Appendix E

Tailings Management Plan

Vista Gold Australia Pty Ltd

Mount Todd Project Area

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Attachment

Attachment E1– Risk Matrix

Attachment E2 – Mt Todd Tailings Storage Facility 1 Assessment Report (TGI 2020)

Abbreviations

AAPA	Aboriginal Areas Protection Authority
AMD	Acid Mine Drainage
ANCOLD	Australian National Committee on Large Dams
DPIR	Department of Primary Industries and Resources
EMS	Environmental Management System
EPA	Environmental Protection Agency
GCL	Geosynthetic Clay
HDPE	High Density Polyethylene
HLP	Heap Leach Pad
Km	Kilometres
LLDPE	Linear low-density polyethylene
LPM	low permeability mater
MTPA	Mt Todd Project Area
NAF	Non-Acid Forming
NT	Northern Territory
OMS	Operations, Maintenance and Surveillance Manual
PAF	Potentially Acid Forming
PGM	Plant Growth Media
PPE	Personal Protective Equipment
QA/QC	Quality Assurance / Quality Control
ROM	Run of Mine

RP	Retention Pond
SWCC	Soil Water Characteristic Curve
TMP	Tailings Management Plan
TSF	Tailing Storage Facility
Vista Gold	Vista Gold Australia Pty Ltd
VWP	vibrating wire piezometers
WAD	Weak Acid Dissociable
WRD	Waste Rock Dump

1 Introduction

Mount Todd Project Area (MTPA) is a brownfield/disturbed site that was historically mined for gold between the 1990s until 2000. The Mt Todd Gold Mine site is located approximately 55 km north-west of Katherine and 250 km south of Darwin. The Northern Territory (NT) has a sub-tropical climate with distinct wet and dry seasons. A number of creeks and/or rivers are located within the MTPA. The area surrounding the mining lease is rural and sparsely populated. The Werenbun community is the closest residential area located approximately 6.5 km from the site. The Stuart Highway, the main arterial road in the region, is located west of the mine.

It is planned to raise Tailing Storage Facility 1 (TSF1) upon resumption of operations, and construct a new Tailings Storage Facility (TSF) - TSF2 later in the mine life.

1.1 Purpose

The Tailings Management Plan forms part of the Environmental Management System (EMS) for the MTPA and is considered a working document. It has been updated following formal consultation and assessment by Department of Primary Industry and Resources (DPIR) as part of the mining authorisation process.

The Tailings Management Plan (TMP) has been prepared to highlight potential risks associated with management of tailings, through the design, operations, closure and decommissioning of the tailings storage facilities, and provide strategies to eliminate or mitigate these risks to acceptable levels.

1.2 Tailings Management Guidelines

The TMP has been prepared based on the following guidelines:

- Leading practice sustainable development for the mining industry: tailings management (DFAT, 2016); and .
- Guidelines on tailings dams: planning, design, construction, operation and closure (ANCOLD, 2012).

These guidelines were prepared to provide TSF designers and operators with a framework to address issues relating to storage and management of tailings, to provide effective, sustainable solutions for the TSF design, operation and closure.

1.3 Associated studies and technical information

Design of the expansion of the existing TSF1 and the design and construction of the proposed TSF2 have derived criteria from multiple studies and sources. These include but not limited to:

- The Mount Todd Gold Project Environmental Impact Assessment 2013;
- Mount Todd Gold Project Mine Site – Hydrogeology;
- Australian National Committee on Large Dams (ANCOLD) 2010 Guidelines on Planning, Design, Construction, Operation and Closure of Tailings Dams;
- Mount Todd Gold Mine, Tailings Storage Facility Manual, Volume 1; and

- Mount Todd Gold Mine, Tailings Storage Facility Manual, Volume 2 Stage 1 Construction Report.

1.4 Legislation

Legislative requirements for tailings management in the Northern Territory are contained within the following:

- *Waste Management and Pollution Control Act 1998; and*
- *Mining Management Act 2001.*

1.5 Risk management hierarchy

The management of tailings at the mine is undertaken in general accordance with the risk control hierarchy. The hierarchy of control in order from the most to the least effective controls are elimination, substitution, isolation, engineering, administration and personal protective equipment (PPE) as detailed in ***Table 1-1 Hierarchy of Risk Controls***Table 1-1.

Table 1-1 Hierarchy of Risk Controls

Risk Control	Example
Elimination	Prevent AMD from SCATS reporting to the tailings pond by removing SCATS from the TSF catchment, during operations
Substitution	Introduce automated systems of monitoring (e.g. water level, flow monitoring) to eliminate the need for manual reading
Isolation	Tailings to be isolated at TSF.
Engineering controls	Reduce risk of driving over batter slopes by engineering safety bunds on the edge of access roads
Administrative controls	Ensure all TSF operators have completed a tailings dam safety course, and have read the Operations, Maintenance and Surveillance (OMS) Manual.
Personal protective equipment	Use eye, hand, foot, head and high visibility protection as required.

2 Existing Conditions

2.1 Tailings storage facility 1 (TSF1)

2.1.1 Design

The existing TSF at the mine, TSF1, was constructed in 1996, and operated until 2000. TSF1 is contained within the Horseshoe Creek catchment, with an external clean water diversion drain isolating TSF1 and diverting the creek. The design of TSF1 was conducted by Knight Piesold Pty Ltd.

TSF1 is a side-hill storage, with embankments on the north, east and southern sides and founded into natural ground on the west. TSF1 is unlined.

The embankment was constructed as a zoned earth and rockfill structure, with run of mine waste rock (Zone C) forming the majority. A six metre wide upstream sloping zone of select mine waste rock (Zone B) was constructed on the upstream side of Zone C, with a six metre wide low permeability clay core and cutoff trench constructed upstream of Zone B.

The TSF features a system of decant towers and underdrains, that report by gravity pipes to the decant and polishing ponds located on the downstream side of the southern embankment. The decant tower and valves on the underdrain system were closed in 2004-2005, to minimise overflow from the ponds into Horseshoe Creek.

Key details of TSF1 are summarised in ***Table 2-1 Summary of TSF1***.

Table 2-1 Summary of TSF1

Item	Details	
Embankment type	Zoned earth and rockfill	
Year of construction	1996	
Catchment area	245 Ha	
Tailings storage	5.44 million tonnes (Mt)	
Remaining capacity to Full Supply level (FSL)	4.29 million m^3 (4,290ML)	
Embankment length	3.5km	
Embankment height	19m max.	
Cutoff trench depth	3m max.	
Underdrainage system	Vee trenched drains at 20m centres, 63mm or 100mm draincoil. Backfilled with filter medium (heap leach material). Underdrains report to the decant tower.	
Decant system	6 x precast concrete vertical towers. Gravity fed polyethylene pipes report to HDPE lined reclaim water pond.	
Spillway	Broad crested weir cut into natural ground 6m wide 1m deep	
Instrumentation	Vibrating wire piezometers	7 x foundation 6 x tailings 8 x downstream groundwater

Item	Details	
	Monitoring bores	Slotted PVC pipe, 3 x surficial, 3 x groundwater
	Flow measuring flumes	5 stainless steel in concrete channels

2.1.2 Summary of deposition

Approximately 5.44Mt of tailings were deposited at the TSF1 intermittently between 1996 and 2000, covering approximately half the storage area.

Tailings were pumped to the TSF1 where it was split into two distribution lines around the embankment crest. The slurry was deposited sub-aerially via a series of spigot offtakes, connected to slotted PVC pipes taking the slurry down the upstream embankment batter. This method of deposition allows for tailings beach development from the crest; spigotting of tailings is implemented to try and maximise consolidation and provide a material that may be suitable as a foundation for future upstream raises.

2.2 Water management

TSF1 contains a significant depth of water. This water will be utilised in the process circuit once processing of ore commences.

2.2.1 Potential environmental issues

There are existing environmental issues associated with seepage of acidic water into the receiving environment from TSF1. These include:

- Water in the TSF1 pond is chemically consistent with the acidic drainage from the waste rock dump retention pond. Sulfidic scat that is stockpiled within the south-western section of TSF1 catchment is also contributing to acidity in the pond water.
- Flowing seepage and salt efflorescence were observed downstream of the north-eastern and eastern TSF1 embankments. The seepage locations are located along the original Horseshoe Creek line. The creek was backfilled during construction, however not sufficiently enough to prevent seepage.
- Water quality of seepage is consistent with surface water in TSF1.
- The tailings have a positive net acid producing potential, however approximately 95% of the tailings body has remained saturated since deposition and oxidation has been minimised.
- The chemical signature of process water was also observed in groundwater down gradient of TSF1.
- Future tailings deposition may significantly lower surface and groundwater seepage, by providing a low permeability cover material over the storage area (previous deposition did not cover the whole area).

The issues outlined above will be addressed in this TMP.

3 Tailings Management

3.1 Overview of TSF designs

Over the course of the proposed 13 year production schedule, it is estimated that approximately 221 Mt of tailings will be stored within two TSFs:

- The existing TSF1, is to be raised through a series of upstream raises to store an additional 62 Mt of tailings.
- The new TSF2, a zoned earth and rockfill embankment to be raised by upstream construction, with the capacity to store 159Mt of tailings.

The storages have been designed under an assumed tailings dry density of 1.5t/m^3.

Comprehensive detail of the TSF1 proposed raise is provided in **Appendix A12** and a summary provided below.

Comprehensive detail of the TSF2 proposed raise is provided in **Appendix A12** and a summary provided below.

3.1.1 Material characterisation

Materials characterisation was carried out on site utilising multiple methods. This is detailed in **Appendix A – PFS**, **Attachment A12** and **Attachment E2)**.

3.1.2 Predicted materials properties

Tailings properties were investigated as a component of the preliminary feasibility study (**Appendix A12**) to ascertain the appropriate design criteria for additional lifts to the existing TSF1 and the design of TSF2.

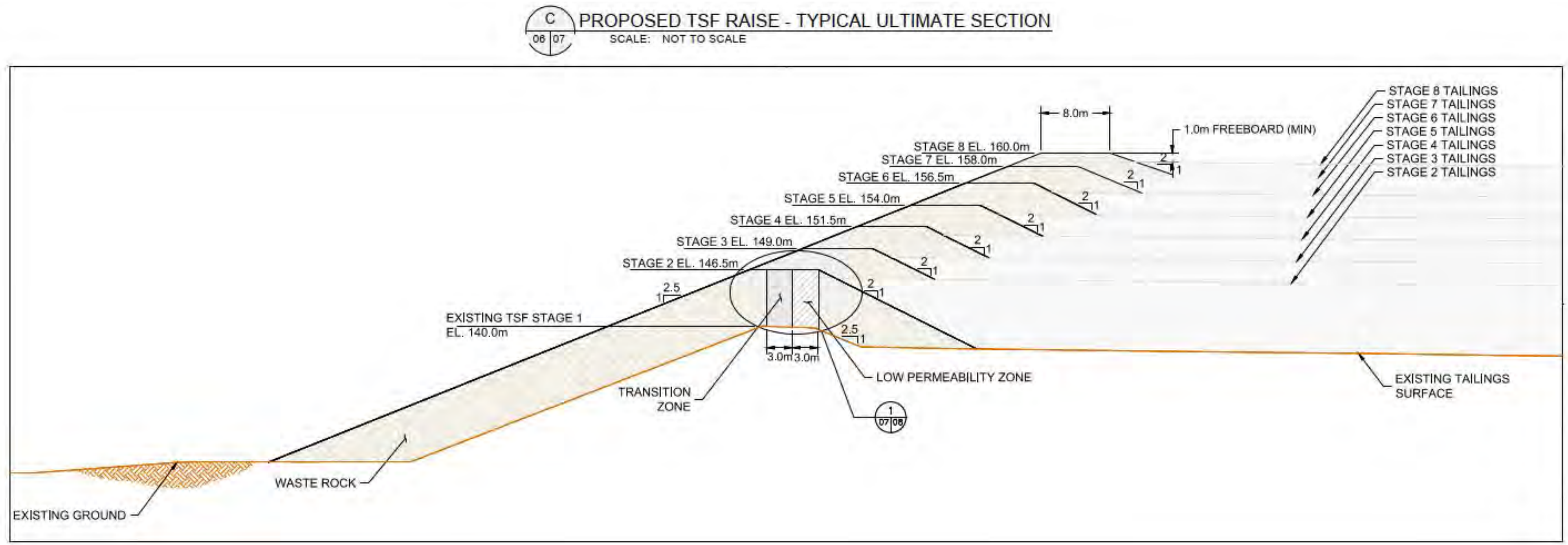
Tailings materials were tested for compaction and permeability by Modified Proctor Compaction (AS 1289.5.2.1) and Falling Head Permeability (AS 1289.6.7.2) methods, respectively. These tests require samples to be dried to a specified value. The maximum dry density presented in ***Table 3-3 TSF 2 – Design Storage Capacity*** of the Preliminary Feasibility Study may be considered the maximum expected value, but is not typically replicated in the field. Results presented in ***Table 3-4 TSF 2 Design Criteria*** of Preliminary Feasibility Study show samples that were run on 95 percent of the proctor dry density, and so the samples are at a slightly lower water content (if you compare the numbers within the two tables, the first sample dry density of 1.83t/m^3 is equivalent to 95 percent of the previous test dry density of 1.92t/m^3). The dry densities presented in the Preliminary Feasibility Study (**Appendix A12**) should not be considered as typical field values. Rather, they are laboratory modified to conform to testing procedures and represent an optimum value. Dry density cannot be measured directly within the field as the sample is disturbed upon collection. Dry density values must therefore be predicted within the laboratory. Tailings storage facility design used laboratory predictions by Knight Piesold (1996) ranging from 1.7-1.8t/m^3 as a material characteristic when designing the Tailings Storage Facility (TSF2).

Tailings grain size, percent solids and specific gravity are dictated by milling and thickener performance within the process circuit. Grain size is a function of the grinding capability of the ball mill, which reduces the incoming materials to a P80 of 90µm. Solids content of the thickened tailings is expected to be in the range of 51 to 54 percent and specific gravity is anticipated to be 1.49.

3.1.3 TSF 1 design overview

Preliminary designs for TSF1 have been completed by Tetra Tech, with high level and the proposed cross-section to final height presented in ***Figure 3-1 Proposed TSF1 cross section to final height***. Detailed discussion of the raise design is provided in section 4 of **Appendix A12**.

Figure 3-1 Proposed TSF1 cross section to final height



The TSF1 expansion consists of seven separate embankment raises (up to Stage 8) to accommodate tailings produced for the Base Case. Three embankment raises (up to Stage 4) are required to accommodate the tailings produced for the Alternate Case. For the Base Case, two saddle dams will be constructed along the relatively high ground at the west side of the TSF to contain tailings.

The existing embankment is identified as Stage 1 at a 140m crest elevation. The Stage 2 embankment shall be constructed using 6.5m high centerline construction method with an upstream slope of 2H:1V (2 horizontal units to 1 vertical unit) and downstream slope of 2.5H:1V. Each subsequent upstream raise will be founded on the previous embankment and the perimeter tailings beach of the previous stage. The upstream raise heights are 2.5. A network of wick drains will be installed in the foundation of each raise to promote tailings consolidation prior to embankment raise construction. Non-acid generating run-of-mine waste rock from the open pit mining operations shall be used to construct the upstream and downstream portions of the Stage 2 embankment. The central low permeability core for the Stage 2 embankment shall consist of a 3 m wide layer of Zone A material which shall be keyed into the upstream low-permeability zone of the existing TSF1 embankment. A 3m wide transition zone of Zone B material shall be provided between the downstream waste rock portions of the embankment and the central low-permeability core.

The Stage 2 expansion will include construction of two saddle containment dams across existing shallow valley features on the western side of the facility. These saddles will be incorporated into the future raised perimeter embankment. The saddle dams shall be constructed primarily from run-of-mine waste rock and incorporate a 3m wide zone of low-permeability (Zone A) material adjacent to a 3m wide layer of transition (Zone B) material.

Stages 3 through 8 of the TSF1 expansion shall be constructed using upstream construction techniques using an upstream slope of 2H:1V and downstream slope of 2.5H:1V. The Stage 3 through 8 embankment raises are constructed of mine waste rock. The waste rock used for all stages of the TSF1 expansion shall be hauled by mine equipment and spread using dozers. Compaction shall be achieved by controlled traffic of loaded haul trucks and roller compaction of the embankment core zone.

The design storage capacities and crest elevation for each stage are presented in ***Table 3-1 TSF1 Expansion – Design Storage Capacity***. The staging of TSF1 and construction schedule will be further optimized during the feasibility study stage of the project. This will be undertaken to optimize placement of available mine waste direct from the pit to minimize potential re-handling requirements of mine waste from dump.

Table 3-1 TSF1 Expansion – Design Storage Capacity

Base Case Expansion Stage	Embankment Crest Elevation (m)	Design Storage Capacity (Mt)
Stage 2	146.5	42.6*
Stage 3	149.0	8.6
Stage 4	151.5	8.4
Stage 5	154.0	8.3
Stage 6	156.5	8.2
Stage 7	158.5	6.5
Stage 8	160	4.9

Table 3-2 TSF1 Expansion Design Criteria

Design Parameter (Base Case)	Value
Design Tailings Storage Capacity	87.4 million tonnes
Average Tailings Dry Density	1.5 t/m3
Tailings Production Rate	50,000 tpd
Design Life	12 years

Design objectives also include the following when the operating procedures are adhered to:

- Maximum densities for deposited tailing resulting in long term dam stability and economical tailings management;
- Optimum tailings strength parameters against the embankment to assist staged embankment construction;
- Maximum process water return from the facility for reuse in the plant to minimise the requirement for raw water resources; and
- Reduction of Weak Acid Dissociable (WAD) cyanide levels in the tailings decant pond and return water to below 55ppm

The maximum designed tailings level is RL 160.0m, with a predicted beach slope of 1%.

The ultimate TSF has been designed with a capacity of 61.4 Mt for a total design life of 5.8 years, based on the predicted production rates and tailings dry density.

Exiting tailings characterisation is detailed in section 3.4.1 of **Appendix A12**. This section outlines the following characteristics:

- Tailings composition;
- Compaction test results;
- Permeability test results;
- Consolidation test results; and
- Index test results

3.1.4 TSF2 design overview

Preliminary designs for TSF2 have been completed by Tetra Tech (**Appendix A12**), with high level details and the proposed cross-section to final height presented in ***Table 3-3 TSF 2 – Design Storage Capacity*.**

Figure 3-2 Proposed TSF2 cross section to final height shows the final height of TSF2.

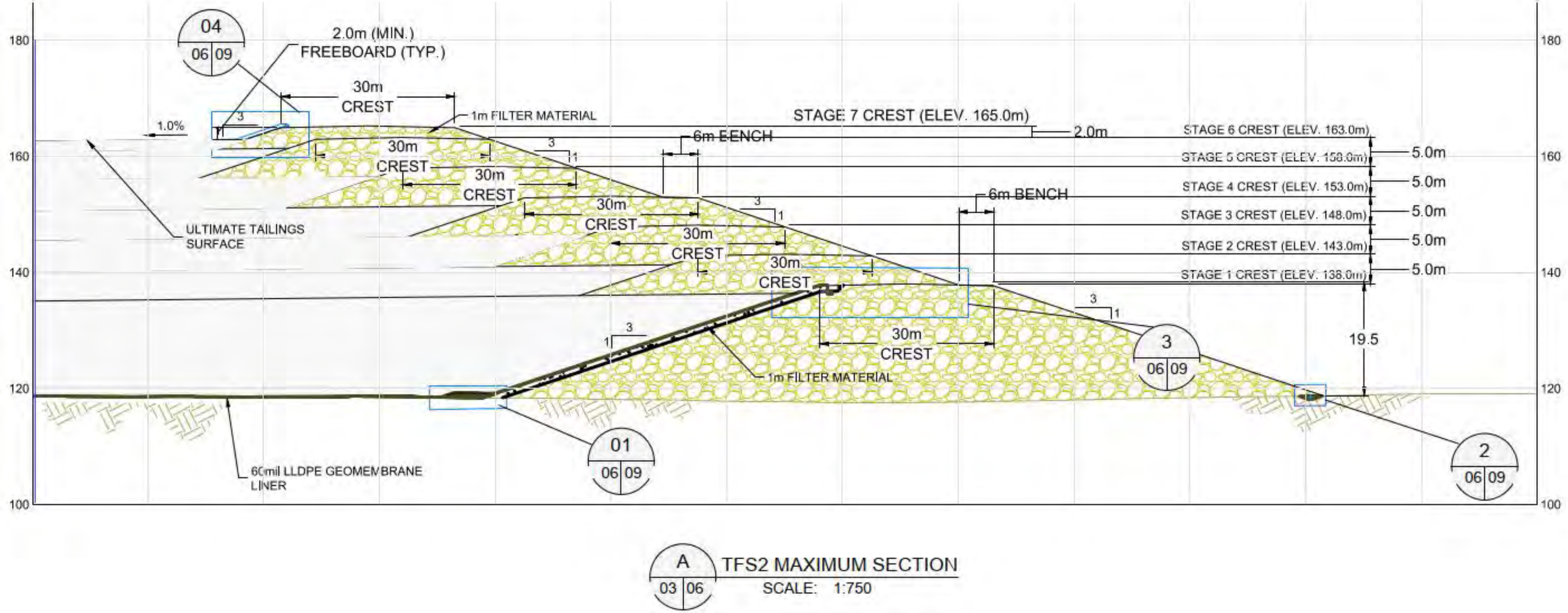
Table 3-3 TSF 2 – Design Storage Capacity

50,000 tpd TSF 2 Stages	Embankment Crest Elevation (m)	Design Storage Capacity (Mt)
Stage1 *Cell1*	138.0	17.0
Stage1 *Cell2*	138.0	17.0
Stage2 *Cell1*	143.0	8.3
Stage2 *Cell2*	143.0	8.3
Stage3 *Cell1*	148.0	7.7
Stage3 *Cell2*	148.0	7.7
Stage4 *Cell1*	153.0	7.8
Stage4 *Cell2*	153.0	7.8
Stage5 *Cell1*	158.0	6.9
Stage5 *Cell2*	158.0	6.9
Stage6 *Cell1*	163.0	7.1
Stage6 *Cell2*	163.0	7.1
Stage7 *Cell1*	165.0	2.5
Stage7 *Cell2*	165.0	2.5
Total		**114.7**

Table 3-4 TSF 2 Design Criteria

Design Parameter Base Case	Value
Design Tailings Storage Capacity	114.7Mt
Average Tailings Dry Density	1.5t/m^3
Tailings Production Rate	50,000tpd
Design Life	13 years

Figure 3-2 Proposed TSF2 cross section to final height



Separate designs were prepared for TSF2 to accommodate the Base Case production rate and the Alternate Case production rate. The TSF2 designs follow a similar construction approach and incorporate the same design elements, but the Alternate Case was developed with a smaller footprint. Design drawings for TSF2 are included in Appendix A12

The TSF2 starter embankment will be constructed using mine waste and select borrow material after the TSF1 Stage 2 raise is completed and operational. The TSF2 embankment will be raised by upstream methods and using mine waste. TSF2 raises will be constructed in an alternating sequence with construction of TSF1 raises. This alternating sequence was adopted to provide adequate time for tailings consolidation and strength gain to permit upstream raising construction. The installation of wick drains in the foundation of each tailings raise is planned to improve the tailings consolidation rate, reduce risks associated with upstream embankment raising construction, and improve water recovery from the deposited tailings.

The design criteria for TSF2 are summarized in ***Table 3-4 TSF 2 Design Criteria***. TSF2 will accommodate approximately 114.7Mt of tailings for the Base Case and 54Mt for the Alternate Case. For both production cases, an average tailings dry density of 1.5t/m3 was adopted. The average tailings dry density was selected based on tailings testwork (KP, 1996) and operational considerations that include subaerial deposition in thin lifts and accelerated tailings consolidation through installation of wick drains. The operational life of TSF2 is approximately 13 years

The following design risks for TSF2 have been identified, that will need to be addressed during detailed design:

- The rate of rise for the tailings storage is high, particularly for TSF2, for upstream construction raises. The detailed design phase will need to show that there is adequate time for consolidation / pore pressure dissipation for upstream raise construction. This is a particular risk for large raises 10 m or more in height. Mitigating design options may include:
  - Operating both storages (TSF1 and TSF2) at once;
  - Treating the tailings as placed with Amphirols (i.e. ‘mud farming’) thereby speeding up consolidation and drainage of tailings;
  - Constructing raises using downstream methods.
- The storage designs have been based on an assumed dry density of 1.5t/m^3. This will need to be confirmed as achievable.
- The embankments are planned to be constructed out of waste rock. As the tailings have a positive acid producing potential, modelling will need to be undertaken to determine the required permeability of the waste rock for use as an embankment material, to prevent oxygen ingress and subsequent oxidation of tailings. The waste rock will then need to meet the permeability requirements as placed in the embankment.
- The designs include a high level assessment of the tailings liquefaction potential, and assume that liquefaction of tailings does not pose a significant risk to the project. This will need to be confirmed in detailed design through investigations and laboratory testing. For TSF1, there is a height differential in embankments, meaning the final tailings level is 4.5m above the saddle dams. Liquefaction of tailings may therefore cause overtopping of the embankments unless it is included in the design. There

would also be a significant risk of embankment deformation, particularly in TSF2 with the high tailings rate of rise.

- The Consequence Category for both TSF1 and TSF2 needs to be determined, as per ANCOLD guidelines.

3.2 Tailings deposition strategy

The tailings deposition strategy has been prepared with the aim of achieving the following goals:

- Prevent tailings oxidation and potential subsequent AMD.
- Maximise consolidation of tailings, and therefore storage capacity of the facilities.
- Maintain the decant pond away from the embankment faces for dam safety, with a minimum beach length of 100m (nominal).
- Deposit tailings in a manner that provides a suitable foundation for future upstream raises.

The high level deposition strategy is summarised as follows:

- Tailings will be thickened at the processing plant to approximately 58% solids content, then pumped to the operating TSF.
- The tailings distribution system at the TSF dam walls will consist of header pipelines running around the crest of the embankments, with tailings distributed through a series of spigots.
- Tailings will be deposited sub-aerially.
- Spigotted deposition will be controlled such that the decant pond is located within the centre of the TSF.

The following deposition challenges have been identified, that will be addressed and managed through detailed design and operations:

- As previously discussed, the tailings rate of rise is high at the storages, particularly at TSF2. This may have impacts on the future upstream raise designs and achieved densities.
- Geochemical testing has found that the tailings have a positive NAPP, with kinetic test work indicating that the tailings have a high degree of reactivity.

The controlling measures for these conflict to some degree. To encourage consolidation and maintain a minimum beach width of 100 m, then dewatering of tailings will need to be maximised; however this desaturation of tailings will reduce lag times for oxidation. This will require a high level of management throughout operations to ensure neither deposition goal is compromised. This will need to be backed up with monitoring and surveillance, and revision of management plans/operating procedures if required.

A detailed overview of the tailings deposition strategy is provided in section 4 of Error! Reference source not found.. Final depositions strategies and operating procedures will be finalised with the construction and operation manuals associated with the TSF2 build.

3.3 Water management

The water management strategy at the TSFs has been prepared with the aim of achieving the following goals:

- TSFs to be operated as zero discharge facilities, with supernatant water and runoff collected to be returned to the processing plant for reuse in processing.
- Manage legacy AMD issues and prevent further formation of AMD.
- Prevent water of poor quality entering receiving environments.
- Minimise the decant pond sizes, to keep phreatic surfaces within the embankments low, and maximise consolidation of placed tailings.

The water management at the TSF sites is summarised as follows:

- No AMD runoff water from other site locations shall be pumped to the TSFs, throughout their life cycles. In addition, Potentially Acid Forming (PAF) scats material that is located within the TSF1 catchment, shall be removed to prevent any further AMD entering the TSF storage area from this source.

TSF1

- The pre-existing TSF1 decant and underdrainage system will be partially reinstated (three of the existing six decant towers will be raised during staged construction) to manage pond and phreatic surface water levels. Further details of the decant and seepage collection system are provided in the Tetra Tech design report (**Attachment A12**).
- The TSF1 decant and drainage system reports to the existing lined return water pond, located on the downstream side of the southeast corner of the embankment. Water will be pumped from the return water pond to the process water pond for reuse in processing.
- A spillway for extreme flood events will be located within the southern saddle dam, as an overflow structure. The spillway is to be raised incrementally with the staged raises.
- The decant pond shall be kept a minimum of 100 m away from the upstream raised embankments.

TSF2

- A drainage network will be installed above the linear low-density polyethylene (LLDPE) liner, intended to draw pore water down in the tailings. The drainage will report to a seepage collection sump located south of the TSF, with water pumped back to the process plant for reuse.
- A secondary underdrainage network has been designed below the liner, to capture seepage and prevent groundwater mounding. The seepage will report to a collection sump located at the southwest corner of the TSF and pumped back to the process water pond.

- Water is to be returned to the process water pond via skid mounted pumps. The pumps will be located on causeways constructed adjacent to the decant pond. The causeways shall be a minimum of 1m above the pond level.
- The storage has been designed to store a 24 hour, Probable Maximum Precipitation (PMP) flood event. No spillway has been designed for the TSF2.

3.3.1 Detailed design considerations

The following items should be considered in the detailed design, relating to water management:

- Water returned from TSF2 is to be reused in processing. Therefore, a filtering structure (e.g. concrete tower with filter rock surrounding) may be required to ensure water is of sufficient quality for reuse.
- For TSF2, the high tailings rate of rise will require pond access causeways to be constructed approximately 5m in height every year. This will result in significant earthworks on tailings that will likely be of low strength. It will need to be shown that the tailings will be sufficiently strong to found the access causeway on, or consider alternative designs such as a floating pontoon or a permanent decant tower structure accessible from natural ground (i.e. in the northwest corner of the proposed TSF footprint).
- ANCOLD recommends that a spillway should always be provided, to “guard against uncontrolled spillage during unforeseen circumstances that could lead to failure of the dam structure.” (ANCOLD, 2012). Given the design allows for 24 hour PMP flood event storage, it is arguable that a spillway is not required during operations, however it should be considered for closure and in the case of early closure / care and maintenance. For example, an unforeseen circumstance may be that the storage is used as an auxiliary water storage for runoff from other areas on site, as was the case at TSF1, resulting in a pond level that reduces the design storage allowance.
- The MTPA received a total of 1,990mm rainfall during the 2010/2011 wet season. This is well in excess of the 1,200mm estimated for the 24 hour PMP flood event that TSF2 has been designed for. Wet season storage allowances will need to be taken into account in detailed design, particularly if the storage is to have no spillway. It is recommended that flood modelling is undertaken during the detailed design phase, commensurate to the risk.

3.4 Closure

The TSF closure plan includes the placement of a layer of waste rock over the tailings in order to provide a bridging layer to allow construction of a store and release cover over the entire facility. As detailed in the PFS, the TSF closure cover is the same for both TSFs and consists of, from the top down, a 0.2 meter (m) layer of plant growth media (PGM), 0.8 m 66% low permeability material (LPM) (clay)/34% fine non-potentially acid generating (non-PAG) rock mixture, and at least 1 m of sorter reject (over the tailings surface only). The cover will be placed over the bridging layer of coarser non-PAG waste rock. The waste rock will provide a surface on which to construct the closure cover and allow for the top surface of the facilities to be crowned (graded to drain). The bridging layer will be configured differently for TSF1 and TSF2. The closure of TSF 1 will include the placement of the bridging layer over the tailings and the facility embankment, while the bridging layer for TSF2 will only be placed over the tailings surface. The configuration of the closure cover for TSF1 is shown on ***Figure 3-3 TSF1 Closure Cover Design*** and ***Figure 3-4 TSF 2 Closure Cover Design***.

Additional detail on the closure of the tailings storage facilities is provided in ***Appendix R – Closure Plan*** and the TSF1 Assessment Report (TGI 2020) (***Attachment E2***), Attachment A to the Reclamation Plan (***Attachment A8***).

3.4.1 Proposed reclamation materials and plant growth media

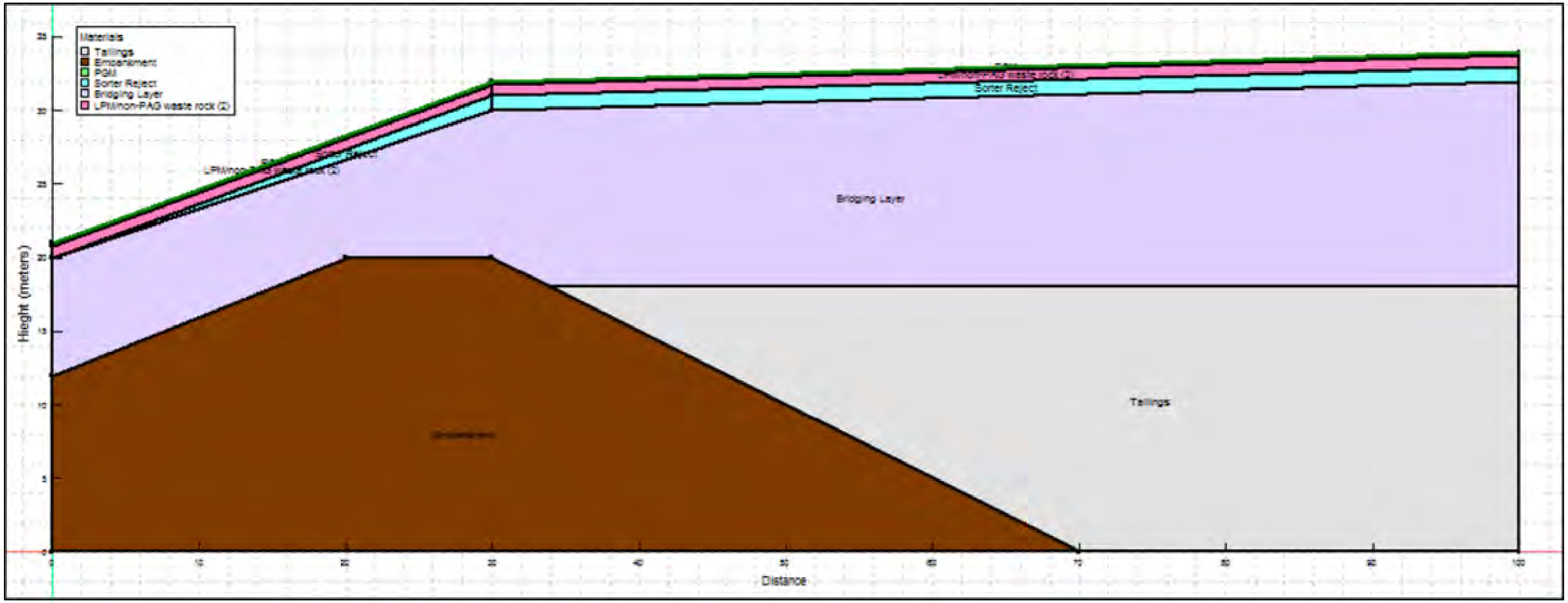
Reclamation materials utilised will include:

- ROM NAF waste rock
- imported low permeability materials
- Geosynthetic Clay (GCL)
- Plant Growth Media (PGM) from existing stockpiles
- PGM salvaged from construction
- crushed NAF waste rock to supplement PGM

PGM will be used as the top layer of reclamation cover for vegetation establishment. PGM will be obtained from existing stockpiles at MTPA, as well as through salvaging surficial soils within the footprints of new facility construction, including TSF2 and expansion areas of the WRD. The latter method will reduce the time soil is stockpiled and thereby maximise its viability to support vegetation.

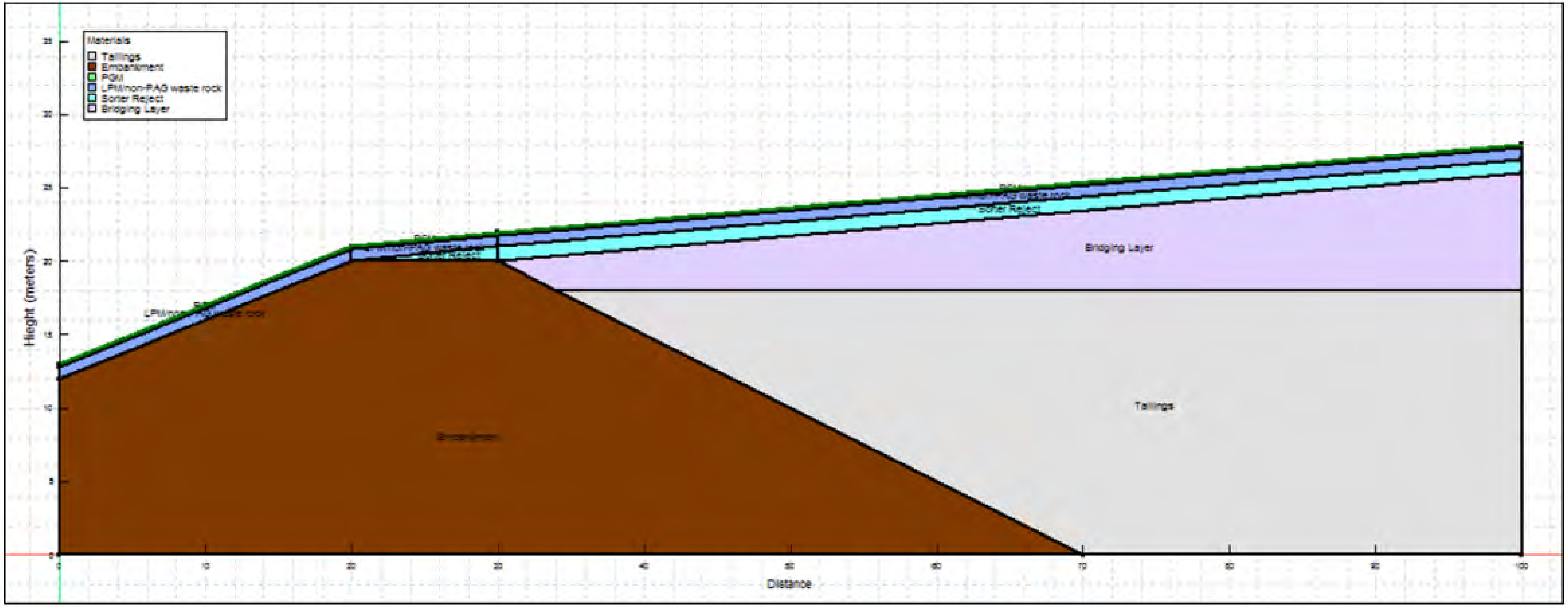
As needed, NAF waste rock will be crushed and used as supplemental PGM. It is assumed that PGM from existing stockpiles, new salvage and crushed NAF waste rock will be of sufficient quality to facilitate plant growth and will not require any additional soil amendments.

Figure 3-3 TSF1 Closure Cover Design



Note: the brown region is the embankment, the gray region is the tailings, purple is the bridging layer, aqua is the sorter reject, pink (TSF1)/blue (TSF2) is the LPM/non-PAG rock mixture, and green is the PGM.

Figure 3-4 TSF 2 Closure Cover Design



Note: the brown region is the embankment, the gray region is the tailings, purple is the bridging layer, aqua is the sorter reject, pink (TSF1)/blue (TSF2) is the LPM/non-PAG rock mixture, and green is the PGM.

4 Risk Assessment

A summary of risks identified in the TMP, through design, operations and closure, is provided in the risk register in ***Table 4-1 Risk Register***.

The risk register provided is a live document that should be updated regularly as the mine progresses. In the first instance, the risk register should be upon completion of the TSF1 Stage 2 detailed design.

Table 4-1 Risk Register

Source of Impact/ Potential Event	Potential Consequence	Residual Risk		
		Consequence	Likelihood	Risk
Failure of TSF	Widespread uncontrolled release of contaminated tailings and water in to the surrounding environment	Critical	Rare	Medium
	Major adverse environmental impacts			
Increase capacity of TSF1	Localised increase of groundwater levels in comparison to surrounding areas	Major	Possible	High
	Increased seepage of contaminated waters from structure to underlying aquifer			
	Increased seepage through artisan boreholes adjacent to structure to surrounding surface waters / localised contamination waterlogging and risk to embankment stability			
	Increased long-term risk to groundwater			
Establishment of TSF2	Localised increase of groundwater levels in comparison to surrounding areas	Major	Unlikely	Medium
	Seepage of contaminated waters from structure or artesian bores causing contamination			
	Increased long term risk to groundwater			
Seepage from the pond causes contamination of groundwater and downstream surface water.	Poor quality water entering the receiving environment having adverse effects on ecosystems.	Significant	Unlikely	Medium
Unknown geotechnical ground conditions	Unforeseen conditions during construction result in an inability to construct the proposed new TSF to the proposed design.	Major	Rare	Medium
Inadequate sources of materials	Inability to construct the design economically, due to a lack of available construction materials that can be won locally.	Major	Rare	Medium

Source of Impact/ Potential Event	Potential Consequence	Residual Risk		
		Consequence	Likelihood	Risk
Extreme flood event	Filling up of the storage and overtopping of the embankment crest, causing catastrophic failure of the embankment and subsequent release of tailings / water.	Critical	Rare	Medium
Extreme flood event	Severe rainfall event leading to AMD in surface runoff (disturbed) leaving site (e.g. leachate from WRD, HLP)	Significant	Unlikely	Medium
Extreme earthquake event	Earthquake causes instability of the embankment / liquefaction of tailings that result in catastrophic failure and / or deformation of the embankment, and subsequent release of tailings / water.	Critical	Rare	Medium
Extreme wind events	Wave overtopping of the embankment causing erosion / damage	Significant	Rare	Low
Runoff from external catchments	Erosion of embankment downstream face causing instability Water entering the storage causing elevated pond levels /overtopping	Significant	Rare	Low
Internal erosion (piping) of clay core material	Propagation of piping causing uncontrolled release of water and potential catastrophic failure	Critical	Rare	Medium
High tailings deposition rate of rise	High rate of rise results in low strength, unconsolidated tailings adjacent to the embankment crest, unsuitable for the planned upstream design raises.	Significant	Possible	Medium
Construction materials are PAF	Materials oxidise and form Acid and Metalliferous Drainage (AMD) from rainfall runoff	Major	Rare	Medium

Source of Impact/ Potential Event	Potential Consequence	Residual Risk		
		Consequence	Likelihood	Risk
Deposited tailings are not covered within the correct timeframe	Unsaturated tailings oxidise and form AMD	Major	Rare	Medium
High rainfall events / poor operations resulting in elevated pond level	Release of water that may be of poor quality Phreatic surface levels in the embankment elevated above design	Significant	Unlikely	Medium
Tailings pond against an embankment not designed for water retention	Poor pond operations results in an elevated water level against an upstream raised embankment, resulting in instability and piping risk.	Major	Rare	Medium
Embankment deformation	Deformation/slumping of the embankment causes cracking becoming a dam safety risk	Major	Unlikely	Medium
Closure of the facility	Inability to economically close the TSFs at the end of life, resulting in unsafe conditions and/or environmental issues resulting from exposed unsaturated tailings	Major	Rare	Medium
Oxidation of tailings	Final cover design is not sufficient to prevent oxidation of unsaturated tailings, resulting in oxidation and AMD formation.	Major	Rare	Medium
Fauna drinking tailings dam water	Mortality or poisoning of fauna	Moderate	Rare	VL

5 Monitoring and Surveillance

Monitoring and surveillance of the TSFs will be crucial throughout operations, to ensure they are operated safely, sustainably and effectively. Monitoring and surveillance will also be required post-closure to ensure the closure design intent is met, and the mine can be relinquished.

5.1 Surveillance inspections

ANCOLD recommends surveillance inspection frequencies for tailings dams as outlined in ***Table 5-1 Surveillance inspection frequencies for tailings dams.***

Table 5-1 Surveillance inspection frequencies for tailings dams

Consequence Category	Inspection Type			
	Comprehensive	Intermediate	Routine	Special
Extreme; High A, B and C	On first filling then 5 yearly	Annual	Daily to tri weekly	As required
Significant	On first filling then 5 yearly	Annual	Twice weekly to weekly	As required
Low		On first filling then 5 yearly	Monthly	As required

The types of inspections, as defined in ANCOLD, are provided in ***Table 5-2 Types of inspections***.

Table 5-2 Types of inspections

Type of inspection	Personnel	Purpose
Comprehensive	Dams Engineer and Specialist (where relevant)	The identification of deficiencies by a thorough on-site inspection; by evaluating data; and by applying current criteria and prevailing knowledge. Equipment should be test operated to identify deficiencies.
Intermediate	Dams Engineer	The identification of deficiencies by visual examination of the dam and review of surveillance data against prevailing knowledge. Equipment is not necessarily operated.
Routine	Operations personnel / inspector	The identification and reporting of deficiencies by field and operating personnel as part of their duties at the dam.
Special	Dams Engineer and Specialist	The examination of a particular feature of a dam for some special reason (e.g. after earthquakes, heavy floods, rapid draw down).

Type of inspection	Personnel	Purpose
Emergency	Dams Engineers	The examination of a particular feature of a dam which has been identified as having a possible deficiency or which has been subject to abnormal conditions.

5.2 Monitoring instrumentation

The following instrumentation has been installed and is operational at TSF1:

- 7 x vibrating wire piezometers (VWP) in the foundation, installed during the initial construction in 1996.
- 6 x standpipe piezometers with automatic level loggers within the existing tailings to a maximum depth of 10m, installed in 2010.
- 5 x standpipe piezometers with automatic level loggers, installed downstream of the southern and eastern embankments, to a maximum depth of 16m.
- 3 x standpipe piezometers with automatic level loggers, installed outside of the western boundary of the TSF, to a maximum depth of 25m.
- 6 x slotted PVC groundwater monitoring bores, 3 x surficial, 3 x deep, installed during initial construction in 1996.
- 5 x flow measuring flumes. Stainless steel plates installed in concrete channels.
- Pond level gauge board.

The following additional instrumentation will be installed during the Stage 2 raise of TSF1. Details for the instrumentation plan will be provided in the detailed design.

- Extend existing piezometers in the tailings beach, and install new ones if it deemed to be required during detailed design.
- Install movement monitoring points along the downstream side of the new crest, and a series of survey monuments external to the TSF.
- Install matric suction and moisture sensors within the tailings beach to begin data collection for the final cover design.
- Isolate seepage flows through the embankment and install v-notch weirs with automatic flow measuring instrumentation (if this has not already been done).

The TSF2 will include a similar arrangement to TSF1, including:

- VWPs for phreatic surface and groundwater monitoring.
- Survey monuments and movement monitoring points to observe deformation and movement in the embankment over time.
- Seepage flow monitoring, both quantity and quality, if seepage occurs.

- Pond and surface drainage water quality.

In addition to surveying any movement in the embankment, it will be important to regularly survey the tailings levels within the storages, so as to validate the deposition plan/schedule, as well as compare the achieved tailings consolidation and beach slopes with the design. The survey data will be used in future raise designs.

5.3 OMS Manual & Review

The existing OMS manual for TSF1 will be updated prior to commissioning of each proposed raise as a minimum.

An OMS manual for TSF2 will be prepared prior to commissioning of the starter dam. The OMS manual will include the following information:

- Design intent of the facility
- Tailings deposition plan and expected behaviour
- Inspection requirements and frequencies, and pro formas
- Operating procedures for infrastructure and instrumentation
- Water management procedures and management plan
- Maintenance requirements and schedule for infrastructure and instrumentation
- Operating levels for effective management and trigger levels for event/emergency response
- Operator training requirements.

The OMS manual will be reviewed and updated every two years if there have been no significant changes requiring a review/update, as per ANCOLD recommendations.

Any changes to the mining and deposition strategy will also require a review of the OMS manual (for example, changes in the tailings rheology, thickness, deposition rate).

5.4 Standard Operating Procedures for TSF 1 and TSF2

During the detailed design phase of the project, Vista Gold will prepare a Standard Operating Procedure (SOP) for each TSF to provide clarification on the conditions that would result in the transfer of water to and from the TSFs and will include discussion on how the assumptions made in the stability analysis will be achieved.

The operational manual will include inspections, audit, review and operational parameters to ensure that each of the TSFs is operated and managed in a way that ensures that the structure is sound before is manifests into a problem/failure.

6 Review and Updates

This TMP has been prepared outlining the proposed management of tailings over the 13 year production phase of the mine life, during which time it is estimated that 208Mt of slurry tailings will be produced. The TMP is considered appropriate for the level of design that has been completed.

As discussed within the TMP, a number of critical parameters will need to be determined during detailed design phases. The TMP should be updated accordingly as these items are resolved. This includes, but is not limited to:

- Determine the Consequence Category of facilities for input into design.
- Tailings rate of rise, and the effects on proposed designs, in terms of consolidation, achieved density, strength, potential for liquefaction.
- Flood storage/passing requirements and modelling, and the associated infrastructure needs such as decant systems, pumps and spillways.
- Material classification, both geotechnical and geochemical, and quantification of resources.
- Site specific seismic studies and associated risks associated with the proposed designs.
- Modelling to be completed for water management, embankment stability, unsaturated behaviour of the cover system, and deformation (if deemed required).

Attachment E1 – Risk Matrix

Definitions Consequence Ratings

Rating	Consequence	Environmental (including Heritage)	Social and Regulatory (including Health & Safety)	Economic
5	Critical	Extensive long term environmental harm and / or harm that is extremely widespread. Impacts unlikely to be reversible within 10 years. Widespread / catastrophic detrimental long term impacts on the environment, which could include extensive pollutant discharges. Unsalvageable and permanent damage to sensitive structures or sites of cultural significance or sacred value.	Loss of life / fatality; or long term or permanent disabling effects on human health (more than one person). Community condemnation and irreconcilable community loss of confidence (including severe and detrimental long term impacts on the community and / or public health). Public or media attention of national to international scale. Severe action / prosecution by key agencies including the likes of NT EPA, DPIR, AAPA and NT WorkSafe. Major litigation or prosecution.	> $10m impact on company or stakeholders.
4	Major	Major or widespread, unplanned environmental impact on or off the site. Significant resources required to respond and rehabilitate. Major detrimental long term impacts on the environment, which could include substantial pollutant discharges. Major damage or infringement to sensitive structures or sites of cultural significance or sacred value.	Injuries requiring hospitalisation. Serious long term or permanent disabling effects on human health (one person). Prolonged community condemnation or annoyance and / or loss of confidence and local media attention. Major regulatory restrictions or orders – substantial prosecution.	$5m - $10m impact on company or stakeholders.
3	Significant	Significant, unplanned environmental impact contained within the site or minor impact that is off the site. Considerable damage or infringement to sensitive structures or sites of cultural significance or sacred value.	Injury or illness requiring medical treatment. Short term or reversible disabling effect (impairment) to human health. Limited and localised loss of confidence by the community. Significant breach of regulations. Direction to operate under limited regulatory restrictions or orders.	$2m - $5m impact on company or stakeholders.

Rating	Consequence	Environmental (including Heritage)	Social and Regulatory (including Health & Safety)	Economic
2	Moderate	Moderate, unplanned localised environmental impact (maybe of a temporary nature) or discharge contained on-site or with negligible off-site impact. Moderate but repairable damage to important historic structures or sites of cultural importance.	Injuries requiring first aid treatment. Minor short term inconvenience or symptoms to human health. Localised community impacts and concerns. Some regulatory restrictions, associated with breach of regulation with investigation or report to authority necessary.	$100k - $2m impact on company or stakeholders.
1	Minor	Minor environmental impact. Any impacts are contained on-site and short term in nature. No detrimental effect on the environment. Minor repairable damage to more common structures or sites. No disturbance of historic and / or cultural heritage sites.	Incident with or without minor injury. No impact on human health or very minor short term inconvenience or symptoms. Isolated community or individual issue-based concern and complaints. Minor issues around non-compliance.	Insignificant < $100k impact on company or stakeholders.

Definition of Likelihood Ratings

Rating	Likelihood	Definitions
5	Almost certain	The event is expected to occur in most circumstances (The event is likely to occur once per year).
4	Likely	The event will probably occur in most circumstances (The event is likely to occur once every 1 – 2 years).
3	Possible	The event might occur at some time (The event is likely to occur once every 2 – 5 years).
2	Unlikely	The event could occur at some time (The event is likely to occur once every 5 – 10 years).
1	Rare	The event may occur only in exceptional circumstances (The event is unlikely to occur in any 10 year period).

Attachment E2 – Mt Todd Tailings Storage Facility 1 Assessment Report (TGI 2020)

File Name: *Appendix E - Tailings Management Plan.docx*

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev A	Andrew Simmons	Kirsten Marmion		Jill Woodworth		15/11/2017
Rev O	Andrew Simmons	James Hill	[signature]	Jill Woodworth	[signature]	17/11/2017
REV 1	Brent Murdoch	John Rozelle		Brent Murdoch	[signature]	31/10/2018
Rev 2	Julia Curran	Jill Woodworth		Brent Murdoch		

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