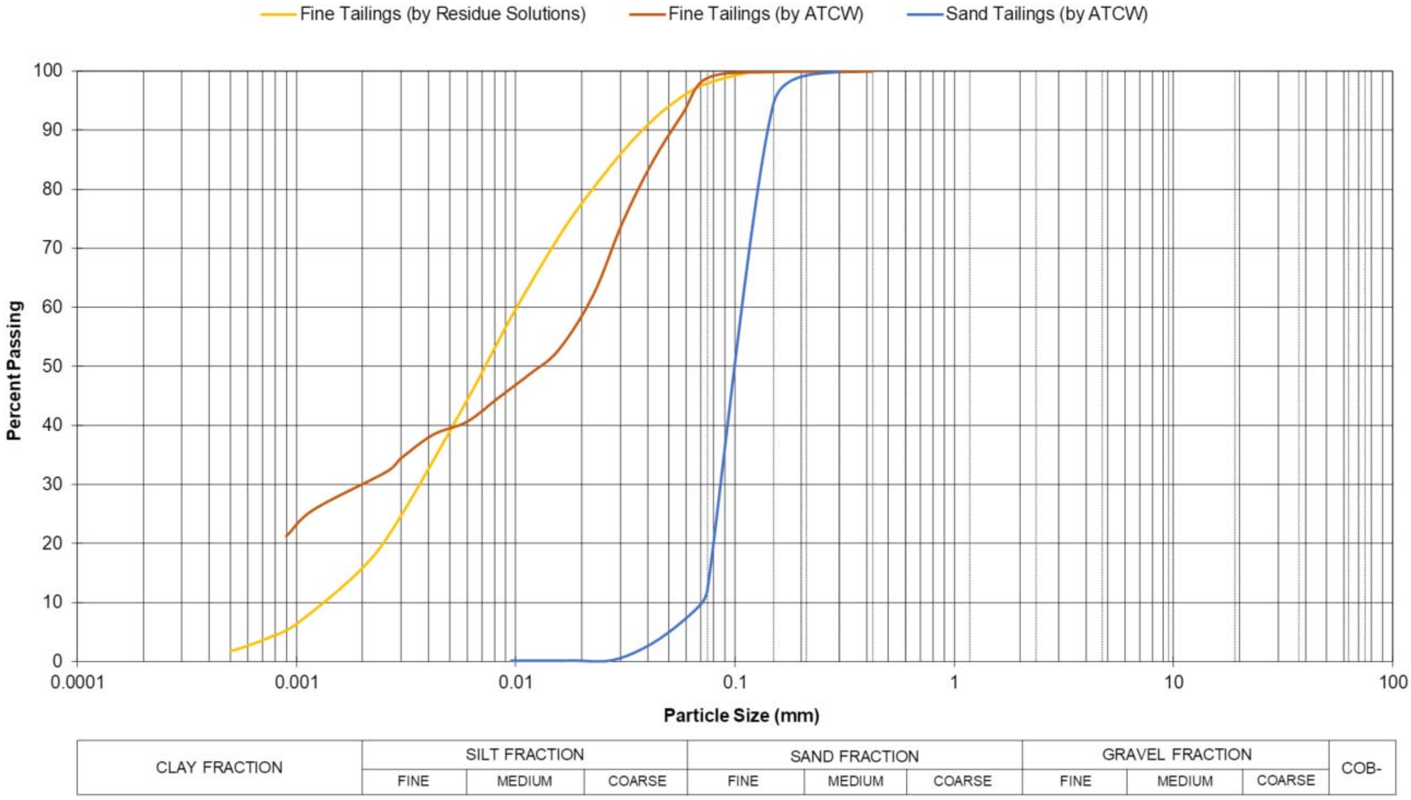


Figure 11.4 Tailings Samples Size Analyses

11.3.2 Physical Properties

11.3.2.1 Fine Tailings

The fine tailings will be deposited at a slurry density of 1.28 t/m^3 (35% solids w/w) and the rate of consolidation for the fine tailings is expected to be low due to the high percentage of fines. The consolidated field densities achieved for the fine tailings are dependent on the rate of rise, cycle times, rainfall and evaporation/desiccation.

The dry densities of the fine tailings after consolidation is expected to be 0.8 t/m^3 (saturated density of 1.5 t/m^3). Densities are maximised when the storage facility is operated in a manner that minimises the supernatant pond size, allowing effective drying of the tailings. A suitable deposition plan and efficient operation of the facility can greatly improve the achieved tailings densities.

'Mud Farming' or accelerated mechanical consolidation (AMC) is proposed for the fine tailings material after deposition in the TSFs and the consolidated dry densities of the fine tailings after AMC is expected to be 1.25 t/m^3 to 1.35 t/m^3 (saturated density of 1.78 t/m^3 to 1.83 t/m^3).

The beach angle for the fine tailings is expected to be 1:160 (v:h). However, a flatter beach slope will impact on the TSF storage requirements. The beach slope will be influenced by the deposition strategy and the tailings solids content produced by the thickeners at the WCP.

11.3.2.2 Sand Tailings

The nature of the sand tailings allows it to be effectively dewatered by cyclones and stacked to form a stable slope. It is therefore proposed to use the coarse tailings to construct freestanding TSF embankment. With the information available it is predicted that the sand tailings will be fairly free draining with a medium to high permeability. It should be noted that if the coarse tailings contain small percentages of fine tailings (slimes), it can cause stratification that will have an impact on the permeability of the embankment. This should therefore be carefully monitored during the operational phase of the TSF.

It is important to note that the material <75 µm should be limited to not more than 15% of the coarse tailings. The coarse tailings can potentially be susceptible to liquefaction if it contains excessive fines and therefore reducing the percentage of fines will minimise the compressibility of the material and susceptibility to liquefaction.

11.4 Geotechnical Investigation

The project location is sited on elevated tablelands pastural lands, adjacent to the broader Mitchell River valley. The plateau area is generally 80 to 100 metres above the floodplains. The tablelands is generally flat lying or has a slight undulating topography. Most of the vegetation consists of grasslands, with occasional trees or forest remnants. The Haunted Hills Formation forms the capping to the plateau. However, once the Haunted Hills Formation (HHF) is broken, the underlying silty sands of the Coongulmerang Formation erode easily and form deep erosion gullies within the project area. These gullies can typically drop 70 to 80 metres over a few kilometres in length.

Coongulmerang Formation sediments are known to be dispersive and easily erodible. This makes these sediments prone to tunnel erosion. This form of erosion occurs when water flows through a weakness in the sedimentary profile and rapidly carries the dispersive sediments with the water flow.

The study determined that the Haunted Hills Formation consists of two broad layers. The upper layer is clay-rich silts with minor sand sized material. The sediment is free of gravels varies in thickness from between 2 to 16 metres. Geotechnical testing of this material showed that it is stiff to hard, with moderate plasticity. However, it was noted that the clays are highly dispersive and will be prone to erosion when saturated with water.

A layer of clay-rich, sandy gravels is found at the base of the Haunted Hills Formation and varies between 6 and 10 metres in thickness. The gravels have been variably cemented or lithified in places. Liquid Limits for these soils range from 19% to 23%, with plasticity index values between 8% and 11%, indicating the fines fraction is of low plasticity. Linear shrinkages values for the clayey gravel were between 3.5% and 6.0%, indicating a low shrink/swell potential. Emerson Class numbers of 1 or 2 indicating that this material is dispersive. Compaction testing was carried out on the two composite samples of this material. The Standard Maximum Dry Density (SMDD) of the material was between 2.06 t/m3 and 2.11 t/m3, with a corresponding optimum moisture content (OMC) of 9.5% and 8.5%.

The silty sandy soils of the Coongulmerang Formation (mineral deposit) were intersected below the Haunted Hills Formation in all of the geotechnical boreholes. This deposit was intersected at depths varying between 8.6 m and 29.2 metres. The material varies from a silty sand to a sandy silt and generally consists of yellow/brown, fine grained sand and low plasticity fines. Laboratory testing on these silty sandy soils was limited to in situ density testing of undisturbed thin-wall tube samples. This testing indicated these soils have a wet density of between 1.82 t/m^3 and 2.05 t/m^3, and a dry density of between 1.49 t/m^3 and 1.85 t/m^3. Field moisture contents for the materials sampled varied between 11.0% and 25.4%.

The upper clay unit of the Haunted Hills Formation has a high plasticity and low permeability, it is likely that this material will be suitable for construction embankments and dam walls, however, consideration will need to be given to the dispersive nature of this material as discussed above.

Soils of the Haunted Hills Formation were found to be dispersive. In addition, although no testing has been carried out on the Quaternary sediments, based on local experience it is possible that these materials may also be dispersive.

A brief assessment of the excavatability of the in-situ materials was made based on the geotechnical drilling and the available field testing. Rock was not intersected in any of the four geotechnical boreholes within the Starter Pit footprint. The geotechnical logs indicate that the basal gravel layer (Haunted Hills Formation) is variably cemented, with zones of moderate cementation.

11.4.1 Groundwater

A GHD geotechnical study was undertaken in 2015 and found that the ground water level is significantly lower than the excavation base and the materials encountered on site are not expected to be “sensitive” (lose significant strength and release water when disturbed).

11.4.2 Permeability

In 2017, GHD carried out three permeability tests on ore material (sandy clay and silty sand) and the permeability results ranged from 9×10^{-7} m/s to 2×10^{-8} m/s. Constant head permeability testing was also undertaken in 2015 on the two disturbed samples of the clayey gravel, which had been remoulded to 95% of SMDD (at OMC). Measured permeabilities of these compacted samples ranged between $2 \times 1\ 0^{-9}$ m/s and 2×10^{-8} m/s. The dry density of these remoulded/compacted samples was between 1.86 t/m^3 and 1.89 t/m^3.

11.4.3 Construction Materials

The geotechnical investigation undertaken by GHD (2015), indicates that there are sufficient clay-rich materials available at the Fingerboards site that can potentially be used for construction of dam embankments and compacted clay liners. However, the testing undertaken showed that clayey subsoil material has Emmerson Class numbers of 1 and 2, indicating highly dispersive soils. This is evident on site by the presence of erosion gullies and tunnel erosion.

Dispersive soils are a major contributing factor to piping failures of earthfill embankment dams and therefore soils with Emmerson Class 1 to 4 need to be used with caution when used for dam construction works.

However, as indicated in ICOLD (1990), safe dams can be constructed with dispersive materials provided that certain precautions are taken:

- Materials compaction and density control is important preferably to a density ratio of 98% (standard compaction) or greater and water content at optimum plus 2%.
- Proper design and construction of pipes through the embankment (i.e. providing cut-off collars).
- Most dispersive soils can be rendered non-dispersive by adding 2% to 3% lime and it should be mixed into the soil with equipment that can break the soil lumps so that 80% to 90% of the particles are less than 25 mm in diameter.
- Provide properly designed and constructed filters in the dam embankments.

11.4.4 Future Geotechnical Work

The following future work is recommended to be undertaken during the detailed design phase:

- It is recommended that further dispersion testing be conducted during the detailed design stage of the Project (i.e. Soil Conservation Service Test, Pinhole Dispersion Classification, etc.)
- Testing to confirm stabilisation of dispersive soils with lime, including compaction and permeability.
- Some CPTu and shallow test pits are recommended in the valley/gully lines in areas where dams are proposed to be constructed and sand tailings materials are to be stacked.
- Some CPTu and shallow test pits are recommended to be undertaken on the footprint of the Temporary Fine tailings storage facility.

11.5 Basis of Design

A summary of the basis of design and operating criteria for the tailings management system is summarised in this section.

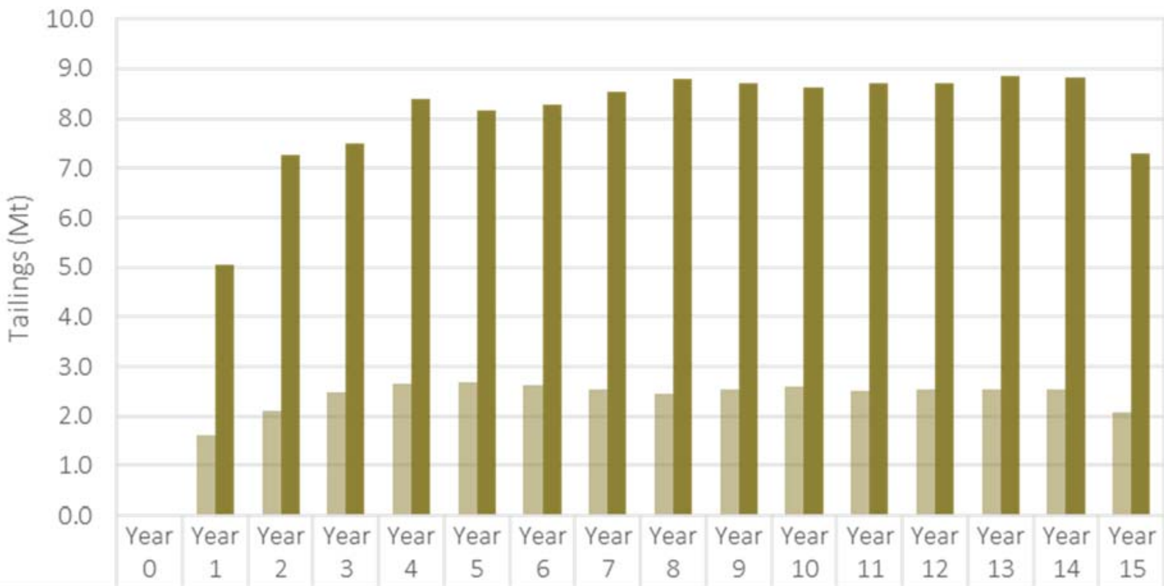
11.5.1 Design Guidelines

The design works have been undertaken in accordance with the following documents and guidelines:

- ANCOLD 'Guidelines on Tailings Dams, Planning, Design, Construction and Closure' May 2012.
- Victoria State Government (Department of Economic Development, Jobs, Transport and Resources), 'Technical Guideline – Management of Tailings Storage Facilities', April 2017.

11.5.2 Tailings Production

The tailings production parameters used for the study are summarised in this section. Two tailings products will be generated by the WCP and will be deposited in separate areas on the mine lease, of which fine tailings will be 1.63 Mtpa to 2.69 Mtpa and sand tailings will be 5.05 Mtpa to 8.86 Mtpa, as shown in Figure 11.5.



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Fine Tailings (Mt)	0.00	1.62	2.10	2.48	2.66	2.68	2.63	2.54	2.45	2.54	2.58	2.51	2.53	2.52	2.53	2.07
Sand Tailings (Mt)	0.00	5.05	7.27	7.50	8.40	8.17	8.27	8.52	8.79	8.70	8.61	8.71	8.71	8.86	8.82	7.31

Figure 11.5 Tailings Production Schedule

The design parameters for the tailings streams are summarised in Table 11.3. Sand tailings material will be pumped to two dewatering cyclones located at the two mining areas labelled as MUP1 and MUP2.

Table 11.3. Tailings Streams

Parameter	Fine Tailings (thickener underflow)	Sand Tailings (cyclone underflow)	
		MUP1	MUP2
Solids (t/h)	377	526	505
Water (m^3/h)	700	271	260
Slurry (m^3/h)	841	471	450
% Solids (w/w)	35	66	66
Solids SG	2.65	2.65	2.65
Slurry Density	1.28	1.7	1.7

11.5.3 Tailings Density

For the purpose of volume calculations, the overall dry density of the tailings deposits has been considered as follows:

- fine tailings 0.8 t/m^3 prior to AMC
- fine tailings 1.25 t/m^3 after AMC
- sand tailings 1.6 t/m^3 with design and installation of suitable underdrainage.

11.5.4 Beaching Profile

Flat slopes are generally associated with very fine tailings and the beach profile will be dependent on the ore type and thickener performance and it is expected that the beach slope will range from 0.45% to 0.9%. An estimated average tailings beach slope of 0.63 % or 1:160 (v:h) has been used for the purpose of this study.

Stacking angle for mineral sand tailings is typically at 30° to 35° and is in general at the angle of repose of the material. The angle of repose of the sand material is currently being tested and this parameter will be confirmed once testing data become available.

11.5.5 Category of TSFs

ANCOLD (2012a) require a risk assessment be undertaken on all TSFs and a consequence category then assigned for the following categories:

- dam failure consequence
- environmental spill consequence.

An assessment of TSF hazard rating was undertaken based on ANCOLD Guidelines on Tailings Dam Design, Construction and Operation considering embankment failure and uncontrolled release or seepage.

Based on severity of potential damage and loss, in conjunction with the population at risk (PAR), further assessment of hazard rating was conducted based on ANCOLD Guidelines on Assessment of the Consequences of Dam Failure.

Based on population at risk (PAR) 1 to 10 and highest damage and loss severity level 'Medium', hazard rating 'Significant' was adopted for the proposed TSF designs as per the ANCOLD guidelines. This is a conservative assessment as the population in the immediate vicinity of the proposed TSFs at risk is minimal.

11.6 TSF Design for Fine Tailings

11.6.1 Tailings Deposition Methodology

Some options were reviewed prior to and during the feasibility study to evaluate different tailings deposition methods:

- Solar drying of fine tailings and cyclone discharge of sands directly to pits or constructed cells.
- Co-disposal of sands and fine tailings without pipehead flocculation.
- Co-disposal of sands and fine tailings with pipehead flocculation.

The fine tailings deposition will take place from the TSF perimeter embankments via spigot deposition. It is proposed to use spigot outlets at specified intervals, currently designed at 50 m. Discharge will be controlled at these spigot outlets via valves. The proposal is to open at least 3 to 5 spigots at a time to reduce the flow rate at the deposition point and to manage the beach slope. It is recommended that the optimum operational sequence should be determined during commissioning and start-up stages.

'Mud Farming' or accelerated mechanical consolidation (AMC) is proposed for the Fingerboards Project to assist with the management of the tailings, maximizing water return to the WCP and to ensure adequate consolidation of the fine tailings to allow future mining through this area, i.e. mechanical relocation of the fine tailings material.

Fine tailings material is planned to be deposited in the Temporary TSF at 27% solids (w/w) and after AMC it is estimated that the solids content will increase to 70% solids (w/w).

The proposed Temporary TSF is divided into four (4) cells. This will provide two (2) active tailings deposition cells (maximum depth of 1.0 m per cycle) and two (2) cells that can be treated mechanically with amphirol equipment (MusMasters®).

Based on the above assumptions it is estimated that the Temporary TSF should be designed to store up to 9.1 Mm^3 fine tailings storage material, i.e. fine tailings produced in the first five years.

The development of fine TSFs will be staged over the life of mine and staging will have the following advantages:

- Will allow the evaluation of the consolidation behaviour of the tailings which will assist with future development of cells and the timing of their construction.
- Process and storm water will only have to be managed on a limited number of cells at a time and not on one large facility that could potentially reduce pumping and operating costs.

11.6.2 General Arrangement

A off-path TSF will be constructed 500 m north of the WCP and will consist of four compartments covering an area of about 69 ha. The general fall of the area is towards the south and the embankment height will range between 3 m and about 15 m. The embankments will be constructed with materials borrowed from the TSF basin. Return water piping from the TSF will run overland to the process water dam to the west of the WCP.

11.6.3 TSF Storage Characteristics

The capacity analysis for the fines TSF (off-path) was developed to a level sufficient to determine the available storage volume and the life of the facility. Based on current production forecast, this is estimated to provide about 60 months (5 years) storage. The TSF will be raised in two stages to provide a total storage volume of 9.17 Mm^3, see Table 11.4 and Table 11.5.

Tailings consolidation occurs continuously during deposition and will continue after completion of operations until all excess pore pressures have dissipated. AMC will be used at the site to accelerate the consolidation process and placement of the tailings in 1.0 m thick layers will allow excess pore pressures to dissipate.

Table 11.4. Fines TSF Storage Characteristics

TSF (Stage 1)	Storage Volume (m^3)
Compartment 1	1,150,000
Compartment 2	1,300,000
Compartment 3 (West)	1,000,000
Compartment 4 (East)	800,000
Total	4,250,000

Table 11.5. Fines TSF Storage Characteristics

Stage	Top of Embankment	Storage Volume (Mm^3)
Stage 1	RL 128.5	4.25
Stage 2	RL 133.0	2.57
Stage 3	RL 137.5	2.35
	Total	9.17

11.6.4 Embankment Construction

Homogeneous embankments using low permeability material will be constructed with fill borrowed from the dam basin, with 1:2.5 (v:h) slopes both upstream and downstream as dictated by stability analyses and design economics. A general crest width of 10 m has been designed to accommodate pipework and other TSF operational infrastructure. The Stage 1 embankments will be constructed to RL 128.5 as part of CAPEX.

Due to the dispersive nature of the onsite soils it is proposed that the upstream slopes of the perimeter embankments are stabilised with 3% lime. However, further testing is required during the detailed design stage to confirm this.

Unsuitable will be removed from the embankment footprint areas prior to construction, in particular in the drainage lines.

The perimeter embankments are proposed to be raised using the upstream method and the division embankments will be raised using the centre line method. Material for the staged construction of the embankments will be sourced from local borrow and overburden (HHF) from the mining operations can potentially be used. Geotechnical testing will be required to confirm the engineering properties of the materials prior to use. Geotechnical investigation and testing will also be undertaken on the tailings materials to assist with the design of the upstream embankments.

11.6.5 Water Management

The principles on which the surface water management plan is based, and which are implemented in the design are:

- separation of clean and dirty water;
- clean storm water run-off from the upstream catchments will be diverted around the facility;
- zero discharge of tailings or supernatant water to the environment;
- minimisation of seepage to the groundwater; and
- minimum storage of water on the TSFs.

The Temporary TSF is located above the natural ground and will have no external catchment. Small perimeter drainage ditches may be required around the facility to manage local runoff.

Water will be controlled in a manner that minimises erosion in areas disturbed by construction activities and prevents the release of sediment laden water to the receiving environment.

11.6.5.1 Storage Requirements and Freeboard

The TSF do not have an external catchment and the 1:100 ARI flood-related overtopping analyses was still used in freeboard analyses. The tailings beach angle of 0.63% will result in a centrally located depression against the division embankments that will provide additional volume for containment of storm events. It is expected that, these conservative assumptions will ensure that storm-related freeboard will be available at all times, within the design limits described.

The critical design case during the operation phase will occur when the maximum volume of tailings occupies the TSFs.

The design storm storage allowance is based on the 1:100 year ARI, 72-hour storm even, will generate 243 mm rainfall and will result in about 167,670 m^3 and are summarised in Table 11.6.

Table 11.6. Design Storm Storage

TSF	1:100 72-hr Storm Volume (m^3)
Compartment 1	42,525
Compartment 2	42,740
Compartment 3	44,995
Compartment 4	36,450
Total	167,670

The design philosophy is to operate the TSF so that tailings beaching will create a depression around the decant water collection points from where water will be returned (pump back) to the WCP for re-use. The location of decant ponds will ensure water is kept away from the perimeter embankments.

Although continuous decanting of water from the tailings beach is proposed, an allowance of 1.0 m height between the end of deposition tailings surface and the TSF embankment was allowed for in the feasibility design.

The TSF shall be operated in accordance with the ANCOLD (2012a) minimum freeboard requirements.

11.6.5.2 Water Balance

Water balance model for Temporary TSF.

The sections below outline the average monthly water balance approach adopted and summarises the results obtained from the water balance computations. The aim of the average monthly water balance is to simulate the performance of the TSF under assumed operating conditions.

The average monthly volume of water returned to the WCP varies and is directly related to the following factors:

- monthly rainfall
- monthly evaporation
- solids content of deposited slurry

- volume of water trapped in the voids of the tailings material
- size of the decant pool
- efficiency of decant system
- seepage losses.

The results of the water balance analysis indicate that an annual average water return of 76% of the tailings slurry water deposited into the facility is likely to be available for recovery under average climatic conditions.

The development of the average water balance involved a number of assumptions, the results should therefore be considered as indicative only. In particular, the figures should be considered as indicative and not a prediction of the return water volumes.

The water balance calculations for the proposed TSF are included as APPENDIX 11A.

Return water from the TSFs will be pumped back to the WCP for re-use. The calculation of the volume of water available for return to the WCP is based on the following data and assumptions:

- Water return will be maximised by 'mud farming' (AMC) and water retained in void of the tailings material (entrained water) are based on tailings consolidated to 70% solids (w/w).
- Low seepage losses were assumed based on the estimated low permeability of the fine tailings material.
- The decant pond is kept to minimum to reduce evaporation losses.

11.6.5.3 Decant Water Return System

Tailings deposition will be managed to allow tailings beaching towards the dividing embankments and the supernatant pool. Decant barges will be located against the central division embankments. Water will be recovered via a floating pontoon mounted pump and returned to the process water dam via a HDPE return water pipeline.

Water recovery will be an important part of tailings management. The sub aerial deposition will not only facilitate evaporation from the beached tailings surface, but also allow control of discharge points to force the decanted water (liquor) to the required pond area for immediate pump back.

Assuming that all this rain water has to be returned to the WCP during the wet season, approximately 80 m^3/h to 145 m^3/h (per Cell) of water will have to be pumped to the WCP (based on 21 hours/day). The 1:100 72-hour storm volume will not be stored on the TSF cells and will have to be removed within a reasonable time (approximately 7 to 10 days). The return water pumping system for each of the cells should be designed to return approximately 145 m^3/h of processing water and 200 m^3/h of stormwater, i.e. pump capacity of 350 m^3/h.

11.6.6 Seepage Assessment

Constant head permeability testing was undertaken on the two disturbed samples (GHD in 2015) of the clayey gravel (Haunted Hills), which had been remoulded to 95% of SMDD (at OMC). Measured permeabilities of these compacted samples ranged between 2×10^{-9} m/s and 2×10^{-8} m/s.

The permeability of the fine tailings material is estimated to be in the order of 5×10^{-9} m/s to 1×10^{-9} m/s.

The Temporary TSF will cover and area of 69 ha and the tailings material will be deposited in 1.0 m thick layer and then mechanically consolidated with amphirol equipment. This will release water from the deposited tailings slurry and will further reduce the permeability with the accelerated consolidation. It is therefore expected that the TSF will not generate a significant phreatic surface during its operating life. Seepage losses are thus estimated to be low and between 60 to 360 m^3/day from the TSF footprint. The seepage losses during commissioning and the initial few months may be at the upper limit and it is expected that it will then reduce to about 80 m^3/day.

Seepage from the embankment underdrainage will be collected in a surface drain along the toe of the embankment and will report to a seepage collection pond/sump located at the toe of the Southern embankment.

11.6.7 Stability Analysis

The stability assessment was undertaken with 2D Slope Stability Analysis software (based on Limit Equilibrium concept), "Slide" (7.0). The analyses were undertaken for static and earthquake (seismic) conditions using the Bishop's simplified method. The minimum acceptable factor of safety (FoS) adopted for the stability assessment (ANCOLD 2012a) is as follows:

Static steady state condition (long-term drained)	-	1.5
Static steady state condition (short-term undrained - construction)	-	1.3
Seismic loading condition (OBE & MDE)	-	1.1

11.6.7.1 Seismicity

The seismic parameters relevant for the slope stability analyses are summarized below:

Horizontal Peak Ground Acceleration (PGA)	-	0.06 g (500-year return period)
Operating Base Earthquake (OBE)	-	0.03 g (for 1:100 AEP)
Maximum Design Earthquake (MDE)	-	0.078 g (for 1:1,000 AEP)

ANCOLD (2012a) recommends the 1:100 Annual Exceedance Probability (AEP) earthquake events as the Operational Basis Earthquake (OBE) and the 1:1,000 AEP earthquake event as the Maximum Design Earthquake (MDE) for a TSF Dam Failure Consequence Category of 'Significant'.

The horizontal PGA coefficients of 0.03 g and 0.078 g were subsequently determined (by extrapolation) for the OBE and MDE earthquake events respectively. These pseudo static (seismic) coefficients were used to compute the forces caused by a potential earthquake as part of the overall equilibrium computation to determine the factor of safety.

11.6.7.2 Model Assumptions

The phreatic surface used in the stability analyses were based on the seepage analysis and on a maximum operating decant pond.

No detailed geotechnical investigation was undertaken at the location of the Temporary TSF and the material parameters for the assessment was estimated from the GHD (2015 and 2018)[3] geotechnical investigation at the starter pit area of the mine. Wave reviewed the exploration drill hole information in the area of the TSF and it was confirmed that the general soil profile is comparable with the GHD geotechnical drill holes.

Detailed geotechnical investigation is required at the TSF during the detailed design phase.

No groundwater was encountered at the site during the geotechnical investigations.

11.6.7.3 Material Parameters

The strength parameters adopted for the stability analyses are summarized in this section.

[3] GHD Pty Ltd, Glenaladale Starter Pit Preliminary Geotechnical Investigation, November 2015 & Trial Pit Short Term Batter Stability Assessment, February 2018

Table 11.7. Summary of Strength Parameters

Material Type	Unit Weight (kN/m^3)	Effective Strength Parameters		Consolidated Undrained Strength Parameters		Undrained Shear Strength S_u (kPa)
		Cohesion c´ (kPa)	Friction Angle ϕ´ (degrees)	Cohesion c (kPa)	Friction Angle ϕ (degrees)	
Foundation – clayey sand	18	5	33	5	33	
Foundation – clay	19	15	33	15	33	
Foundation – clayey sandy gravel	20	10	35	10	35	
Embankment - Fill	19.5	15	33	8	30	
Tailings	16.5					60

11.6.7.4 Results of Stability Analyses

The results of the stability assessment are summarized in this section, the stability assessment diagrams are presented in APPENDIX 11B.

Table 11.8. Results of Stability Analyses

Load Case	FoS	Acceptable FoS
Static steady state condition (short-term undrained - construction) – Upstream Slope	2.02	1.3
Static steady state condition (short-term undrained - construction) – Downstream Slope	1.95	1.3
Static steady state condition (long-term, drained)	1.99	1.5
Seismic (OBE)	1.83	1.1
Seismic (MDE)	1.62	1.1

Upstream embankment raising is proposed for the TSF and the following is recommended to be reviewed in the detailed design and operational phases:

- The embankment raise staging is recommended to be to a maximum of 4 m high for each stage.
- CPTu probing should be undertaken on the fine tailings material during the operational phase prior to upstream raising. The footprint of the upstream raise should be investigated, and the design of the upstream raise should be verified by appropriate stability assessments.
- If field testing indicates there is not sufficient strength gain in the fine tailings, the following foundation strengthening methods should be implemented:
  - Ploughing of the upper surface of the fine tailings material to increase in the in-situ shear strength of tailings and to creates a bridging layer for future the upstream embankment.
  - Install geomembranes or geogrids to the foundation of the upstream embankment.

11.6.8 Tailings Delivery System

The tailings are delivered to the Temporary TSF from the WCP through HDPE pipes.

Tailings deposition takes place in the facility via multiple spigots located on the perimeter embankments of the facility, with spigots located at up to 50 m centres. Spigot points are to be rotated in such a way to maintain the supernatant pool to form around the decant water collection pumps to facilitate water return to the WCP. The decant pool for the cells are to be located away from the outer embankments, against the internal division embankments.

Tailings deposition will be sub aerial to provide flexibility in the deposition management and will take advantage of:

- the rate of tailings deposition which will allow rotation of discharge points along the perimeter embankment;
- the 'Mud Farming' for enhanced evaporation and thereby increasing the density of the in- situ tailings through rapid drying/desiccation within a short period; and
- minimising hydraulic head and hence seepage by ensuring pond size control within storage and regular pump back.

It is estimated that the fine tailings beach slope will vary along the beach towards the decant pool. The flow rate per discharge point can be manipulated by operating 3 to 5 discharge points simultaneously to create a flatter or steeper beach slope.

The Temporary TSF will be operated for about 5 years and once tailings deposition in the Temporary TSF has been completed, the barge pumps, spigot pipework and valves will be stripped out, and will be moved to the In-pit fine TSF locations. Additional pipework will also be required as new TSFs are developed on areas of the site further away from the WCP. From time to time pipework and valves will also have to be replaced when they reach the end of their serviceable lives.

11.6.9 Fines Tailings Management Planning

A Tailings Management Plan (TMP) will be developed for the project and should address the design, construction, operation and closure of the TSFs. The plan should be subdivided into Short, Medium and Long-Term plans to accommodate changes which commonly occur throughout the life of a project.

Fine tailings deposition for the first 5 years of operations will be in the Temporary TSF located to the North of the WCP. Fines tailings storage cells will be developed In-pit during year 5, and fines tailings storage will then be managed at the In-pit TSFs for the rest of the life of mine. Fine tailings storage for the first 9.5 years of operations are summarised in Table 11.9, and the fines storage management for the In-pit TSFs will be developed on future mining areas, see Figure 11.6 and Figure 11.7.

It is planned to construct the In-pit TSFs for Panels 3, 4 and 7B in two stages with construction of the first stages starting on pit backfill level of RL 110 to top of embankment to RL 115, and the Stage 2 upstream embankment raises to RL 120. The necessary geotechnical investigation and testing will be undertaken in the pit backfill areas and the in-pit TSFs will be designed in accordance with the minimum requirements and guidelines (ANCOLD and Victoria DEDJTR). Overburden (HHF) materials are proposed to be used for the embankment construction.

Table 11.9. Fines Tailings Storage Summary

Facility	Tailings Storage Volume (m^3)	Total Tailings Storage Volume (m^3)	Time (Months)	Time (Years)
Temporary TSF	9,170,000	9,170,000	60	5.0
Panel 3	1,600,000	10,770,000	69	5.8
Panel 4	4,800,000	15,570,000	98	8.1
Panel 7B	2,800,000	18,370,000	114	9.5

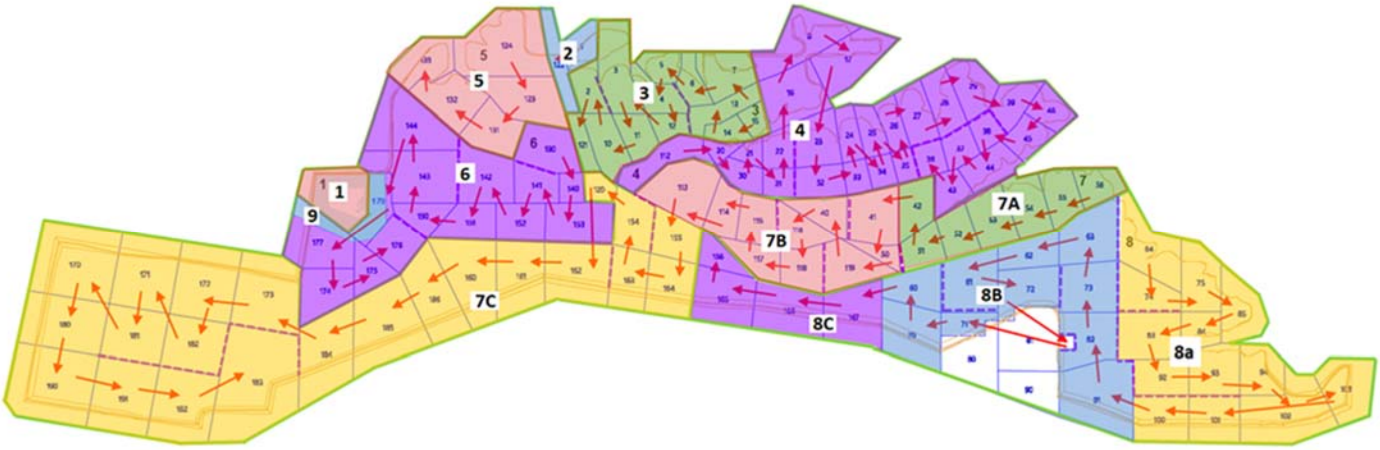


Figure 11.6 Mining Panels

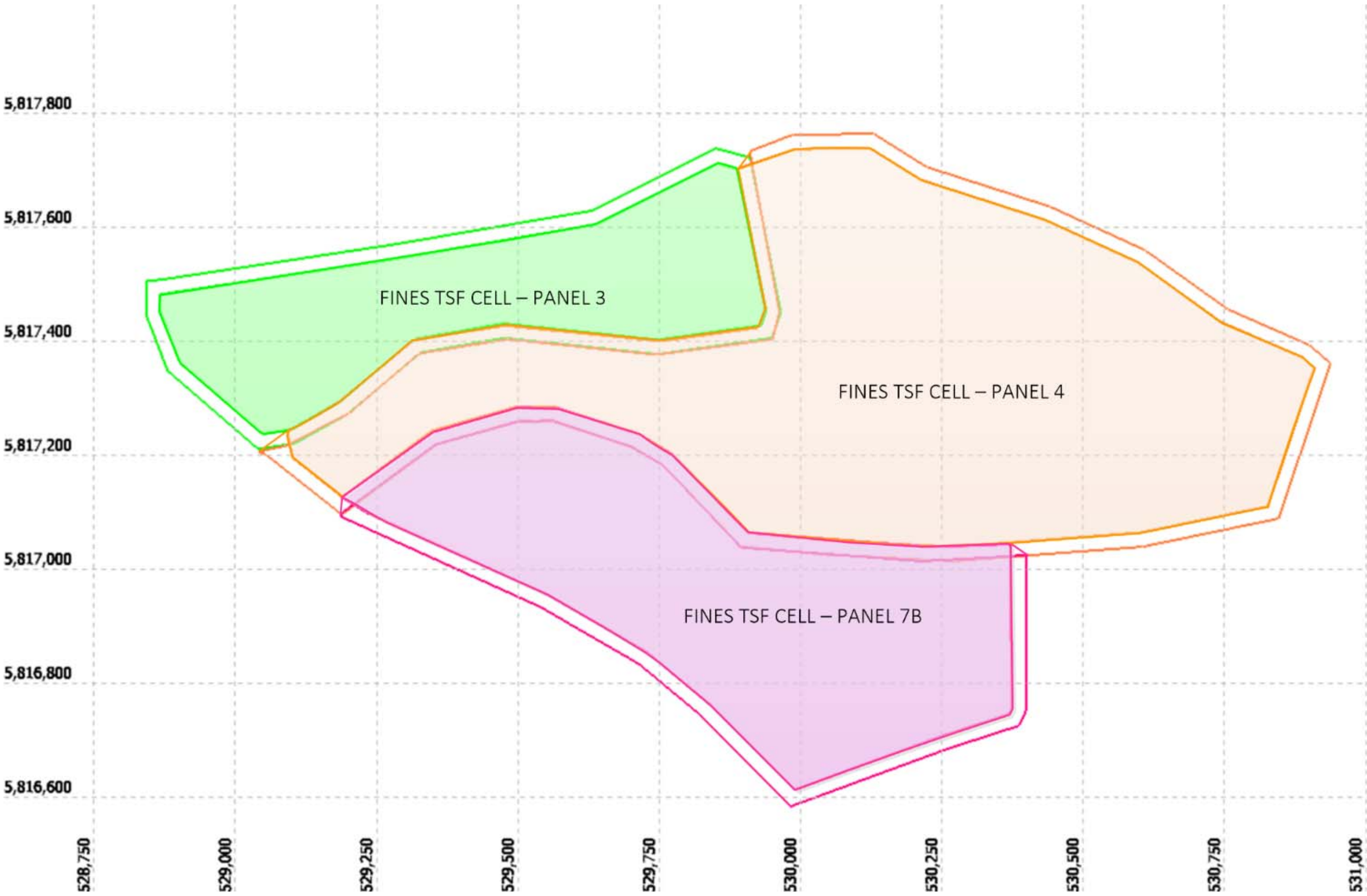


Figure 11.7 In-pit Fines Tailings Areas

11.7 TSF Design for Sand Tailings

11.7.1 Tailings Deposition Methodology

Sand tailings make up the bulk of the reject material from the WCP and will be pumped back to the mining void to be discharged, via cyclone stackers, see Figure 11.8. The sand tailings material will be shaped to design with dozers, which will also be required to move the stackers.

The two sand tailings dewatering cyclone feed sumps each feed to a separate pipeline whereby the combined sand tailings are pumped overland to separate sand stacking cyclone clusters at the pit crest. The sand tailings cyclone underflow discharges directly in to the mine void at a pulp density of approximately 66% solids (w/w).

The parallel sand stacking systems are designed to operate independently from one another. This allows for flexibility to move the stackers around the mine site without affecting the operation of the other unit, as well as maximising system availability.

Each stacker is sized for approximately half the plant throughput.

Stacker cyclone overflow is returned to a sand tailings water transfer sump adjacent the stacker, where it is pumped overland back to the WCP.

A minimum stacking embankment crests width of 15 to 20 m will be required to allow space for piping and access for construction equipment. The mobile stacker units will be relocated frequently as sand stacking advance and will include extension of pipe work.

The concept for pit backfill with sand tailings is to stack the sand tailings without a downstream containment embankment allowing surface run-off and seepage to free-drain from the area, into a catchment dam. Surface water run-off and seepage water is therefore not allowed to pond against the sand stack areas.

Underdrainage is proposed to be installed in predetermined locations to assist with collection of seepage water from the sand tailing areas. Seepage from the underdrains will flow away from the stacked sand area and collected in a downstream sump/dam.

Sand stacking during the start-up stages of the operations will be in the Perry Gully catchment. Surface water run-off from the Perry Gully catchment and seepage will be collected in a dam.

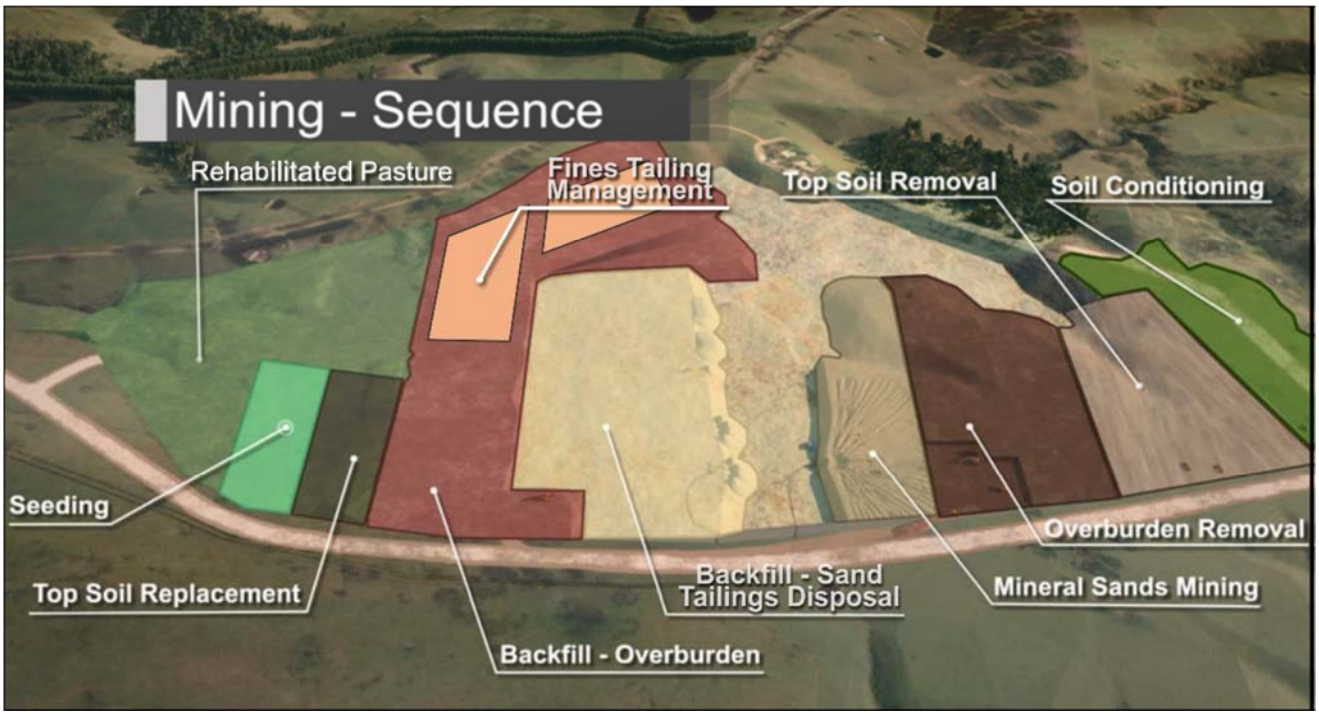


Figure 11.8 Mining Method – Schematic 1

11.7.2 Perry Gully Catchment Dam

Surface water is required to be managed across the mine site and once topsoil has been stripped, areas will be classified as mine affected water run-off catchments. The Perry Gully catchment covers an area of about 280 ha (including mining block North of catchment divide) and a 375,000 m^3 catchment dam will therefore be required to contain a 1:100 72-hour event. The dam will require an emergency spillway, the sizing for which will be established based on Victoria/ANCOLD requirements for dams and Critical Rainfall events.

The preliminary design of the dam has been based on ANCOLD guidelines as a "Significant" Consequence Category (ANCOLD 2012b).

The extreme flood modelling (undertaken by others) indicates that the flooding of the Mitchell river will not push back into the gully, in the area where the dam is proposed.

As silt collection pond is proposed between the sand tailings area and the dirty water dam. This will reduce the silt load in the water dam. The silt pond can be designed to allow mechanical removal of silt from the pond during the dry months.

11.7.2.1 Geotechnical Investigation and Construction Materials

There is no geotechnical information or bore holes available to assess the foundation of Perry Gully (see Figure 11.9), hence batter slopes and foundation preparation work for embankments will have to be confirmed in during the detailed design stage, once this information becomes available.

The geotechnical investigation undertaken by GHD (2015), indicates that there are sufficient clay-rich materials available at the Fingerboards site that can potentially be used for construction of dam embankments and compacted clay liners. However, the testing undertaken showed that clayey subsoil material has Emmerson Class numbers of 1 & 2, indicating highly dispersive soils. This is evident on site by the presence of erosion gullies and tunnel erosion.

Dispersive soils are a major contributing factor to piping failures of earthfill embankment dams and therefore soils with Emmerson Class 1 to 4 need to be used with caution when used for dam construction works.

However, as indicated in ICOLD (1990), safe dams can be constructed with dispersive materials provided that certain precautions are taken:

- Materials compaction and density control is important preferably to a density ratio of 98% (standard compaction) or greater and water content at optimum plus 2%.
- Proper design and construction of pipes through the embankment, i.e. providing cut-off collars.
- Most dispersive soils can be rendered non-dispersive by adding 2% to 3% lime and it should be mixed into the soil with equipment that can break the soil lumps so that 80% to 90% of the particles are less than 25 mm in diameter.
- Provide properly designed and constructed filters in the dam embankments.

It is recommended that further dispersion testing be conducted during the detailed design stage of the Project, i.e. Soil Conservation Service Test, Pinhole Dispersion Classification, etc.

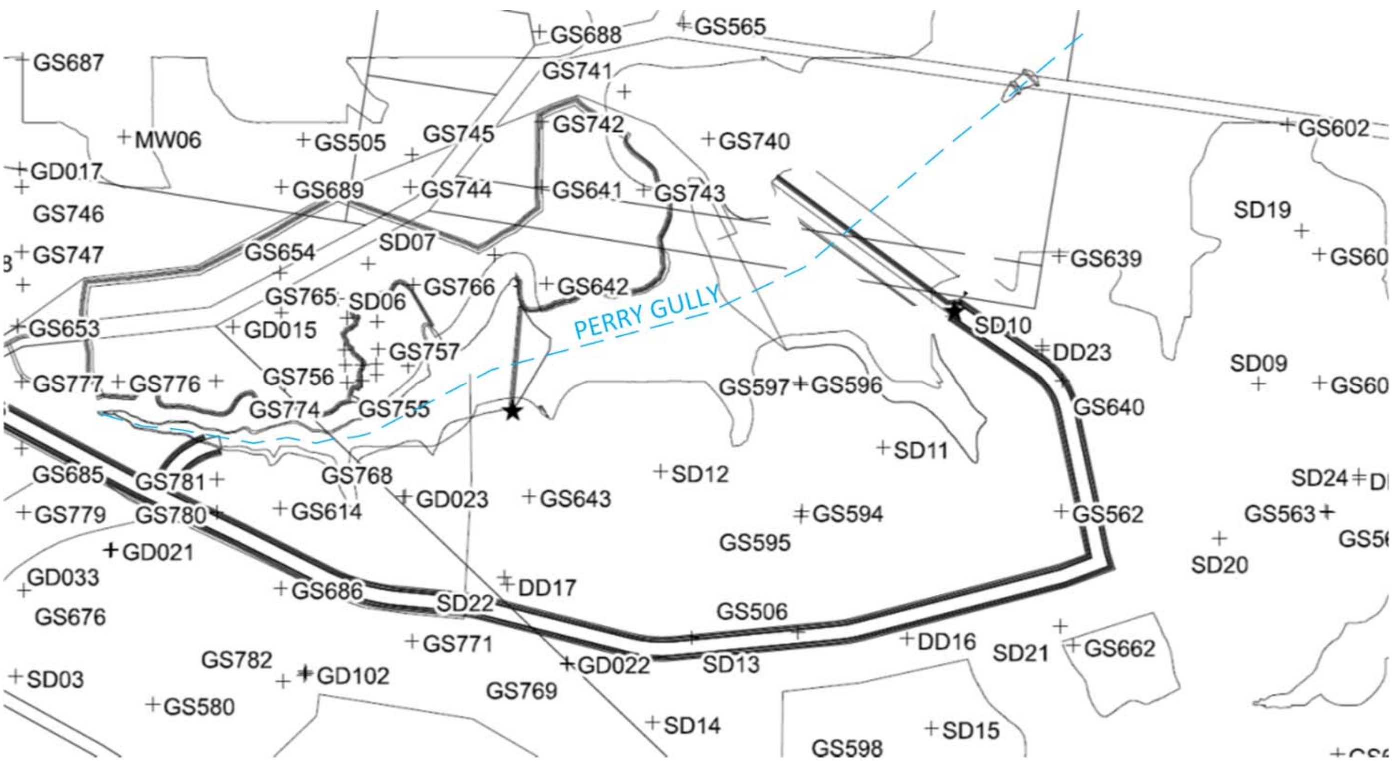


Figure 11.9 Project Drill Holes - Perry Gully Area

11.7.2.2 Embankment

The embankment design has been undertaken based on limited geotechnical information and has been based on assumption that will have to be confirmed during the detailed design stage. The embankment design is for the top crest level at RL 66.5, the full storage capacity for the 1:100 storm event at RL 63.5, and the spillway overflow at RL 64.5.

The design features provided for the embankment are summarised below:

- upstream and downstream batter slopes at 1:3 (v:h)
- 900 mm thick compacted clay layer on the upstream face of the embankment, stabilised with 3% lime
- 450 mm thick rip-rap protection and geofabric filter layer upstream face of the embankment
- homogeneous earthfill embankment from local borrow with curtain and blanket drains for seepage control

- embankment foundation key cut to a minimum of 2.5 m deep.

Due to the dispersive nature of the onsite soils, a slurry curtain will be required for the foundation as well as the left and the right abutments of the embankments, for foundation seepage control and embankment stability.

The stability assessment and seepage assessment should be undertaken during the detailed design, based on material parameters from geotechnical testing.

11.7.2.3 Spillway

The spillway design capacity is for a 1:2,000 Annual Exceedance Probability (AEP) Critical Rainfall event of 285 mm over a 24-hour period with an estimated peak discharge capacity over the spillway of 20.8 m^3/s. The preliminary design allows for a reinforced concrete spillway structure with energy dissipating structure at the downstream toe of the embankments. Rip-rap erosion protection is provided in the gully line, downstream of the concrete spillway structure, with a gabion weir about 30 m of the toe of the embankment.

11.7.2.4 Decant Water Return System

Perry Gully Catchment Dam has been designed to contain the 1:100 72-hour storm volume. Seepage water from the sand stacking operations will report to the silt collection pond with a flow through wall. Water will seep into the Catchment Dam and will be returned to the WCP via the return water pumping system installed at the dam.

The return water pumping system should be designed to return approximately 1,500 m^3/h and will empty the dam after a 1:100 storm event in about 10 days.

11.7.2.5 Flood Protection Berm

A flood protection berm is proposed to be constructed in the gully area upstream of the Catchment Dam. The 1:100 72-hr level of the Catchment Dam is at RL 63.5 and it is proposed that a flood protection embankment is constructed to RL 66.5, see Figure 11.10.

The details for the flood protection berm are summarised below:

- The embankment is to be constructed with selected compacted fill material from approved borrow areas;
- All unsuitable organic silts and clays should be removed from the foundation of the embankment prior to construction and a minimum of 1 m deep foundation key-cut is proposed along the embankment centreline;
- The downstream slope of the embankment is to be constructed at a slope of 1:3 (v:h) with an erosion protection layer of 450 mm thick rip-rap and bidim A44 or similar approved;
- The gully area upstream of the flood protection berm is to be backfilled with compacted sand/overburden material prior to sand stacking operation in the area.

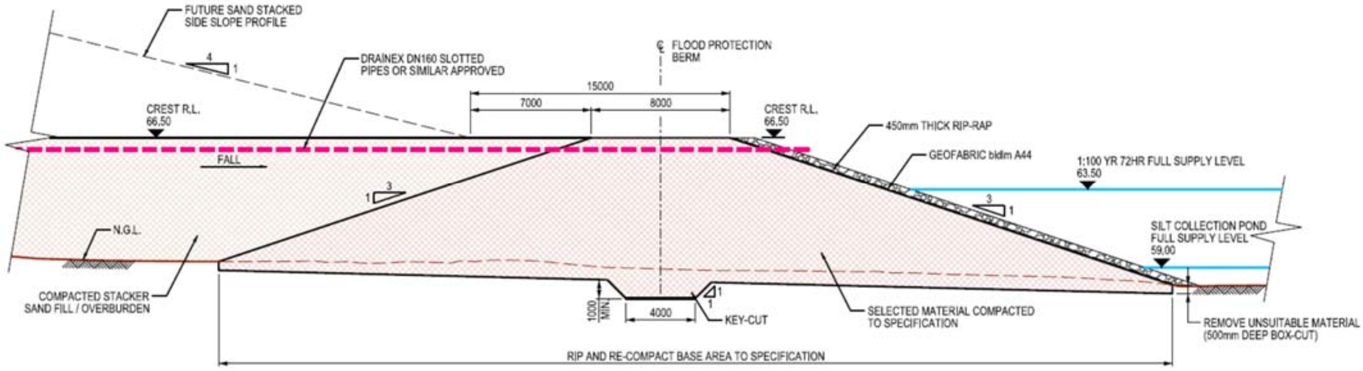


Figure 11.10 Perry Gully Flood Protection Berm

11.7.2.6 Silt Collection Pond

A small silt collection pond is proposed directly downstream of the final toe of the sand stacking backfill in Perry Gully. The pond embankment is to be constructed as a flow-through structure with selected high permeability rock material. Run-off water from normal rainfall events will flow through a spillway on the embankment and larger flood events will overtop the embankment into the Perry Gully Catchment Dam. The purpose of the pond is to collect the majority of silt before it enters the catchment dam. The silt accumulated in the pond can be cleaned out during the dry months.

11.7.3 Sand Stacking Underdrainage System

The mine pit backfill operations sand stackers will deposit about 1,031 dry tonne per hour of sand and 531 m^3/h of water will report to the cyclone underflow.

The sand tailing material has a typical permeability of 5×10^{-6} m/s to 1×10^{-5} m/s. It is estimated that if no underdrains are installed within the sand stacking areas, large uncontrolled wet areas may develop along the toe of the stacked sand embankments, in particular in topographical low-lying areas. The seepage rate is a direct function of the permeability of the sand tailings, and to increase the daily recovery of cyclone underflow, it is proposed that an underdrainage collection system is installed to the pit floor and gully/valley lines. The installation of underdrainage will improve water recovery and the overall structural stability of the sand backfill operations.

The underdrainage system is proposed to recover the seepage water from the sand stacking operations and to discharge it to collection points along the toe of the sand stacking areas for return to the WCP.

It is proposed to use 160 mm diameter corrugated flexible slotted HDPE pipes (DN160 Draincoil or similar approved) for the underdrainage system. The pipes are to be installed in separate trenches to prevent the potential for crushing under loading.

Larger HDPE collector pipes will be required in some areas to collect the seepage water from the slotted pipe network.

The underdrainage pipe system will have to be designed to withstand the vertical load from the sand fill over the pipes and to prevent crushing.

11.7.4 Stability Assessment

The sand stack embankments are typically at 30 to 35 degrees, which is close to the natural angle of repose for the sand material.

The liquefaction potential for the sand material are generally high and therefore the key issues for the stability of a sand stacked embankment is to ensure that the phreatic surface within the embankment is low, keeping seepage and ponding away from the outer toe of the embankment. Embankment underdrainage should therefore be installed to manage the phreatic surface. During stacking operations where, low solids content (higher volumes of water) are produced coupled with fast advanced rates of the embankment, it is important to allow water to dissipate from the embankment to ensure slope stability. The sand stack embankments will be constructed on the pit floor and the permeability of the foundation material will dictate the seepage rate and accordingly the stability of the stack. The seepage water from the sand stack embankment drains vertically through the embankment and if the foundation permeability is low, generally very little to none seepage is entering the foundation.

The critical stage for the embankment underdrains are during embankment sand stacking. The water added to the embankment during stacking requires to be removed fast to ensure the stability of the sand embankment. The sand stacking generates a water plume in the embankment that has a typical radius of approximately 50 m. This plume represents the area that requires dewatered by the underdrains and is always the critical area in terms of embankment stability during stacking. The water plume and phreatic surface can be impacted by (i) flushing of the stacking system, and (ii) when the stackers are delivering low density sand to the embankment.

The management of the sand embankment stability risks for the pit backfill stacking operations are summarised below:

- Any ponding of water at the downstream toe of the embankment should not be allowed and collection sumps should be placed away from the toe of the active stacking slope.
- It is important that the stacker performance is continuously reviewed, and the necessary adjustments be introduced to reduce the cyclone underflow water volume in accordance with the design underflow density.
- It should be noted that the permeability of the sand material governs the volume of water that can drain through the sand stacked embankment and by increasing the number of underdrains below the stacking area may not always increase the time associated with dewatering of the sand embankment. The percentage silt fraction in the sand material is a function of the permeability. Grading envelopes of the stacked sand material should be tested on a daily basis at the onsite laboratory to allow the monitoring of the percentage of silt fraction in the sand material.
- The pipe outlets from the sand embankment underdrains should always be free-draining and not be covered by sand from the sand staking operation or water ponding, at the collector pipe outlets. Non free-draining conditions at the outlets will cause backup of the underdrainage system, and will causing an increase in the phreatic surface, reducing the sand embankment factor of safety against slope failure.

11.8 Liquefaction Assessment

During a strong seismic event, saturated non-cohesive materials, like sands and silts can experience a large reduction in strength and stiffness associated with seismic induced pore pressure build-up and is referred to as soil liquefaction.

11.8.1.1 Screening

The following section discusses some screening techniques used as a general guideline for evaluation of the liquefaction potential of tailings materials (ANCOLD 1998).

- The primary factors affecting the susceptibility for liquefaction includes phreatic level or saturation of the materials, material classification of the tailings and the composition/consolidation or relative density.
- In order to be susceptible to liquefaction, a potential liquefiable soil must be fully saturated or nearly saturated.
- Liquefiable tailings of limited thickness and limited lateral extent may not create a liquefaction risk. But relatively thin seams of liquefiable tailings, if laterally continuous over sufficient areas, can represent potentially hazardous weak planes of sliding.
- Sand and silty sands are particularly susceptible to liquefaction. Generally, the presence of fines content (silt and clay size particle passing 75 µm) reduces the susceptibly to liquefaction. ANCOLD states that saturated sands, silty sands, silts and

gravely sands are susceptible to liquefaction and gives particle size envelopes for potentially liquefiable soil and most liquefiable soil.

Based on the liquefaction assessments, the fine and sand tailings material is potentially susceptible to liquefaction with a medium resistance to liquefaction when saturated, see Figure 11.11 and Figure 11.12.

The deposited fine tailings material within Temporary TSF may be susceptible to liquefaction as a result of seismic loading depending on the in-situ density and degree of saturation. However, as the fine tailings material will be fully contained by engineered embankments, the chance of liquefaction of the embankment structure is negligible.

Sand tailings will be partially dewatered by cyclones during the stacking operations. Underdrainage networks will be designed below the sand stacking areas in the pits for static stability and to reduce risk of deformation due to liquefaction under seismic loading.

The geotechnical investigation information indicate that the deeper foundation soils are cohesive soils and the upper layer is in general dense to very dense clayey sand and there is no water table present. The potential for liquefaction of foundation soils during an earthquake event is therefore very low, due to their high plasticity clay content.

CPTu probing is proposed to be used in future to review the tailings materials liquefaction potential during the operational stages.

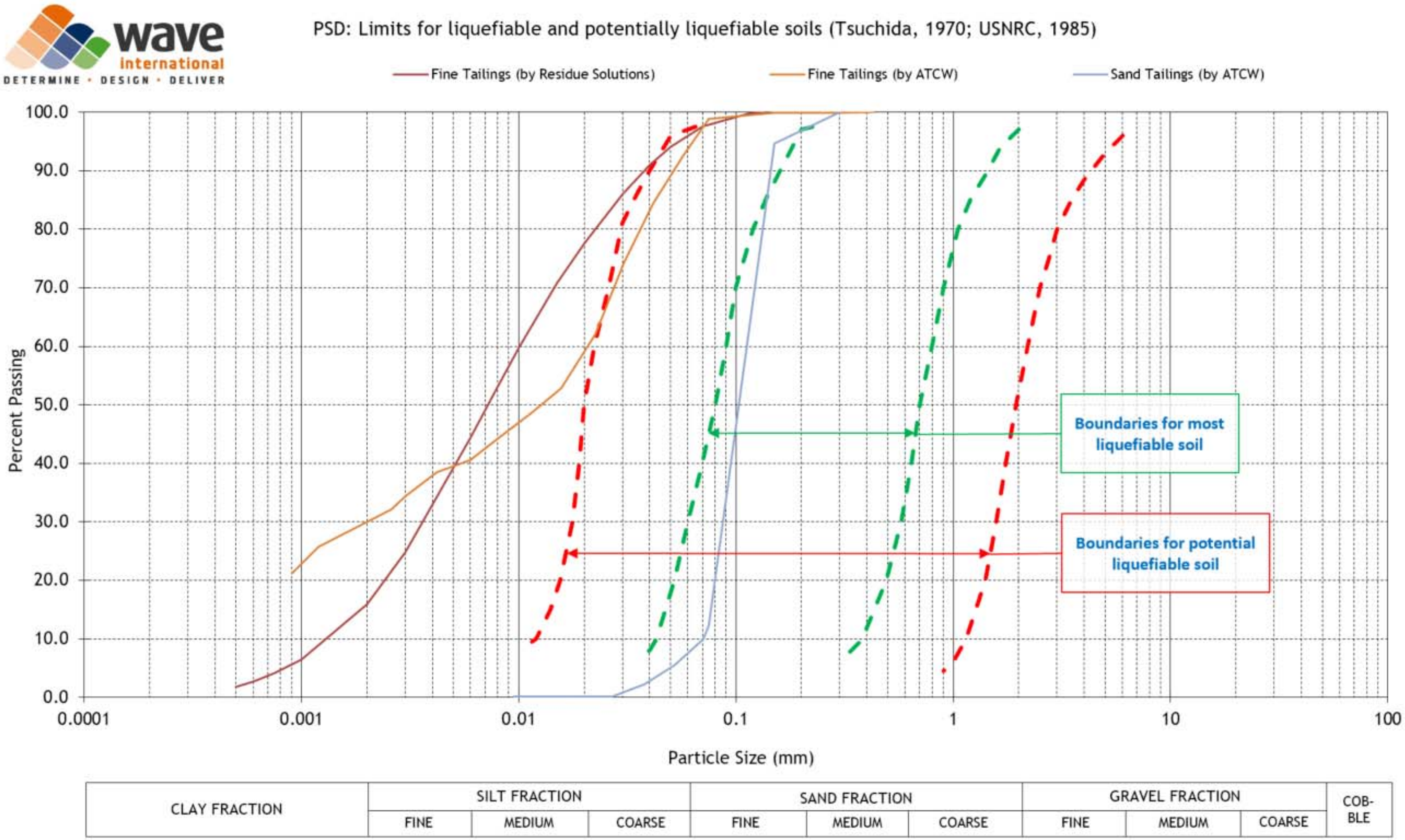


Figure 11.11 Tailings Material PSD Screening (ANCOLD)

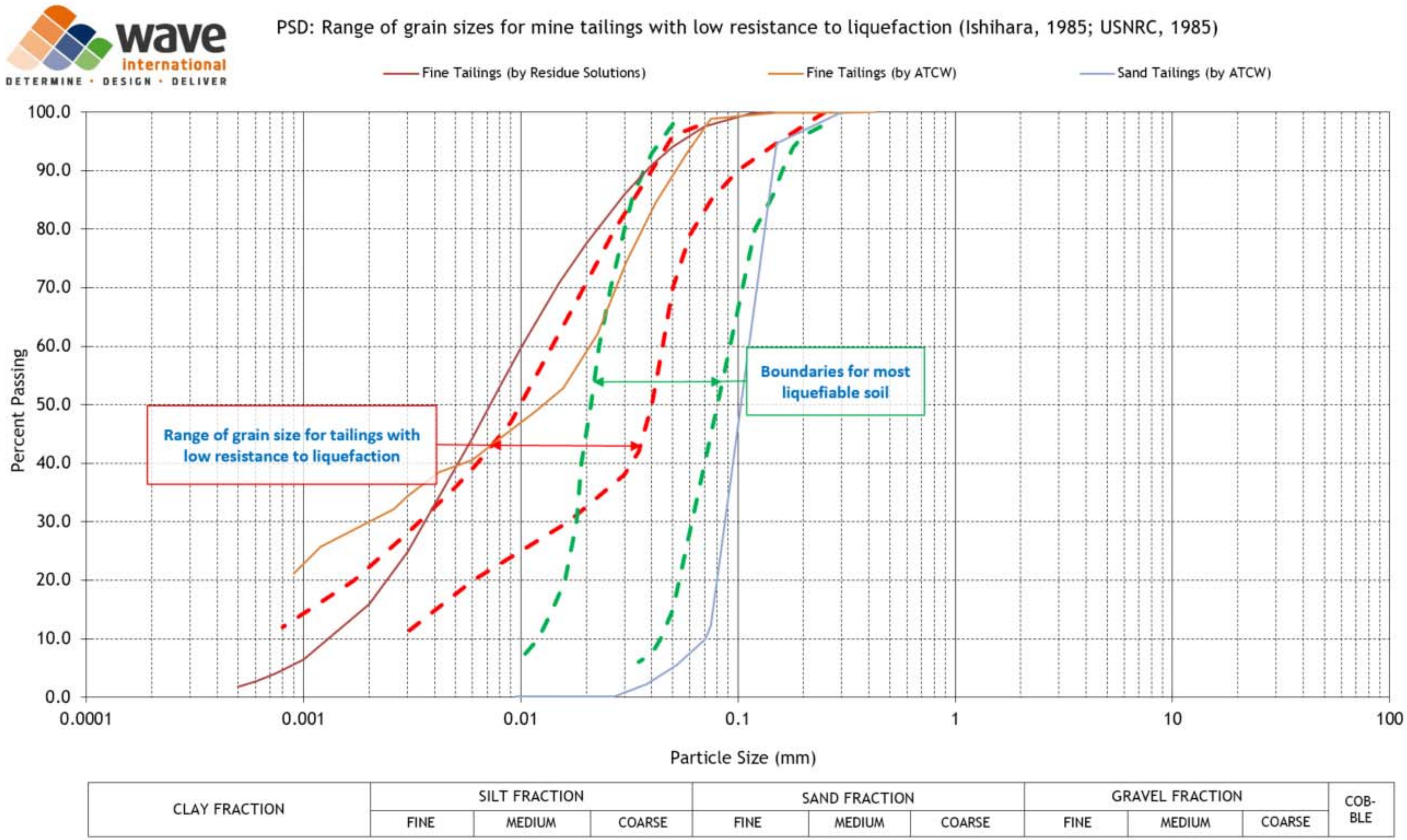


Figure 11.12 Tailings Material PSD Screening (ANCOLD)

11.9 Construction

The construction processes described in this section applies to the works for TSF.

The TSF will be constructed in accordance with a technical specification and construction drawings. The implementation of the technical specifications and associated construction drawings, during the construction phase is essential to ensure that the facility will function according to the design intent. The following aspects will need to be carefully monitored during the construction phase by suitably qualified personnel:

- embankment area foundation preparation
- removal of unsuitable foundation material from beneath the embankment footprints
- selection of suitable materials for embankment fill
- selection of appropriately graded filter materials for the underdrains
- moisture conditioning and compaction of embankment fill materials.

All the appropriate measures shall be employed to ensure that construction of the project is completed to the highest level of quality to achieve the design intent and all regulatory requirements.

The following will be required:

- A qualified civil contractor that is familiar with dam embankment construction works.
- Full construction QA and submit a 'as constructed' report and the construction certification to Victoria DEDJTR.
- Certification by a Responsible Engineer as "person with appropriate qualifications and experience responsible for the supervision of construction of the tailings dam" (ANCOLD 2012a).

11.9.1 Clearing, Grubbing and Site Preparation

TSF construction will require clearing of vegetation, stripping of top soil and general foundation preparation. Clearing will only be done for the areas necessary for construction works and any other space requirements such as top spoil and vegetation stockpile area, contractor laydown and other site establishment facilities. All clearing will only occur within the already approved footprint.

11.9.2 Quality Control/Assurance

A comprehensive tendering process will be undertaken to select an appropriate earthworks construction contractor with experience in tailings dam construction. Adequate supervision to ensure safe and quality construction is one of the major criteria for contractor selection. While the selected construction contractor will undertake supervision of the project to meet design intent, specifications and all other requirements.

Any significant modifications to design will be done in conjunction with the Design Consultant. These measures will ensure that the TSF is constructed to the correct standard and meet all relevant and regulatory requirements.

Monitoring during the construction phase should include a construction quality assurance (CQA) program. The CQA program will be designed to:

- verify the fill characterisation by inspection and laboratory testing;
- confirm the compaction requirements;
- monitor the placement and compaction by inspection; and
- confirm the compaction requirements have been met by in-situ and laboratory testing.

11.9.3 Earthworks

Fill materials for embankments will generally be placed in layers up to 300 mm thick by and compacted to 95% of its maximum dry density at optimum moisture content by a pad foot roller to promote interlayer bonding.

The thickness of the layers and number of passes required to obtain the required compaction will be based upon the material properties and size of compaction plant. Trial compaction with in-situ density testing should be undertaken to confirm the required procedures.

Construction activities for earthworks should be scheduled for the dry season or low rainfall periods (October to April) to improve the control and progress of the works.

11.9.4 As Built Construction Report

At the end of construction, Kalbar will prepare an As Built construction report which shall incorporate As Built construction drawings. The construction report shall detail any design modifications during construction. The Responsible Engineer will provide certification of the construction works (ANCOLD 2012a).

11.10 Operating Objectives

11.10.1 Operation and Maintenance Manual

An operation and maintenance manual will be developed during the detailed design phase and will be in place prior to the commissioning of the TSFs.

The manual will document all relevant operational procedures for the site and will reflect all items covered in the work plan and design that relate to operational, monitoring and surveillance procedures.

11.10.2 Deposition Methodology and Water Recovery

The operating phase of the Temporary TSF will commence with commissioning of the WCP and first deposition of tailings. Tailings will be pumped from the WCP to the TSF via a HDPE slurry delivery pipeline and will be deposited from the outer perimeter of the TSF embankment crest into the cells.

The tailings will be deposited with the use of valves on the tailings deposition ring main. This will be managed to develop the beach profile in such a way that the supernatant pool in the cell will be located in the same position as the decant barge, during the operating phase.

Two TSF cells will be used for deposition of fine tailings slurry to a nominal thickness of 1 m. Tailings deposition will then be moved to the other two cells and during this time the amphirol equipment will be used to assist with consolidation of the fine tailings material. The estimated cycle time for the amphirol equipment will be about 40 to 50 days to achieve optimum consolidation.

11.10.3 Monitoring and Surveillance

11.10.3.1 TSF Operational Inspections and Monitoring

A monitoring and surveillance program will be developed during the detailed design and an operating manual will specify the requirements for the TSFs.

In accordance with the ANCOLD and Victoria DEDJTR tailings guidelines, surveillance will involve routine daily and monthly inspections and mandatory annual audits for all TSFs.

11.10.3.1.1 Daily Operational Inspections

Daily Operational Inspections will usually involve a drive around and walk around the TSF area and should be conducted by dedicated TSF operations personnel to check:

- tailings delivery lines and discharge lines/spigot points;
- pond locations and sizes;
- pump operations and return water pipelines;
- embankment crest, identifying any unusual changes; and
- embankment toe and perimeter drainage or seepage, identifying any unusual changes.

11.10.3.1.2 Special Inspections

Special Inspections should be undertaken immediately after heavy rains or any unusual events related to the TSF, to ensure that the embankments and all TSF infrastructures are functioning as required or if any immediate action should be taken to arrest an important situation. Special inspections should ensure pond sizes and pump back operation has not been adversely affected, or erosion has not created any adverse conditions.

11.10.3.1.3 Environmental Inspections

Environmental inspections should be conducted monthly as a minimum or whenever there is a need (e.g., when fauna death or any environmental incident is reported). This will ensure the TSF is operated in accordance with all Kalbar's environmental requirements.

11.10.3.1.4 Annual Audits

These are required to be conducted by a qualified geotechnical engineer and focus on the identification of deficiencies by visual examination of embankments and all appurtenant structures, as well as a review of all surveillance and monitoring data. These audits are required to be carried out to ensure compliance with legislation.

11.10.3.2 Instrumentation

Piezometers (Casagrande standpipe or Vibrating Wire type) will be installed in the TSF embankments for monitoring of the phreatic surface through the embankment. The data records from piezometer monitoring will provide timely information on changes in water level within or beneath the embankments and will be used for operational review of embankment geotechnical stability.

In the event the piezometric level rises above expectations, further investigations will be carried out and controls will be implemented to maintain an acceptable factor of safety for the embankments.

Water levels in the piezometers will be recorded at least once a month and the results provided reviewed as part of TSF annual engineering inspection/audits.

Settlement monitors will be installed and will mainly consist of Settlement Markers installed vertically on the embankment crest and constructed to very precise line and level and surveyed immediately after construction. Ongoing settlement will be monitored via periodic surveys as part of operations measures.

A series of groundwater monitoring bores will be installed around the TSFs to monitor groundwater levels and quality.

Water quality monitoring of the seepage through the embankment and foundation shall be monitored as outlined in the water quality monitoring program.

11.10.4 Emergency Response Plan

Kalbar will prepare an emergency response plan (ERP) for the site that will include and address all specific issues relevant to the TSFs.

The ERP will include responses to all potential emergency scenarios including, but not limited to, TSF failure, spill events and pipeline rupture. The ERP will include procedures describing and prioritising actions such as protection of personnel, the public, the environment and infrastructure, notification of emergency services and resource management agencies, advice to neighbours and immediate and longer term remedial actions.

11.11 Rehabilitation

The Temporary TSF for fines storage will be excavated and backfilled into the mine pit, as mining will progress through this area in future. Rehabilitation of the fines tailings storage cells in-pit will be undertaken progressively for the backfilled panel. Rehabilitation activities in this mining study include:

- shaping of the backfilled material to its final landform (see Figure 11.13);
- spreading of the HHF fine tailing bunds across the dried fine tailings and deep ripping to mix the overburden with the fine tailings immediately below;
- placement of topsoil and shallow ripping to mix the topsoil into the upper layer of HHF / fine tailings.

The final topography design objective was to mimic the original topographic features as much as possible whilst considering the post mining land usage and mellowing of the landscape. The design surface has been created to allow for all the sand tailings, fine tailings and overburden to be backfilled. The surface aimed to provide drainage channels that direct surface run-off water as indicated in Figure 11.13 .

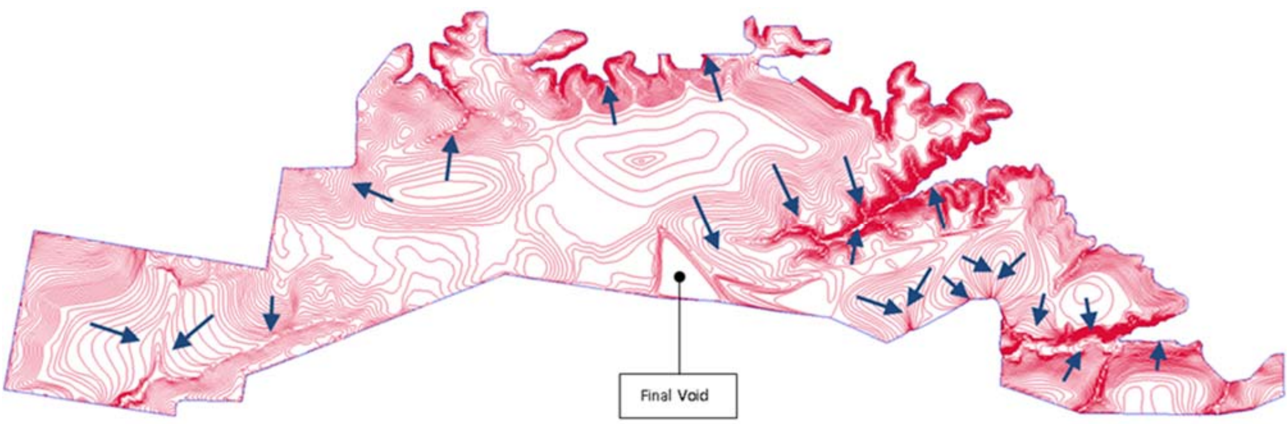


Figure 11.13 Final Landform Topography

11.12 Risk Management

11.12.1 Design Risks

The following risks have been identified in terms of the scope and technical aspect of the TSFs:

- No test pits or BH information has been obtained from inside the fines TSF basin area. Further investigations are recommended prior to construction.
- No geotechnical information or testing is available for the gully lines and the risk of construction medium to large embankments is estimated to be high and engineering will be required to reduce the risk rating, resulting in higher construction costs.
- The on-site soils have been identified as dispersive and further testing should be undertaken during the detailed design and construction phases to confirm the required engineering of the soils for embankment dam construction. It is recommended that for all water retaining structures and TSFs, the potential dispersive tendencies of the soils are addressed reduce the risk of 'piping' failure. The risk can be ameliorated by the addition of lime (or gypsum) mixed with the construction materials, soil compaction specifications and installation of the necessary underdrainage.
- The design of the sand stack tailings areas will include adequate underdrainage systems. This design relies on maintaining a free-draining downstream sand embankment for static stability and to reduce risk of deformation due to liquefaction under seismic loading.
- The risks associated with the upstream raising of the fines TSFs cannot be minimised, downstream embankment raise construction methods may be employed. Each raise in this method is structurally independent since the raises are not supported on the tailings beach. However, high cost of construction will be associated with this approach.

11.12.2 Environmental Risk

The fines tailings containment embankments have been designed specifically to prevent the uncontrolled release of tailings and water from the TSF area and the facility location selected to maximise natural topographic containment. Contingency measures to cater for extreme floods and earthquakes have also been incorporated in the design. The likelihood of containment failure is therefore very low since the risk-based design measures have been incorporated in the design process.

Generation of excessive dust from drying tailings beaches presents a potential environmental and health risk and the operational procedures for the fine tailings cells should incorporate the necessary mitigation measures during the drier months of operations.

The principal mitigating measure to minimise the likelihood of dust generation for the fines TSFs is to operate a cyclic deposition system, whereby fresh wet tailings are discharged over the previously deposited layer that have been treated mechanically with amphirol equipment (MudMasters®).

11.12.3 Construction and Operation Risks

Risk factors associated with construction and operation of the TSFs which could influence the facility performance:

- Water management including decant pond size control and surface water control
- Dust management
- Sand tailings stacker performance low densities can influence the stability of the sand backfill areas.
- Stacking sand tailings from downstream to upstream in valley lines may are associated with higher risks and stability of embankments may be compromised. Stacking of sand tailings material in the gully line during the wet season may result in stacking onto water and a wet foundation. This will present stability issues during stacking and will increase the risks during operations for the stacking equipment and personnel required to move the stacking equipment and pipe work.

- Tailings management planning is important to be considered throughout the mine life. Adequate planning will result in timely construction of fines TSFs to ensure sufficient tailings and storm storage allowance.

An operation and maintenance manual (OEM) is required to be developed during the detailed design stage. The Manual shall contain a section on emergency response and shall form an integral part of the overall risk management plan for the TSFs.

A Responsible Engineer (ANCOLD, 2012a) is "a person with appropriate qualifications and experience responsible for the design and supervision of construction of the tailings dam". This person shall be appointed by Kalbar to ensure that design requirements are met by the construction and operational phases, including risk-based design and review.

11.13 Recommendations for Future Studies

The following is a list of recommendations for additional investigations, testing and design studies required to carry the TSF designs through to final design and construction:

- All the TSFs for the site should be designed in detail to comply with ANCOLD tailings guidelines (2012a), Victoria DEDJTR tailings guidelines (2015), and the relevant environmental legislation and guidelines.
- Geotechnical assessments:
  - It is recommended that further dispersion testing be conducted during the detailed design stage of the Project, i.e. soil conservation service test, pinhole dispersion classification, etc.
  - Testing to confirm stabilisation of dispersive soils with lime, including compaction and permeability.
  - Some CPTu and shallow test pits are recommended in the valley/gully lines in areas where dams are proposed to be constructed, and sand tailings materials are to be stacked.
  - Some CPTu and shallow test pits are recommended to be undertaken on the footprint of the Temporary Fine Tailings Storage facility.
  - Additional geotechnical laboratory testing will be required at detailed design phase to verify the engineering characteristics of the materials to be used for the construction of the TSFs and dams;
  - Assess engineering properties for embankment construction materials (specifically low permeability soils for embankment core zone).
- Any changes to the current Life of Mine plan should be identified at the start of the detailed design phase and the potential impact thereof on the TSF designs should be investigated.
- CPTu probing is proposed to be used in future to review the tailings materials liquefaction potential during the operational stages.

11.14 Design Certification

The design certification for the feasibility design of the Fingerboards Project, confirming that the design meets appropriate engineering and safety standards and is consistent with the industry guideline for Tailings Dams (ANCOLD and Victoria DEDJTR), is provided in APPENDIX 11D.

APPENDIX 11A Temporary TSF Water Balance

Fingerboards Project
Temporary Tailings Storage Facility - 2 x Cells ACTIVE DEPOSITION
Average Annual Water Balance

GENERAL DESIGN CRITERIA AND ASSUMPTIONS		
Ave Monthly Dry Tailings Production	208,333	tonnes
Slurry Percent Solids	35.0	%
Tailings S.G.	2.65	
Tailings Interstitial Water	65%	

CATCHMENT AREAS				
Temp TSF (ha)	34.5			
	% of Area	Evap. Factor	Run-off Coeff.	
			Summer	Winter
Dry Beach	5%	0%	30%	50%
Active Beach	75%	90%	65%	85%
Water Pond	20%	100%	100%	100%
Check	100%			

(4 Cells)	69ha	
2 x cells active deposition		34.5ha
2 x cells AMC "mud farming"		
	Catchment (ha)	
Cell1	17.5	
Cell2	18	
Cell3	18.5	
Cell4	15	
	69	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Nov	End of Year Totals	Monthly Average
	Average Annual Water Balance													
Meteorological Parameters														
Precipitation (mm/month)	48.0	47.0	44.5	58.2	44.4	64.7	48.0	36.6	52.4	60.9	78.3	61.5	644.5	53.7
Evaporation of Pond Water (mm/month)	131.3	97.5	75.0	45.0	37.5	15.0	30.0	37.5	45.0	78.8	116.3	123.8	832.5	69.4
Water Inputs (m^3) - Reporting to Decant														
With Slurry	475,626	429,597	475,626	460,283	475,626	460,283	475,626	475,626	460,283	475,626	460,283	475,626	5,600,109	466,675.7
Pond Precipitation	3,312	3,243	3,071	4,016	3,064	4,464	3,312	2,525	3,616	4,202	5,403	4,244	44,471	3,705.9
Active Beach Run-off	8,073	7,905	7,484	9,789	9,765	14,230	10,557	8,050	8,813	10,243	13,169	10,344	118,421	9,868.4
Dry Beach Run-off	248	243	230	301	383	558	414	316	271	315	405	318	4,004	333.6
Sub-Total Inputs	487,259	440,988	486,411	474,388	488,837	479,535	489,909	486,516	472,983	490,386	479,260	490,531	5,767,004	480,583.6
Water Losses (m^3)														
Tailings Interstitial Water	307,384	277,637	307,384	297,468	307,384	297,468	307,384	307,384	297,468	307,384	297,468	307,384	3,619,200	301,600.0
Evaporation from Water Pond	9,056	6,728	5,175	3,105	2,588	1,035	2,070	2,588	3,105	5,434	8,021	8,539	57,443	4,786.9
Evaporation from Active Beach	30,565	22,705	17,466	10,479	8,733	3,493	6,986	8,733	10,479	18,339	27,072	28,818	193,868	16,155.7
Seepage Loss	9,300	8,400	9,300	9,000	9,300	9,000	9,300	9,300	9,000	9,300	9,000	9,300	109,500	9,125.0
Sub-Total Losses	356,305	315,470	339,325	320,053	328,004	310,997	325,740	328,004	320,053	340,457	341,561	354,041	3,980,011	331,667.6
Water Surplus / (Deficit) at End of Month	130,954	125,518	147,086	154,336	160,833	168,539	164,168	158,512	152,930	149,929	137,698	136,490	1,786,993	148,916.1
% Return of Operations Water to Process Plant	28%	29%	31%	34%	34%	37%	35%	33%	33%	32%	30%	29%	N/A	32%

Figure 11.14 Temporary TSF – 2 x Cells, Active Deposition

Fingerboards Project
Temporary Tailings Storage Facility - 2 x Cells AMC
Average Annual Water Balance

GENERAL DESIGN CRITERIA AND ASSUMPTIONS	
Ave Monthly Dry Tailings Production	208,333 tonnes
Slurry Percent Solids	35.0 %
Tailings S.G.	2.65
Tailings Interstitial Water	31%

CATCHMENT AREAS				
Temp TSF (ha)	34.5			
	% of Area	Evap. Factor	Run-off Coeff. Summer	Run-off Coeff. Winter
Dry Beach	40%	0%	30%	50%
Active AMC Beach	45%	70%	65%	85%
Water Pond	15%	100%	100%	100%
Check	100%			

(4 Cells) 69ha
<u>2 x cells active deposition</u> 34.5ha
2 x cells AMC "mud farming"

	Catchment (ha)
Cell1	17.5
Cell2	18
Cell3	18.5
Cell4	15
	69

Average Annual Water Balance

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Nov	End of Year Totals	Monthly Average
Meteorological Parameters														
Precipitation (mm/month)	48.0	47.0	44.5	58.2	44.4	64.7	48.0	36.6	52.4	60.9	78.3	61.5	644.5	53.7
Evaporation of Pond Water (mm/month)	131.3	97.5	75.0	45.0	37.5	15.0	30.0	37.5	45.0	78.8	116.3	123.8	832.5	69.4
Water Inputs (m^3) - Reporting to Decant														
Water locked up in tailings prior to AMC	307,384	277,637	307,384	297,468	307,384	297,468	307,384	307,384	297,468	307,384	297,468	307,384	3,619,200	301,600.0
Pond Precipitation	2,484	2,432	2,303	3,012	2,298	3,348	2,484	1,894	2,712	3,152	4,052	3,183	33,353	2,779.4
Active Beach Run-off	4,844	4,743	4,491	5,873	5,859	8,538	6,334	4,830	5,288	6,146	7,901	6,206	71,052	5,921.0
Dry Beach Run-off	1,987	1,946	1,842	2,409	3,064	4,464	3,312	2,525	2,169	2,521	3,242	2,546	32,028	2,669.0
Sub-Total Inputs	316,699	286,758	316,020	308,763	318,605	313,819	319,514	316,633	307,637	319,203	312,664	319,319	3,755,634	312,969.5
Water Losses (m^3)														
Tailings Interstitial Water	94,777	85,605	94,777	91,719	94,777	91,719	94,777	94,777	91,719	94,777	91,719	94,777	1,115,920	92,993.3
Evaporation from Water Pond	6,792	5,046	3,881	2,329	1,941	776	1,553	1,941	2,329	4,075	6,016	6,404	43,082	3,590.2
Evaporation from Active Beach	14,264	10,596	8,151	4,890	4,075	1,630	3,260	4,075	4,890	8,558	12,633	13,449	90,472	7,539.3
Seepage Loss	4,650	4,200	4,650	4,500	4,650	4,500	4,650	4,650	4,500	4,650	4,500	4,650	54,750	4,562.5
Sub-Total Losses	120,483	105,446	111,459	103,439	105,443	98,626	104,240	105,443	103,439	112,060	114,869	119,279	1,304,224	108,685.3
Water Surplus / (Deficit) at End of Month	196,217	181,312	204,561	205,324	213,162	215,193	215,275	211,191	204,199	207,142	197,795	200,040	2,451,410	204,284.2
% Return of Operations Water to Process Plant	64%	65%	67%	69%	69%	72%	70%	69%	69%	67%	66%	65%	N/A	68%

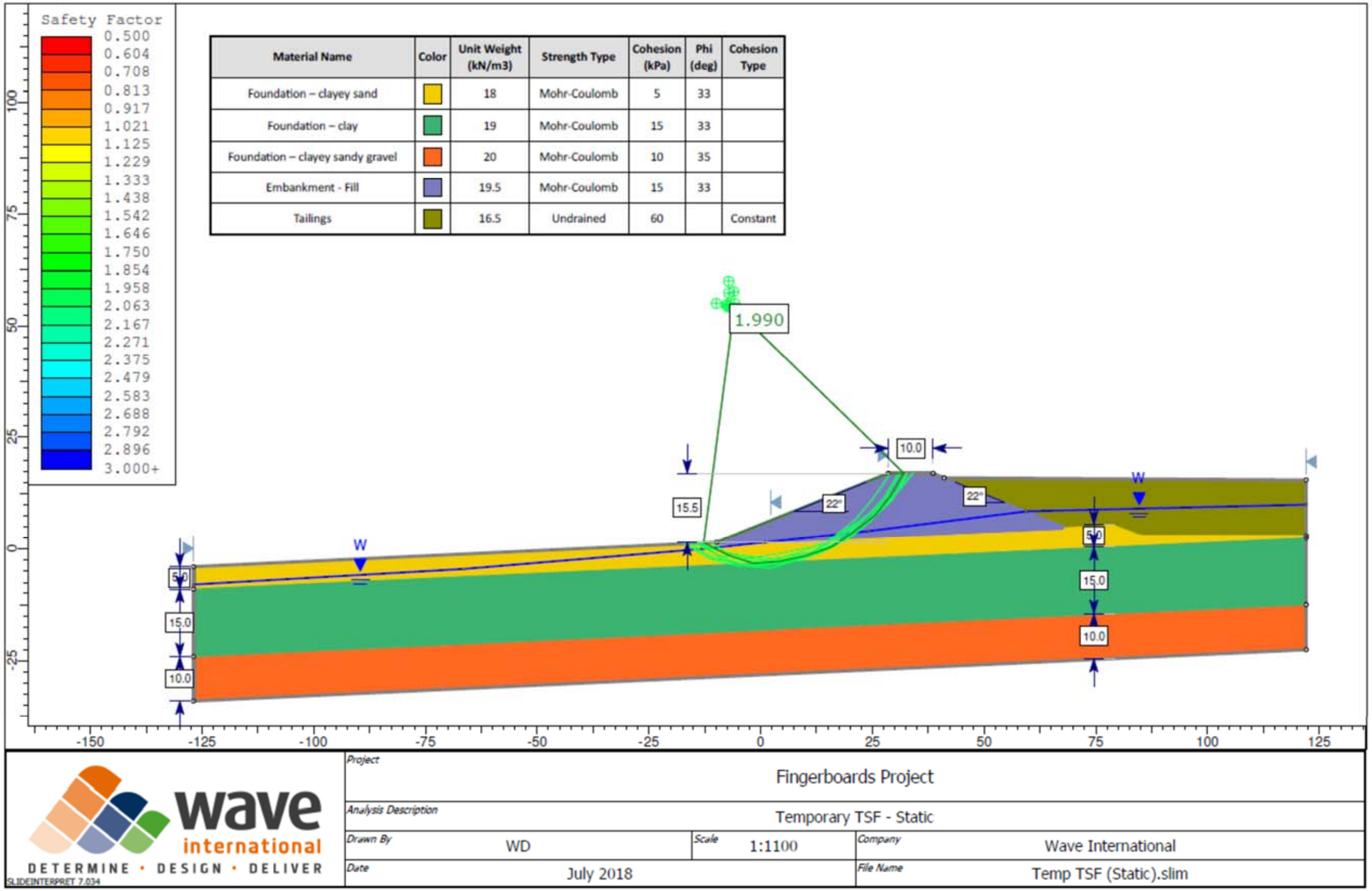
Figure 11.15 Temporary TSF – 2 x Cells, AMC

Fingerboards Project
Temporary Tailings Storage Facility - 4 x Cells, Active Deposition and AMC
Average Annual Water Balance

	Average Annual Water Balance - Return Water Volumes												End of Year	Monthly
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals	Average
	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3/month)	(m^3)	(m^3/month)
Water deposited with slurry	475,626	429,597	475,626	460,283	475,626	460,283	475,626	475,626	460,283	475,626	460,283	475,626	5,600,109	466,676
2 x cells active deposition														
Return of Operations Water to Process Plant	130,954	125,518	147,086	154,336	160,833	168,539	164,168	158,512	152,930	149,929	137,698	136,490	1,786,993	148,916
2 x cells AMC "mud farming"														
Return of Operations Water to Process Plant	196,217	181,312	204,561	205,324	213,162	215,193	215,275	211,191	204,199	207,142	197,795	200,040	2,451,410	204,284
Total	**327,170**	**306,830**	**351,647**	**359,660**	**373,995**	**383,732**	**379,443**	**369,703**	**357,129**	**357,071**	**335,493**	**336,529**	**4,238,403**	**353,200**
% Return of Operations Water to Process Plant	69%	71%	74%	78%	79%	83%	80%	78%	78%	75%	73%	71%		76%

Figure 11.16 Summary - Temporary TSF – 4 x Cells, Active Deposition and AMC

APPENDIX 11B Temporary TSF Slope Stability Assessment



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type
Foundation – clayey sand		18	Mohr-Coulomb	5	33	
Foundation – clay		19	Mohr-Coulomb	15	33	
Foundation – clayey sandy gravel		20	Mohr-Coulomb	10	35	
Embankment - Fill		19.5	Mohr-Coulomb	15	33	
Tailings		16.5	Undrained	60		Constant

Figure 11.17 Temporary TSF - Static

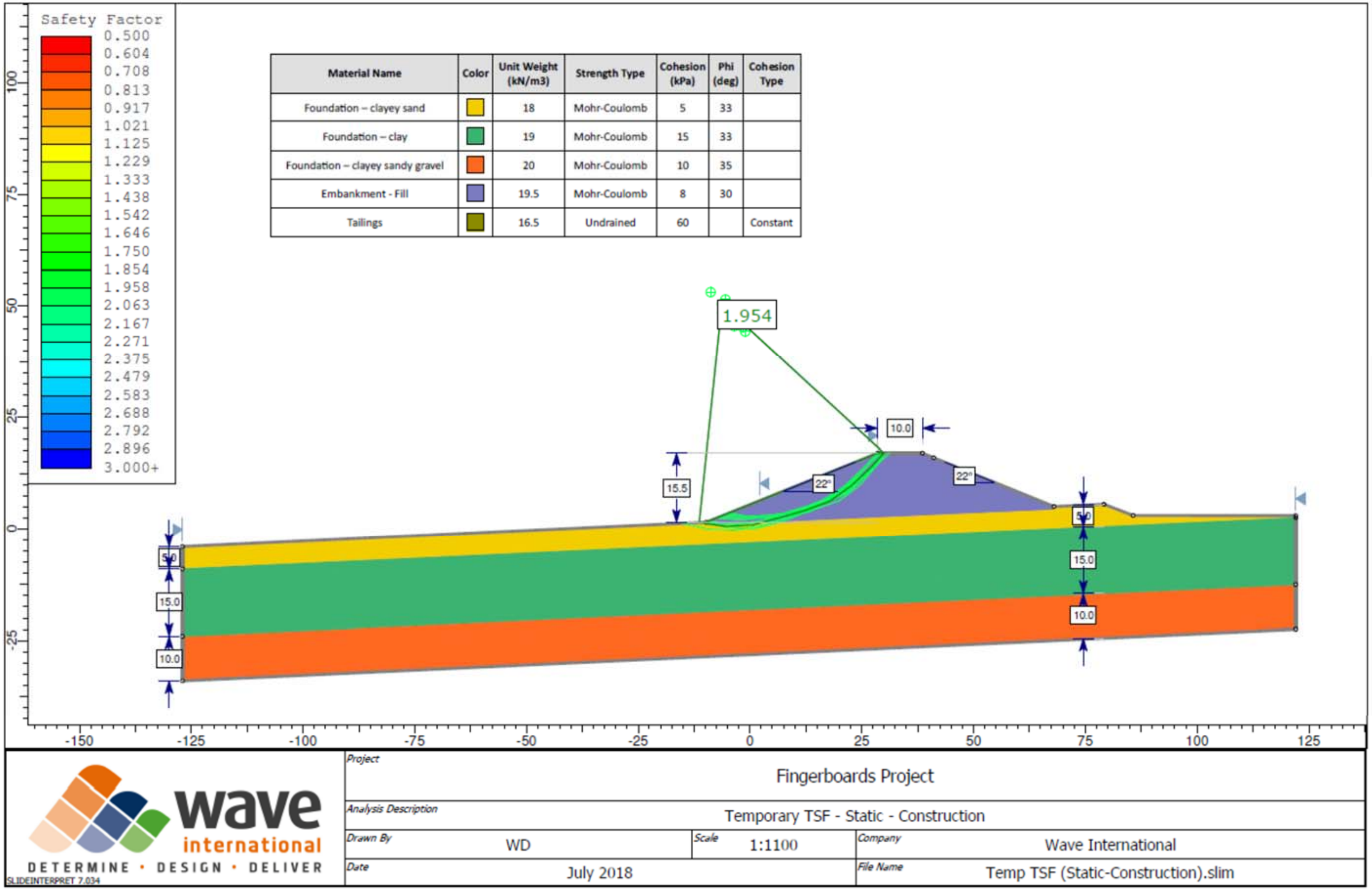
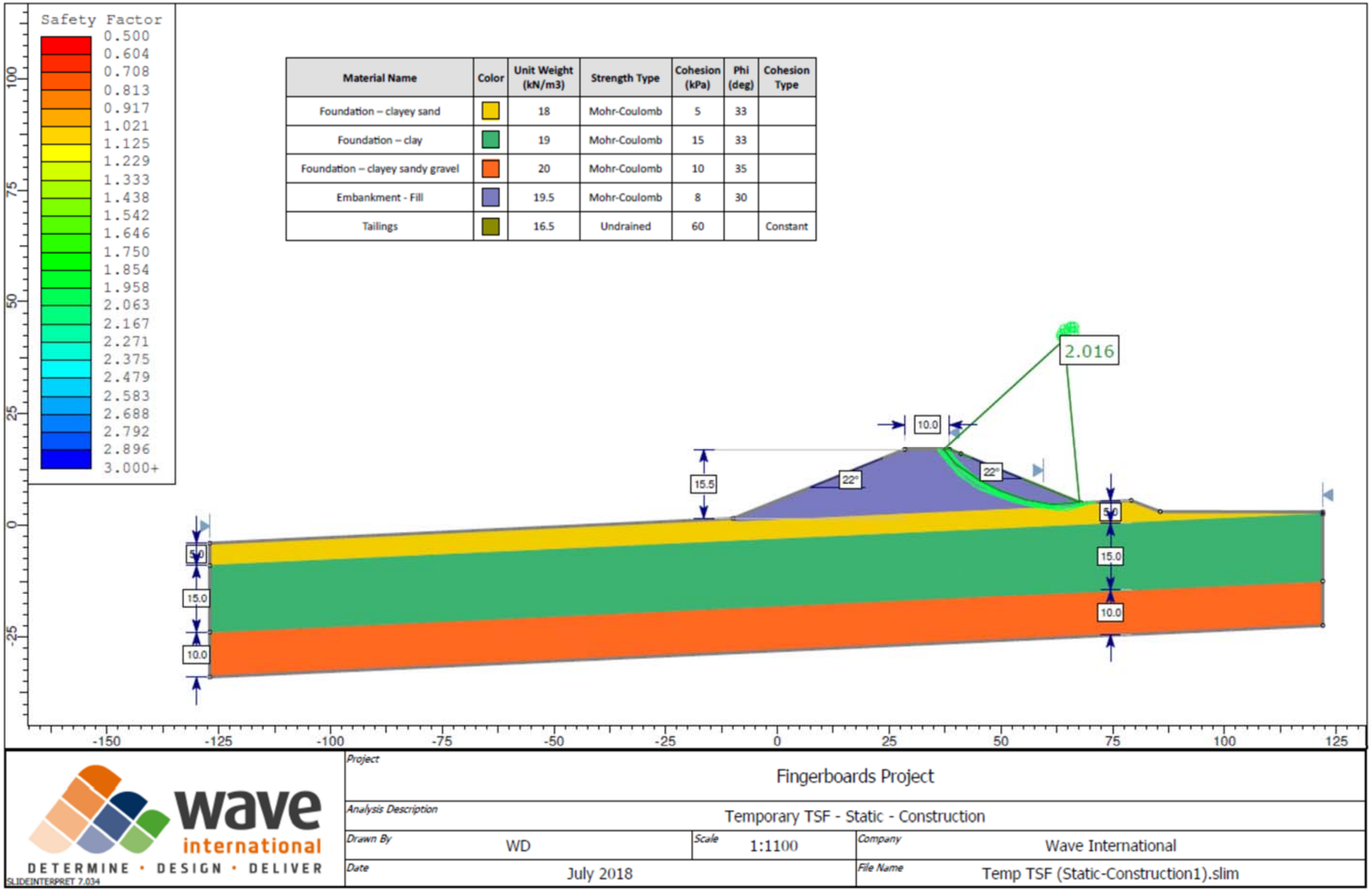


Figure 11.18 Temporary TSF – Static Construction (downstream slope)



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type
Foundation – clayey sand		18	Mohr-Coulomb	5	33	
Foundation – clay		19	Mohr-Coulomb	15	33	
Foundation – clayey sandy gravel		20	Mohr-Coulomb	10	35	
Embankment - Fill		19.5	Mohr-Coulomb	8	30	
Tailings		16.5	Undrained	60		Constant

Figure 11.19 Temporary TSF – Static Construction (upstream slope)

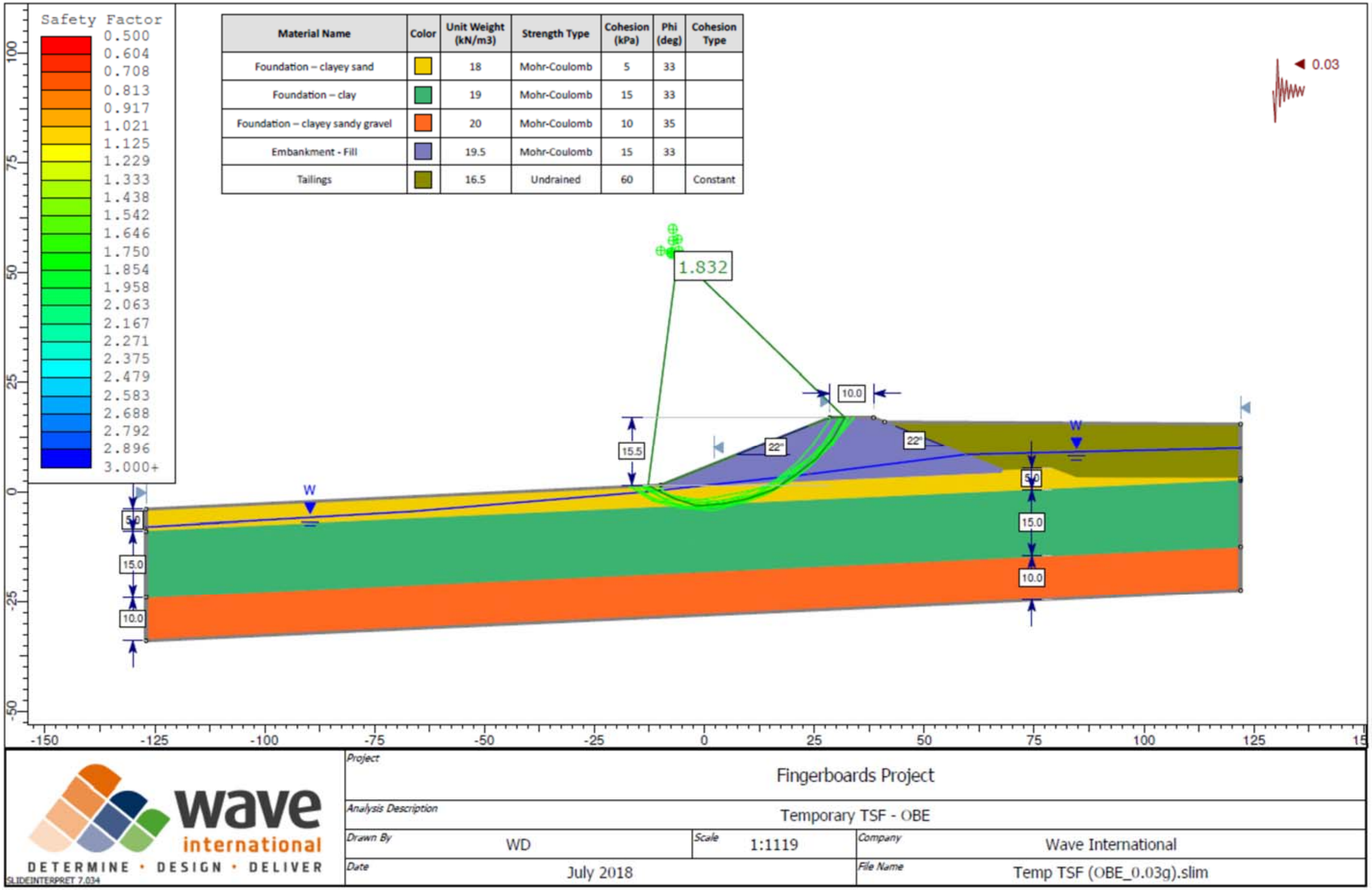


Figure 11.20 Temporary TSF - OBE

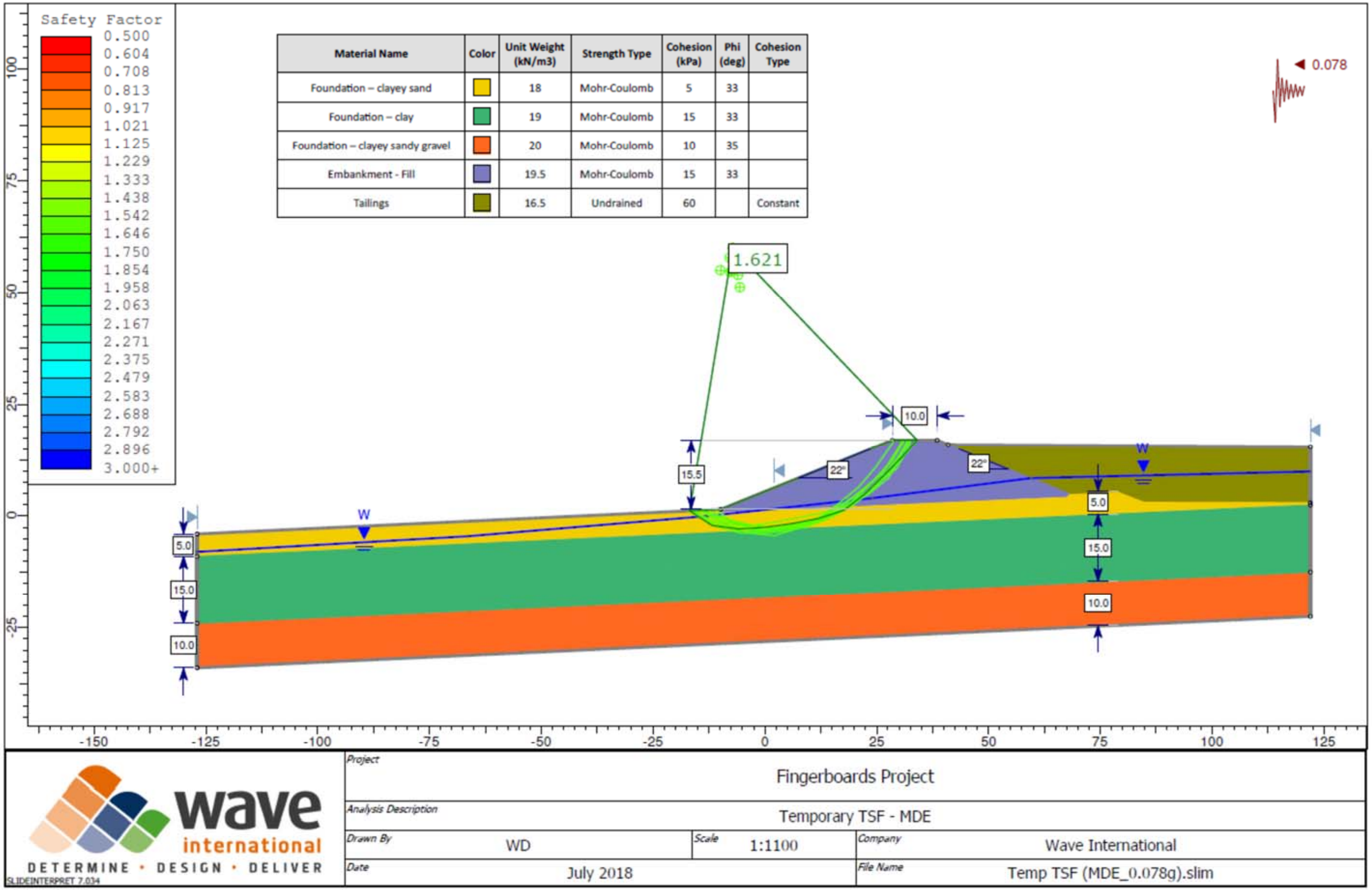


Figure 11.21 Temporary TSF - MDE

APPENDIX 11C Drawings

Attachment 1	4567-40-DWG-CI-31101 TSF and Freshwater Dam General Arrangement
Attachment 2	4567-40-DWG-CI-31102 TSF Typical Sections and Details
Attachment 3	4567-40-DWG-CI-32001 Perry Gulley TSF Catchment Dam General Arrangement
Attachment 4	4567-40-DWG-CI-32002 Perry Gulley TSF Catchment Dam Typical Sections and Details
Attachment 5	4567-40-DWG-CI-32003 Perry Gulley TSF Catchment Dam Typical Spillway Details
Attachment 6	4567-40-DWG-CI-32004 Perry Gulley TSF Sand Stacking Area – Drainage and Flood Protection Berm Details

APPENDIX 11D Certificate of Compliance

FHUWLILFDWH#RI#FRPSOLDQFH#

WDLOLQJV#VWRUDJH#IDFLOLW\#EIV#GHVLJQ#UHSRUW#

For and on behalf of Wave International Pty Ltd, I, WALDO DRESSEL being a duly authorised officer of Wave International, a qualified geotechnical engineer, current Chartered Member of the Institution of Engineers Australia (TMIEAust CEngT NER, 3288601) and Associate Member of the Australian National Committee on Large Dams (ANCOLD), do hereby certify and confirm that the tailings storage facilities at the Fingerboards Mine Site has been designed in accordance with the current edition of Victoria State Government (Department of Economic Development, Jobs, Transport and Resources), 'Technical Guideline – Management of Tailings Storage Facilities' (DEDJTR).

The BFS design is referenced as *4567-30-RPT-GE-00011 Revision [#],* dated [##] August 2018.

Signature of above person……………………………………………………………………………………

Signature of Witness…………………………………………………………………………………………..

Name of Witness …………………………………………………………………………………………….…

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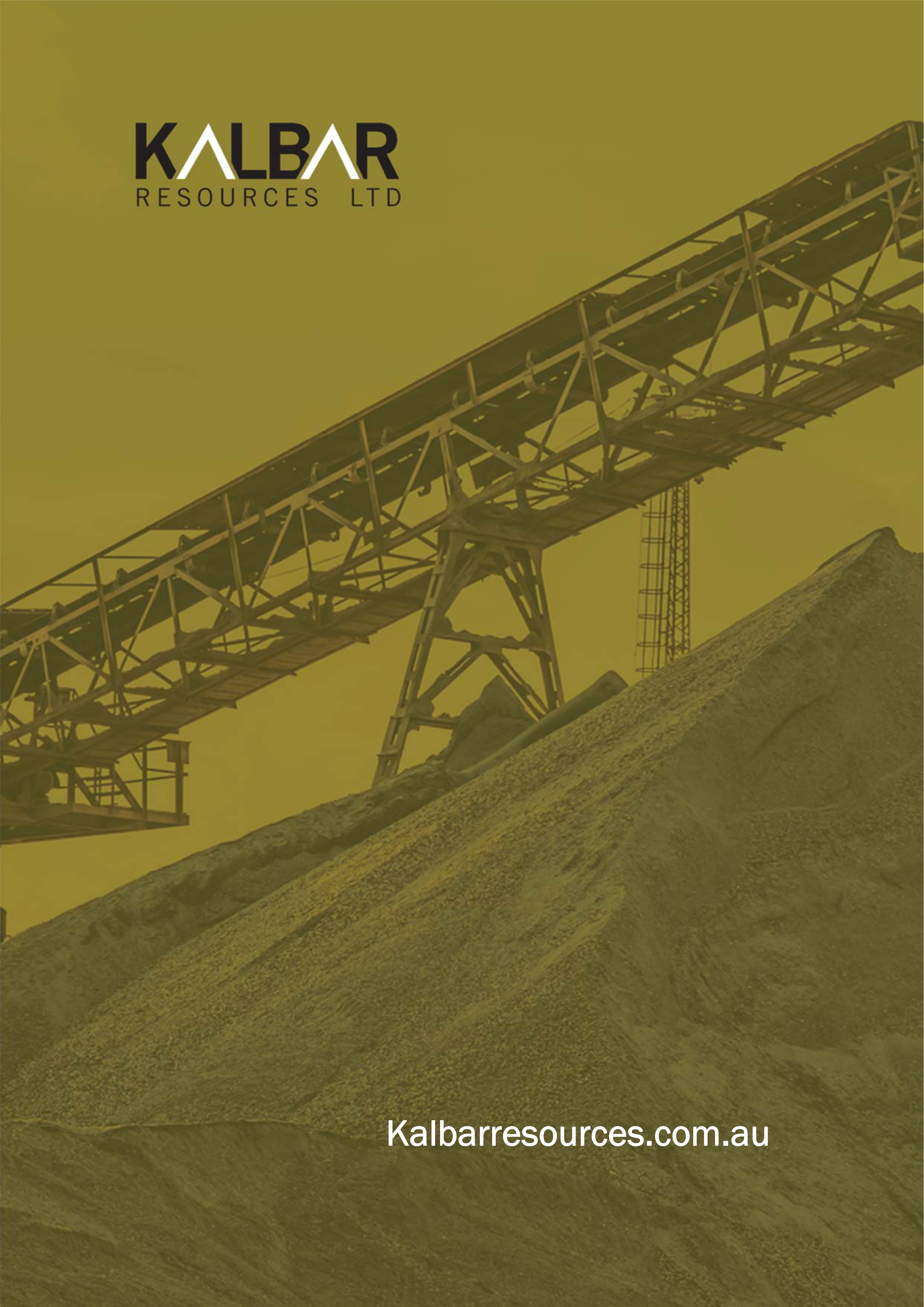

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