Appendix D

Tailings Storage Facility – design review and response to submissions

REGIS RESOURCES LTD

REPORT

MCPHILLAMYS GOLD PROJECT

Tailings Storage Facility

Design Review and Response to submissions received in relation to the Development Application and associated EIS

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1 INTRODUCTION

1.1 Background

ATC Williams Pty Ltd (ATCW) has prepared a Definitive Feasibility Study (DFS) for the Tailings Storage Facility for the McPhillamys Gold Project on behalf of LFB Resources NL, a wholly owned subsidiary of Regis Resources Limited (Regis). The DFS was dated July 2019 (Rev E) and was provided for the purpose of inclusion to an EIS for the project as well as Regis commercial review.

Following exhibition of the EIS, submissions were received raising issues; and seeking clarification and/or additional data and details. To address this request for additional details, ATCW has prepared the following documentation to clarify primarily the submissions from public authorities on the TSF.

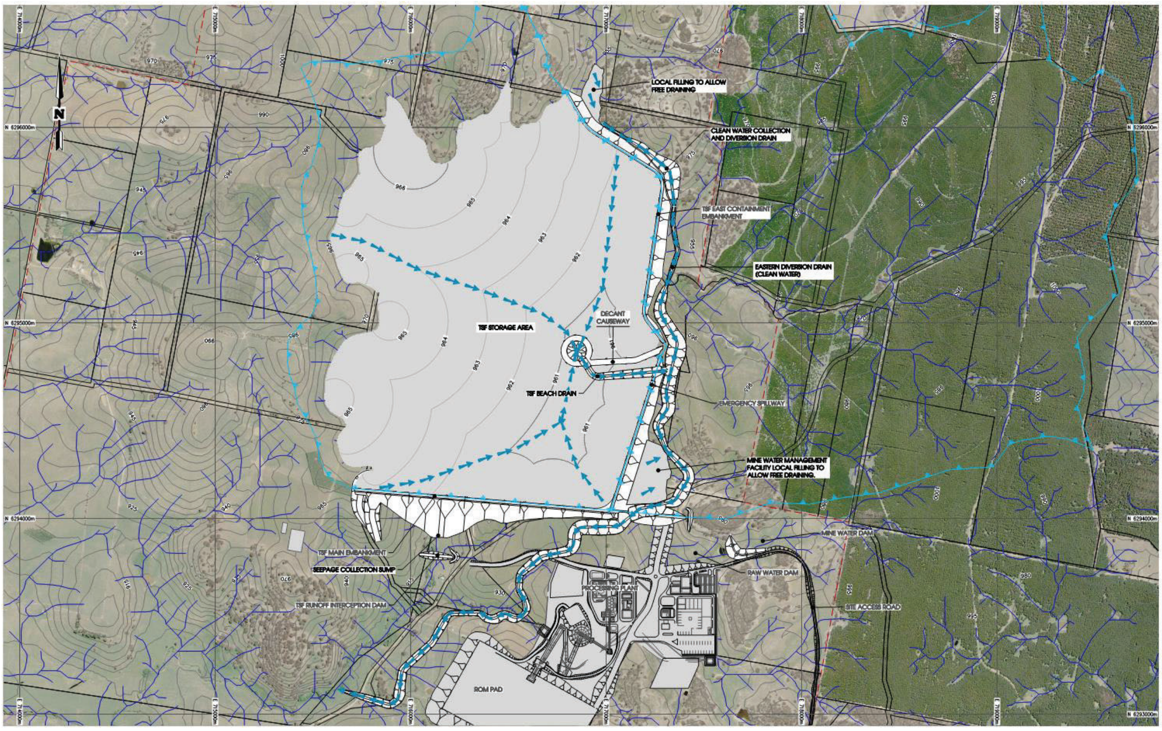
1.2 Design Update Summary

Following submission of the EIS and liaison with Regis, further assessment/workshopping of the TSF design was undertaken to enhance the robustness of landform in terms of surface water management during operations and post-closure. A comparison of the refined design and the proposed development as submitted in the EIS is shown on **Plate 2**. Whilst discussed in further details in **Section 2**, the main changes are as follows:

1. **Relocation of the Mine Water Management Facility (MWMF) from the north west to south east perimeter of the TSF**.

   We believe this provides significant benefit for diversion of clean water post closure as can be seen in **Plate 1**.

Plate 1
Post-Closure Surface Water Drainage System



In addition, the relocation of this structure avoids impacting a property with potential heritage value in the area of the original MWMF. Secondly, it minimises the pumping requirements and associated risks by having the storage closer to the site water management system for the plant and waste rock dump areas, as well as the TSF decant.

2. **Refinement of an upstream TSF embankment to the north to maximise diversion of clean water and to maximise protection of an identified plant community.**

   As can be seen in **Plate 1**, a significant portion of the trees to the north of the TSF will have a reduced risk of inundation from upslope runoff. This refinement also permits the diversion of the water to the east which minimises the transfer systems required during operations. Furthermore, it ties into the post closure drainage system which fully drains this eastern catchment. In addition, some minor filling of the remaining ponded area to the north will permit 100 percent of diversion of the upslope runoff in this catchment.

3. **Amendment to the tailings beach profile.**

   To tie into the post-closure water diversion system, amendments have been made to the deposition locations (noting that the same subaerial deposition approach is proposed) to form the final surface such that it drains towards the east to discharge into the post-closure drainage system.

4. **Relocation of the TSF post-closure discharge point and final diversion channel.**

   This is considered a significant improvement over the initial proposal. It negates the need for a significant drop structure, as previously identified along the western abutment to channel water from the TSF to the Belubula River channel. The initial proposal comprised a drop channel with a grade in the order of 8% over a length of some 770m. The revised channel is in the order of 0.5 to 2.0 % over a length of approximately 2,500m reducing the risk associated with the channel not performing as intended.

5. **Refinement in staging of TSF embankment construction.**

   The additional time since submission has allowed for the refinement of the mining schedule, which includes the development of site infrastructure to minimise the impacts on the surrounding communities and environment. It has resulted in a revised mining fleet and subsequently requires a longer duration/period of rock fill placement for the TSF embankment construction. The final landform will not be impacted by this adjustment and the staged development will exceed Regulatory and Industry Standards.

6. **Further analysis/understanding of the TSF storage area available clays.**

   Based on queries raised as part of the Submissions, further examination of the clay availability and suitability within the TSF storage area was undertaken to further validate proposed approach.

In addition to the above, it is emphasised that the following aspects are maintained as per the initial EIS submission:

7. **Seepage control proposed using a robust multi-barrier approach.**

   Noting that queries on the TSF were predominantly focused only on the lining system, when the actual modelling as presented in the EIS showed that the combination of the liner, cut-off key and seepage interception system had a significantly greater benefit to the reduction of seepage flows beyond the TSF than a liner only system. It is proposed to continue with this multi-barrier approach as it is considered to provide the greatest short- and long-term environmental benefits as well as enhance the structural integrity of the facility.

   The proposed seepage management comprises the following:

   - Storage Liner of equivalence to 1m of clay at 10^{-9} m/s
   - Clay core on upstream embankment face
   - Foundation cut-off key
   - Seepage interception system at the downstream embankment
   - TSF runoff dam
   - Monitoring and if required the use of pump back bores

8. **Proposal consistent with highest Regulatory Requirements and Industry Standards.**

   Emphasise again that the highest Regulatory Standards and Industry Standards were applied for the structure in terms of structural safety and water management.

9. **Proposed controls and management is considered leading practice.**

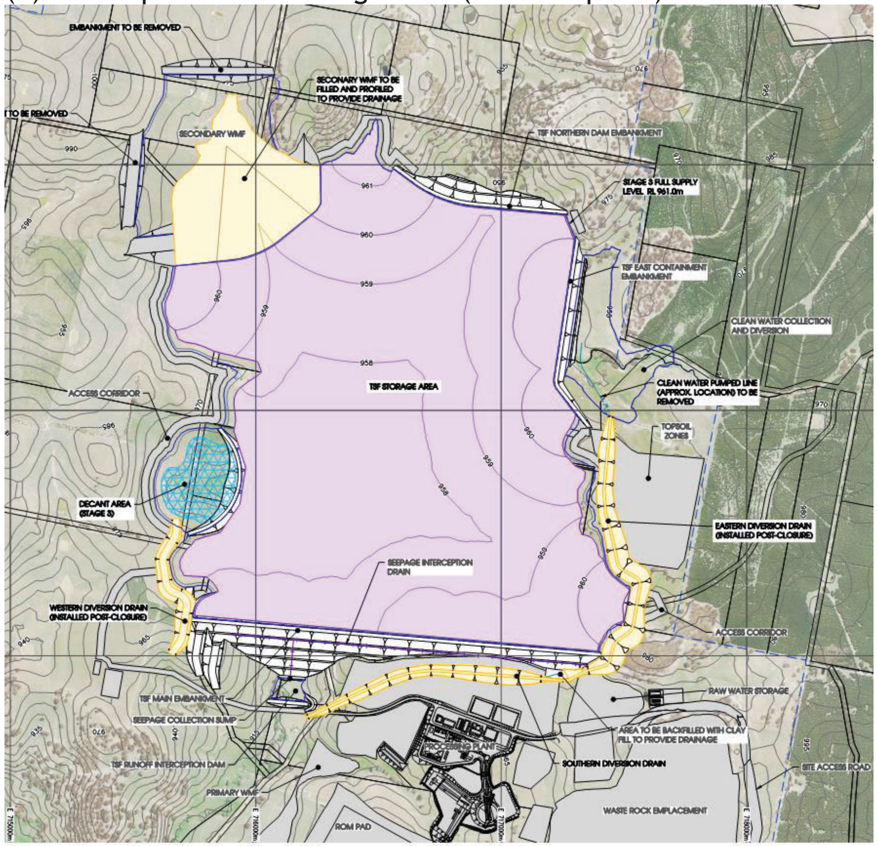
10. **Foundation investigations and understanding to be continued.**

    Recognition that as part of ongoing works, and as outlined in the EIS submission, further investigations have been identified to enhance the knowledge base in terms of geology, geotechnical characteristics and hydrogeological understanding. As part of these works, two additional monitoring bores have been completed (one to the north and one to the south of the TSF) with testing and documenting of these works currently ongoing and would be used along with current known data to inform detailed design.

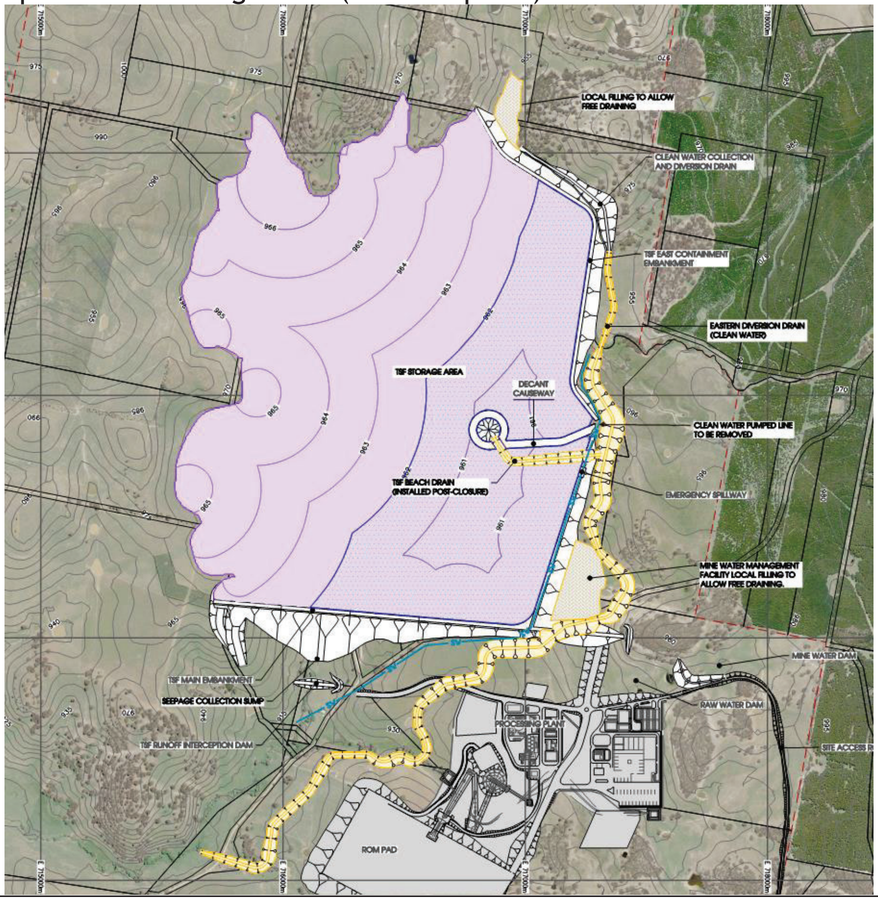
The changes for water management are considered significant improvements, while the changes to the TSF configuration and performance, as previously detailed in the EIS is considered minimal, noting that the final height and main embankment have not changed.

Plate 2
TSF Layout EIS Submission and Comparison to 2020 Proposal

(a) EIS Proposed TSF Arrangement (2019 Proposal)



(b) Proposed TSF Arrangement (2020 Proposal)



2 DESIGN REVIEW

2.1 Preface

As outlined in Section 1.2, the TSF design has been primarily updated to improve the clean water diversion around the TSF and to accommodate the resiting of the MWMF. To this end, this section addresses updates to the design from the original EIS submission. This section should be read as an addendum to ATCW (2019) report and it is not intended to repeat all the discussion as the overall arrangement of the TSF is highly similar and not expected to perform materially different to that as modelled in the initial works.

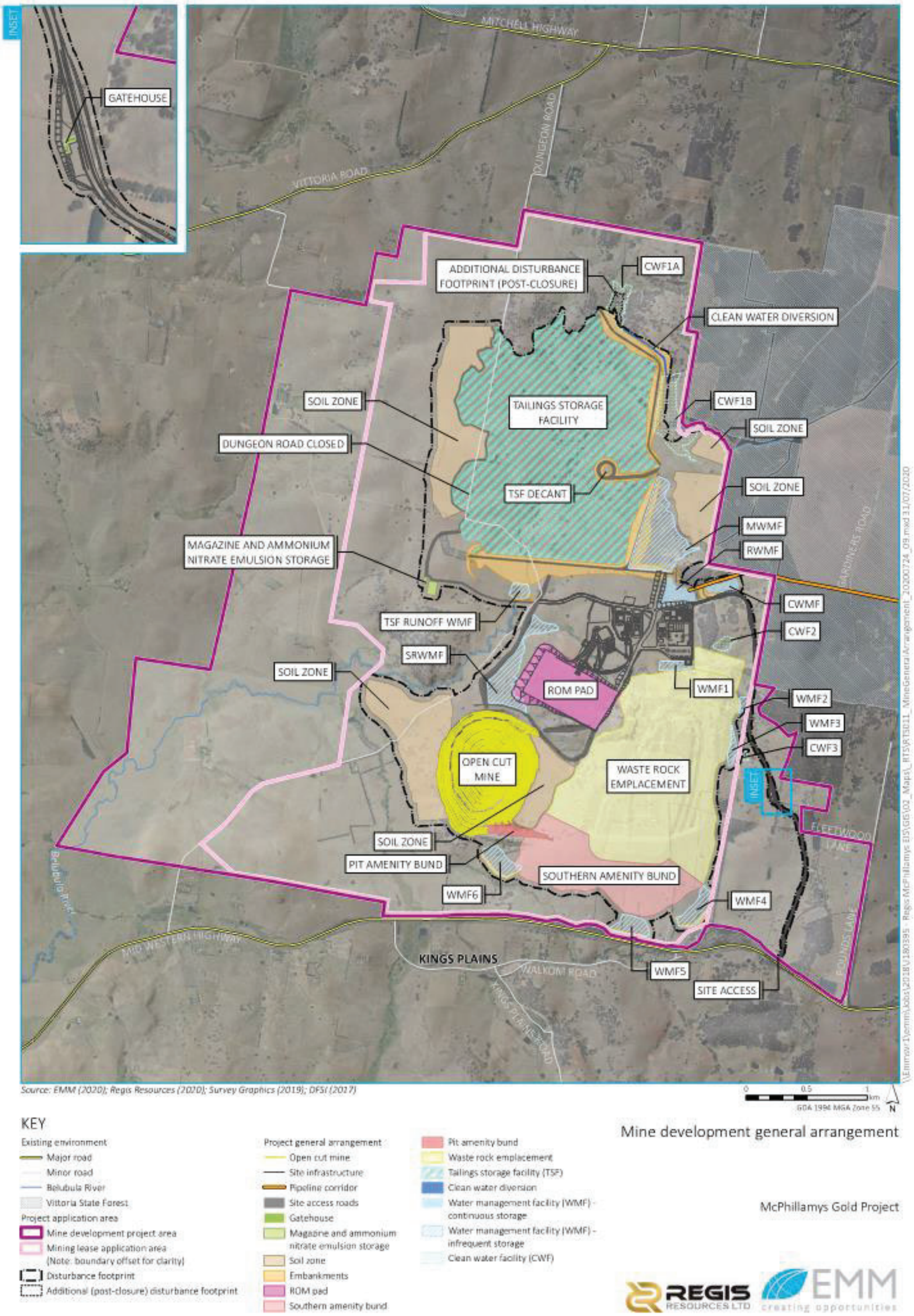
2.2 Project Basis

LFB Resources NL is seeking development consent for the construction and operation of the McPhillamys Gold Project (the project), a Greenfield open cut gold mine with a water supply pipeline in the Central West of New South Wales (NSW). McPhillamys Gold Project comprises two key components; the mine site where the ore will be extracted, processed and gold produced for distribution to the market (the mine development), and an associated water pipeline which will enable the supply of water from approximately 90 km away near Lithgow to the mine site (the pipeline development). This Tailings Storage Facility (TSF) Definitive Feasibility Study Review is associated with the mine development component of the McPhillamys Gold Project.

LFB Resources NL is a 100% owned subsidiary of Regis Resources Limited (referred to from now on as Regis). The mine development project boundary (referred to from now on as the project area) is illustrated in **Plate 3**. The mine development is approximately 8 km north-east of Blayney, within the Blayney and Cabonne local government areas (LGAs). The project is in the upper reaches of the Belubula River catchment that is located within the greater Lachlan River catchment.

A Tailings Storage Facility (TSF) Definitive Feasibility Study report formed part of the EIS with this document representing an addendum to the initial proposal.

Plate 3
Mine Development Project Area



2.3 Scope

The scope of the TSF study for this project and relevant documentation outline in **Table 1**.

Table 1
TSF Feasibility Design Scope and Document Reference

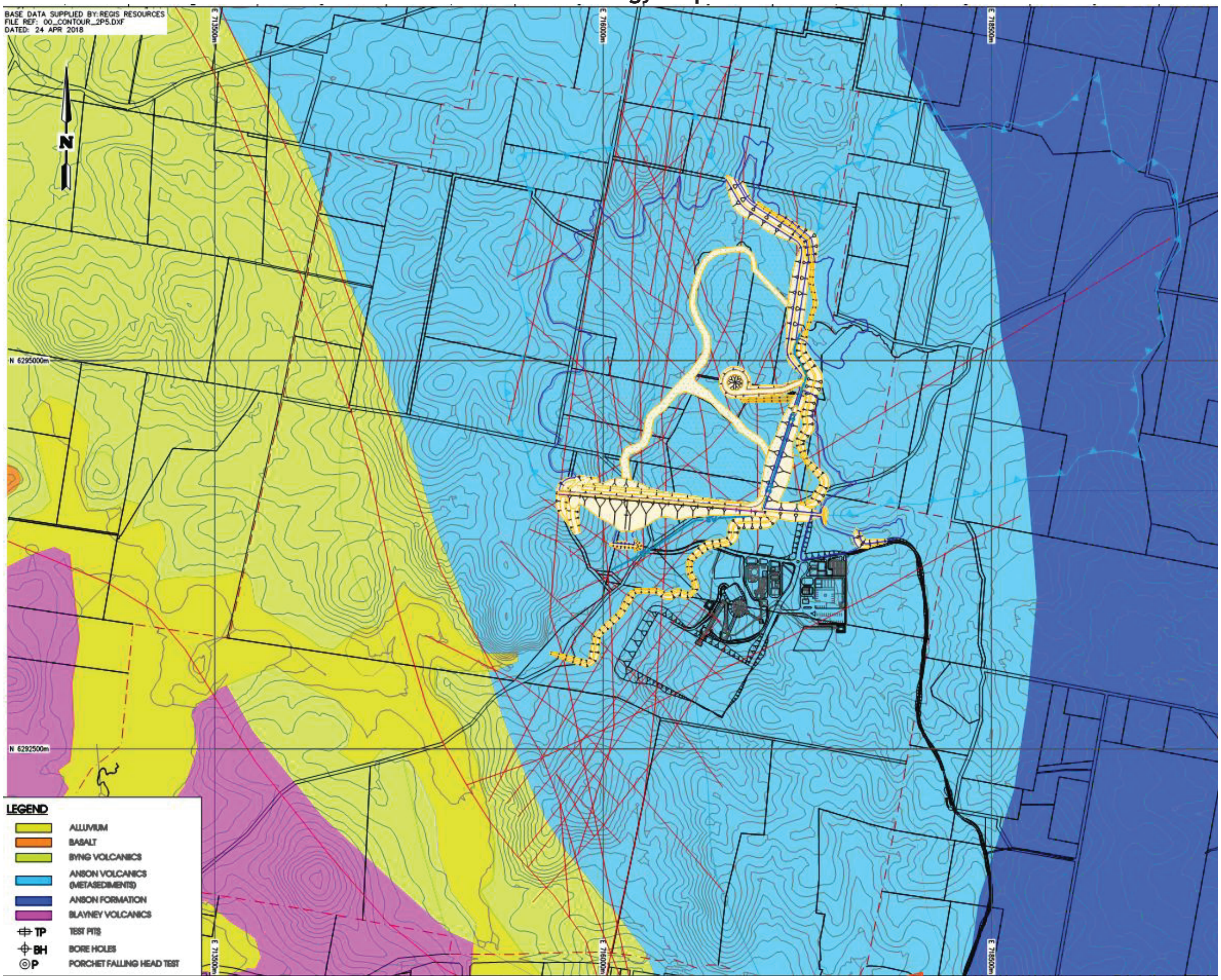
Scope Element	Document Reference
• Develop an understanding of the proposed development, including tailings deposition/water recovery practices and proposed operational and environmental performance;	ATCW (2019)
• Compile available background data as a means of characterising geological, hydrological, geotechnical and hydrogeological conditions within the site area. The focus of this input will be to provide appropriate background and substantiation for the selected concept and to effectively support the feasibility study design work;	ATCW (2019) **Section 2.4**
• Compile available geotechnical data to provide understanding and characterisation of the geotechnical conditions at the site with emphasis on hydrogeological conditions and available construction materials surrounding the TSF;	ATCW (2019), EMM (2019) **Section 2.4**
• Develop a concept for the ultimate TSF development to support the project's development. The feasibility study design works would address development staging, design of embankment(s) and associated infrastructure and geotechnical/ environmental performance assessment;	**Section 2.5**
• Undertake preliminary engineering design analyses for capital work items related to the TSF development and associated infrastructure; and	**Section 2.6**
• Provide conceptual landform development and post closure landform.	**Section 2.7**

2.4 Background Conditions Updates

2.4.1 Geology and Structure

The proposed TSF is sited wholly within the Anson Formation, dominated by sedimentary and volcanic lithologies. Geological interpretation of the TSF site as shown on **Plate 4** indicates the main structural features within the site area are the slightly trending faults and based on **Plate 4** are run in north-south direction across the proposed TSF embankment location.

Plate 4
TSF Geology Map

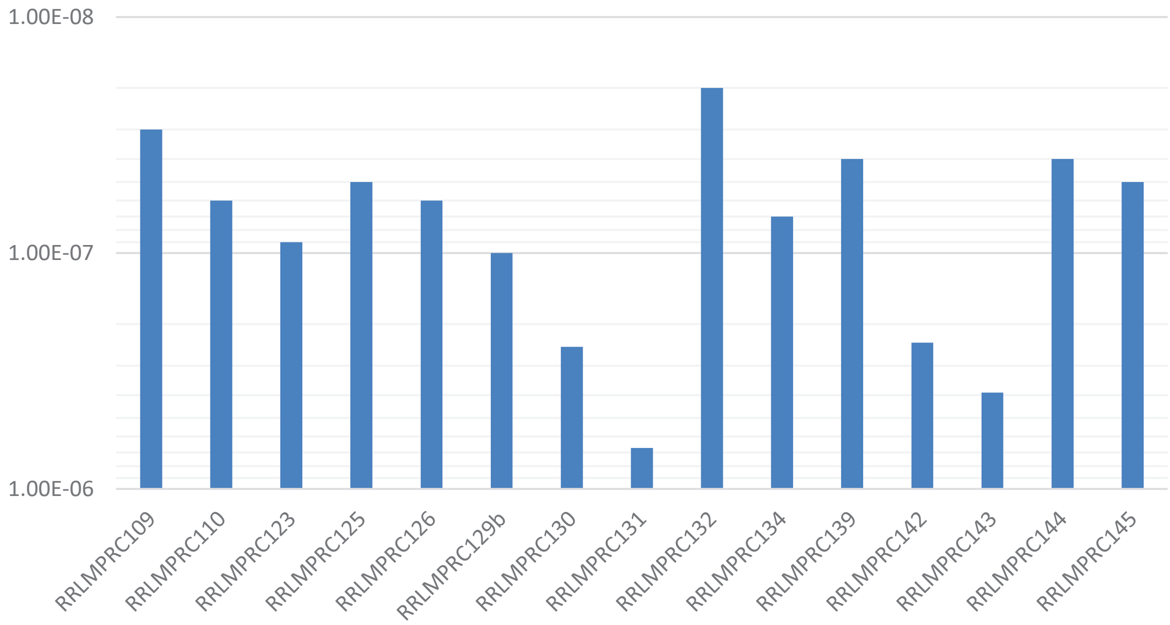


2.4.2 Interpretation of In-situ Permeabilities

This section has been updated to reflect the updated/final groundwater modelling undertaken by EMM and to rectify a graph presentation in our EIS submission report (ATCW, 2019). The graphing error had no impact on the modelling or presented outcomes as it was in the presentation only. The finalised groundwater modelling was completed after the reporting in ATCW(2019), and indicates that the permeability of the basement sequences for Anson Formation to be significantly lower than modelled. Due to the reduction in the permeability, seepage rates into the footprint will be further minimised and reduces the total seepage.

The corrected near surface permeabilities as graphed is provided in **Plate 5**.

Plate 5
Borehole Permeabilities (Falling Head)



Updated Permeabilities from EMM (2019) and compared to modelled inputs are summarised in **Table 2**.

Table 2
TSF Storage Area In-situ Permeabilities

Basement Zone	Permeabilities Reported in ATCW (2019) based on investigation data and earlier groundwater calibration results	Modelled range ATCW (2019)	Permeabilities estimated from groundwater modelling/calibration (source from EMM, 2019)
Anson Formation Weathered Basement (<20m bgl)	$K_h = K_y$ $5x10^{-7}$m/s to $5x10^{-9}$m/s Mean 5 x 10^{-8} m/s	$K_h = K_y$ 1 x 10^{-8} m/s	K_h 7 x 10^{-7} m/s K_y 7 x 10^{-8} m/s
Anson Formation Fresh Basement (>20m bgl)	K_h 2 x 10^{-8} m/s K_v 1 x 10^{-9} m/s	K_h 2 x 10^{-8} K_y 1 x 10^{-9}	K_h 1 x 10^{-12} m/s K_y 1 x 10^{-12} m/s

Based on the above, the model setup used to estimate seepages was within the expected ranges for the field investigation results and reported by EMM (2019). It is noted that the fresh basement sequences may have a significantly lower permeability than modelled by ATCW, however it is deemed to be appropriate in understanding potential impacts related to seepage. For completeness, the seepage modelling as reported herein has been updated to reflect the EMM (2019) reporting.

2.4.3 Storage Clay Suitability

The availability and suitability of clays within the TSF storage area is represented in the following section based on the investigation works and test results undertaken as reported in ATCW (2019).

The representation has been separated into two primary aspects for clay:

1. the existence and suitable thickness of clay to use as a storage liner; and
2. the material can achieve a suitably low permeability (i.e. K <10^{-9}m/s).

The outcomes from this assessment will assist in defining areas that will need to be lined using either borrowed clay or an imported engineered liner. This work has been undertaken at a level to inform the feasibility of the storage lining and will be updated as part of the detailed design. It will include the refinement of limits required for the lining systems, and to confirm the suitability of the imported lining system. For the purpose of this assessment, the imported lining system would comprise a propriety manufactured product such as Geosynthetic Clay Liner (GCL) and would be installed in accordance with the manufacturers specifications.

2.4.3.1 Investigation Data Reviewed

A summary of field investigations undertaken in the TSF footprint, storage area and immediate surrounds is outlined in **Table 3** (reference ATCW, 2019).

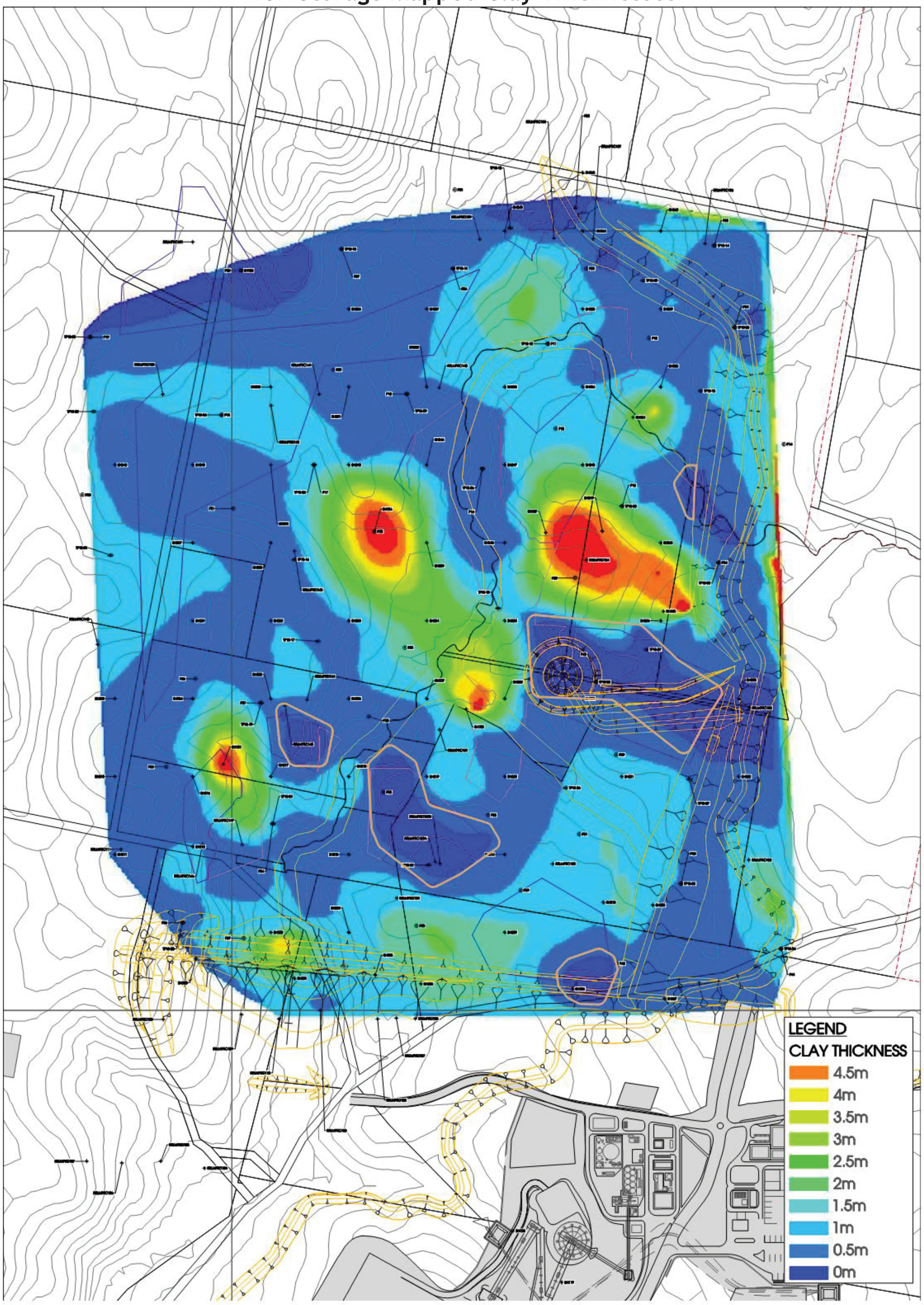
Table 3
TSF Surface Soils Investigations

Investigations	Discussion
Field In-situ Permeability within Soil Horizon (Infiltration Testing) 30 Test Sites	The outcome of the in-situ permeabilities on the near surface soils indicated that without re-engineering (i.e. conditioning and compaction) the materials would not be suitable to achieve a low permeability barrier.
Engineering Testpits (deep pits to excavator reach) 37 Testpit Sites	Initial investigation to target and identify potential clay fill borrow and assess embankment foundation conditions. Outcomes were: • Clay Thickness of 0.0 to 3.9m thick with an overall average of 1.1m thick • 10 of the 37 testpits (27%) did not reach base of clay, with an average of 2.05m thickness of clay in these areas • 16 of the 37 testpits (43%) had less than 1.0m of clay thickness
Shallow Testpitting (nominally 1.0m for shallow soils sampling) 113 Testpit Sites	Systematic grid approach over the storage area to sample and test soils within the upper (nominally 1m depth) soil horizon. Outcomes were: • Clay thickness of 0.0 to 2.4m thick with an overall average of 1.0m thick • 79 of the 113 testpits did not reach base of clay, with an average of 1.0m thickness of clay in these areas • 20 testpits that extended through the clay horizon had less than 1m of clay thickness
Geotechnical Boreholes (Shallow to 10m) 7 Boreholes	Investigation to assess the underlying weathered basement. All seven boreholes encountered significant depth of residual weathered basement which was logged as clays (post – disturbance condition). Outcomes were: • Clay thickness of 0.2 to 9.6m (limited by maximum depth of holes being 10m) thick with an overall average of 6.7m thick • 4 of the 7 boreholes did not reach base of clay, with an average of 9.6m thickness of clay in these areas • 1 borehole had less than 1m of clay thickness

2.4.3.2 *Clay Thickness*

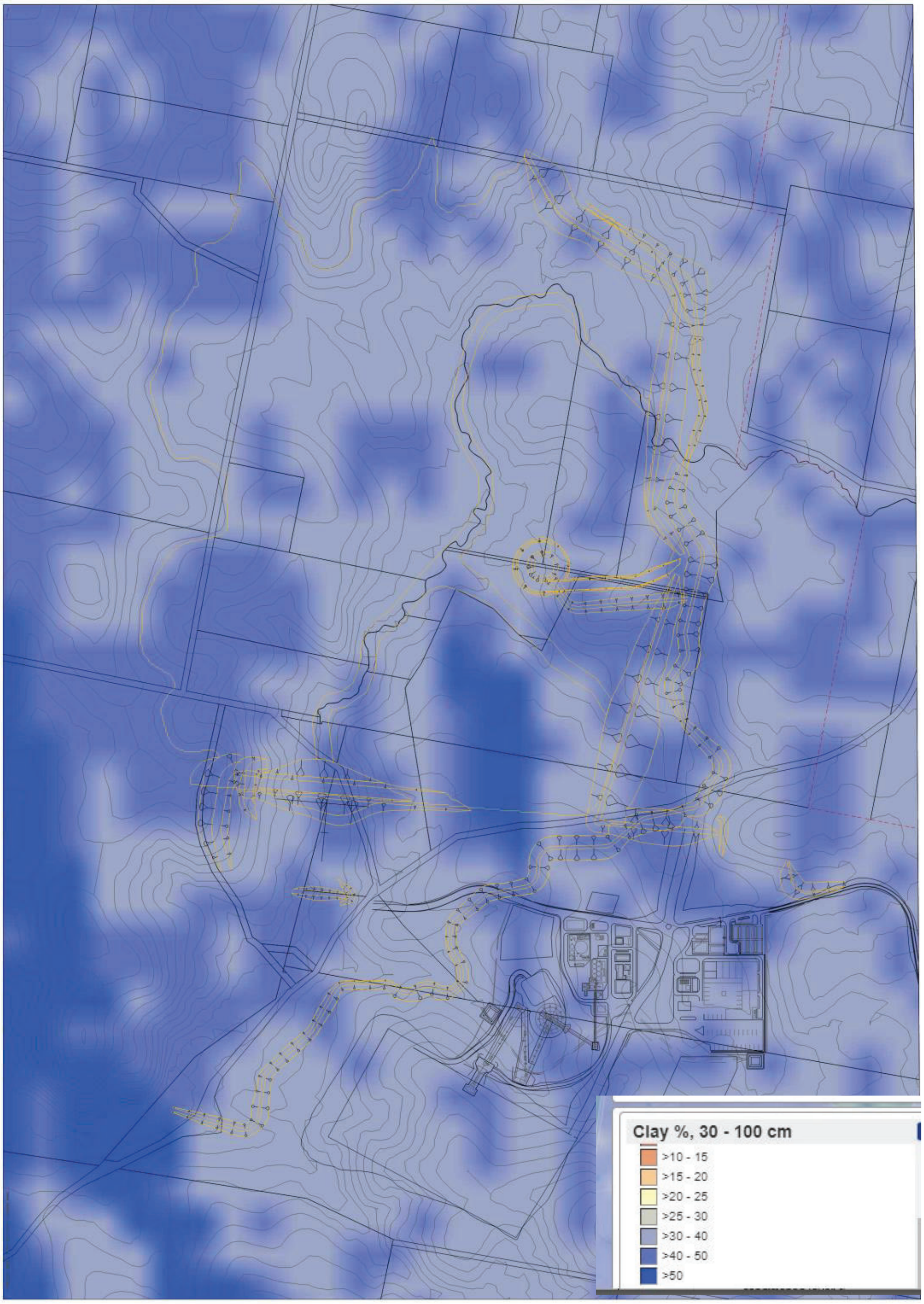
Clay thickness mapping of the storage based on the above investigation logs (Geotechnical Boreholes limited to max testpit depth) is presented in **Plate 6**. Noting that over 50% of the investigations did not extend through to the base of clay materials and that with the use of modern construction equipment, it is highly likely to significantly extend the available clay borrow excavation into the completely weathered basement horizon.

Plate 6
TSF Storage Mapped Clay Thicknesses



To further verify the likelihood of the mapped clay, the NSW Government Website eSPADE v2.0 mapping of clay units, with modelled clays as a percentage for the depth 0.3m to 1.0m are shown on **Plate 7**. This mapped data supports the general concept that the site is underlain with clayey materials with clay contents greater than 25%. Material with a clay content greater than 20% is generally suitable for the construction of a liner subject to optimal compaction to attain hydraulic conductivity performance.

Plate 7
Percentage Clay Content within 0.3m to 1.0m (Source eSPADE v2.0)



2.4.3.3 Clay Permeability Suitability

Clay suitability is based on the re-engineered properties of the material, i.e., conditioned to optimum moisture content and compacted to 98% maximum dry density. It was completed as part of the preceding clay property investigations. The data were mapped to show areas with unsuitable (mapped as zero/fail) and suitable (mapped as one/pass) clay permeabilities using linear interpolation between data points.

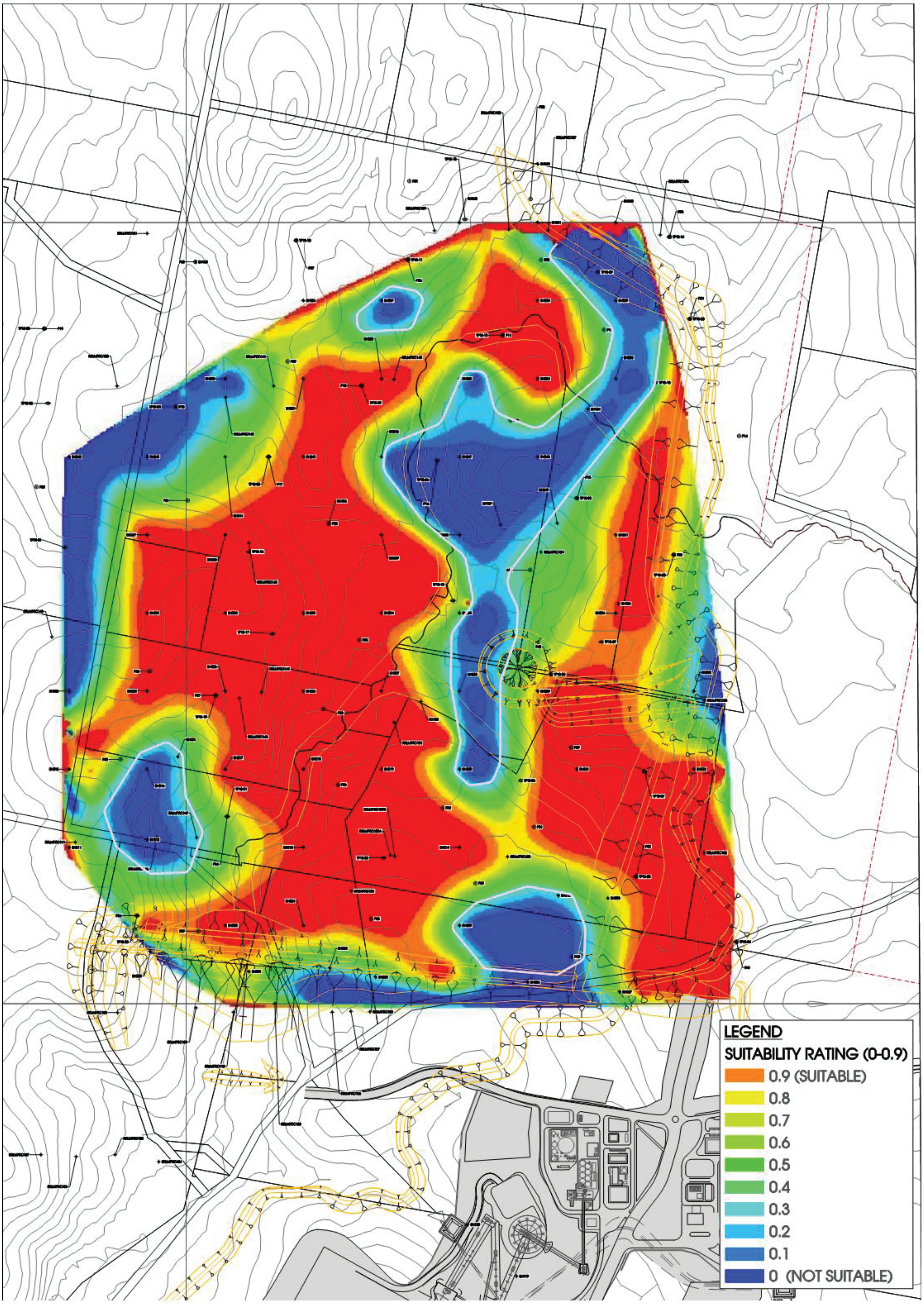
A total of 75 permeability tests have been completed to date, of which 49 had permeabilities of less than 10^{-9}m/s. The mapped areas showing suitable clay permeability is shown on **Plate 8**.

Summary of permeabilities for the two zones is as follows:

- Very Low Permeability Areas – 5 x10^{-10}m/s
- Low Permeability Areas – 1 x 10^{-8}m/s

As a further comment, based on our engineering experience, the use of large bulk earthworks type construction equipment significantly breaks down weak rock structure. This observation is relevant to a significant portion of materials identified as having a gravel component in the laboratory tests with a "failed" permeability. The difference of compaction can be illustrated by using a 2.7kg hammer falling on 300mm sample in a laboratory test, as opposed to field compaction using a 22,000kg protruding sheepsfoot compactor (ie Cat 815 or similar). Therefore, as part of the detailed design, further trial compaction testing and permeability testing of materials will be undertaken to maximise the use of site materials.

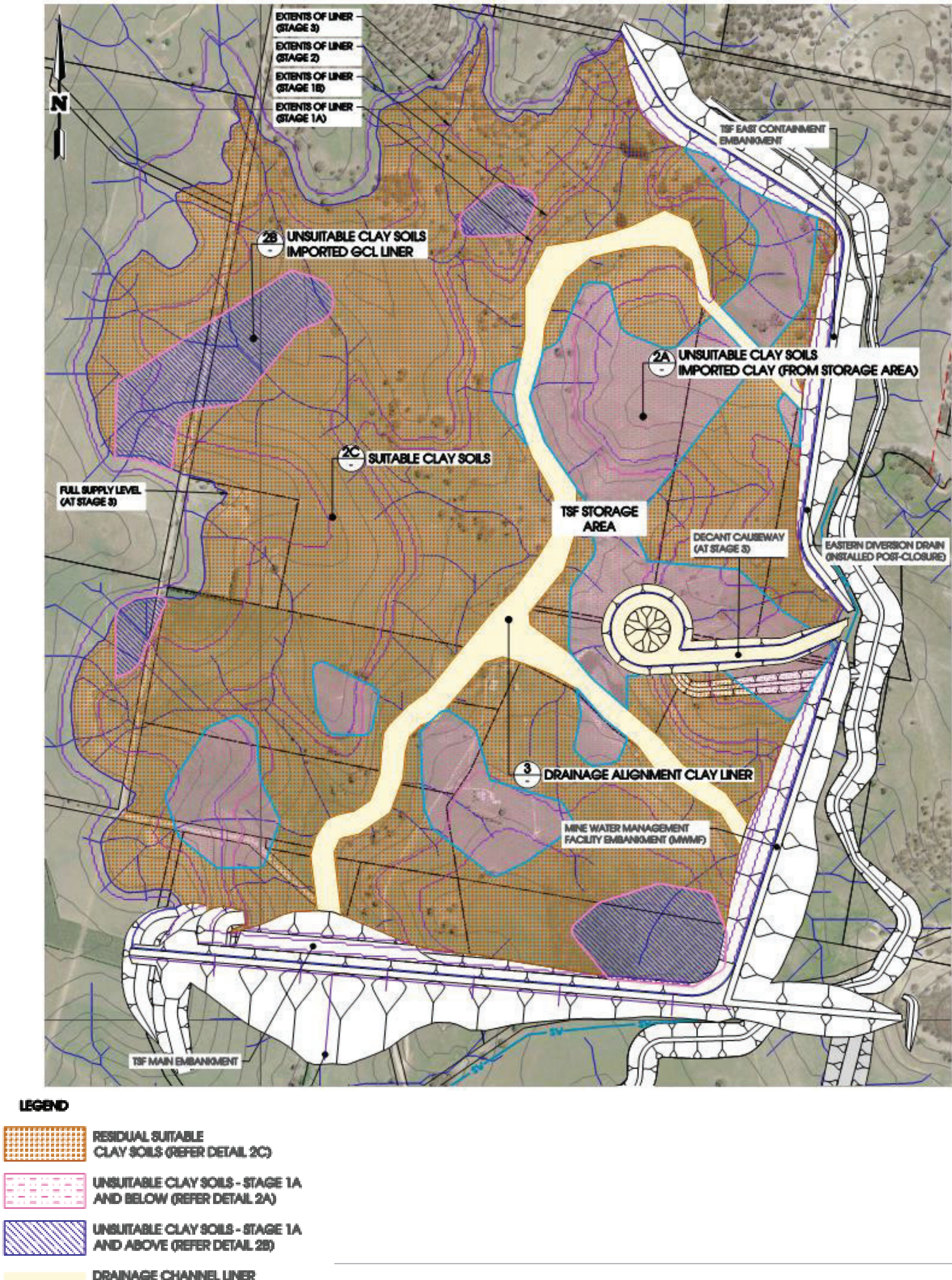
Plate 8
TSF Storage Showing Mapped Suitable Clay Areas



2.4.3.4 *Definition of Areas for Borrow and Lining*

To define the suitable clay zones, the clay thickness map and the clay suitability map were overlain. The resulting map indicates areas that are suitable to provide borrow material as well as zones that would require an artificial lining system, for additional details see attached Drawings. The resulting proposed lining plan is provided in **Plate 9**.

Plate 9
TSF Storage Showing Mapped Areas Requiring Lining



2.5 TSF Description

2.5.1 TSF Capacity

The proposed capacity of TSF is some 50,000ML. This capacity would accommodate LoM tailings production under the following operational scenario:

- Life-of-Mine (LoM) 10 years
- Tailings production 7Mtpa
- Adopted tailings density 1.5t/m3
- Net tailings storage capacity 46,700ML

In addition to the disposal of tailings, small quantities of waste rock from the mining operation will be placed within the TSF to form the decant structure and facilitate access with construction plant. The estimated volume of waste rock to be disposed would be approximately 100,000m^3 (loose cubic metres) per stage of development, equivalent to a storage volume of less than 100ML.

2.5.2 Description of TSF Development

The proposed TSF development concept to contain the LoM tailings as well as the provision for the freeboard to contain process water and stormwater inputs, is shown on the attached **Drawings**, with the LoM TSF development schedule based on this assessment, provided in
Table 4.

Table 4
Development Schedule for LoM - TSF Development

Development Stage	Construction Type	Maximum Embankment Lift Height (m)	Embankment Crest Level (RLm)	Incremental Storage Increase (ML)	Cumulative Storage Increase (ML)	Embankment Incremental Volume (m^3)	Storage Area (ha)	Approximate Construction Timing
1a - Starter	Starter Embankment	24	938.0	5,800	5,800	1,530,000	80	12 Months prior to Plant Commissioning
1b	Downstream	32	945.0	7,500	13,300	2,810,000*	139	Commissioning to Year 1
2	Downstream	40	953.0	14,500	27,800	1,000,000	218	Year 1 to 2.5
3	Downstream	49	962.0	22,200	50,000	1,270,000	273	Year 3 to 5

*Inclusive of MWMF

For each stage, an Emergency Spillway would be constructed as shown on the Drawings, with the location on the southern perimeter, western abutment of the Main Embankment for Stages 1a, 1b and 2 into the MWMF for Stage 3, with any discharge ultimately reporting into the Belubula River.

Conceptual landform of the LoM TSF development for each construction stage are provided on attached **Drawings**. **Drawing 210** provides a typical cross section through the final landform, indicating the configuration of the proposed stages.

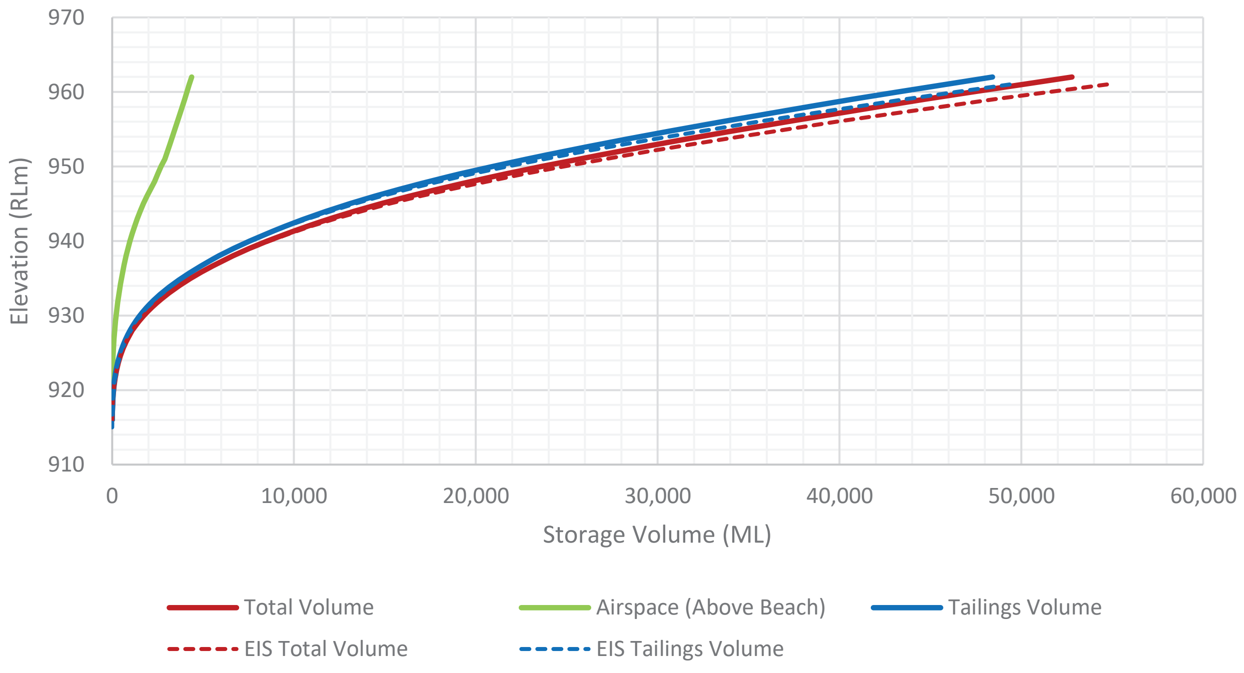
The final configuration of the TSF following completion of the LoM TSF is provided in **Table 5** and for comparative purposes the EIS proposed development and the variation from the original submission is also provided in **Table 5**.

Table 5
Proposed TSF Arrangement

TSF Parameter	Current Proposed	EIS Proposal	Variation
Embankment crest level	RL 962.0m	RL 962.0m	No Change
Spillway invert level	RL 961.0m	RL 961.0m	No Change
Spillway base width	15.0m	15.0m	No Change
Total Embankment length	3,600m	2,450m	+1,150m (47% increase)
Maximum embankment height	49m	49m	No Change
Embankment crest width	15m	15m	No Change
Storage Area (at full supply level)	273ha	270ha	+ 3ha (1.1% increase)
Embankment base width (at maximum embankment height)	333m	333m	No Change
LoM Tailings Storage Capacity Available	46,700ML	49,300ML	-2,600ML
LoM TSF Total Storage Capacity (including freeboard)	50,030ML	54,700ML	-4,670ML

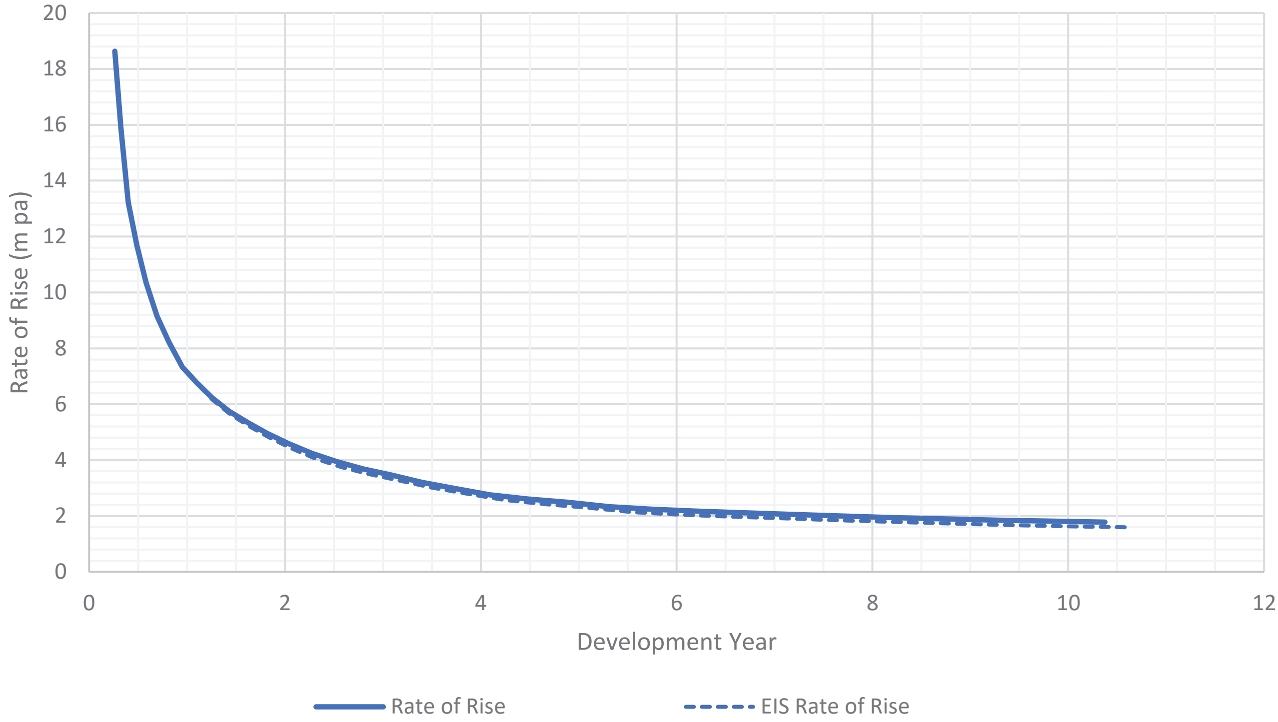
A storage curve for the proposed TSF is provided on **Plate 10**.

Plate 10
TSF Storage Curve



The plan extent of the storage allows for sufficient area to limit the average rate of rise for Stages 2 and 3 to less than 2.5m per annum (refer **Plate 11**), which based on site climatic conditions, provides sufficient time for consolidation and the associated higher densities and reduction of permeabilities in the tailings mass. Details of this assessment is provided in ATCW (2019).

Plate 11
TSF Storage Curve*



*Note: Rate of Rise describes the tailings beach level rise when normalised on an annual basis

2.5.3 TSF Decant

As part of the TSF development, it is proposed to incorporate a decant structure within the central extent of the eastern section of the TSF. The structure would be formed as a perimeter causeway, using coarse mine waste/overburden, it will allow runoff from the tailings solution to pass whilst generally retaining the tailings solids. A skid mounted centrifugal pump would be located at the decant location for return of the decant water to the Process Plant via the MWMF. Towards the end of the TSF development in Stage 3, the decant would be relocated further towards the east, closer to the Emergency Spillway. This final decant area would assist in developing a final closure landform that can be drained once the surface has been rehabilitated. The approximate locations of the decant and associated details are shown on the **Drawings**.

2.5.4 Seepage Interception System

The general principals of seepage from a TSF is described in the following phases:

1. The tailings slurry is pumped into the TSF allowing the solids content of the slurry to settle. This process results in a percentage of the water being liberated to the surface. Due to the tailings forming a beach with a slope, the liberated water flows on the beach to the low point (decant area).

2. Within the settled tailings mass, initially all the voids are filled with water (non-liberated water from previous step). Over time, this water will start to migrate either upwards, vertical or downwards. Water draining downwards due to gravity could eventually reach the footprint and result in seepage due to hydraulic gradients. Water migrating upwards could be a result of evaporation on consolidation of tailings resulting in a reduction of pore space. Due to tailings being deposited from spigots and forming beaches, it is likely that horizontal pathways dominate in the tailings and water can migrate along these pathways instead of moving upwards or downwards, i.e., decant pond that is being dewatered. As water is drained and/or evaporated, air will penetrate into the voids within the tailings with air pressure at atmospheric pressure. This zone is termed the vadose zone above the phreatic surface and depends on the tailings properties, i.e., soil moisture characteristics, either resulting in capillary forces that enhance evaporation rates or promote gravity drainage. With the draining of the tailings mass, consolidation, i.e., tighter packing of the solids particles occur and reduces the permeability of the structure as a whole. It should be noted that hydraulic gradients (driving force) within a TSF is not linear due to evaporative (suction forces), basal seepage (gravity) and lateral pathways (drainage) linked to consolidation in the structure.

3. In the longer term, the upper sequences of the vadose zone are excluded since it may be subject to capillary rise which would be in the order of 3 to 5m. Water that is not affected by the vadose zone can drain under gravity until a point is reached where sufficient surface infiltration occurs to maintain a phreatic surface level within the TSF. It should be noted that tailings, like all soils, can only be drained to a certain moisture content beyond which no further drainage could occur.

Based on the above principals of water movement within a tailings mass, the management of seepage can be implemented. Firstly, it can rely on a barrier layer/zone which reduces the rate of seepage either into the embankments or footprint. Secondly, water is actively recovered to promote the drainage of the tailings mass and for reuse/treatment. It should be noted that seepage management options do not impact on the total volume of water that is available to seep and only controls the rate of seepage loss. The barrier effectively prolongs the duration of seepage by reducing the seepage rate while the seepage drainage/recovery approach reduces the duration of seepage by increasing the seepage rate. Combining a barrier and a seepage recovery system allows the hydraulic gradient to be retained over a barrier while directing seepage to a defined area to improve management.

The proposed seepage management for the TSF comprises a combination of these controls. It acknowledges that the TSF barrier system will control the rate of seepage and that seepage passing through the barrier system will be actively recovered via a seepage interception system to provide the secondary seepage management. It is proposed that the system will comprise the following details:

- Barrier System comprising a liner that achieves an equivalent performance as a 1m thick clay liner with a permeability of at least 1 x 10^{-9}m/s. It is recognised that this will be subject to in-situ earthen material encountered with equivalent liner alternatives detailed on the **Drawings**.

- Seepage Interception System comprising:
  - Seepage Interception Trench downstream of the embankment cut-off key. The trench will extend on both the abutments of the Main Embankment across the two drainage features intersected by the embankment with the location indicated on **Drawings**.

- The trench will range from 4m to 6m in depth with a slotted drainage collection pipe and backfilled with a drainage aggregate. The downgradient face of the trench will be lined to minimise transmission of seepage through the trench. Typical details of the Interception Trench are shown in the **Drawings**.
- The Interception trench will discharge into a Seepage Sump comprising a 1,500mm diameter lined concrete chamber. Typical details of the Seepage Sump are shown in the **Drawings**.
- Seepage Sump to be equipped with an automated pump recovery system sized based on a minimum pump back capacity of 5L/s (432m^3/day), being subject to detailed design and required operational performance.

2.5.5 Earth Fill Borrow Areas

Earth fill/clay fill materials required to form the embankment core/low permeability zone will be sourced from borrow areas within the TSF storage area footprint. These borrow areas are shown in the Drawings, situated a minimum 100m from the upstream toe of the TSF embankments and shall off-set from the major drainage features to minimise risk of exposing geological structures conductive to groundwater/seepage flows. Borrow areas shall be developed such that at the completion of borrow development, a minimum of 1.0m of earth/clay material will be maintained in situ. In addition to maintaining a minimum thickness, an appropriate amount of material would be conditioned to meet the proposed specifications for the Clay Fill Lining of the TSF storage area.

2.6 SEEPAGE AND STABILITY ANALYSIS

2.6.1 Design Criteria

2.6.1.1 Background

Seepage and Geotechnical analyses have been carried out to confirm the configuration of the proposed TSF embankment and to assess the suitability construction materials.

The adopted design criteria TSF has been derived from the following references:

1. (ANCOLD, 2019), Guidelines on Tailings Dams- Planning, Design, Construction, Operation and Closure – Revision 1 (July 2019)

2. (ANCOLD, 2019), Guidelines for Design of Dams and Appurtenant Structures for Earthquake, (July 2019)

3. M Leonard, D. Burbidge and M. Edwards (2013). *Atlas of Seismic Hazard Maps of Australia, Seismic hazard maps, hazard curves and hazard spectra*. Geoscience Australia, Record 2013/41.

A summary of modelling undertaken is provided in **Table 6**.

Table 6
Summary of Geotechnical Analyses

Analysis	Condition	Relevant Model Output	Model Links/Coupling
Seepage	• Steady State/ Equilibrium Conditions	Steady state phreatic surface within embankment	Slope Stability Analysis
Slope Stability	• End-of-construction • Steady State/ Equilibrium Conditions • Seismic loading	Factors of safety against embankment slope failure	Slope Stability Analysis

Stability and Seepage modelling have been undertaken using SEEP/W and SLOPE/W which are packages within GeoStudio Program Suite. GeoStudio iteratively solves mass balance differential equations for a grid of finite elements, based on appropriate boundary conditions. The primary purpose of the seepage modelling was to provide input to embankment stability analyses, in the form of piezometric pressures likely to develop within the embankment for the range of operating conditions anticipated.

Analysis undertaken in the stability assessment is to determine potential displacement within the TSF embankment. Based on recent update of ANCOLD (2019) that indicates *"Pseudo-static as a screening tool for earthquake stability is now not recommended"*. Pseudo static analysis was only used to compute the yield acceleration. In addition, it was applied to the analysis to assess if the computed pseudo-static factor of safety is less than 1.0 under the design earthquakes as per the consequence category rating and corresponding earthquake criteria.

2.6.1.2 Assessment Criteria

On the basis of general limit equilibrium (GLE), the minimum factors of safety as presented in **Table 7** have been adopted based on ANCOLD (2019) for the expected range of stability conditions for the embankment.

Table 7
Recommended Factors of Safety

Loading Condition*	Recommended Minimum for Tailings Dams	Shear strength to be used for evaluation
Long-term drained	1.50	Effective Strength
Short-term undrained (potential loss of containment)	1.50	Consolidated Undrained Strength
Short-term undrained (no potential loss of containment)	1.30	Consolidated Undrained Strength
Post-Seismic	1.00-1.20**	Post Seismic Shear Strength***

* In accordance with ANCOLD (2019);
** To be related to the confidence of selection of residual shear strength. 1.0 may be adequate for use with lower bound results; and
*** Cyclically reduced undrained/drained shear strength and/or liquefied residual shear strength for potentially liquefiable materials.

The design scenarios for earthquake loading as outlined in **Table 7**, relate to Operating Basis Earthquake (OBE) and Safety Evaluation Earthquake (SEE) conditions. The OBE and SEE scenarios require an earthquake ground acceleration to be applied to the embankment. **Table 8** indicates the ANCOLD (2019) guidelines criteria for the Annual Exceedance Probabilities (AEP) for the OBE and SEE seismic events.

Table 8
Recommended Deterministic Analysis Seismic Design Ground Motion (ANCOLD,2019)

Dam Consequence Category	Operating Basis Earthquake (OBE)(1)	Safety Evaluation Earthquake (SEE)(2,8)
Extreme Consequence Category Dams	Commonly 1 in 475 AEP up to 1 in 1,000 AEP	The greater of: Ground motion from the MCE on known active faults (3) Or Probabilistic ground motion Extreme: 1 in 10,000 AEP (4)
High A, B and C Consequence Category Dams	Commonly 1 in 475 AEP up to 1 in 1,000 AEP	Probabilistic Ground Motion (5,6,7) High A: 1 in 10,000 AEP High B: 1 in 5,000 AEP High C: 1 in 2,000 AEP
Significant Consequence Category Dams	Commonly 1 in 475 AEP	Probabilistic Ground Motion 1 in 1,000 AEP (5,6)
Low Consequence Category Dams	Commonly 1 in 475 AEP	Probabilistic Ground Motion 1 in 1,000 AEP (5,6)

Notes:
(1) To be determined by the Owner and other Stakeholders in consultation with the Dam Design Consultant and/or Engineer of Record.
(2) The design of the dam should be such that there will be a low likelihood of the dam failing given the SEE.
(3) Active faults are as defined in ANCOLD, 2019
(4) 85th fractile. This is required so that the design is more likely to have a sufficiently low likelihood of failure given the SEE than if the median loading was used.
(5) Median, 50th fractile.
(6) For High B, High C, Significant, and Low Dam Failure Consequence Category dams, if the structure is susceptible to liquefaction or has components that will fail at ground motions only a little greater than those presented in Table 2.1, check the design for the critical ground motion and assess the adequacy of the design using risk assessment methods.
(7) Adoption of these SEE criteria for High B and High C Dam Failure Consequence Category dams may not provide an acceptable level of risk in accordance with the Loss of Life criteria contained in ANCOLD (2003), or where catastrophic environmental impact is likely. It is therefore recommended that some level of risk assessment should be undertaken in these cases before adopting the AEP stated in the table. If it cannot be demonstrated that an acceptable level of risk would be achieved, a higher earthquake loading should be adopted.
(8) These Guidelines have been developed specifically for Australia, which is a region of relatively\ low seismic activity, making estimation of a realistic MCE difficult. Accordingly, the use of probabilistic methods to estimate the SEE is preferred. However, if using this Guideline in other regions, the choice of an appropriate SEE needs to take into account the regional seismicity and where the extent of active faults can lead to the assessment of a realistic MCE, this value could be used as an upper limit of the SEE.

The consequence category of the TSF has been assessed as '**EXTREME**' for the purpose of design and ensuring that the highest regulatory loading requirements are achieved. Seismic design criteria for the TSF is therefore adopted as 1 in 1,000 AEP for OBE and 1 in 10,000 AEP for SEE. These criteria were adopted for the stability analysis.

The interpreted peak ground accelerations (PGA) coefficients considered for this site from ATCW(2019) is detailed in **Table 9**.

Table 9
Seismic Design Criteria

Design Condition	Seismic Design Criteria	PGA Coefficient (g)
OBE	1 in 1,000	0.13
SEE	1 in 10,000	0.40

2.6.2 TSF Model Configuration

2.6.2.1 Geometric Configuration

The TSF LoM geometric modelling configuration for modelling is summarised in **Table 10**.

Table 10
Slope Stability Criteria

Parameter	Stage 1A TSF	Stage 1B TSF	Stage 2 TSF	Stage 3 (LoM) TSF
Downstream Batter Slope	2.5(H):1(V)	2.5(H):1(V)	4(H):1(V)	4(H):1(V)
Upstream Batter Slope	2.5(H):1(V)	2.5(H):1(V)	2.5(H):1(V)	2.5(H):1(V)
TSF Height	21.5m	27.0m	38.0m	50.5m
Crest Elevation	RL 938.0m	RL 944.0m	RL 953.0m	RL 962.0m
Spillway Elevation	RL 937.0m	RL 943.0m	RL 952.0m	RL 961.0m

The location adopted for seepage and stability modelling was on the southern embankment, where the embankment height was the greatest (being the inferred critical location regarding stability). The modelled geometry for TSF Stage 1 and the TSF LoM are depicted in **Plates 12** and **13** respectively.

Plate 12
Stage 1A Geometry Configuration

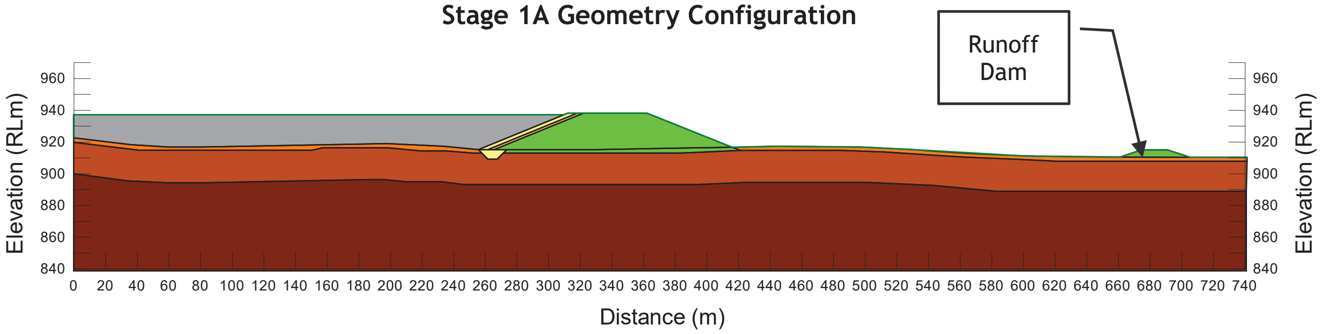
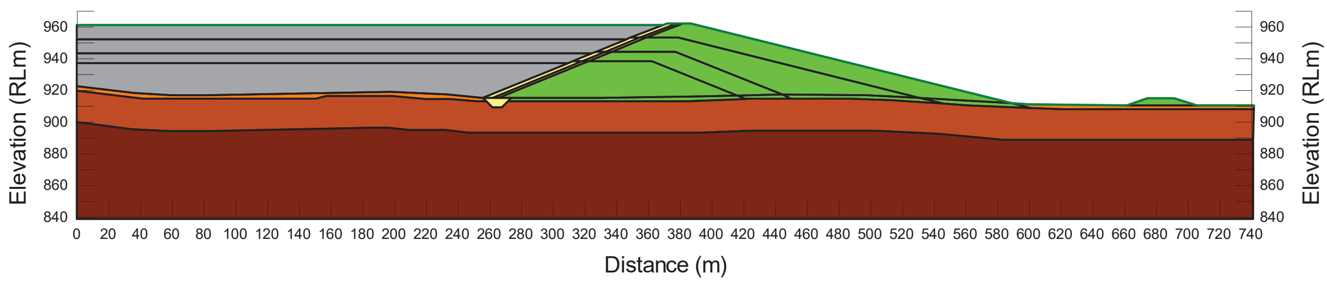


Plate 13
Stage 3 (LoM) Geometry Configuration



Seepage control measures that would be implemented in the construction phase and modelled are:

- General sub-excavation within the embankment footprint to remove topsoil and any weak or loose soils/rock, with a cut off key into competent rock; and

- Seepage collection sump positioned downstream of the embankment with a seepage interception trench positioned beneath the rock fill.

2.6.2.2 Material Characteristics

The following material types are used for embankment construction:

1. Clay Fill: Clay Fill shall be used to form the storage liner, the upstream embankment core and to backfill the cut-off key.
2. Select Rock Fill (Transition Fill): Select Rock Fill shall be used as a transition layer between the Clay Fill and Downstream Rock Fill.
3. Rock Fill: Rock Fill shall be used for the downstream embankment shell.

Geotechnical and hydraulic criteria adopted for earthworks materials is summarised in ATCW (2019) and **Section 2.4.**

Tailings inferred characteristics and geotechnical properties as reported in ATCW (2019) is provided in **Section 2.6.4.1**.

2.6.3 Groundwater and Foundation Sequence Conditions

Groundwater and hydrogeological foundation conditions have been updated based on material properties reported in **Section 2.4**.

2.6.4 Software Modelling

2.6.4.1 Modelled Material Properties

Material properties for modelling have been adopted based on site investigations and laboratory testing as discussed in **Section 2.4**. Where no data was available (e.g. Rock fill), material properties were derived using experience with similar materials from recent projects or literature values. The strength parameters adopted for the analyses are summarised in **Table 11** with modelled permeability values in **Table 12**.

Table 11
Summary of Material Strength Properties

Layer Description	Bulk Density (kN/m³)	Effective Strength Parameters		Undrained Strength Parameters			SHANSEP Su Ratio	Liquefied Su Ratio
		Cohesion c (kPa)	Friction Angle Ø (degrees)	Cohesion Cu (kPa)	Friction Angle $Ø_u$ (degrees)*	Shear Strength Su (kPa)*		
Deposited Tailings	17	0	25	-	20	-	0.2	0.04
Fill Materials								
Clay Core	18	1	28	110	-	88	-	-
Cut Off Key	18	1	28	110	-	88	-	-
Transition Fill	20	0	42	-	-	-	-	-
Rock Fill	20	0	42	-	-	-	-	-
In-Situ Materials								
Surface Soils	18	0	28	0	22.4	-	-	-
Weathered Rock	22	0	40	0	32	-	-	-
Fresh Rock	26	10	45	8	36	-	-	-

* Includes a 20% strength reduction

Table 12
Summary of Saturated Permeability Values Used for Seepage Modelling

Layer Description	K_h/K_v	Permeability, K_{sat} (m/s)
Tailings		
Deposited Tailings	0.1	1.0×10^{-7}
Engineered (Embankment) Materials		
Clay Fill (Upstream Core and Cut Off Key)	1	1.0×10^{-9}
Transition Fill	1	1.0×10^{-6}
Rock Fill	1	1.0×10^{-6}
Insitu Materials		
Surface Soils	1	5.0×10^{-8}
Weathered Rock	1	1.0×10^{-8}
Fresh Rock Foundation Sequence	0.5	2.3×10^{-8}

2.6.4.2 Modelled Scenarios

A seepage model was developed for each stage from TSF Stage 1A to Stage 3 LoM. Geotechnical stability was completed for the four cases summarised in **Table 13.**

Table 13
Embankment Stability Scenarios

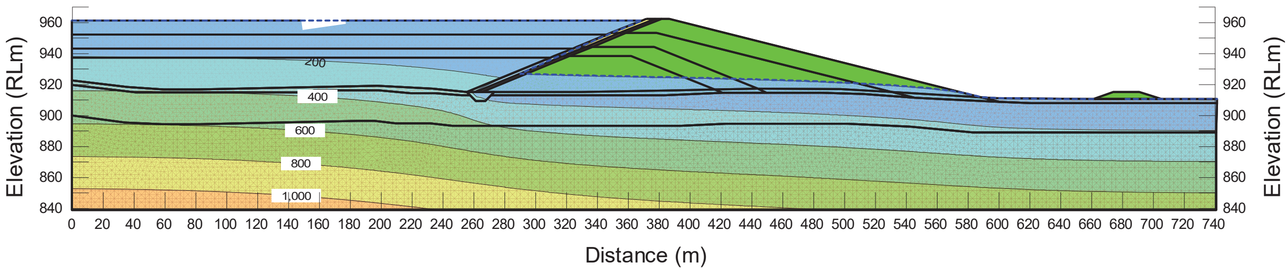
Design Case	Description	Input Parameters
Steady state (long term) condition	The steady state (long term) condition represents the case where equilibrium exists in the groundwater system (i.e. a fully developed phreatic surface exists within the embankment). A phreatic condition was adopted representative of the storage being full.	Effective stress parameters (c', ϕ') with the phreatic surface represented as a piezometric line.
End-of-construction	The end-of-construction condition differs to the steady-state condition to the extent that it considers the effect of excess pore pressures developed within the embankment fill through construction activity and increasing overburden as the design embankment crest level is reached. The rate of dissipation of pore pressure within the fill controls this condition. The approach included a stability check with non-free draining materials assumed to be fully saturated and modelled therefore undrained. These materials included the clay core and cut-off key.	Effective stress parameters (c', ϕ') using estimated excess pore pressures developed during construction and post-construction periods.
Seismic condition	ANCOLD requires a 1:1,000 AEP as the Operating Basis Earthquake (OBE) and a 1 in 2,000 AEP as the Safety Evaluation Earthquake (SEE) for an '**EXTREME**' consequence category. Peak ground accelerations (PGA) were adopted from M Leonard, D. Burbidge and M. Edwards (2013). Linear interpolation/ extrapolation of reported 1:500 AEP, 1:2,500 AEP and 1:10,000 AEP which was used to infer PGA values for 1:1,000 (OBE) AEP. The interpreted peak ground accelerations (PGA) coefficients are 0.13g and 0.40g for the OBE and SEE loading conditions, respectively.	Undrained shear strength (c_u) for cohesive materials and effective strength parameters (c', ϕ') for free draining granular materials and basement foundation rock. Horizontal seismic acceleration coefficients of: 0.13g (OBE), and 0.40g (SEE). Assumed piezometric profile prior to earthquake, as for steady state conditions.
Post Seismic	The post seismic scenario is included to assess stability following a seismic event, with reduced strengths of materials. A 20% strength reduction has been conservatively assumed for non-free draining material strengths and with no reduction in strength parameters for free draining materials.	Strength parameters and piezometric profile as for seismic loading, plus liquefied tailings shear strength, and no seismic acceleration applied.

2.6.5 Results

2.6.5.1 Seepage Modelling

The results from seepage modelling are illustrated below in **Plate 14**. Please note this modelling of seepage is for the purpose of stability analyses. It excludes additional seepage management controls as detailed in ATCW (2019) and discussed in **Section 4.0**.

Plate 14
Seepage Model Results (Stage 3 LoM)



Model results indicate that the probable phreatic surface would be drawn down along the upstream clay face, with a reduced phreatic surface present in the downstream rock fill embankment. Without the inclusion of the Embankment Underdrain, seepage will continually reduce until it reaches the toe of the embankment and present as a seepage zone.

These results are consistent for both the starter embankment and Life of Mine (LOM) assessments. Additional detail on seepage analysis results are available in **Appendix A.**

2.6.5.2 Stability Modelling

Slope stability analyses results are reproduced in **Appendix A**. The modelled factors of safety for each scenario are summarised in **Table 14** through to **Table 17**.

Table 14
Stability Analysis Results: Stage 1A (RL 938.0 m)

TSF CRITICAL CROSS-SECTION EMBANKMENT		
Loading Condition	**Critical Calculated Factor of Safety**	**Required Factor of Safety**
Steady State Long-Term	2.27	1.50
OBE*	2.28	1.20
SEE*	1.13	1.00
Post-Seismic	3.11	1.00-1.20
End of Construction (DS)	3.63	1.30
End of Construction (US)	2.67	1.30

*Peak Ground Accelerations applied were OBE 0.13g and SEE 0.40g

Table 15
Stability Analysis Results: Stage 1B (RL 944.0 m)

TSF CRITICAL CROSS-SECTION EMBANKMENT		
Loading Condition	**Critical Calculated Factor of Safety**	**Required Factor of Safety**
Steady State Long-Term	2.11	1.50
OBE*	2.12	1.20
SEE*	1.07	1.00
Post-Seismic	2.79	1.00-1.20
End of Construction (DS)	3.46	1.30
End of Construction (US)	2.64	1.30

*Peak Ground Accelerations applied were OBE 0.13g and SEE 0.40g

Table 16
Stability Analysis Results: Stage 2 (RL 953.0 m)

TSF CRITICAL CROSS-SECTION EMBANKMENT		
Loading Condition	**Critical Calculated Factor of Safety**	**Required Factor of Safety**
Steady State Long-Term	1.99	1.50
OBE*	2.00	1.20
SEE*	1.02	1.00
Post-Seismic	2.78	1.00-1.20
End of Construction (DS)	3.61	1.30
End of Construction (US)	2.79	1.30

*Peak Ground Accelerations applied were OBE 0.13g and SEE 0.40g

Table 17
Stability Analysis Results: Stage 3 (RL 962.0 m)

TSF CRITICAL CROSS-SECTION EMBANKMENT		
Loading Condition	**Critical Calculated Factor of Safety**	**Required Factor of Safety**
Steady State Long-Term	1.92	1.50
OBE*	1.92	1.20
SEE*	1.02	1.00
Post-Seismic	2.57	1.00-1.20
End of Construction (DS)	3.25	1.30
End of Construction (US)	3.48	1.30

*Peak Ground Accelerations applied were OBE 0.13g and SEE 0.40g

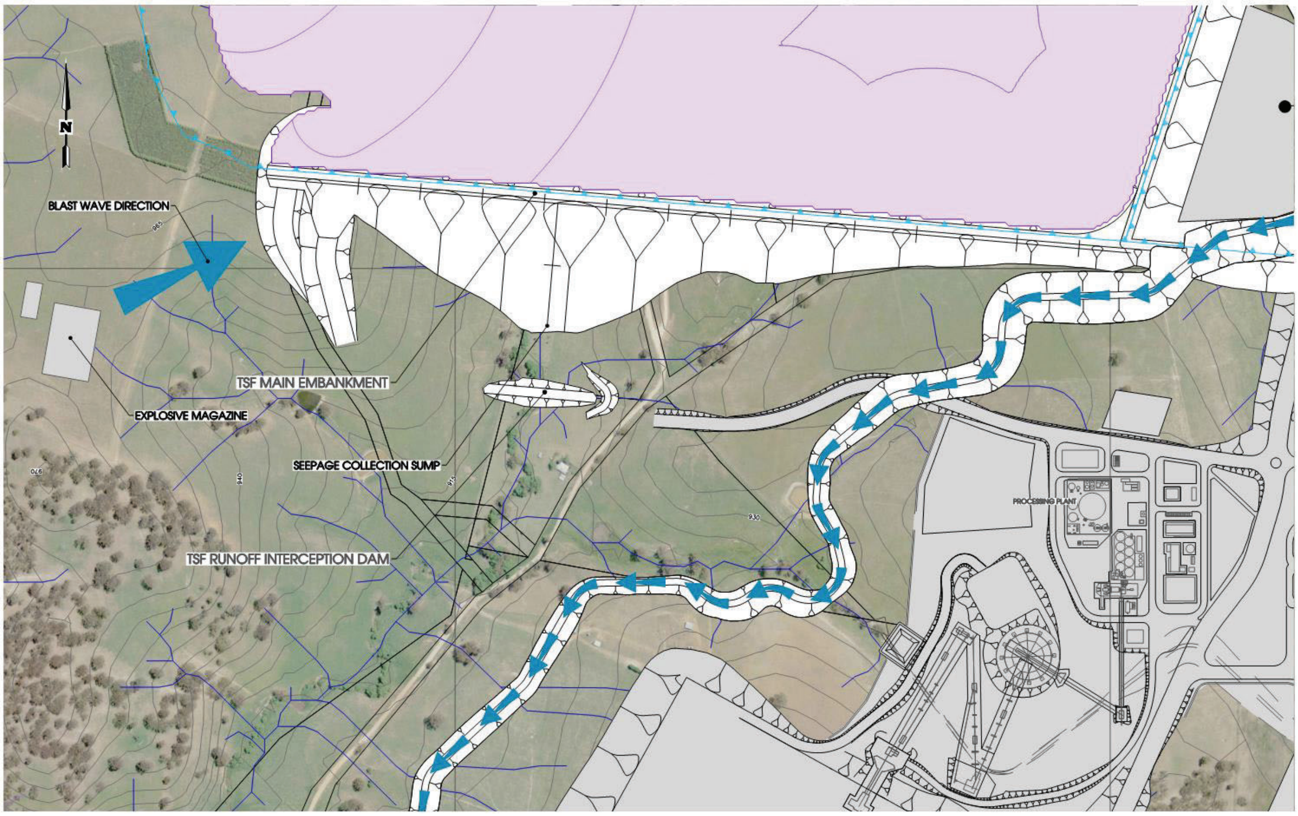
Based on the analyses as outlined above, the embankment configurations are considered to be appropriate in all modelled scenarios.

2.6.6 Embankment Stability from Explosives Magazine Over-blast

In addition to the stability analyses above, a submission was made in relation to the proximity of the TSF main embankment to the proposed explosives magazine, with this layout shown in **Plate 15**. The key comment is to quantify the impact of the 34 kPa overpressure produced if 288t of AN/ANE explodes, could it impact the current TSF wall. To this end and reference to **Plate 15**, the following simplified assessment is provided:

- The loading of a blast from the Magazine on the TSF embankment would be directed to the downstream face while the upstream side of the embankment will be buttressed by tailings. Forces on the upstream face of the embankment and tailings would be significantly less than isostatic and would not result in movement of the embankment.
- The embankment crest width is a minimum 15m and using a density of 20KN/m^3 and a friction angle of 45 degrees would give a shear strength of 300KPa at 1m depth, i.e., the full supply level. This is significantly greater than the estimated over blast pressure/force of 34Kpa acting on the embankment face.

Plate 15
TSF Embankment and Magazine Location



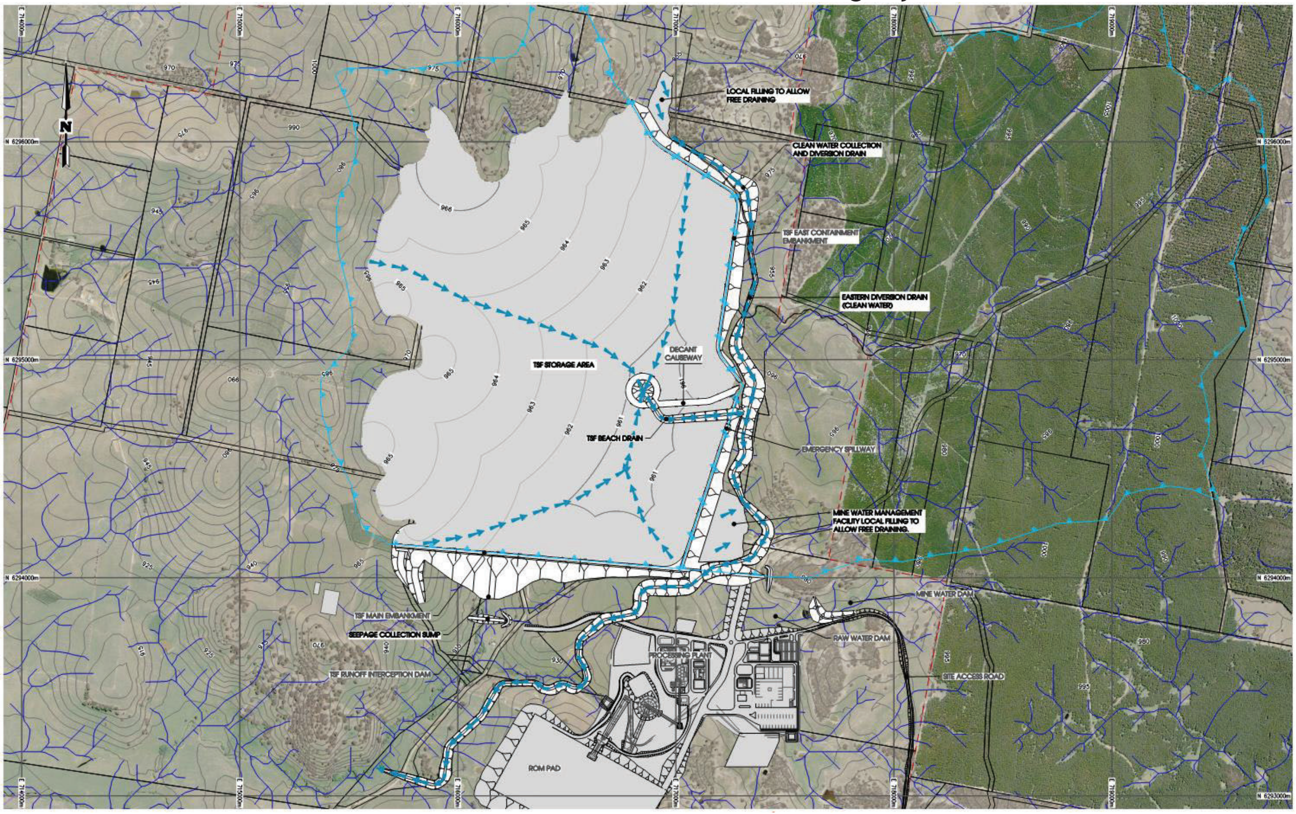
2.7 TSF Closure Concept

2.7.1 Tailings Surface and Drainage Landform

The overall objective of the post-closure tailings beach development will be to allow runoff from the rehabilitated surface to report to the clean water diversion system located on the eastern extent of the TSF as shown in **Plate 16** and detailed in the **Drawings**. It should be noted that this is generally a reversal of the landform drainage to the EIS submission (refer ATCW, 2019). The considered benefits of this change are:

- The post-closure drainage will be more centrally aligned within the catchment, providing greater integration into the surrounding topography.
- The final discharge will be formed to ensure minimise dead storage or ponding areas within the catchment (note that subject to detailed design for closure, some storage areas/dams may be beneficial for post closure land use and would therefore be provided). It will allow the entire catchment to be reinstated post mining, although noting that some storage may be provided as part of the closure plan to use in post-mining land use, i.e., agriculture.
- The grading of the final closure channel will vary from 0.5% to 2% (Refer **Drawings**).

Plate 16
TSF Post-Closure Landform and Drainage System



2.7.2 Surface Treatments

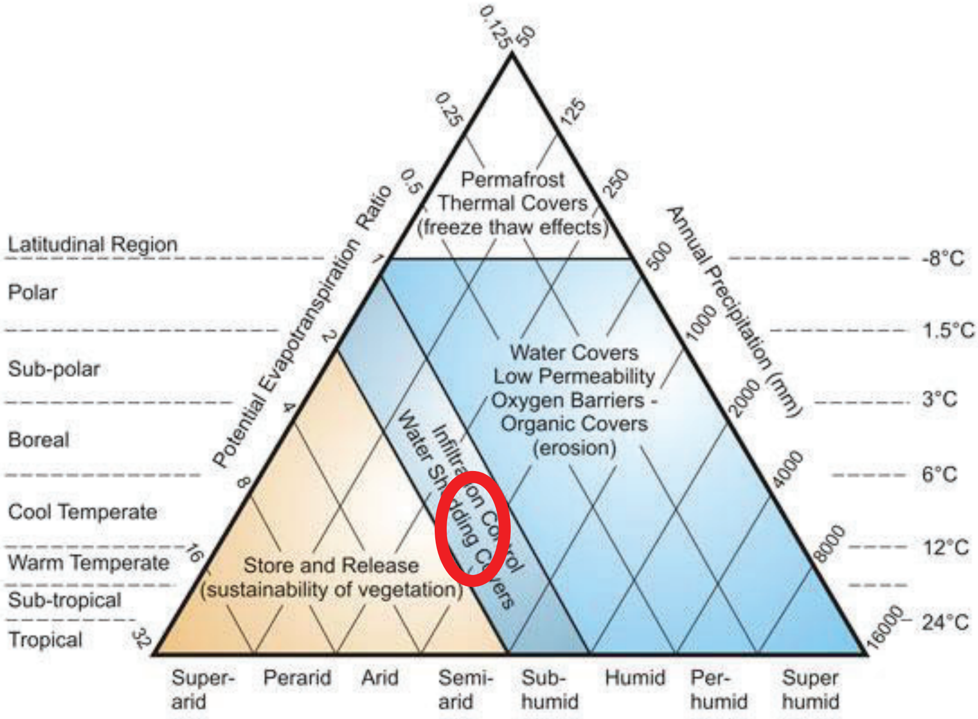
The final landform will be subject to investigation works and detailed assessment in the years prior to closure and would typically include assessment of the water chemistry, surrounding environment, consideration of infrastructure to remain post closure and land use that are subject to relevant agreements.

The typical objectives are to adopt a rehabilitation landform for the TSF that is:

(i) stable and sustainable;
(ii) compatible with the surrounding landform; and
(iii) of minimum long-term environmental impact (i.e. non-polluting).

Based on the above and in accordance with INAP's Global Acid Drainage Guide (Refer **Plate 17**), suggested capping arrangement suitable for the site conditions would be a store and release or water shedding type cap.

Plate 17
Suggested Capping Arrangement (source: Global Acid Rock Drainage Guide, INAP) - Red Circle Indicating General Site Climatic Conditions



2.7.3 Closure Water Management

To maintain the rainfall runoff capacity needed to comply with regulatory requirements within the existing TSF area and operational freeboard is applied. The freeboard will be required until such a time that it can be demonstrated that the runoff is of suitable quality to allow discharge from the site. The final landform/beach and embankment development as provided in the **Drawings** is sufficient to comply with the operational freeboard requirements. Following demonstrated compliance with release criteria, the final ponded area would be breached/filled to facilitate drainage of this area.

2.7.4 Landform Development

It is envisaged that the final TSF landform would comprise long-term stable external batters formed at slopes of 4(H) to 1(V), with an upper surface formed such that ponding is substantially avoided. This would therefore necessitate a final campaign of tailings deposition within the TSF to infill any significant depression, although maintaining DSA as outlined above. The conceptual formation of the final tailings beach is shown in the **Drawings**, which shows the beach generally grading from west to east with an overflow channel incorporated on the eastern perimeter to discharge runoff into Clean Water Diversion Channel. Formation of the release channel would occur following surface rehabilitation of the TSF and subsequent performance monitoring achieving water quality objectives/criteria, with this process envisaged to take several years following completion of deposition.

2.7.5 Tailings Surface Capping

A tailings surface cap would serve the following purposes:

(a) facilitate ongoing surface water drainage and prevent ponding;
(b) stabilise the surface to mitigate against potential ongoing erosion; and
(c) reduce potential rainfall infiltration into the tailings as recharge to seepage.

To address the above, tailings capping options assessment would need to be undertaken prior to completion of the TSF.

Notwithstanding the above, the conceptual cap would comprise the following components. This configuration assumes that the tailings would remain geochemically benign.

- Tailings Surface Stabilisation Layer (Capillary Break)

  To provide a geotechnically competent surface over the surface of the tailings, a stabilisation layer may be necessary. The purpose of the stabilisation layer would be to provide a competent subgrade or bridging layer, which would limit the effective surcharge onto the tailings surface and thereby limit potential settlements. The area most likely to require stabilisation would be the decant pond surface, due to the likely extent of saturated slimes materials.

  The stabilisation layer would typically comprise rock mattress (the rock comprising competent and durable material).

- Surface Cover Layer

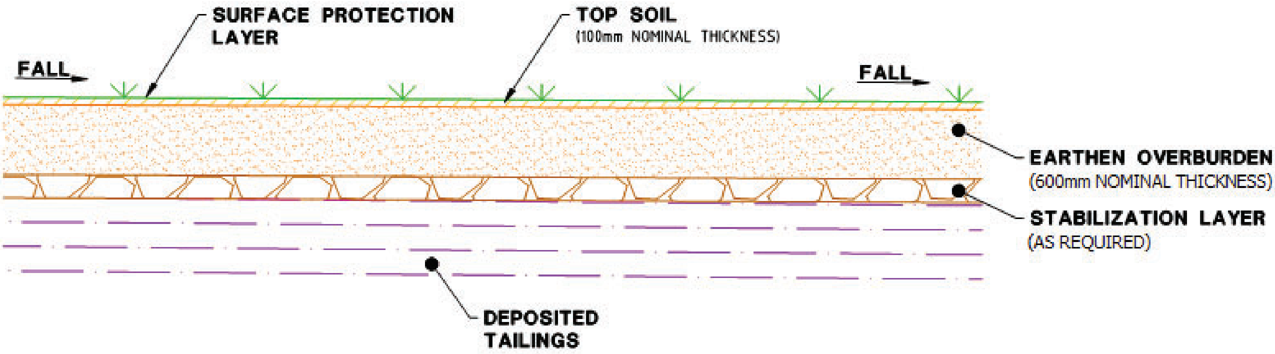
  To protect the tailings surface from erosion and exposure deterioration (through wetting and drying), a surface cover layer would be required. This layer would also be utilised as a rooting zone for vegetation depending on the proposed end land use.

  This layer would be formed typically using select earthen material from run-of-mine weathered overburden. Geochemically, the earthen material should be non-acid producing. From a geotechnical perspective, the material should be non-erosive/dispersive.

  The thickness of this layer would be selected to not only maintain drainage, but also to compensate for settlement within the underlying tailings. A hummocky final land surface may also have some benefit with respect to maintaining moisture within the surface layers to support vegetation growth and to reduce erosion potential. The final surface landform would be subject to further, on-going assessment through the final stages of the facility.

  A conceptual detail of the proposed TSF capping arrangement is provided in **Plate 18**.

Plate 18
Conceptual TSF Capping Arrangement



A more detailed assessment of a suitable capping configuration would need to be completed, subject to additional data being available with respect to the physical and geochemical characteristics of the tailings. In particular, geochemical compatibility between the tailings and capping materials must be confirmed to ensure the integrity of the capping horizon is not compromised.

3 SUBMISSIONS ADDRESSED

3.1 Submissions

Submissions were received from the Environment Protection Authority (EPA) and Resources Regulator in relation to specific aspects of the proposed TSF design, siting and construction.

The issues raised by these public authorities have been addressed in this report under the following main subject areas:

1. TSF Seepage management (Liner System)
2. TSF Closure and Rehabilitation
3. TSF Construction Water Management
4. Options for tailings disposal and long-term management
5. Information for assessment

As outlined above, following submission of the EIS and in response to submissions there have been some variations to the design and layout of the TSF. The submissions received by public authorities have been addressed based on the updated design and layout of the TSF and associated infrastructure (i.e. relocated SWMF and final surface water management).

The EPA submission's issues and recommendations are listed in **Table 18** according to the subject area where the matters raised are addressed in this report. Issues raised by the Resources Regulator are listed in **Table 18** according to the subject area where the matters raised are addressed in this report.

Table 18
Issues Raised

Issue Ref	Issues Raised by EPA	Subject area	Report Section
1	The proponent has detailed that lining of the TSF will be comprised of three low permeability liners: • in drainage features such as the former Belubula River and other areas with weathered geology, a full depth storage blanket liner of clay fill with a minimum depth of 1,000 mm and a permeability of 1 x l0-9m/s; • in other areas and where suitable clay fill is available, the area will be conditioned by scarifying/ripping, moisture conditioning and compacting to provide a clay fill liner with a minimum depth of 300 mm and a permeability of 3.3 x1010m/s (less than or equivalent to 1,000 mm @ 1 x l0-9 m/s); and • in remaining areas where insufficient suitable clay fill is available, the area will be lined with a geomembrane liner with a permeability less than or equivalent to 1,000mm @ 1 x 1 x l0-9 m/s. The proposed spatial distribution of these alternate liner methods across the TSF is not presented in the EIS. The EPA requires a minimum permeability of 1 x 10-9 m/s over a 1,000mm depth to be considered suitable to protect receiving environments as a containment barrier system (Environmental Guidelines: Solid Waste Landfills, 2016). *Rec* 1. The proponent revises the assessment(s) to provide further information regarding the TSF design, liner options and spatial distribution and the prevention of seepage to the underlying strata.	TSF seepage management (liner system)	Updated background data provided in Section 2.0 Specific Response provided in Section 3.2 and 5.0
2	The proposal of compacting impermeable clays, where suitable, to thicknesses that are lesser than 1,000mm is not considered suitable for the preferred TSF site. The identified site of the TSF area incorporates the headwaters of the Belubula River and adjacent weathered slopes. This alternative TSF lining method of scarifying/ripping, moisture conditioning and compacting native clays across a heterogenous weathered profile is not favoured by the EPA at this site due to the full reliance on the modelled performance of this method to mitigate the risk of seepage. The EPA believes a full depth storage blanket liner, of at least 1,000mm is required across this identified TSF site to adequately mitigate the risk of seepage. The host geology and its weathering variability increases the potential for a weakness or high permeability zone to compromise the TSF containment efficacy. For this option to be efficient all variables of risk must be mitigated, as the likelihood of a containment failure increases in relation to variables in the TSF construction. If conditioning is proposed, it should be to a recommended guideline value of a minimum thickness of 1,000mm. *Rec* 2. The proponent revises the assessment(s) to provide more detailed information regarding the availability of suitable clay material'.	TSF seepage management (liner system)	Section 3.3 and 5.0

ATC Williams

Table 18
Issues Raised (Cont'd)

Issue Ref	Issues Raised by EPA	Subject area	Report Section
3	Clay material availability assessment Details regarding the availability and classification criteria for 'suitable clay material' for use in the liner construction are limited. Given that the 300mm thick liner option uses the very low permeability nature of the clay material as the basis for assuming feasibility the quantity of this material and the criteria for decision making about where and when it will be used should be further detailed. *Rec* 3. The proponent revises the assessment(s) to provide more detailed information regarding the Quality Assurance/Quality Control procedures to be used for determining the suitability of clay material for use in the non-compliant 300mm thick lining option.	TSF seepage management (liner system)	Section 3.4 and 5.0
4	Contingency and post closure planning Details regarding contingency events and post closure management for the TSF are not provided. The lack of information regarding the TSF lining proposal places complete reliance on the modelled performance of the various liner options and the correct siting of the liner options by the proponent. This alone entails a high degree of risk however the proposal also does not address any contingency outcomes such as unexpected rates of seepage or failure of the lining systems. *Rec* 4. The proponent revises the assessment(s) to provide more detailed information regarding the acceptance testing regime that will be implemented to ensure the liner has been installed correctly and without material error and will meet the proposed seepage prevention specifications for all options. *Rec* 6. The proponent revises the assessment(s) to provide more detailed information regarding contingency planning for unexpected rates of seepage from the TSF and the maintenance of zero-discharge operations	TSF seepage management (liner system)	
5	Potential impact of the proposed construction phase discharges on the environmental values of the receiving waterway are not assessed. A discharge impact assessment is required to inform licensing considerations consistent with section 45 of the Protection of Environment Operations Act 1997. Given the duration of the construction phase, the proposed sediment and erosion controls and the nature of the receiving environment, a qualitative discharge assessment is likely to be adequate. *Rec* 1. The proponent revises the assessment to include a qualitative assessment of, and mitigation measures to avoid, the potential impacts of construction phase discharges to the downstream environment.	TSF Construction Water Management	Addressed separately by HEC

Table 19
Issues raised by The NSW Resources Regulator (RR)

Issue Ref	Issues Raised	Subject area	Report Section
1	The Resources Regulator advises the Department of Planning, Industry & Environment – Resources Assessments that the SEARs for Rehabilitation have not been adequately addressed in the McPhillamys Gold Project Environmental Impact Statement (dated 27 August 2019) for Project McPhillamys Gold Project, dated 9 September 2019. Information required: a) Figures provided in the EIS and Appendices do not provide an adequate level of detail for the TSF, WRE and ROM final landform. Provide drawings at an appropriate scale of the WRE and ROM final landform including, but not limited to, the following: i. Plan view ii. Section views, including reference to surrounding natural topography and any other proposed landforms or infrastructure. iii. Contours including labels (where appropriate) iv. Dimensions and slopes v. Structures and materials b) In support of the drawings requested above, provide an overview of the key characteristics of the final landform for the TSF, WRE and ROM. Based on the characterisation of materials, the overview should include a discussion on capping strategies; the source of associated capping material and associated volumes that may be required; and measures that will be implemented to ensure a sustainable post-mining landform that is commensurate with the surrounding natural areas is achieved.	TSF Closure and Rehabilitation	1(a) Drawings 1(b) Section 2.7

Table 19
Issues raised by The NSW Resources Regulator (RR) (Cont'd)

Issue Ref	Issues Raised	Subject area	Report Section
2	Issue 4: Tailings Management Agency Requirement:(s) i. provide a detailed options analysis of tailings treatment and disposal methods that may be applicable to the type of tailings generated from this project. This analysis must provide a clear justification of the preferred tailing treatment to demonstrate the feasibility of achieving low maintenance, safe stable non-polluting rehabilitation outcomes, with specific reference to long term seepage management. ii. final capping material concept design, source of capping material and long term design considerations, taking into account the required performance of the capping material long term and likely environmental risks i.e. consolidation of underlying tailing materials. Information required: a) an options analysis table for tailings treatment and disposal is provided, however is brief and unclear in nature. Clarity and detail regarding treatment, disposal methods and justification in relation to low maintenance rehabilitation outcomes and long term management of each option is required. b) more detail regarding final capping design including how final land use can be achieved with proposed capping and cover design since grass cover is proposed on the TSF but consideration of trees potentially naturally establishing on the TSF post-closure has not been provided.	Options for tailings disposal and long-term management	

In addition to the public authorities, community submissions also raised matters associated with the TSF:

The following is a summary created by EMM

Table 20
Issues raised by Community Submission

Issue Ref	Issues Raised by Community Submissions	Subject area	Report Section
C1	TSF Design (including failure risk and location) Of the objections received, 44% (8) of organisations and 69% (262) of community submissions raised concerns about the proposed design of the TSF. This included concerns related to: • the location of the TSF and associated water management facilities at the headwaters of the Belubula River; • how extreme conditions (under which discharges from the TSF may be possible) have been defined; • the adequacy of the peer review and TSF risk assessment process; • the rehabilitation of the TSF at the completion of mining; and • follow-up actions if the TSF fails resulting in flow-on impacts to the surrounding environment.		
C2	TSF impacts on groundwater Of the objections received, 17% (3) of organisations and 48% (185) of community submissions raised concerns about the potential impact of the TSF on groundwater (namely the potential for contamination of the water table). This included concerns about how any identified groundwater impacts will be monitored and managed during operations.		
C3	TSF seepage Of the objections received, 28% (5) of organisations and 53% (201) of community submissions raised concerns about potential impacts associated with seepage from the TSF. This included concerns related to the: • potential contamination of the surrounding environment from leaks and/or leaching originating at the TSF; • accuracy of groundwater flow assumptions used to determine the risks associated with a leak or spill from the TSF; • application of monitoring to detect seepage and subsequent implementation of appropriate management measures; and • post-mining stability of the TSF and integrity of proposed containment strategies.		

3.2 Response EPA 1

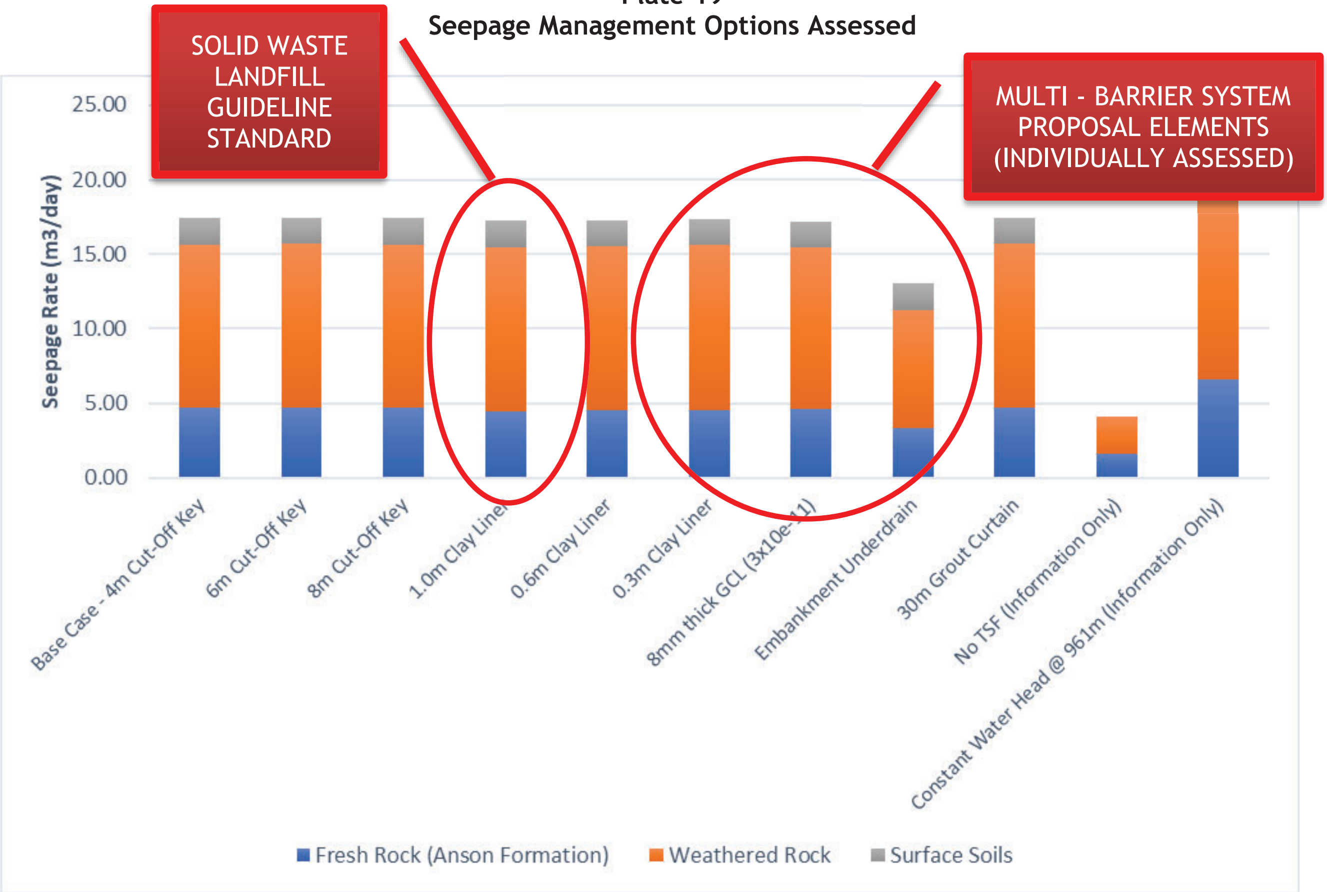
Refer Section 2.4 for more detailed spatial mapping of the existing in-situ clays. Section 5.0 provides further analysis to demonstrate the performance of the proposed seepage system.

Due to gravitational forces, seepage will occur from any structure with elevated water, no matter the lining system as all materials have an inherent permeability. This is an important aspect to understand as the consideration of any lining system should be about the acceptable rate of seepage and not the prevention. In relation to the McPhillamy's TSF, the design basis for seepage management comprises a multi-barrier approach to minimise the volume and extent of seepage that could report to the downstream environment, with the proposed system for this specific site found to exceed the performance of the equivalent 1,000mm at 1 x 10^{-9}m/s liner, as was shown on the presented modelling results.

Results comparing the proposed multi-barrier system against the single liner system is presented below with modelled seepage results from all options assessed shown in **Plate 19**.

Parameter	Multi-Barrier System	Single Liner System
Material Permeabilities	Refer Table __ Liner – 0.3m at 5 x 10^{-10} m/s	Refer Table __ Liner – 1.0m at 1 x 10^{-9} m/s
TSF Arrangement	Final Stage, Refer Drawings, Includes embankment core and cut-off key	
Subsurface Drain	Yes	No
Estimated Seepage at Downstream Toe	<13.01 m^3/day	17.22m^3/day
Subsurface Water Recovered (annual total steady state)	>4.0m^3/day	NA

Plate 19
Seepage Management Options Assessed



3.3 Response EPA 2

The availability and suitability of clay materials within the TSF area is provided in **Section 2.4**.

It is noted that the entire project exists in the headwaters of the Belubula River and this is typically the recommended placement for a TSF to minimise clean water catchment and diversion as well as likely greater groundwater (stream baseflows) in lower catchment areas. Notwithstanding, alternative options for the TSF were considered and comprised large elevated structures requiring significant greater embankment volumes (to the point that they would exceed available mine waste to build) and considered to present greater risks/adverse effects for associated environmental management aspects (greater elevations exposes greater potential for dusting, dam break consequences, multiple seepage paths and final land usability).

Further to the specific commentary used to frame the submission, it is incorrect to refer to the proposed seepage management system for the TSF as fully relying on the proposed lining works. It was demonstrated in the modelling and sensitivity analyses (also refer Section 3.2) that the lining system has a limited impact on the expected seepage performance of the TSF and therefore this was why additional systems were also considered. Ultimately a multi-barrier type approach was demonstrated to be the most effectual in limiting seepage and was chosen to take forward to minimise the environmental risks/impacts.

3.4 Response EPA 3

Noting that QA/QC is typically addressed as part of detailed design when final investigation are completed and licencing conditions provided, the following discussion provides a suggested structure to provide input to the QA plan and then further discusses an inferred QA/QC plan based on the current site knowledge.

The process envisaged to establish/confirm the QA/QC plan for the TSF is summarised as follows:

1. Detailed Design phase to include detailed mapping, trial construction and correlation of clay characteristics (Particle Size Distribution and Atterberg Limits) to permeability testing.
2. Construction phase to include:
   a. Expose Clay Foundations and define material thickness (testpit) and suitability (classification testing)
   b. Define treatment area types –
      i. In-situ material condition and compact only
      ii. In-situ material condition, compact and liner
      iii. Import clay materials (300mm to 1000mm), condition, compact and liner
   c. In-situ conditioning and compaction to extend minimum 450mm (this includes contingency, ensuring that this exceeds the required 300mm thickness) with suitable compaction equipment
   d. Test compacted clay fill materials compacted at suitable moisture content and achieve the appropriate compaction.

Notwithstanding the above process, current results of mapping the clay materials indicated relatively distinct areas where suitable clays exist. These areas would be further refined with additional mapping (inclusive of geophysical techniques) as part of the detailed design. In addition, consideration of a trial compaction program (refer Section 2.4 for discussion) to assess the usability of the weathered basement materials. The outcome of the detailed design phase will be to definitively map the areas requiring imported liner and to prepare a QA/QC for the TSF and liner construction.

The QA/QC of the earthworks would be undertaken in general accordance with Australian Standards, AS3798-2007. A typical structure for the construction QA is provided in Appendix B.

3.5 Response EPA 4

In response to these queries, it is considered that the following statements need to be provided for clarification:

- Without material error is not a credible position to suggest is possible. The intent will be to demonstrate how these risks are minimised as far as practical.
- Seepage prevention is also an incorrect statement. The intent as outlined in Section __ was to exceed the seepage performance of the EPA recommended liner (1m at 10^{-9}m/s) performance.

The proposed QC testing regime is outlined in Appendix B.

Proposed seepage management is described as follows:

1. Physical control elements (multi-barrier system):

   - TSF storage to be lined using a combination of a very low permeability clay liner and imported liner system. The clay liner to be constructed a minimum 1.0m thick within the existing drainage features and a minimum 300mm in areas with in-situ clays having a permeability of less than 10^{-9} m/s.
   - The embankment to comprise a very low permeability clay core and a deepened cut-off key extending into residual basement sequences.
   - A seepage interception trench located downstream of the embankment cut-off key for the recovery of seepage and dewatering of the tailings mass.
   - Downstream monitoring bores. These bores would be located subject to the definition of subsurface structures based on a geophysical investigation. These bores would be constructed to be converted to pump back bores if required.
   - Downstream TSF run-off dam to intercept surface contact water from incident rainfall over the downstream TSF embankment batter.
   - Construct the decant for the TSF some 770m from the main embankment, maximising the seepage flow path for the saturated portion of the TSF

2. Operational control elements:

   - Tailings to be thickened to minimise available water pumped to the TSF in the tailings slurry.
   - Deposition to occur subaerially over a large area to minimise rate of rise and maximise the evaporation and consolidation of the tailings which will minimise the permeability of the tailings and potential for seepage.
   - Minimise the stored water volume on the TSF. These aspects are demonstrated in HEC (2020), which shows the maximum stored volume being of the order of 400ML and that the average stored volume some 100ML

3. Post-closure:

   - Provide a capping system to promote evapotranspiration of near surface infiltration and to direct surface runoff downstream
   - Maintain the seepage interception system until such a time that no measurable impact is assessed and/or rout the seepage to the open cut pit void which would exist as a groundwater sink post-closure.

As can be seen above, a multiple of contingencies method beyond a storage liner exist.

3.6 Response EPA 5

The water management for the TSF construction focusing on erosion and sediment control was outlined in ATCW (2019). It would be expected construction management plans including a soil and water management would be developed as part of the pre-construction regulatory approvals. Key elements as reproduced from ATCW (2019) and HEC (2020) are as follows:

- Coffer dam above stage 1 – 1a embankment construction to divert clean water and run off WMF below embankment
- Soil and erosion control to "blue book" standards stipulated in the Construction Environmental Management Plan referred to EPA and approved by DPIE

3.7 Response RR 1

Plan and sectional views for the TSF are provided in the attached Drawings. These details are presented at a feasibility level and would be finalised/detailed as part of the detailed design process.

3.8 Response RR 2

TSF disposal options assessment is discussed in **Section 4.0**, in terms of tailings engineering with response also provided in Regis (2020), discussing aspects related to ore processing, metallurgy and corporate management.

3.9 Response CS 1

Aspects raised have been discussed in the relevant reporting with the design report and this submission inclusive of expert reviews from Chris Hogg and David Williams. Refer Appendix C1 and C2 for the respective reviews.

3.10 Response CS 2

A comprehensive groundwater monitoring program will be implemented as part of the project development. Specific to the TSF, groundwater monitoring will include the following:

- Upstream and downstream groundwater monitoring bores to assess water quality and groundwater levels with monitoring locations shown in the **Drawings**.
- Downstream/downgradient shallow seepage monitoring
- Surface water monitoring

3.11 Response CS 3

TSF seepage discussion is detailed within this report and emphasised in **Section 5**. Embankment stability is discussed in **Section 2.6**. The proposal for the TSF includes a rock fill embankment with final slopes formed at 4(H) to 1(V). This arrangement achieves factors of safety for all conditions considered greater than regulatory requirements with loading cases considered for "Extreme" consequence category structures.

4 TSF DISPOSAL OPTIONS

4.1 What are Tailings in Context of McPhillamys Project

McPhillamys Gold Project comprises a hard rock deposit with disseminated gold at an approximate grade of 1g per tonne of ore. To recover and extract gold (existing as fine to microscopic particles in the case of McPhillamys Project) from the host rock, the process requires the crushing and grinding (by milling) of the rock to achieve an approximate grain size similar to fine grained sand/silt (the proposed grind will result in 80% of the particles being less than 0.90mm). This grind sizing maximises the exposure of the gold particulates to be chemically liberated/leached from the non-gold particles and is then ultimately recovered. In the case of McPhillamys ore type, gold will extracted via an adsorption process with the use of activated carbon columns. The residue (non-gold particulates and process associated additives) are referred to as tailings and would comprise greater than 99.99% of the grind/milled rock.

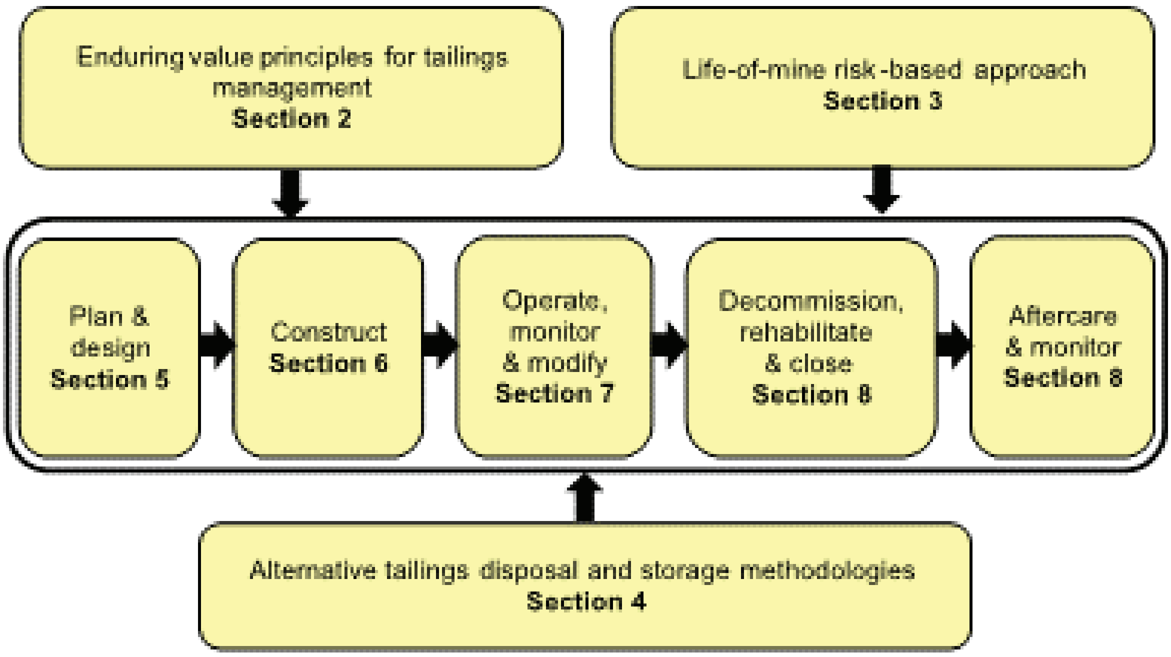
The above aspects are important to understand, as it describes the initial state of the tailings as follows:

Fine grained Slurry, produced at some 7Mtpa of solids (i.e. 19,000t per day of solids)

This is the state form which solutions are determined/assessed to provide the appropriate disposal methods, location and management.

4.2 Best Practice Management Process

Subject to the above processing and initial state of the tailings (i.e. saturated or unsaturated), considerations for the disposal of the tailings will generally require the following process to be addressed (extracted based on Tailings Management, Australian Government, 2016):



The above process steps were used to inform the options assessment and develop the structure as provided in ATCW (2019) and reproduced below.

4.3 Options and Issues Considered and Summary of Outcomes

TSF options considered four main areas within the surrounds of the McPhillamys deposit as detailed in ATCW (2019). An overview of this assessment in terms of addressing aspects raised in Australian Government (2016) are provided in **Table 21**.

Table 21
Options Assessment Overview

Project Processes Addressed	Issues Considered	Outcomes
Alternative Tailings Disposal and Storage methodologies/ Technologies	• Alternatives to CIL considered by Regis • Non-slurry tailings transport and storage • Disposal and storage methods • Tailings transport • Clean and Dirty Water Management • Topography constraints • Community/heritage and cultural constraints • Structural stability • Constructability	• CIL Only Viable Approach • Tailings Slurry Approach is a demonstrated approach with similar issues to "dry" stacking. It is emphasised that dry stacking is not completely consistent with its naming and that water management issues including seepage, dust management, and landform stability will be required regardless. • TSF options assessed to maximise the diversion of clean water and contain TSF impacted water • Topography, cultural/heritage constraints were assessed. • Structural stability(robustness) and constructability was considered
Value Principals for Tailings Management Options	• Sustainable development to operate and decommission the TSF such that post-closure land uses are achieved • Compliance with Industry and Regulatory guidelines and regulations • Business drivers/financial impact to the Business and Local Community	• Drivers for sustainability included: ▪ Stable landform ▪ Seepage management ▪ Diversion of upslope clean waters during and post-closure • Industry and Regulatory guidelines used for the basis of the TSF design • Business and financial impacts considered as part of the total development (Refer Regis, 2020)
Life of Mine Risk Based Approach	• Designed, operated, closed and rehabilitated to achieve negligible operator, public health and safety risks and acceptably low community and environmental impacts • Framework to manage uncertainty and change	• Risks considered for operations and post closure. • Robustness of design also considered to manage change - preferred configuration was a downstream constructed embankment for all options considered

Table 21
Options Assessment Overview (Cont'd)

Project Processes Addressed	Issues Considered	Outcomes
Planning and Design	• Background conditions defined included: ○ Climatic and Topographical Conditions ○ Beneficial water use ○ Proximity to sensitive receptors including Agriculture, surface and groundwater dependent flora and fauna ecosystems ○ Rare and endangered species ○ Surface water hydrology ○ Hydrogeology, including water levels and quality ○ Surface soils ○ Air quality ○ Social, recreational, commercial and heritage values ○ Process parameters including ore mineralisation, geochemistry, expected particle size distribution, slurry solids concentration, tailings inferred geotechnical characteristics, bleed water/liquour, seepage water quality • Suitable Foundation Conditions • Accommodate Processing Rates • Manage Water within the TSF • Maximise tailings settled dry densities (minimise rate of rise and construction requirements) • Consider the future need to upstream lift the TSF • Works required to rehabilitate the TSF and achieve post-closure land-use • Construction Scheduling – commercial considerations and material availability	All options were assessed based on the following: • Climate was considered common to the area • Topography was specific to individual sites, generally comprising broad shall valleys, valley side slopes and ridges/high ground areas • Surface water and groundwater aspects considered and assessed for each site • Impacts on vegetation, farming, forestry and public areas considered for each site • Proximity to the process plant considered • Underlying geology considered • Rate of tailings beach rise was evaluated with preference for rates of rise of the order of 2m per annum which was assessed as suitable for the local climate • Final landform arrangement considered The assessment comprised a qualitative ranking system for all options. The preferred location is as per the proposed TSF.
Construction	• Minimise the total works required • Maximise use of local materials (ie mine waste) • Construction Quality (CQ)	Each option was scheduled and costed on basis of total works required and to maximise the use of local materials. Construction materials and processes proposed are considered well understood and proven with CQA able to be implemented to verify construction works. Preferred sites considering construction aspects only included the proposed TSF and a location to the east of Kings Plains.

Table 21
Options Assessment Overview (Cont'd)

Project Processes Addressed	Issues Considered	Outcomes
Operate Monitor and Modify	• Performance to meet/exceed regulatory requirements • Maximise tailings consolidation/density • Minimise free water on the facility • No measurable health and safety or environmental impacts or operational interruptions • Change management • Operational accountability at senior mine management level • Tailings Pipeline protection/containment • Operational monitoring • Emergency Action Planning	Issues considered as part of the qualitative assessment.
Decommission and Rehabilitate	• No measurable health and safety or environmental impacts • Transportation of exposed sediments (wind/erosion) • Tie into the existing surrounds • Safe stable non-polluting structure with minimal requirement for ongoing maintenance • Community engagement • Agreed post-closure land use • Monitoring and maintenance plan	Issues considered as part of the qualitative assessment.

5 TSF SEEPAGE MANAGEMENT (LINER SYSTEM DISCUSSION)

5.1 Liners for TSF

Acknowledging the submissions received regarding the TSF Liner System, it should firstly be reinforced that the seepage performance of a TSF is subject to the following physical, environmental and operational controls/aspects:

- Tailings Water Chemistry and Receiving Environment – Tailings water chemistry and understanding
- TSF Surface Water Management – includes slurry delivery water content, tailings beach development and free water (either liberated from the tailings or direct and indirect rainfall) management
- TSF foundations hydrogeological properties
- Tailings permeability
- Subsurface drainage systems
- Storage lining system

Therefore whilst the liner geometry/configuration has been singled out in the submissions, the modelling has demonstrated that managing and implementation of a multi barrier approach has a greater benefit to the outcomes for the management of seepage than the adoption of a single prescribed liner as raised in the submissions. To this end, the following assessment has been provided as a comparison of a multi-barrier system and the prescribed liner based on the landfill guideline which specified a 1,000mm thick clay liner with a permeability of 1×10^{-9}m/s. In addition, supplementary analyses were undertaken of a simple 1D model within the storage area which assessed the maximum potential vertical seepage rates through the floor of the TSF and whilst not necessarily directly comparable to the 2D seepage model and groundwater model results, it provides a risk assessment of the storage lining system.

5.2 Multi-Barrier Versus Single Liner

A tabulated description of the multi-barrier seepage management system versus the implied regulatory single liner system is provided below. Description also includes confirmation of modelled elements.

Table 22
Liner Descriptions

Multi-Barrier Seepage Management	Single Liner Seepage Management
Storage Liner – combination of 1,000mm of clay within drainage areas, minimum 300mm within areas of suitable clay and imported liner (GCL or similar) with areas of unsuitable clay	1,000mm at 1 x 10^{-9} m/s
Cut-Off key and embankment clay core	Included
Seepage interception drain	N/A
TSF Run-Off Dam, dewatering bores – not modelled, contingency management	Not modelled or implied requirement
TSF water management with decant located away from the embankment – not modelled	Not modelled or implied requirement
Foundation permeabilities – based on site investigations – sensitivity assessment also included.	Foundation permeabilities – based on site investigations – sensitivity assessment also included.

5.3 Seepage Modelling Summary Outcomes

As sourced from ATCW(2019), re-representation of the seepage modelling results are provided below in Plate 21. The modelling was undertaken using SEEP/W, a computer-based numerical seepage model using finite elements. SEEP/W is formulated on the basis of Darcy's Law for both saturated and unsaturated flow. The model iteratively solves mass balance differential equations for a grid of finite elements, based on appropriate boundary conditions.

Key input to the seepage model consists of saturated permeabilities for the layers forming the modelled profile. The permeability values for the materials modelled are summarised in **Table 2**. **Plate 20** shows the model arrangement, representing a section through the Main Embankment at its greatest height.

The outcomes have been refined down to present only the proposed multibarrier system and the Solid Waste Landfill Guidelines Liner system. Results are presented as sensitivity results compared to the base case data which used the permeability results as shown in **Table 22**. In addition, the sensitivity of seepage to storage depth is also included for both liner options.

Plate 20
TSF Seepage Model Arrangement

Color	Name	Model	Sat Kx (m/sec)	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	Eff Clay Core	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Cut-Off Key	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Fresh Rock (Anson Formation)	Saturated Only	2.31e-08			0.5	0	0	0
	Eff Rock Fill	Saturated Only	1e-06			1	0	0	0
	Eff Surface Soils	Saturated Only	5e-08			1	0	0	0
	Eff Tailings	Saturated / Unsaturated		Tailings	Tailings k = 1e-07m/s	0.1	0		
	Eff Transition Zone	Saturated Only	1e-06			1	0	0	0
	Eff Weathered Rock	Saturated Only	1e-08			1	0	0	0

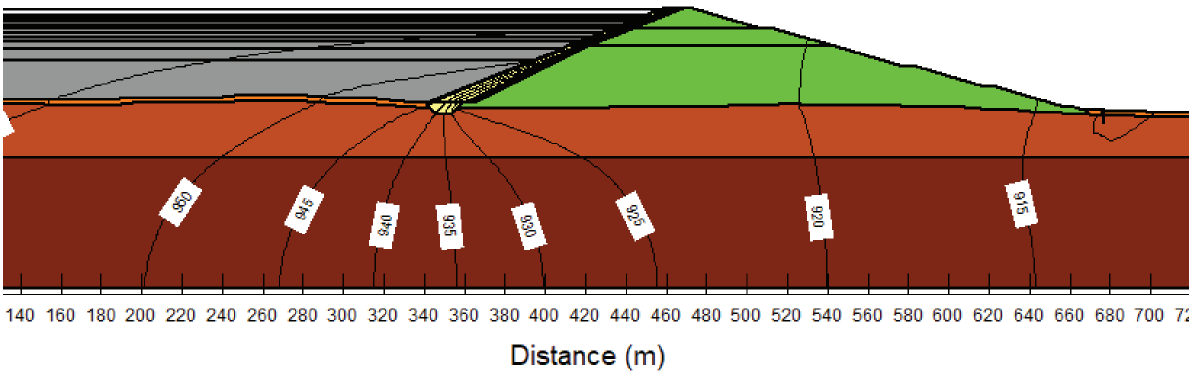
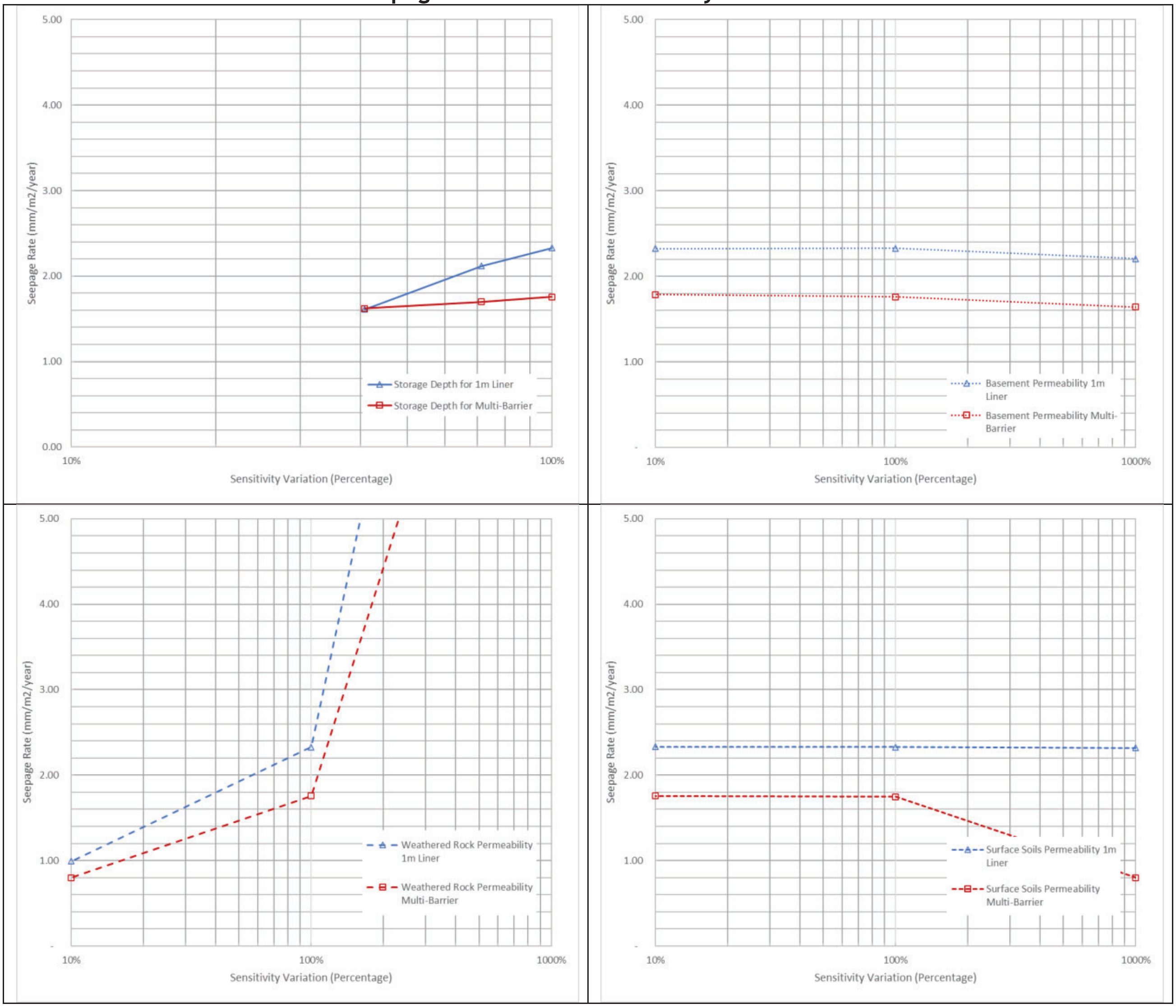


Plate 21
TSF Seepage Model Results Summary with Sensitivities



The above results show daily seepage estimates for both the Solid Waste Landfill Management Guideline (1m Clay at 10^{-9}m/s) and the proposed multi-barrier system. In all cases, the seepage rates reporting downstream of the TSF model were less in the multi-barrier model, although noting that at a storage level of less than 30% of the final proposed TSF height, seepage rates were comparable. The parameter of greatest sensitivity as can be seen above is the permeability of the weathered foundations (i.e. the upper 20m).

5.4 Supplementary 1D Seepage Model Risk Assessment for Storage Liner

5.4.1 Model Description

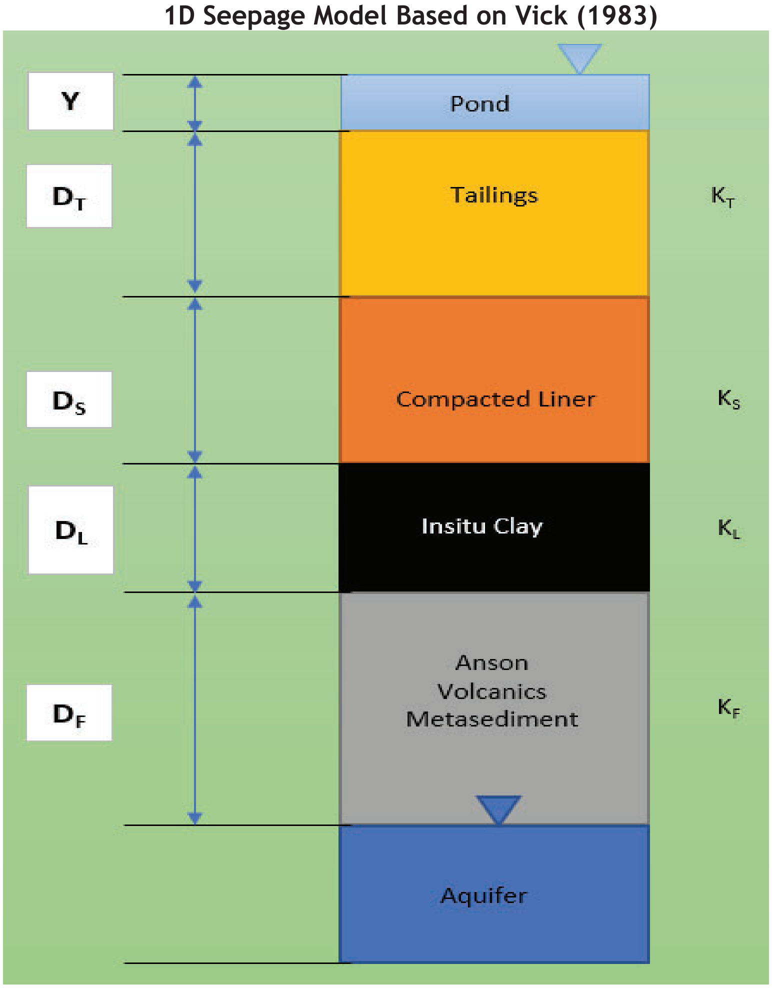
As an addition to the above seepage assessment, an alternative approach of just focusing on the base liner has also been undertaken as outlined in the following section. Seepage has been evaluated through the footprint into the subsurface and the potential risk factors that is associated with it. The assessment includes the potential impact of the compacted clay liner or in situ clay areas. In addition, it assesses the impact of the host rock and the potential impact of construction material substitute areas within the total footprint area.

McWhorter and Nelson (1979, 1980, 1978) described the migration of the wetting front under a constant source of water in different stages. Vick (1983) implemented a methodology to estimate seepage from a tailings storage facility (TSF) under different operating conditions. The method is consistently applied to estimate impacts associated with infiltration in foundations of building structures or geospatial estimates for groundwater recharge and was deemed appropriate for the current analysis of seepage rates (Beven et al., 1984; Nelson et al., 2015).

In this assessment a simulation of the worst-case scenario, i.e., long term saturation of the TSF was considered. McWhorter and Nelson (1978) model can be applied to this problem, resulting in estimates that would be comparable to the actual structure seepage rate through the foundation. It is assumed that all discharge is directed to the footprint with embankment seepage collected within the embankment underdrainage system. Due to the number of options available and the computational effort to statistically assess all possible outcomes, the computational procedure by Vick (1983) was implemented.

Plate 22 illustrates the conceptual layout of the system with the associated parameters. An assessment of pond depth (Y), thickness of tailings (DT), compacted clay layer (DS) and in-situ clay layer (DL). An estimate of the thickness of the unsaturated zone (DF) below the TSF was included in the assessment to determine the time required to percolate the full depth to the perched aquifer (6 metres below ground level). Hydraulic conductivity estimates were obtained from the tailing storage facility definitive study reported **(ATC, 2019)**.

Plate 22
1D Seepage Model Based on Vick (1983)



5.4.2 Permeability of Materials

5.4.2.1 In Situ Permeability

In ATC (2019) general parameters for in situ parameters are defined and reproduced below for completeness.

Table 23
Summary of In Situ Permeability Test Results (ATC, 2019)

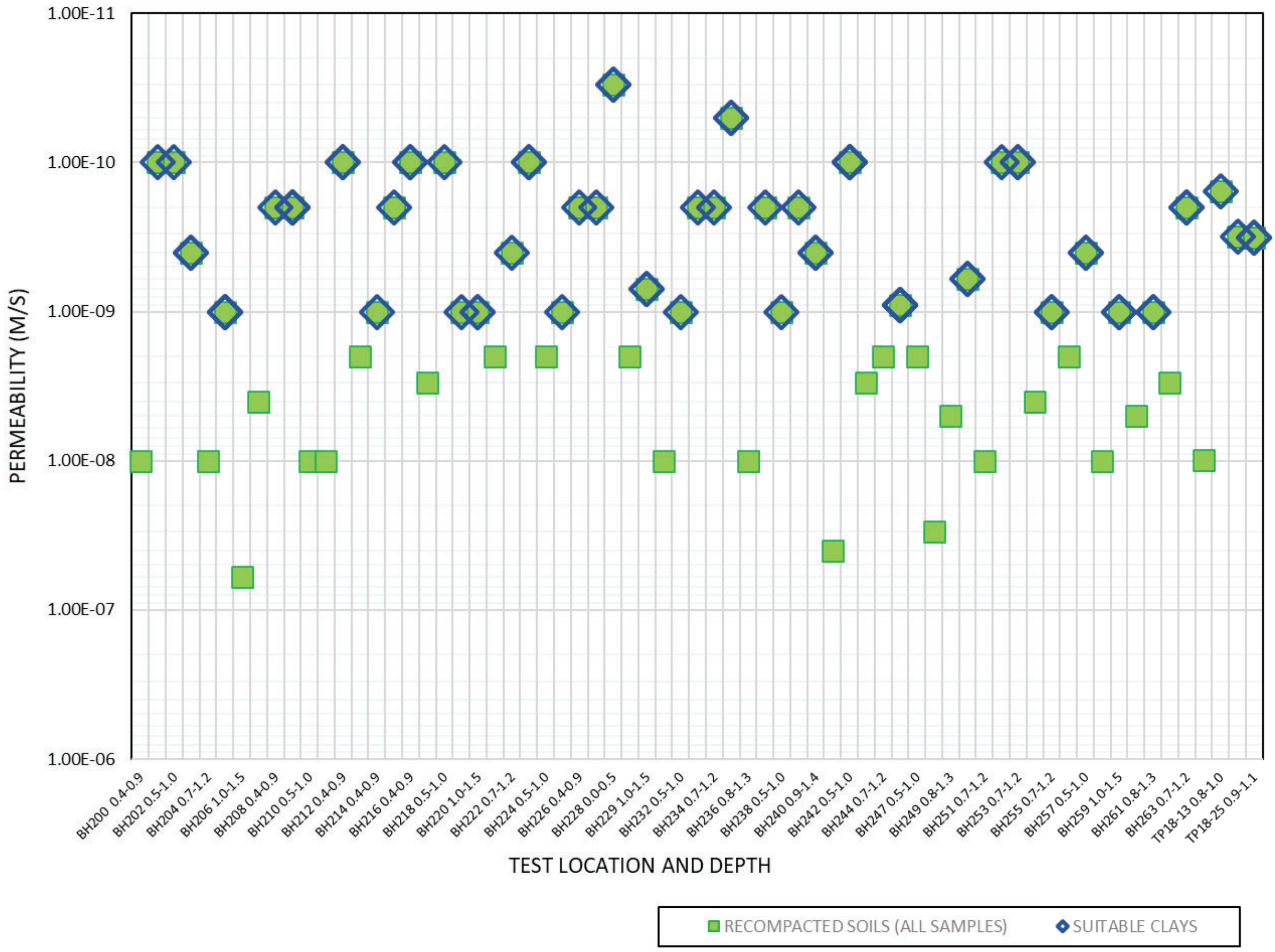
Target Sequence	Range of Measured Permeability Values (m/s)	Average Permeability
Soil Zone (0 to 3 m)	1×10^{-5} to 1×10^{-8}	5×10^{-7}
Upper Weathered Basement (4 to 20 m)	5×10^{-7} to 5×10^{-9}	5×10^{-8}
Lower Fresh Basement (greater than 20 m)	K_z ~2.3×10^{-8} $K_{x/y}$ ~1.2×10^{-9}	K_z ~2.3×10^{-8} $K_{x/y}$ ~1.2×10^{-9}

5.4.2.2 Compacted Clay Liner Permeability

Compaction data for the permeability of all soils (both suitable and unsuitable) is shown in **Plate 23** and were obtained from ATC (2019), with the following statistics derived:

	All Soils Tested	Suitable Clays
Median (P_{50})	4×10^{-9}	4×10^{-10}
P_{25}	2×10^{-10}	1×10^{-10}
P_{75}	3×10^{-9}	9×10^{-10}

Plate 23
TSF Storage Area Soils Hydraulic Permeability Values (m/s)



5.4.2.3 Tailings Permeability

The permeability of mature gold tailings, that have drained and settled, is approximately 1 x 10^{-7} m/s. For the assessment, saturated permeabilities for tailings is assumed to range in the order of 10^{-6} to 10^{-8} m/s. The upper-bound values are indicative of the coarse tailings fraction and conversely the lower-bound values represent the fine fraction. Representative permeabilities determined from the constant head permeameter method for McPhillamys Gold Tailings Sample was 1.0 x 10^{-7} m/s (ATC, 2019).

Due to the nature of tailings deposition, namely being discharged over a beach in thin layers, the tailings will settle and consolidate due to gravity forces on the tailings, with the resulting tailings matrix more tightly packed in the vertical direction. This consolidation effectively results in lower vertical permeabilities in the vertical direction than the horizontal direction (effectively near horizontal due to the shallower beaching profile). Experience with tailings projects and the measurement of the phreatic surface profile across a tailings profile indicates that the difference between vertical and horizontal permeability would be approximately 1 order of magnitude lower (i.e. vertical permeabilities typically 10 times lower than horizontal permeability). Notwithstanding this anisotropic behaviour expected, for the purpose of this modelling assessment, no reduction in vertical permeability was included.

5.4.3 In-situ Clay Thickness and Depth of Tailings

As reported in ATCW (2019) and presented in **Section 2.4**, the proposed TSF area was extensively test-pitted over a number of investigation campaigns to assess the near surface soils, targeting available clays and their thickness. The investigations comprised some 150 test-pits and as this work was undertaken in part for other purposes (agricultural soils investigations), not all test-pits where excavated to the full depth of the soil profile. Based on the logs as provided in ATCW (2019), some 89 test-pits were discontinued within clay soils. It is therefore emphasised that the assessment below could be considered an underestimation of the available clay soil thickness and subsequent overestimating the seepage losses. Further investigations may therefore be used to enhance the knowledge below and further refine the requirement for the proposed alternate lining approach.

The footprint of in-situ clay thickness was estimated based on the testpit data, with clay thickness in the footprint divided into three classes as follows:

Clayey Soils Thickness Class	Thickness Range
1	0.0m to 0.3m
2	0.3m to 1.0m
3	>1.0m

The selection of these classes were motivated by current liner requirements in which at least one metre of compacted clay is stipulated in guidelines. The assessment will evaluate the efficiency of 0.3, 0.5 and 1m thick clay zones in managing seepage rates. In zones where an excess of one metre of clay is reported, it can be utilised as Clay Fill in embankments and storage lining.

The depth of tailings deposition was assessed at RL 943 mAHD (Stage 1b) and RL 962 mAHD (Stage 3) and was derived from these elevations and the topographical data of the storage area. The clay layer thickness and depth of tailings deposition for the Stage 1b and Stage 3 development stages is presented in **Plate 24** and **Plate 25**, respectively.

Plate 24
RL 943 mAHD (at TSF development Year 2) grid layout of clay thickness (A) and tailings depth (B)

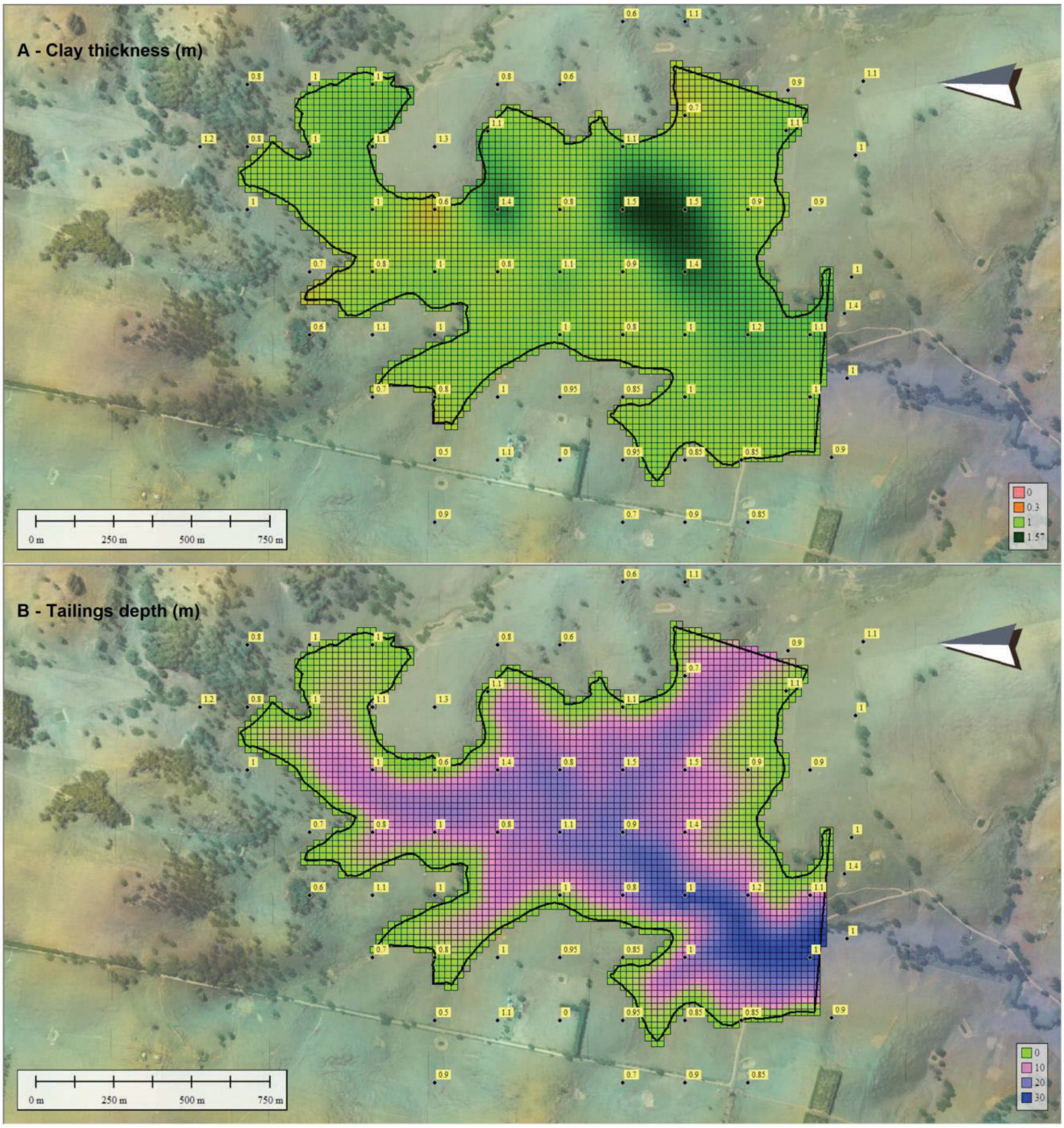
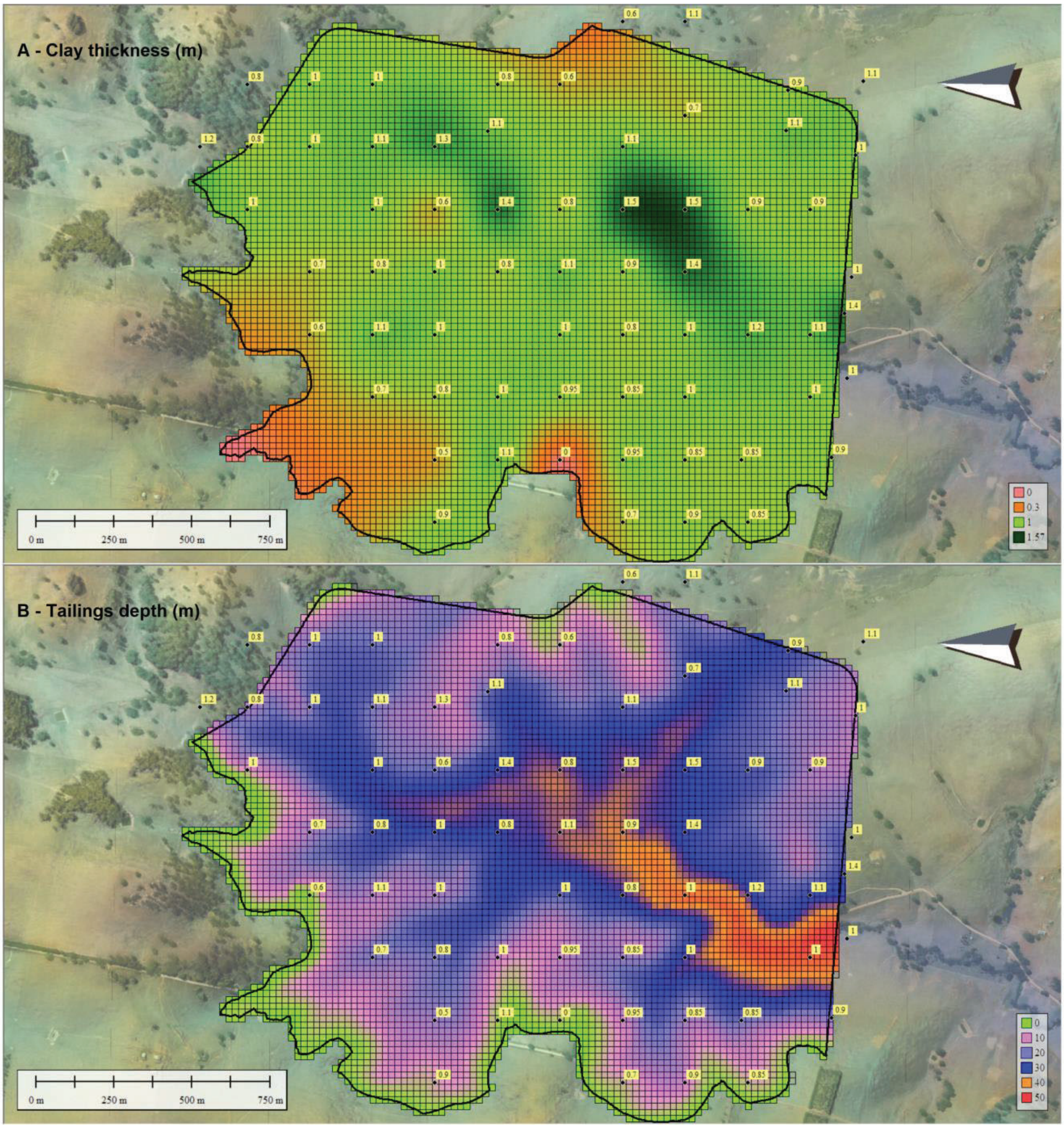


Plate 25
RL 962 mAHD (Year 7) Grid Layout of Clay Thickness (A) and Tailings Depth (B)



The distribution of clay soils thickness class for RL 943 mAHD (**Table 22**) and RL 962 mAHD (**Table 23**) indicate that for the initial footprint, the majority of the substrate clay material is in excess of 0.3m. However, in the final footprint area (RL 961 mAHD), shallow zones are more prevalent on the upper slopes of the hills and fall within Class 1 clays (**Table 23**).

Within the footprint (271 ha) of the TSF, the defined Class 1 clay area is approximately 8 ha. It is expected that these zones as well as areas of unsuitable clays will be lined using an engineered lining product. For the purpose of this assessment, these areas have been modelled as having a minimum 0.3m of suitable clays as sourced from within the TSF storage area and no additional engineered lining product was considered.

An assessment of the distribution of clay class with depth of overlying tailings for RL 943 mAHD and RL 962 mAHD is presented in **Plate 24**. The distribution of clay within the TSF footprint is generally either of Class 2 or better.

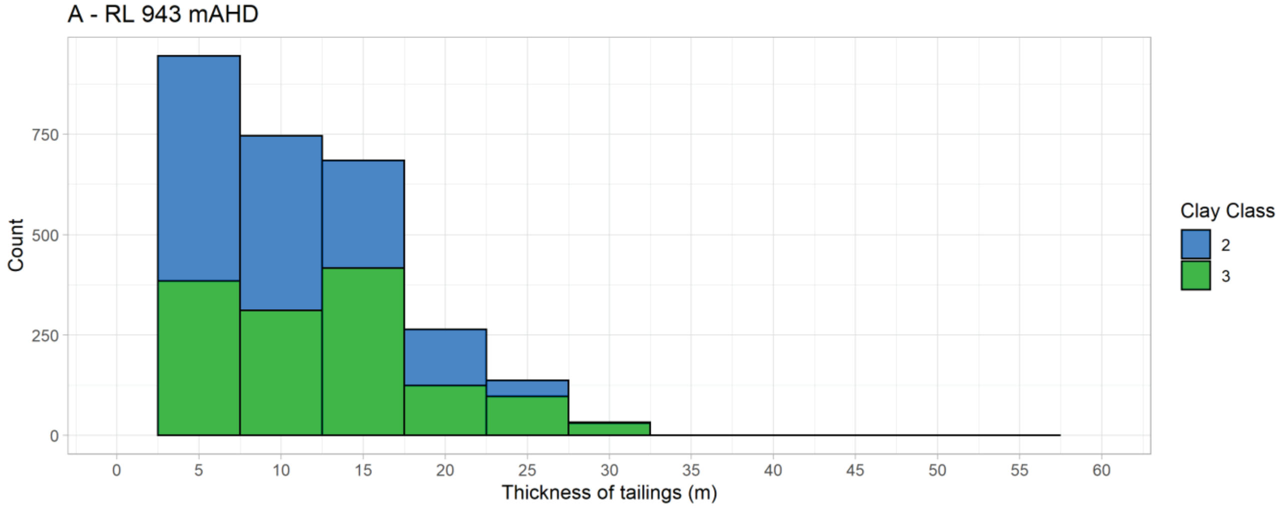
Table 24
Percentile Distribution of Tailings Depth with Clay Class for RL 943 mAHD

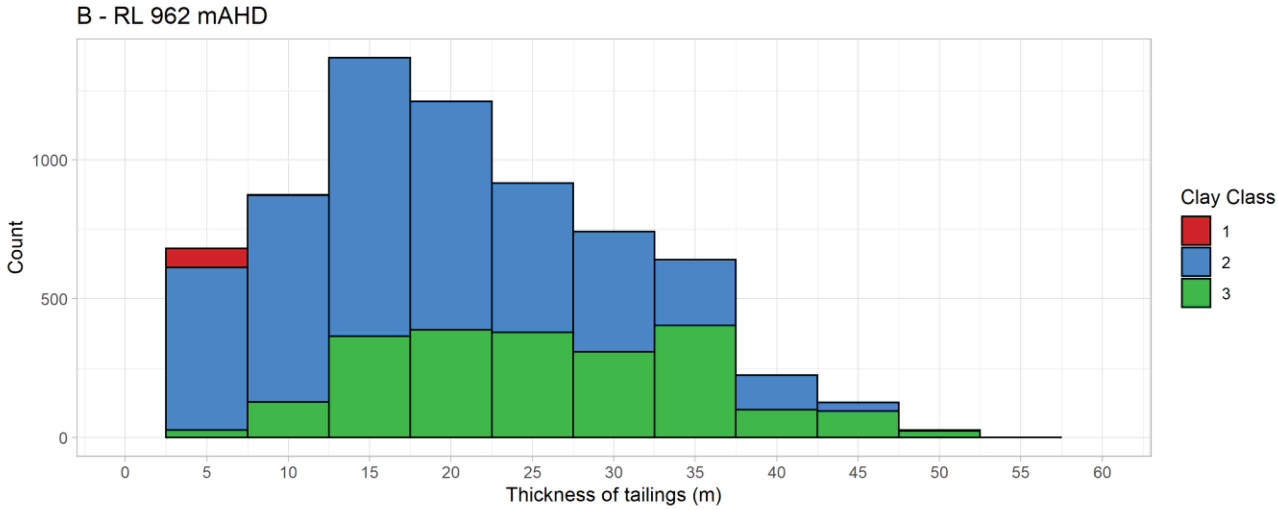
Percentile	1	2	3
0%	-	0.04	0.04
25%	-	2.48	4.61
50%	-	6.71	10.47
75%	-	12.18	16.03
100%	-	27.65	31.44

Table 25
Percentile Distribution of Tailings Depth with Clay Class for RL962 mAHD

Percentile	1	2	3
0%	0.05	0.04	0.29
25%	1.18	9.95	17.77
50%	2.17	16.52	24.81
75%	3.29	23.82	33.33
100%	8.14	48.57	50.00

Plate 26
Thickness of Burial Depth of Tailings for Clay Class





5.4.4 Methodology

The methodology used in this assessment considers the progressive increase in tailings depth in the TSF from RL 943 mAHD to RL 962 mAHD. Due to the footprint development over time and the potential for impact, different substrate materials were evaluated by means of a spatial approach, i.e., clay zones and areas of moderate permeability. The following parameters for each TSF stage lift are defined in **Table 26**.

Implementation of a Monte Carlo approach to evaluate multiple parameters within a defined range was used to develop an understanding of potential seepage rates. In addition, the number of intervals in either depth or permeability is also noted.

A complicating factor in the assessment is the variability of the land surface area in the TSF footprint. To effectively assess seepage consideration of clay cover, depth of tailings, hydraulic head and permeability is required. It is particularly relevant in areas with minimal tailings cover as the presence of a hydraulic driving head for seepage generation would be absent. Conversely, in zones with extensive tailings depth (greater than 40 m), it could be possible that seepage rates are controlled by the permeability of the tailings mass and not the liner. Finally, in this assessment consolidation of tailings were not included and outcomes of seepage rates should be viewed as a conservative estimate of infiltration rates.

Table 26
Variable Ranges for Monte Carlo Simulations

(a) In Situ Soils

Parameter	Thickness (m)	Depth Intervals	Saturated K (m/s)	K Intervals
Fluid (Y)	0 (saturated)	1	-	-
Tailings (T) Class 1	0 / 1-50	0 / 10	$5x10^{-7}$ - $1x10^{-6}$	2
Tailings (T) Class 2	1-30 / 1-50	6 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
Tailings (T) Class 3	1-32 / 1-50	7 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
In Situ Clay Soils (L)	0.1-1.5	6	$1x10^{-10}$ - $1x10^{-8}$	4
Host Rock (F)	6	1	$1x10^{-8}$ - $1x10^{-6}$	3

(b) Clay Liner 1m Thick at 1 x 10^{-9}m/s

Parameter	Thickness (m)	Depth Intervals	Saturated K (m/s)	K Intervals
Fluid (Y)	0 (saturated)	1	-	-
Tailings (T) Class 1	0 / 1-50	0 / 10	$5x10^{-7}$ - $1x10^{-6}$	2
Tailings (T) Class 2	1-30 / 1-50	6 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
Tailings (T) Class 3	1-32 / 1-50	7 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
Clay Liner	1.0	1	$1x10^{-9}$	1
In Situ Clay Soils (L)	0.1-1.5	6	$1x10^{-10}$ - $1x10^{-8}$	4
Host Rock (F)	6	1	$1x10^{-8}$ - $1x10^{-6}$	3

(c) In Situ Clays Liner Minimum 0.3m Thick

Parameter	Thickness (m)	Depth Intervals	Saturated K (m/s)	K Intervals
Fluid (Y)	0 (saturated)	1	-	-
Tailings (T) Class 1	0 / 1-50	0 / 10	$5x10^{-7}$ - $1x10^{-6}$	2
Tailings (T) Class 2	1-30 / 1-50	6 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
Tailings (T) Class 3	1-32 / 1-50	7 / 11	$1x10^{-7}$ - $1x10^{-6}$	3
In Situ Clays Compacted Liner	0.3	1	$1x10^{-8}$ – 1 x 10^{-10}	4
In Situ Clay Soils (L)	0.1-1.5	6	$1x10^{-10}$ - $1x10^{-8}$	4
Host Rock (F)	6	1	$1x10^{-8}$ - $1x10^{-6}$	3

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5.4.5 Seepage Model Rates

Due to the TSF lifts resulting in different stage heights and aerial extent, the number of parameters generated are substantial. To simplify the presentation of the data, box-and-whisker diagrams are used to illustrate general trends and results.

Outcomes of the Monte Carlo simulation for the three modelled scenarios as outlined above are presented in **Plate 27** with variable thickness of overlying tailings (TSF Stage). Discharge rates indicates that increase with depth/Stage of development, with a greater increase in the vertical seepage for the in situ soils (no lining). Both the EPA Solid Waste Landfill Guideline (1m at 10^{-9}m/s) and proposed liner using the in situ clays indicates a smaller range over which discharge values are reported and the distribution is grouped in the lower range for seepage rates. Both lining systems have comparable performance, although noting that this model assessment does not consider the additional seepage management features of the proposed multi-barrier system. Median seepage rates are presented in **Table 27** for RL943m and RL962m, the values are comparable to that obtained for the SeepW model results.

Plate 27
1D Seepage Model Results

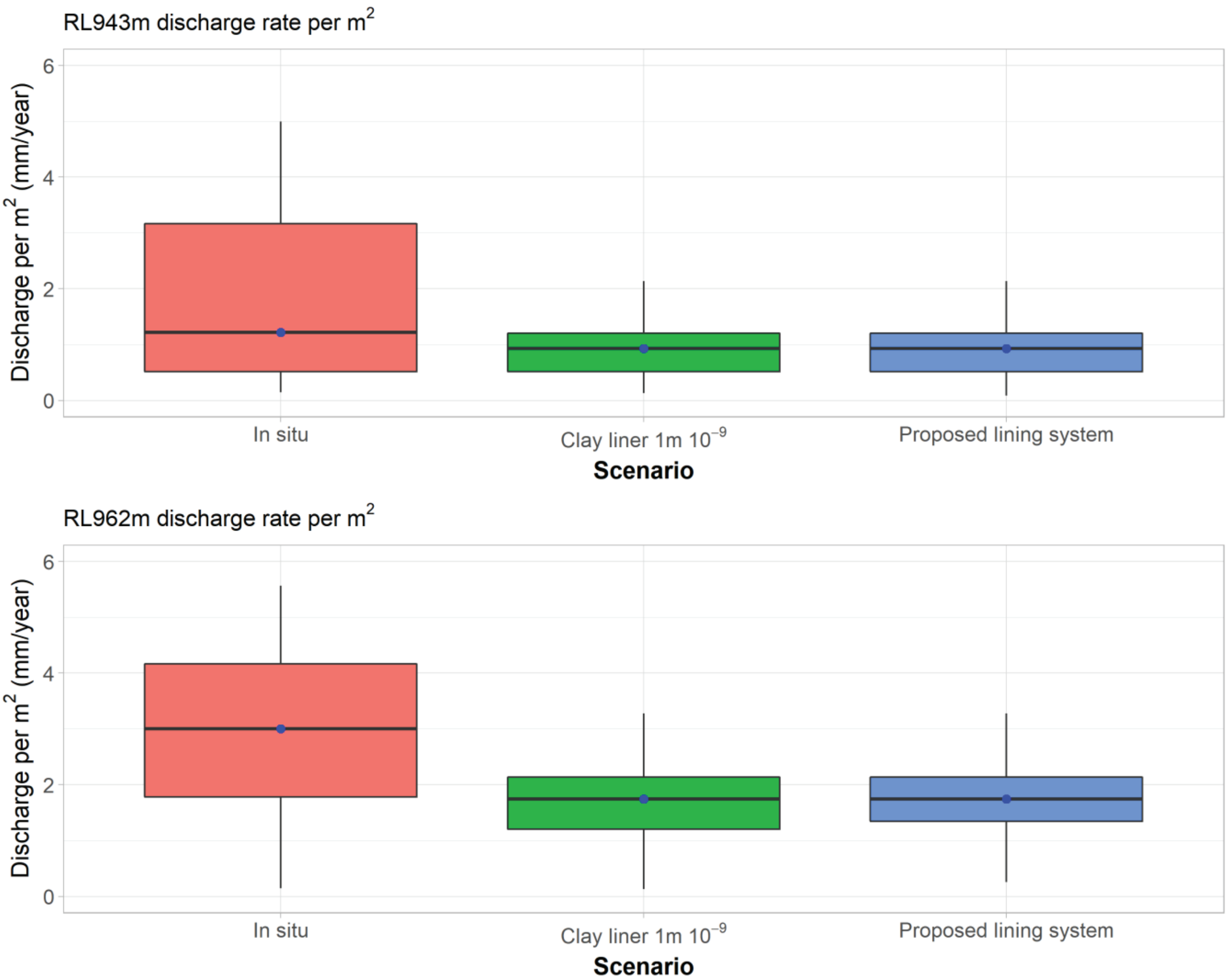

Table 27
Median Discharge Rates (mm/year) over Total Footprint

Model Scenario	RL 943m Beach Elevation	RL 962m Beach Elevation
In situ Conditions	0.76	2.86
Clay Liner 1,000mm at 10^{-9}m/s	0.42	1.62
Proposed Lining System	0.42	1.66

5.5 Seepage Assessment Discussion

Based on the above 1D seepage assessment and with consideration of the seepage modelling as conducted as part of the initial feasibility assessment (ATCW, 2019), the following discussion is provided:

- Using in situ and imported clays within the TSF storage area will achieve an overall equivalent seepage performance to a 1m thick clay liner at $1x10^{-9}$m/s permeability. The in situ clay liner (and using locally imported clays) proposed represents some 86% of the total TSF storage area.
- Enhancing the liner thickness in the areas of the existing drainage features and beneath the decant structure as shown on the Drawings, will comprise a minimum 1.0m at $1x10^{-9}$m/s liner. This liner area represents some 8% of the total TSF storage area.
- Engineered Liner such as a GCL would be provided in areas of limited clays and unsuitable clays as defined in the drawings. This area represents an area of some 6% of the total TSF storage area and would be installed as part of the Stage 1B, 2 and 3, generally on the upper slopes/ridge areas.
- In addition to the lining of the TSF storage, proposed other features for the TSF seepage management include the following:
  - Embankment Cut-Off key and Embankment Clay Core to minimise the lateral seepage movement at the embankment perimeter.
  - Seepage Interception Trench beneath the main embankment to intersect seepage flows within the upper zone of the foundations. This trench is proposed to be constructed to a depth of 6m.
  - Seepage monitoring bores sited at the downstream extent of the TSF to monitor groundwater.
- Further investigations to validate the above and provide input for the “For Construction” documentation of the TSF. These works are envisaged to include the following:
  - Geophysical survey of the TSF storage area and embankment footprint to define geological features (faulting/fracturing which may form conduits for groundwater movement) and thickness of soils/clays within the storage area.
  - Additional test-pitting and foundation bores as required to validate design parameters.

With the above modelling and proposed further investigation and analysis, it is considered that the proposed TSF multi-barrier seepage management system provides a robust system and exceeds the performance of the EPA Solid Waste Landfill Guidelines.

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DRAWINGS

REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

LOCALITY PLAN
SCALE: 1:200,000

DRAWING LIST

DWG NO.	DRAWING TITLE	REVISION
1000-001	SITE LOCALITY PLAN AND DRAWING LIST	A
1000-002	EXISTING SITE CONDITIONS	A
1000-003	DESIGN LAYOUT PLAN	A
1000-101	TAILINGS STORAGE FACILITY (TSF) STAGE 1A GENERAL LAYOUT	A
1000-102	TAILINGS STORAGE FACILITY (TSF) STAGE 1B GENERAL LAYOUT	A
1000-103	TAILINGS STORAGE FACILITY (TSF) STAGE 2 GENERAL LAYOUT	A
1000-104	TAILINGS STORAGE FACILITY (TSF) STAGE 3 GENERAL LAYOUT	A
1000-105	TAILINGS STORAGE FACILITY (TSF) LIFE OF MINE GENERAL LAYOUT	A
1000-201	TSF SURFACE PREPARATION PLAN AND SECTIONS	A
1000-210	TSF MAIN EMBANKMENT PLAN AND SECTIONS	A
1000-211	SEEGAGE COLLECTION SYSTEM DETAILS	A
1000-220	MINE WATER MANAGEMENT FACILITY (MWMF) PLAN AND SECTIONS	A
1000-221	TSF STAGE 3 SPILLWAY PLAN AND SECTIONS	A
1000-230	TSF CONTAINMENT EMBANKMENT PLAN AND SECTIONS	A
1000-240	TSF RUNOFF INTERSECPTION DAM PLAN AND SECTIONS	A
1000-250	EASTERN DIVERSION DRAIN PLAN AND LONG SECTIONS 1 OF 3	A
1000-251	EASTERN DIVERSION DRAIN PLAN AND LONG SECTIONS 2 OF 3	A
1000-252	EASTERN DIVERSION DRAIN PLAN AND LONG SECTIONS 3 OF 3	A
1000-253	EASTERN DIVERSION DRAIN SECTION AND DETAILS	A
1000-260	TSF BEACH DRAIN PLAN AND SECTIONS	A
1000-270	DECANT CAUSEWAY LAYOUT PLAN	A
1000-271	DECANT CAUSEWAY SECTIONS	A
1000-301	POST CLOSURE LAYOUT PLAN	A
1000-302	POST CLOSURE DETAILS	A
1000-401	WATER MANAGEMENT LAYOUT PLAN AND DETAILS	A
1000-501	INSTRUMENTATION LAYOUT PLAN AND DETAILS	A
1000-601	GEOTECHNICAL TSF INVESTIGATIONS	A
1000-701	SURFACE GEOLOGY	A

GENERAL CONSTRUCTION NOTES

1. THESE NOTES APPLY TO ALL PROJECT DRAWINGS IN THE SET UNLESS NOTED OTHERWISE AND SHALL BE READ IN CONJUNCTION WITH THE SPECIFICATION.
2. ALL LEVELS ARE IN METRES TO AUSTRALIAN HEIGHT DATUM (AHD).
3. ALL COORDINATES ARE IN METRES TO MAP GRID AUSTRALIAN (MGA-55).
4. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
5. DIMENSIONS AND LOCATIONS OF EXISTING STRUCTURES SHALL BE CONFIRMED ON SITE BY THE CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS.
6. LOCATION AND DEPTH OF ALL SERVICES TO BE VERIFIED BY THE CONTRACTOR PRIOR TO THE COMMENCEMENT OF WORKS.
7. DIMENSIONS SHALL NOT BE SCALED OFF DRAWINGS.

FOR TENDER PURPOSES ONLY

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE:	1:200,000
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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SITE LOCALITY PLAN
AND DRAWING LIST

1000-001

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

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DATED: 24 APR 2018

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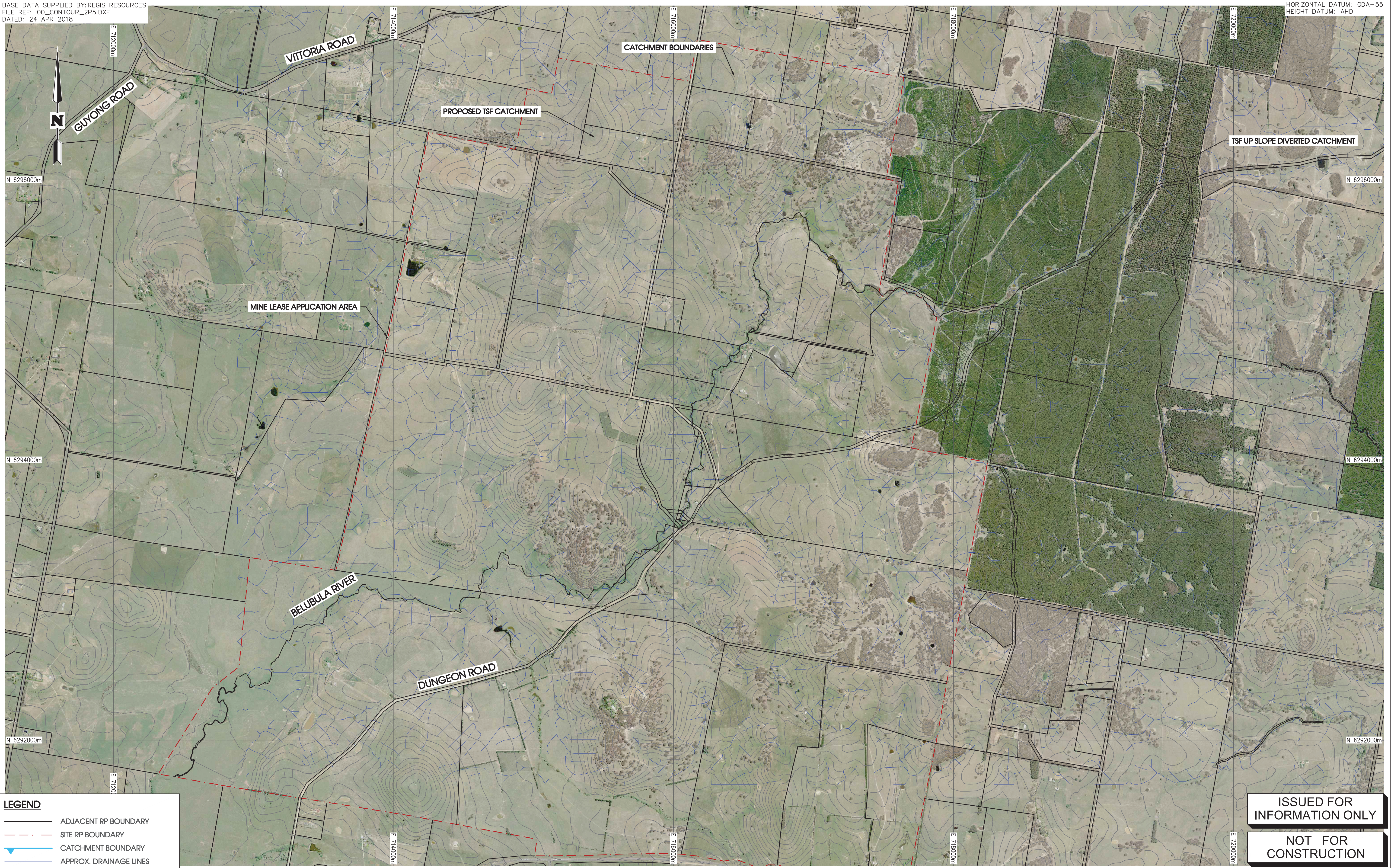
HEIGHT DATUM: AHD



LEGEND

- ADJACENT RP BOUNDARY
- SITE RP BOUNDARY
- CATCHMENT BOUNDARY
- APPROX. DRAINAGE LINES

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EXISTING SITE CONDITIONS

1000-002

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SHEET 1 OF 1

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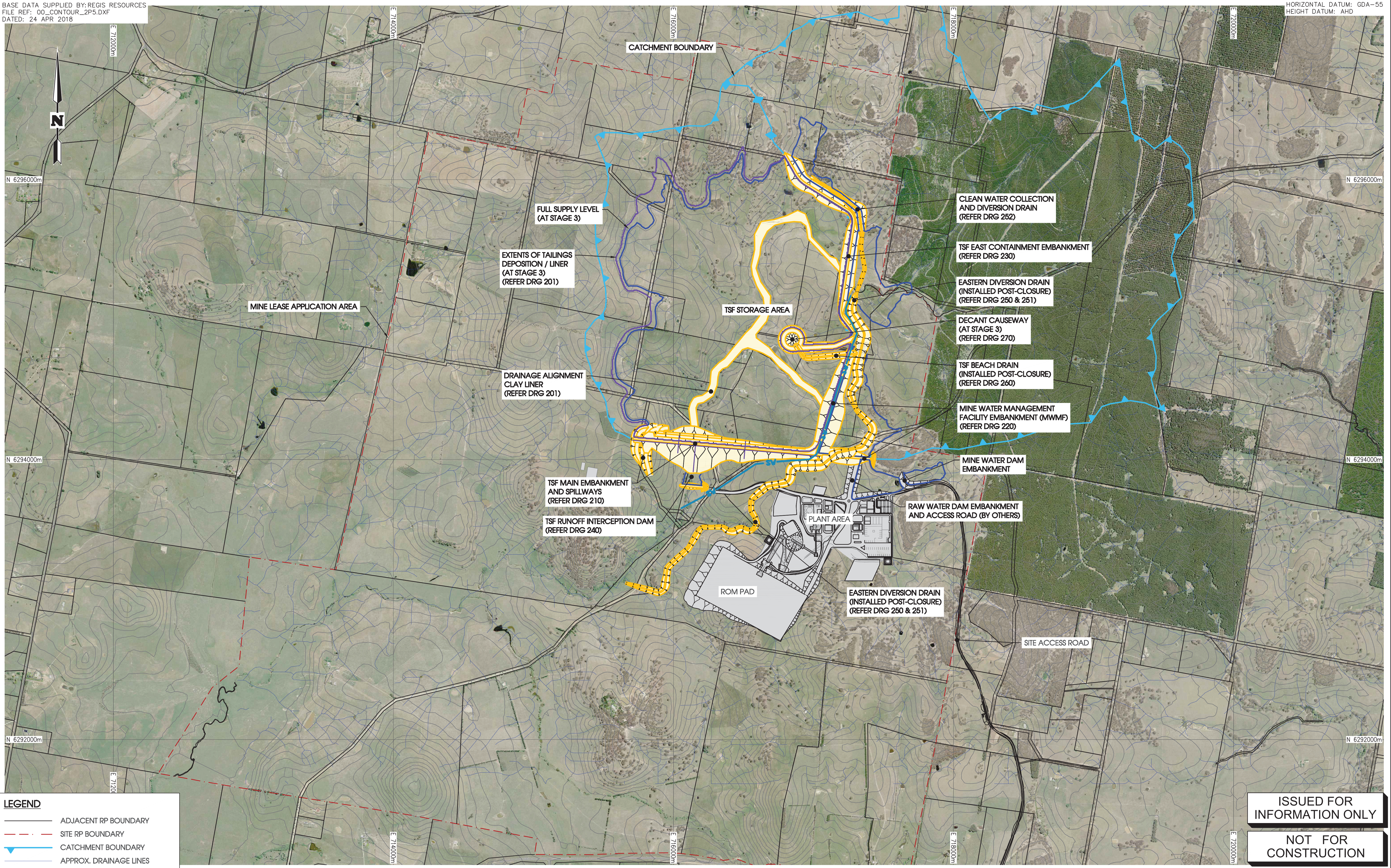

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JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
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APPROVED	GS

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DESIGN LAYOUT PLAN

1000-003

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

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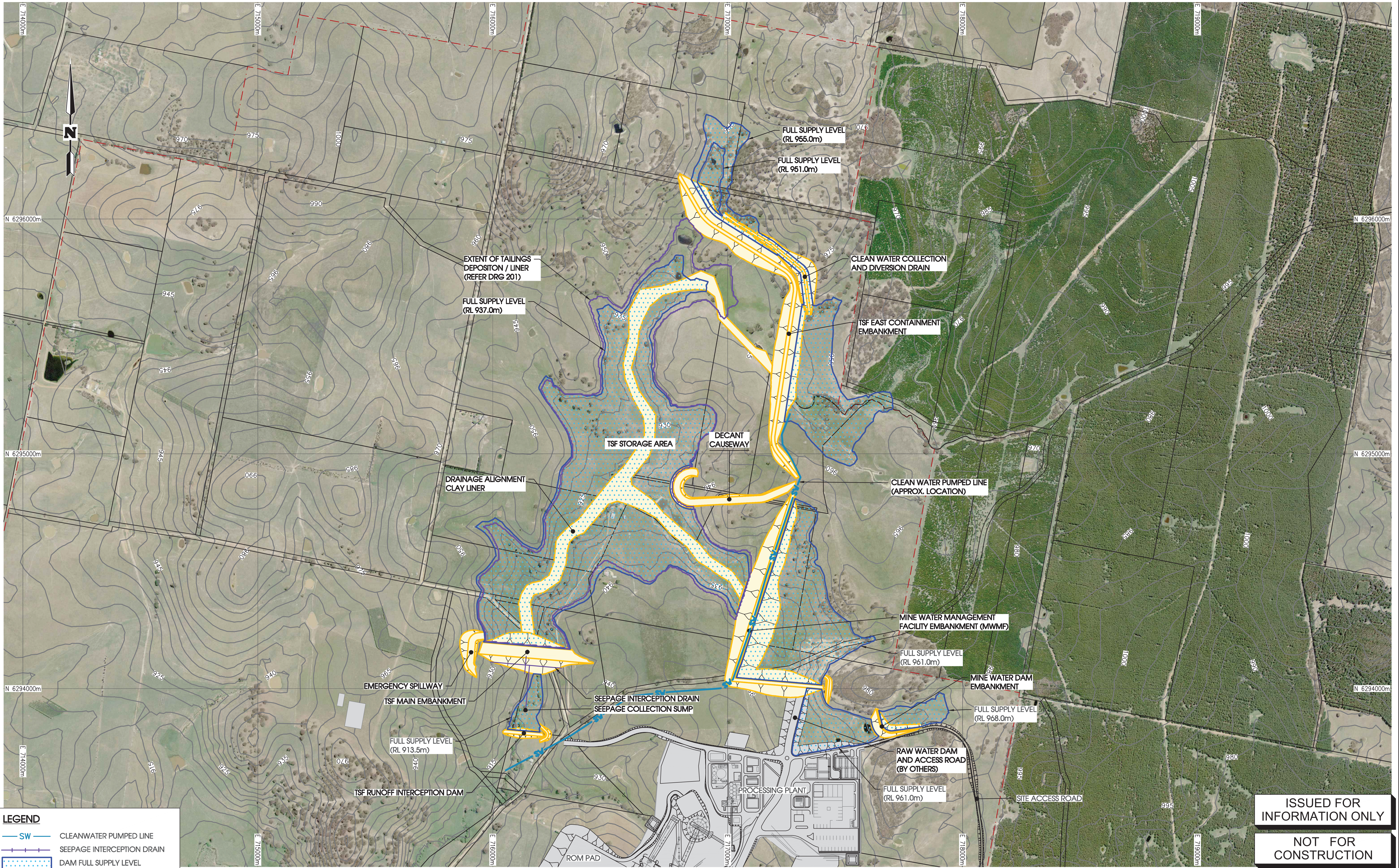

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DATE	MAR. 2020
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DRAWN	MJC
CHECKED	RH
APPROVED	GS

CHECK PRINT
PRELIMINARY
ISSUED FOR REVIEW / COMMENT / APPROVAL

	INITIALS	COMMENTS	DATE
1. DRAFTER			
2. CHECKER			
3. PROJECT MANAGER			

ALTERATIONS REQUIRED SHOWN IN RED PEN
INFORMATION FOR ENGINEER / DRAFTER IN BLUE PEN

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...h@atcwilliams.com.au

REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TAILINGS STORAGE FACILITY (TSF)
STAGE 1A GENERAL LAYOUT

1000-101

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

Plotted By: MichealL Plotted Time: 10:55:18 Plotted Date: 22/07/20

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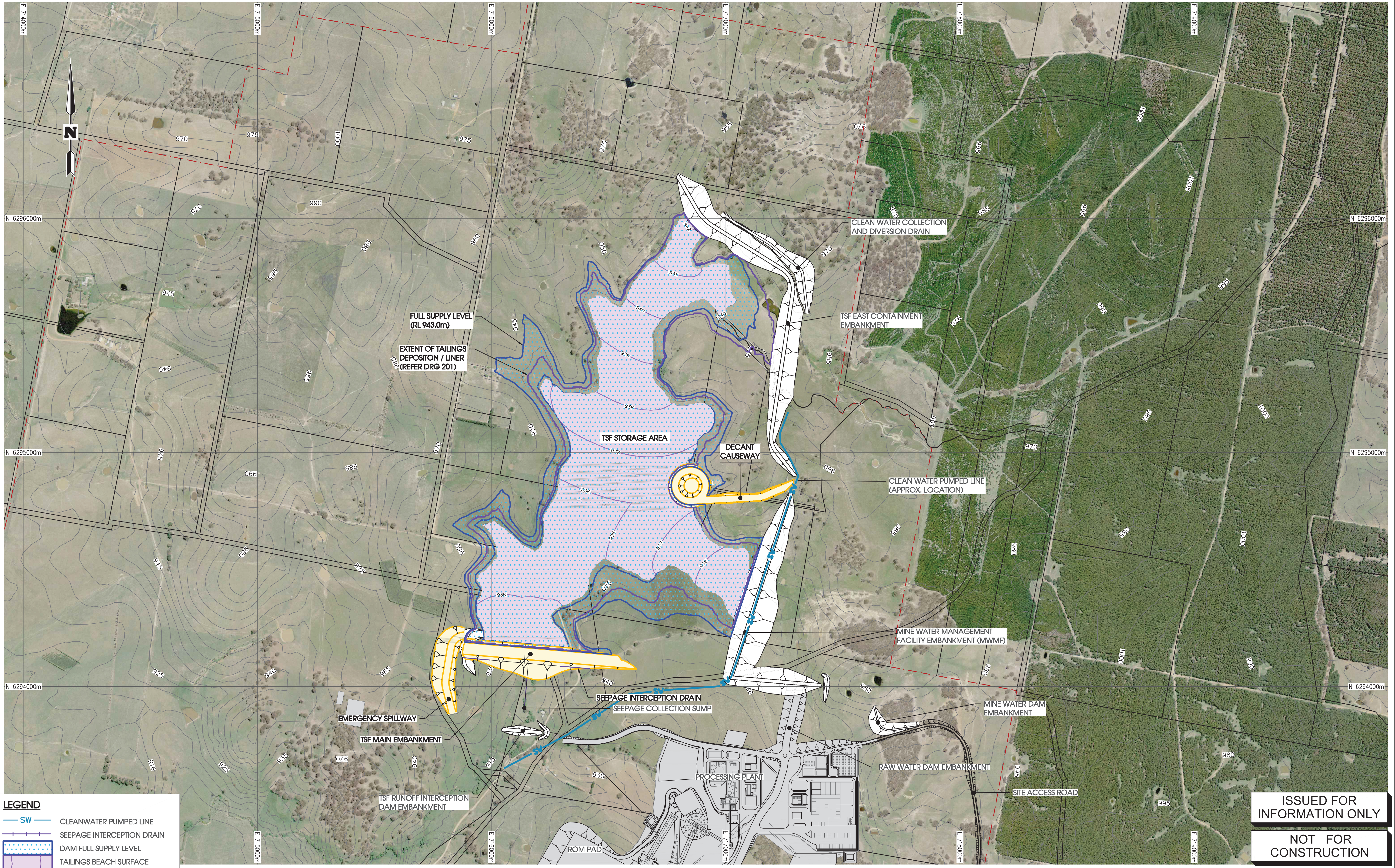

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A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE: 1:15,000	
JOB No.	113272-02
DATE	MAR. 2020
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MCPHILLAMYS GOLD PROJECT

TAILINGS STORAGE FACILITY (TSF)
STAGE 1B GENERAL LAYOUT

1000-102

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted By: MichaelL Plotted Time: 10:55:54 Plotted Date: 22/07/20

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DATE	MAR. 2020
DESIGN	MJC
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TAILINGS STORAGE FACILITY (TSF)
STAGE 2 GENERAL LAYOUT

1000-103

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 10:56:32 Plotted By: MichealL

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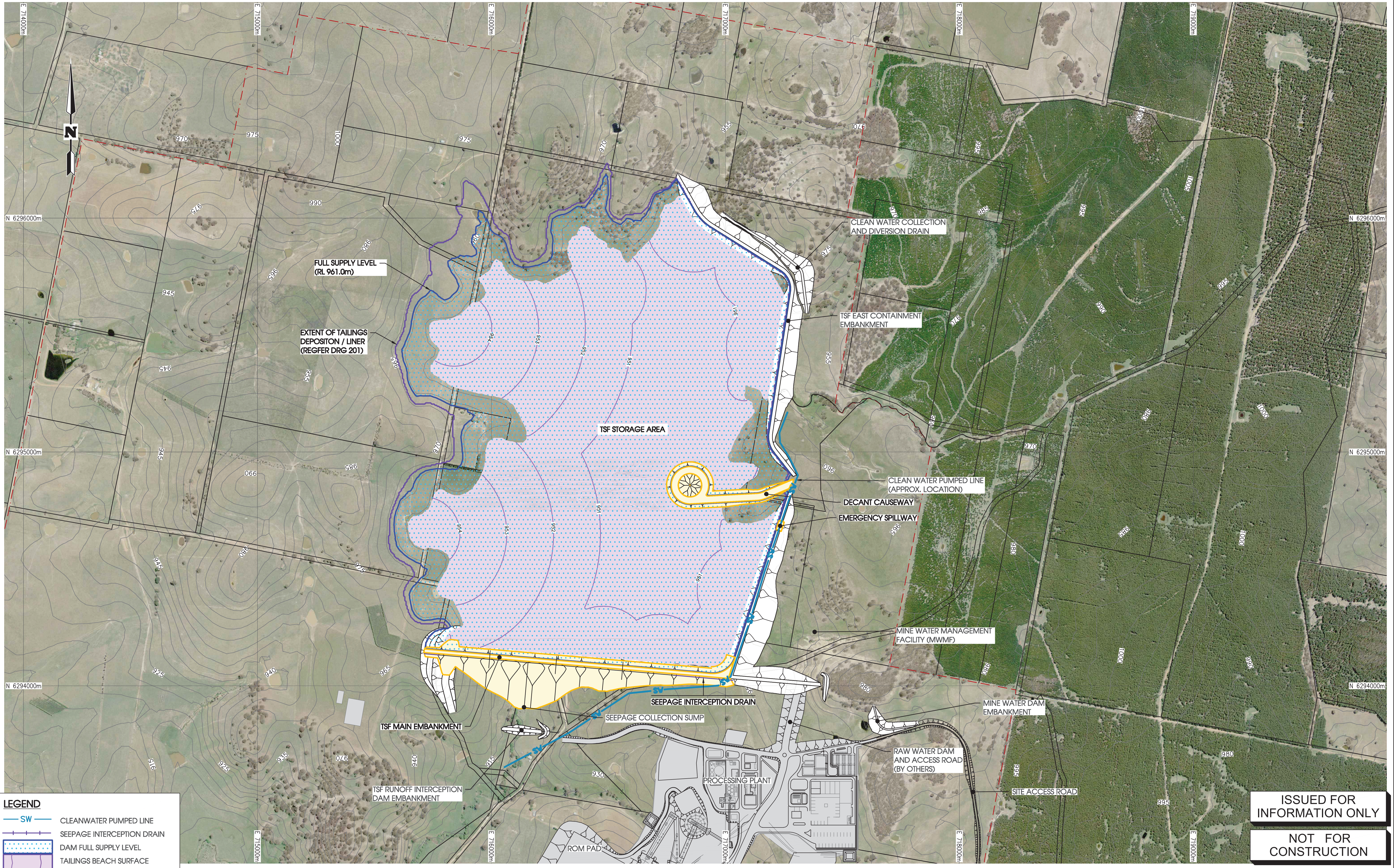

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A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

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JOB No.	113272-02
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MCPHILLAMYS GOLD PROJECT

TAILINGS STORAGE FACILITY (TSF)
STAGE 3 GENERAL LAYOUT

1000-104

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted By: MichaelL Plotted Time: 10:57:08 Plotted Date: 22/07/20

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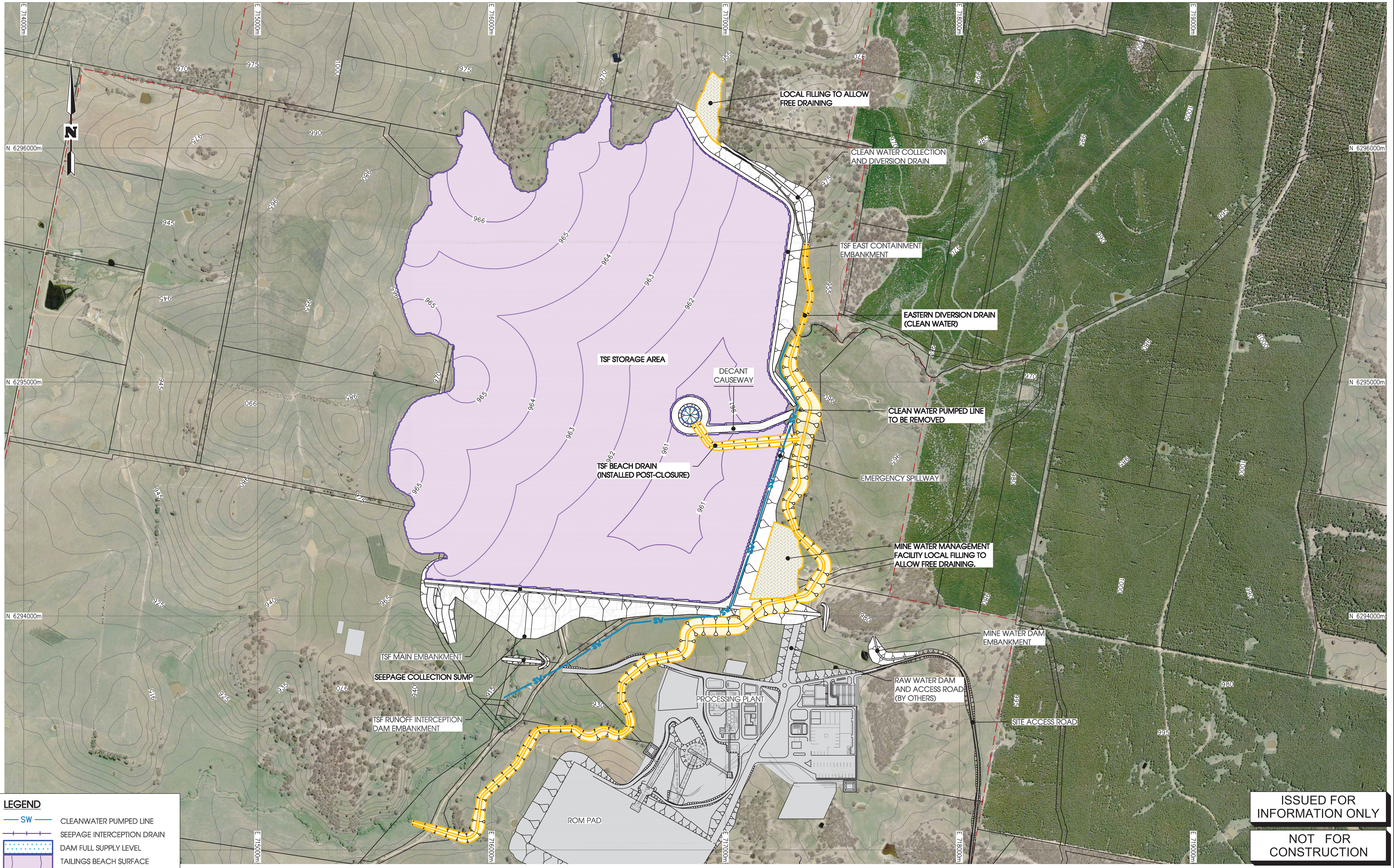

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE:	1:15,000
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TAILINGS STORAGE FACILITY (TSF)
LIFE OF MINE GENERAL LAYOUT

1000-105

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 10:57:45 Plotted By: MichaelL

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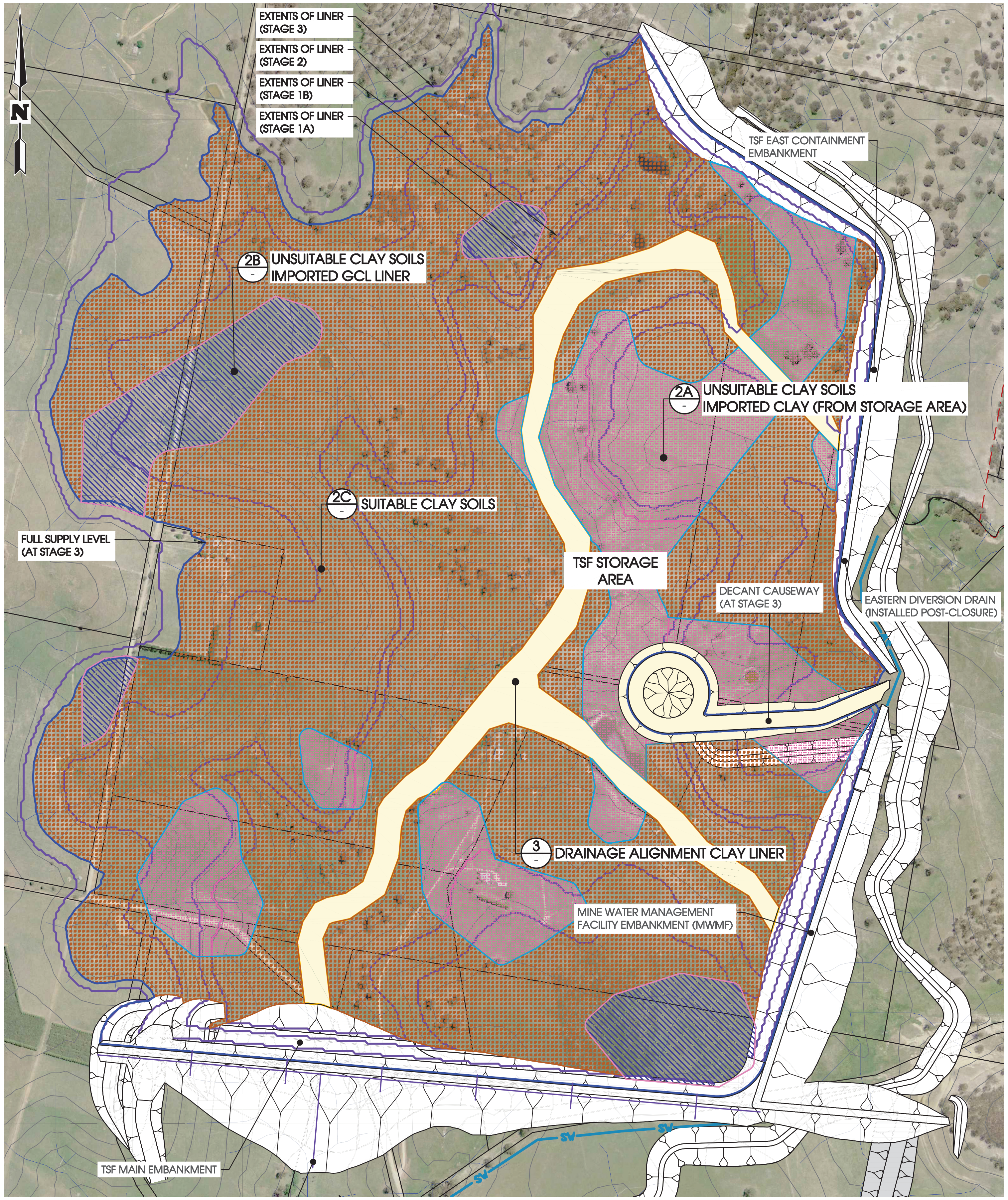

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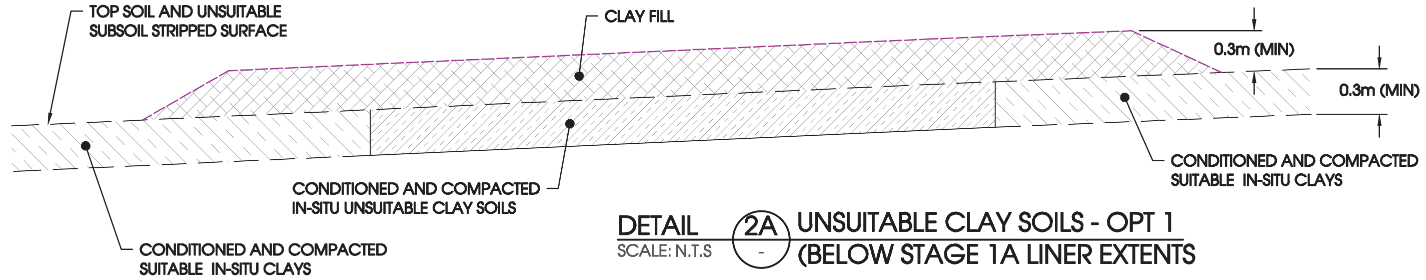
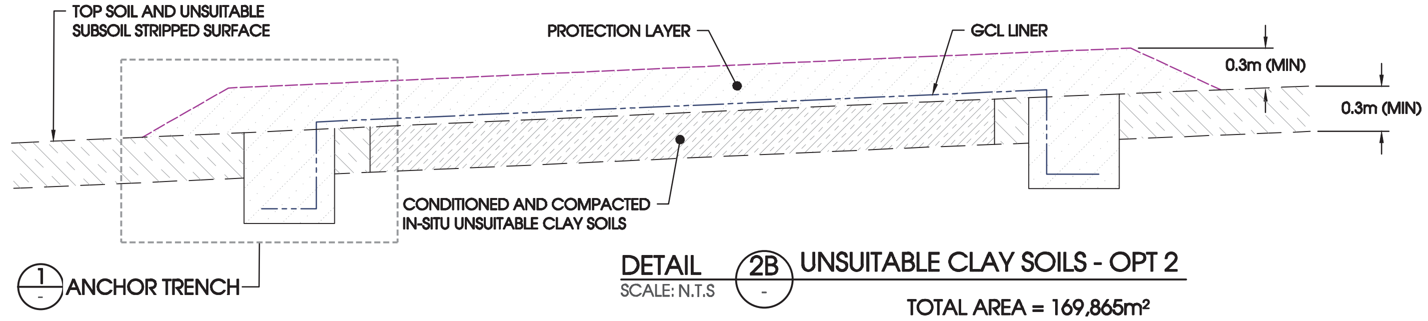
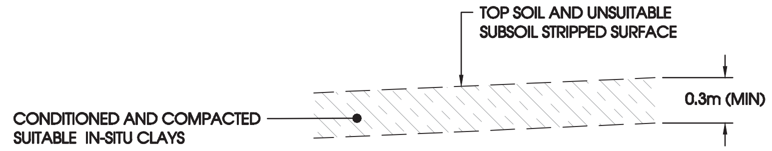
SCALE: 1:10,000



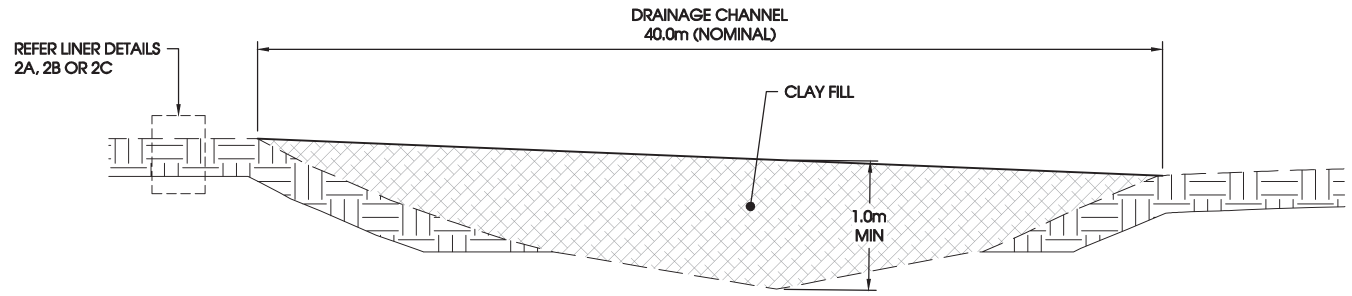
DETAIL 2A UNSUITABLE CLAY SOILS - OPT 1 (BELOW STAGE 1A LINER EXTENTS
SCALE: N.T.S
TOTAL AREA = 489,296m²



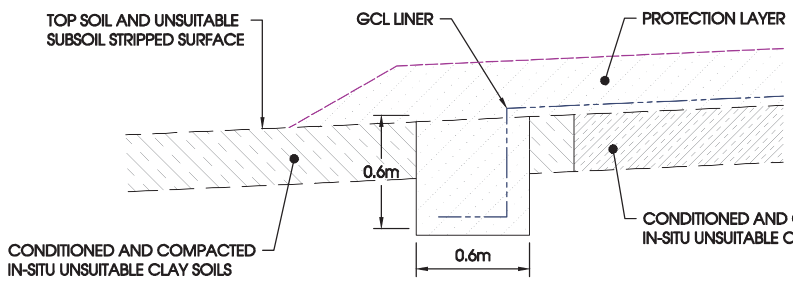
DETAIL 2B UNSUITABLE CLAY SOILS - OPT 2
SCALE: N.T.S
TOTAL AREA = 169,865m²



DETAIL 2C SUITABLE CLAY SOILS
SCALE: N.T.S
TOTAL AREA = 1,848,881m²



DETAIL 3 DRAINAGE ALIGNMENT CLAY LINER
SCALE: 1:200
TOTAL AREA = 157,456m²



DETAIL 1 ANCHOR TRENCH
SCALE: 1:40

LEGEND

- RESIDUAL SUITABLE CLAY SOILS (REFER DETAIL 2C)
- UNSUITABLE CLAY SOILS - STAGE 1A AND BELOW (REFER DETAIL 2A)
- UNSUITABLE CLAY SOILS - STAGE 1A AND ABOVE (REFER DETAIL 2B)
- DRAINAGE CHANNEL LINER

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF SURFACE PREPARATION
PLAN AND SECTIONS

1000-201

SHEET SIZE A2 Rev. A

SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 10:58:25 Plotted By: MicheaIL

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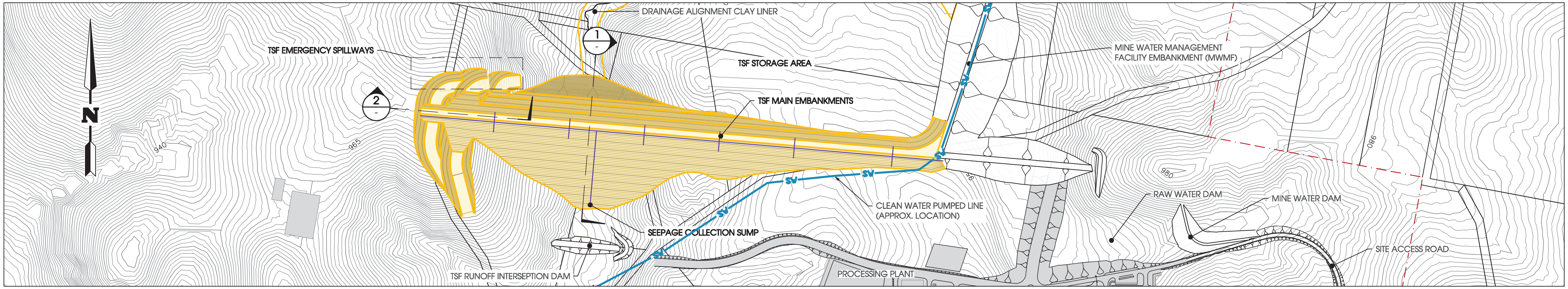

PLAN
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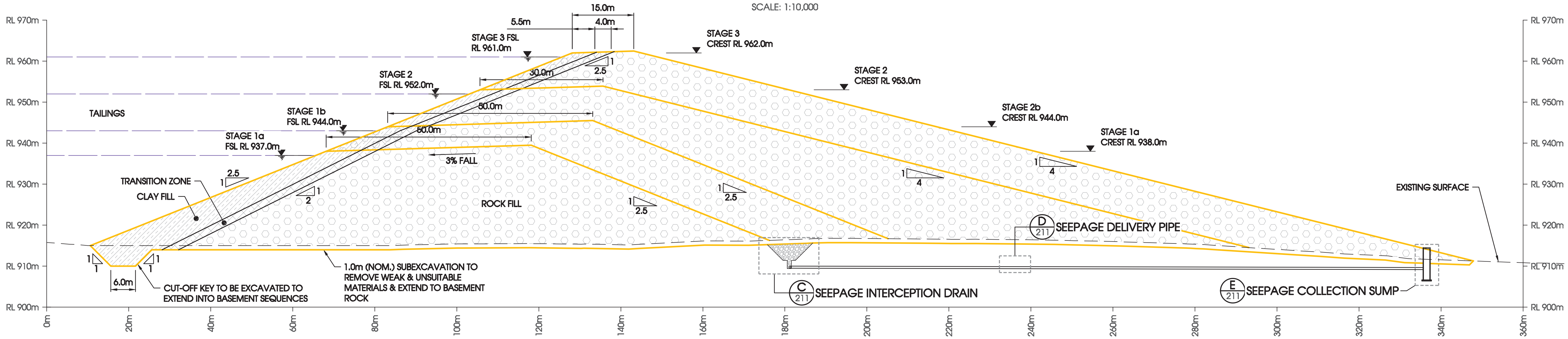
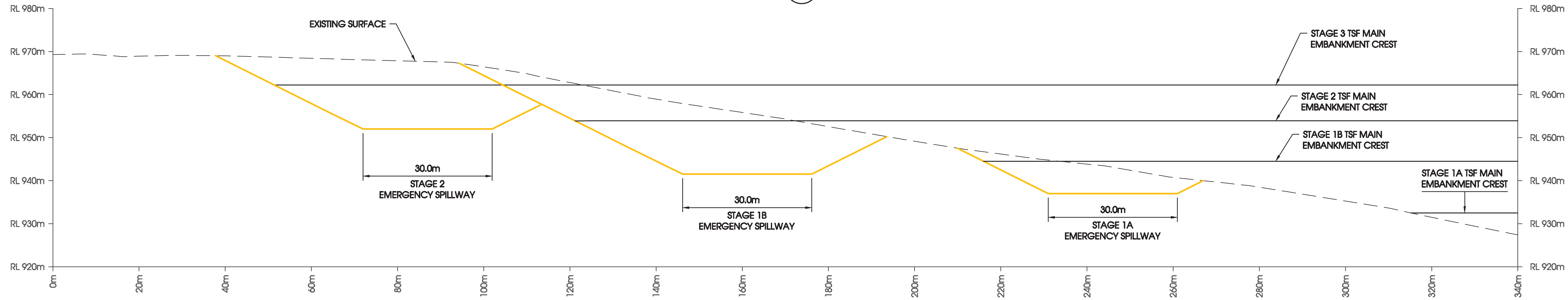


SECTION 1 TSF MAIN EMBANKMENT
SCALE: 1:1000



SECTION 2 STAGE 1A, 1B & 2 TSF EMERGENCY SPILLWAY
SCALE: 1:2000

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SCALE:	AS SHOWN
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF MAIN EMBANKMENT
PLAN AND SECTIONS

1000-210

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

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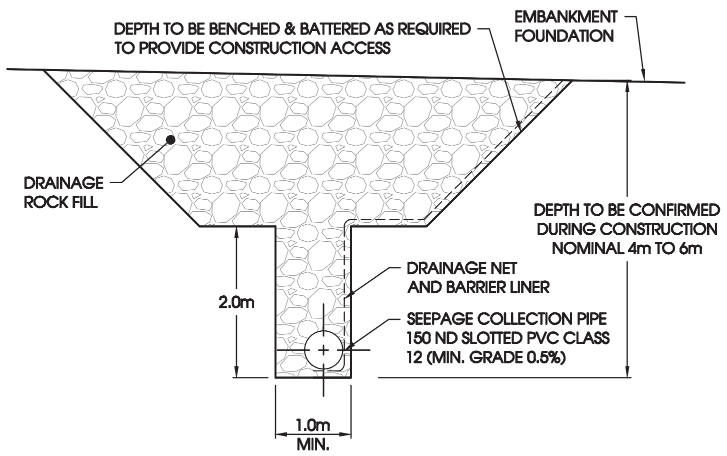
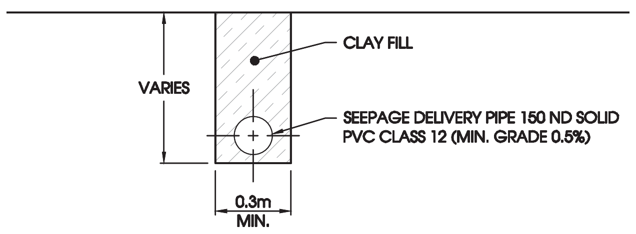
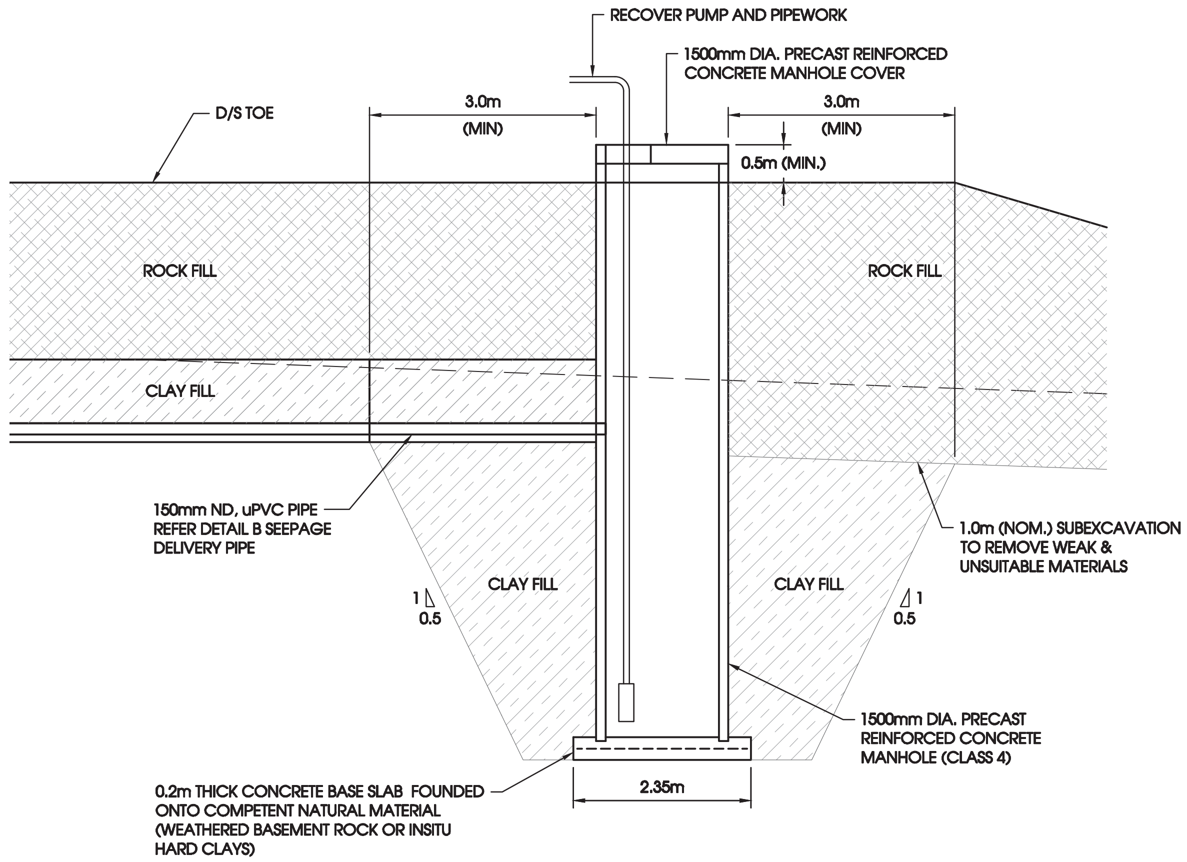


DETAIL C/210 SEEPAGE INTERCEPTION DRAIN
SCALE: 1:100



DETAIL D/210 SEEPAGE DELIVERY PIPE
SCALE: 1:100



DETAIL E/210 SEEPAGE COLLECTION SUMP
SCALE: NTS

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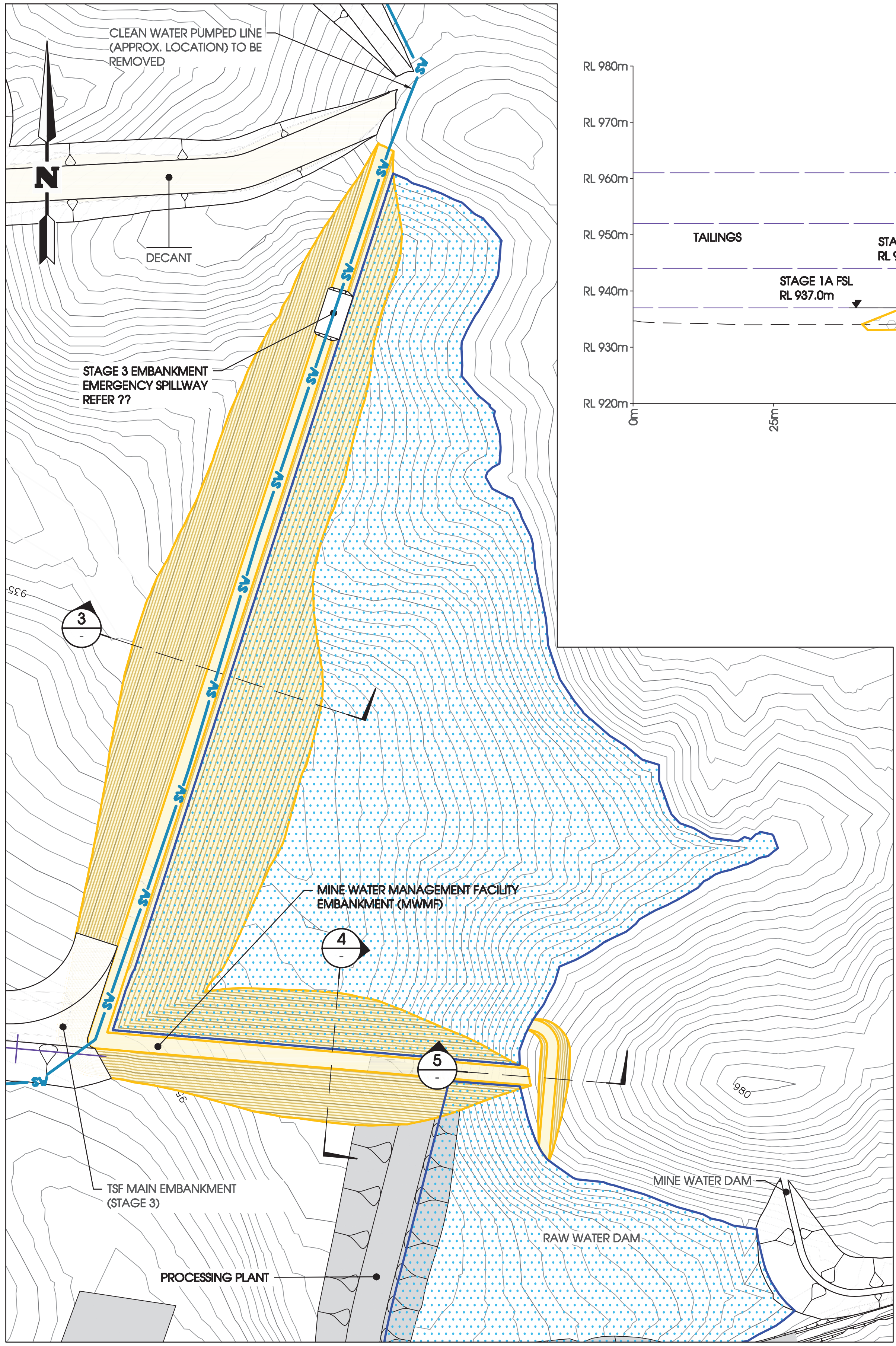
REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

SEEGAGE COLLECTION SYSTEM
DETAILS

1000-211

SHEET SIZE A4 Rev. A

SHEET 1 OF 1



PLAN
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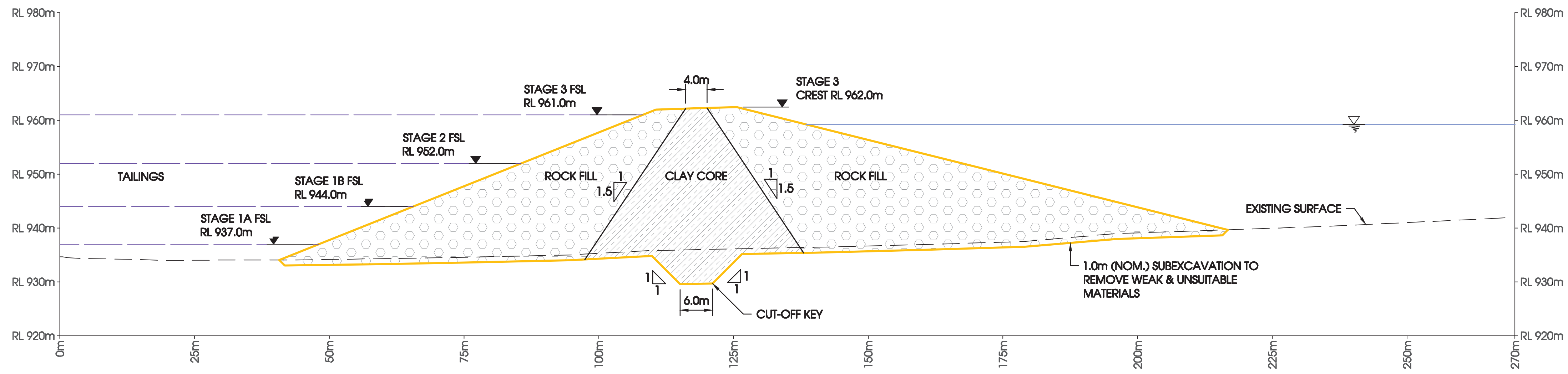
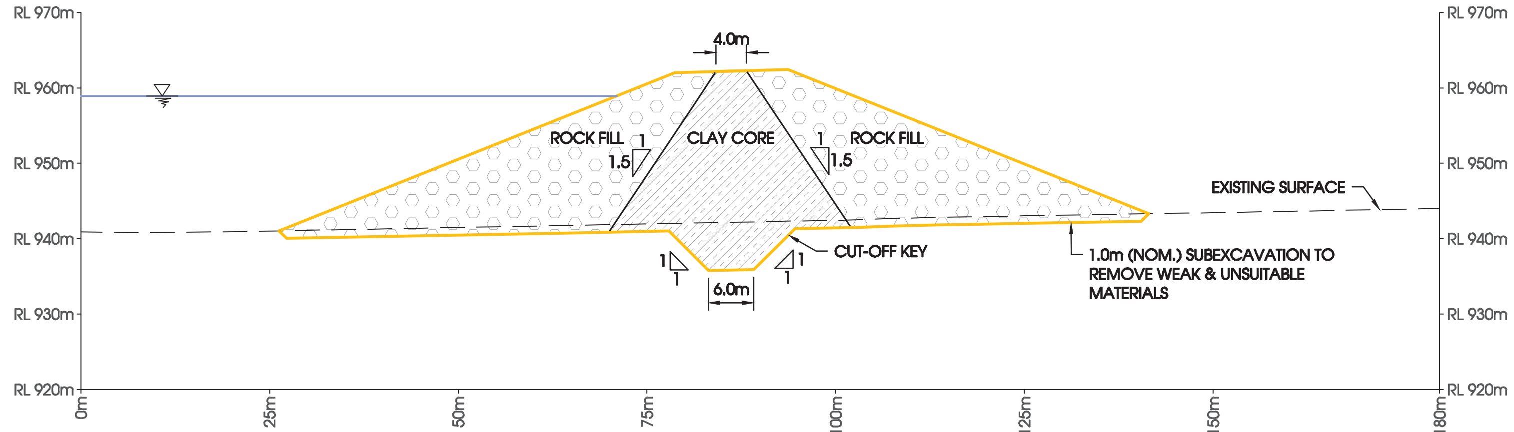
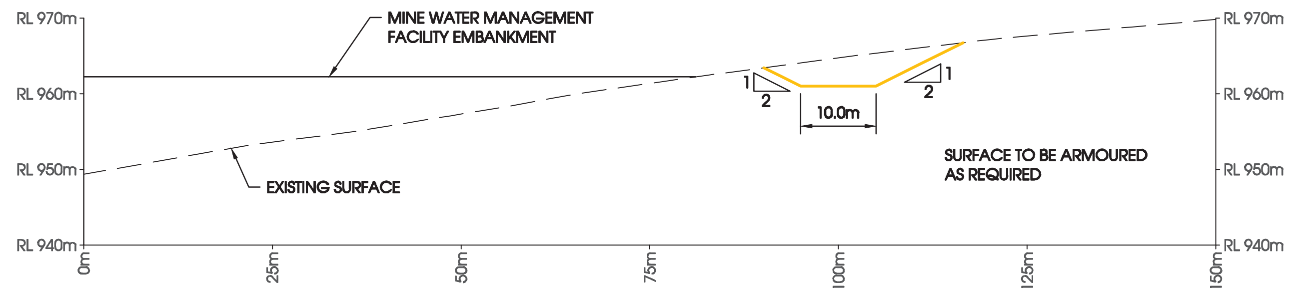


SECTION 3 MINE WATER MANAGEMENT FACILITY
SCALE: 1:1000



SECTION 4 MINE WATER MANAGEMENT FACILITY
SCALE: 1:1000



SECTION 5 SPILLWAY SECTION
SCALE: 1:1000

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DATE	MAR. 2020
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DRAWN	REF
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

MINE WATER MANAGEMENT FACILITY (MWMF)
PLAN AND SECTIONS

1000-220

SHEET SIZE A3 Rev. A

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SHEET 1 OF 2

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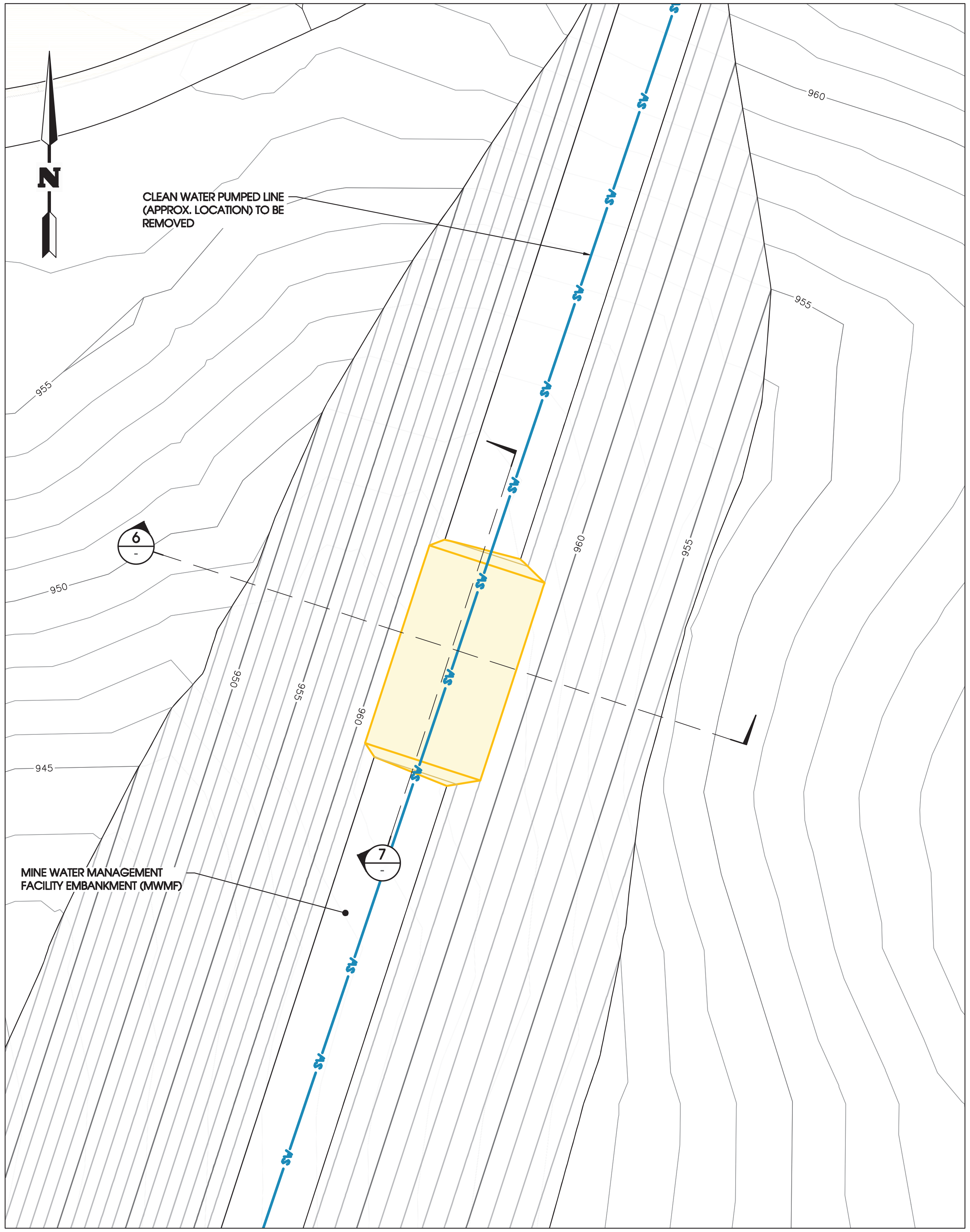

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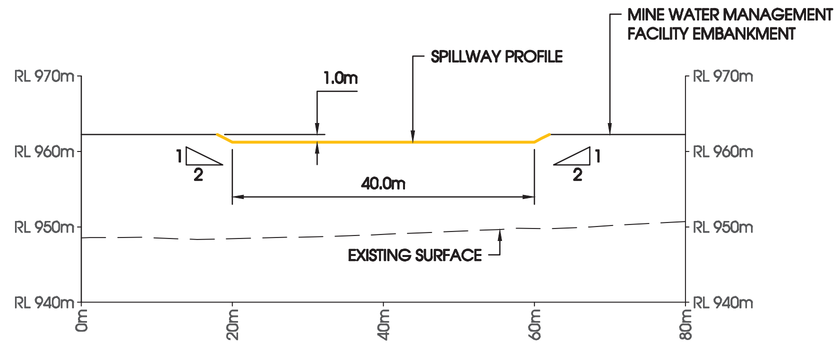
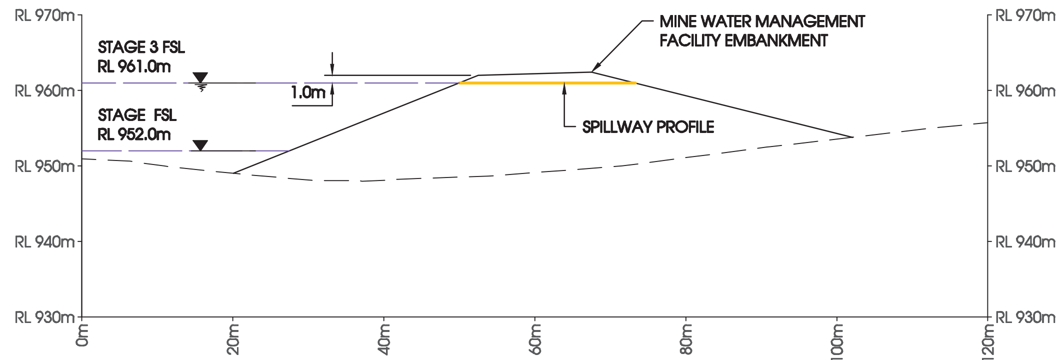


SECTION 7 STAGE 3 SPILLWAY
SCALE: 1:1000



SECTION 6 STAGE 3 SPILLWAY
SCALE: 1:1000

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF STAGE 3 SPILLWAY
PLAN AND SECTIONS

1000-221

SHEET SIZE A3 Rev. A

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SHEET 2 OF 2

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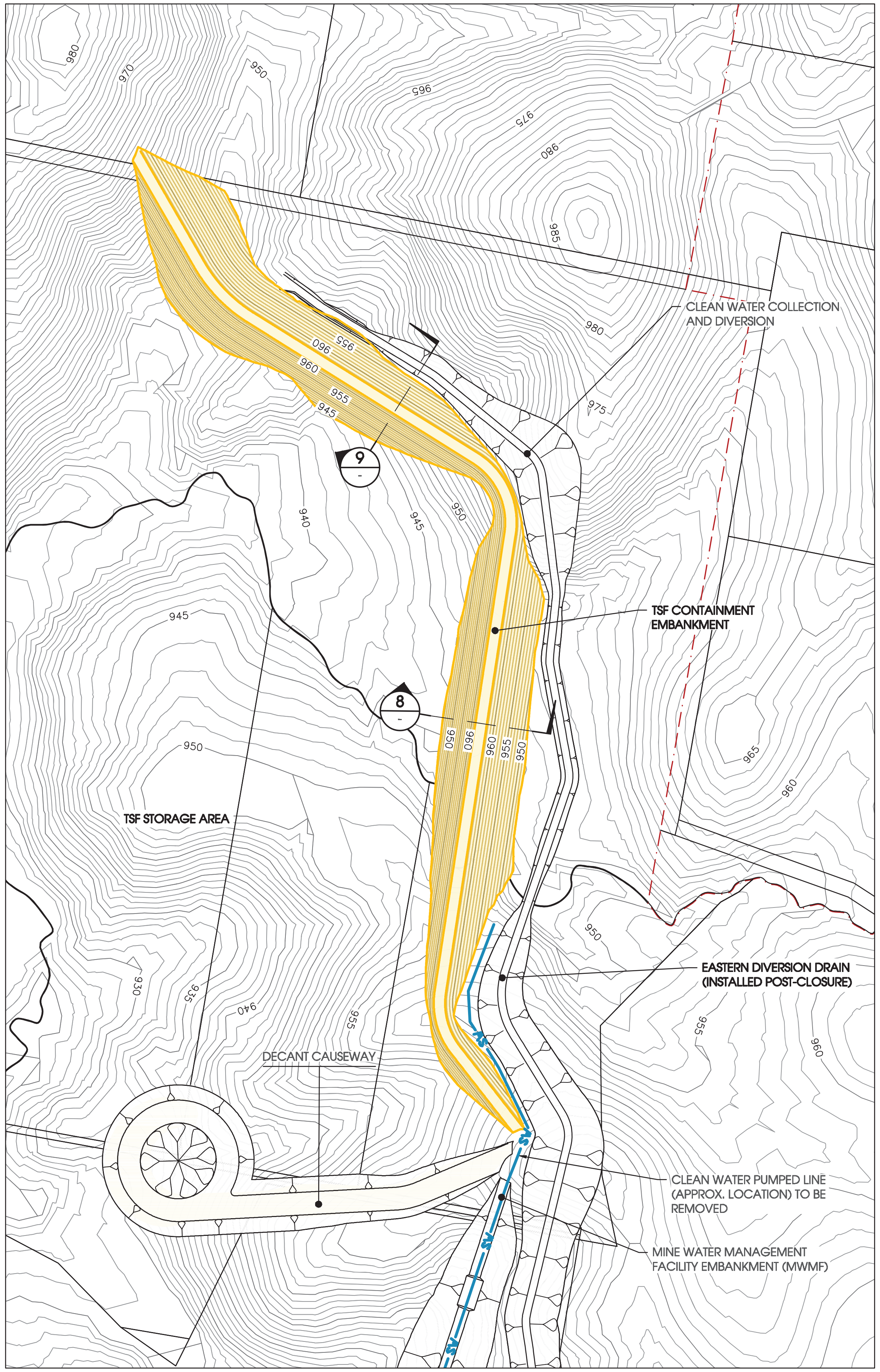
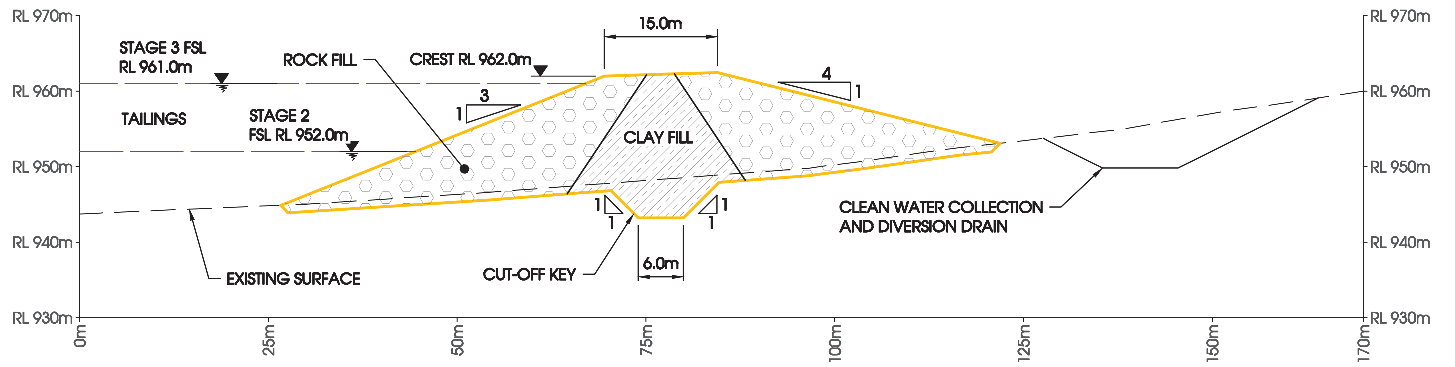
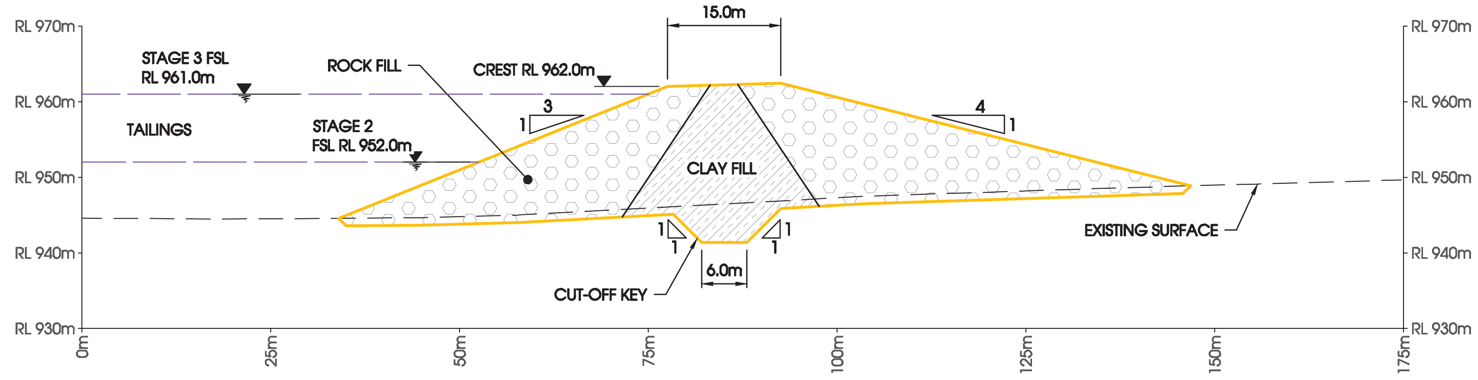




SECTION 9 EASTERN CONTAINMENT EMBANKMENT

SCALE: 1:1000



SECTION 8 EASTERN CONTAINMENT EMBANKMENT

SCALE: 1:1000

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

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DATE	MAR. 2020
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF CONTAINMENT EMBANKMENT
PLAN AND SECTIONS

1000-230

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

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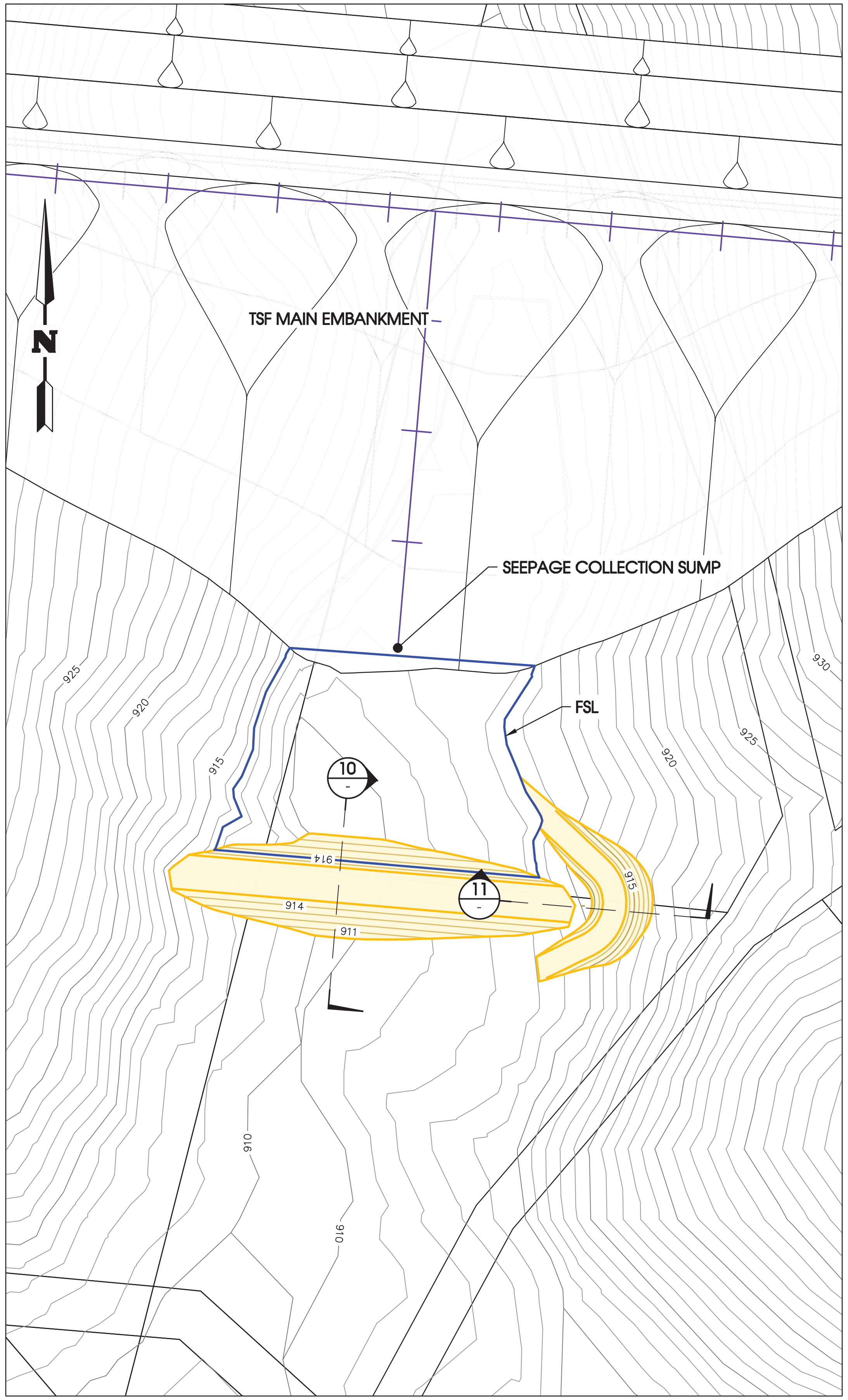

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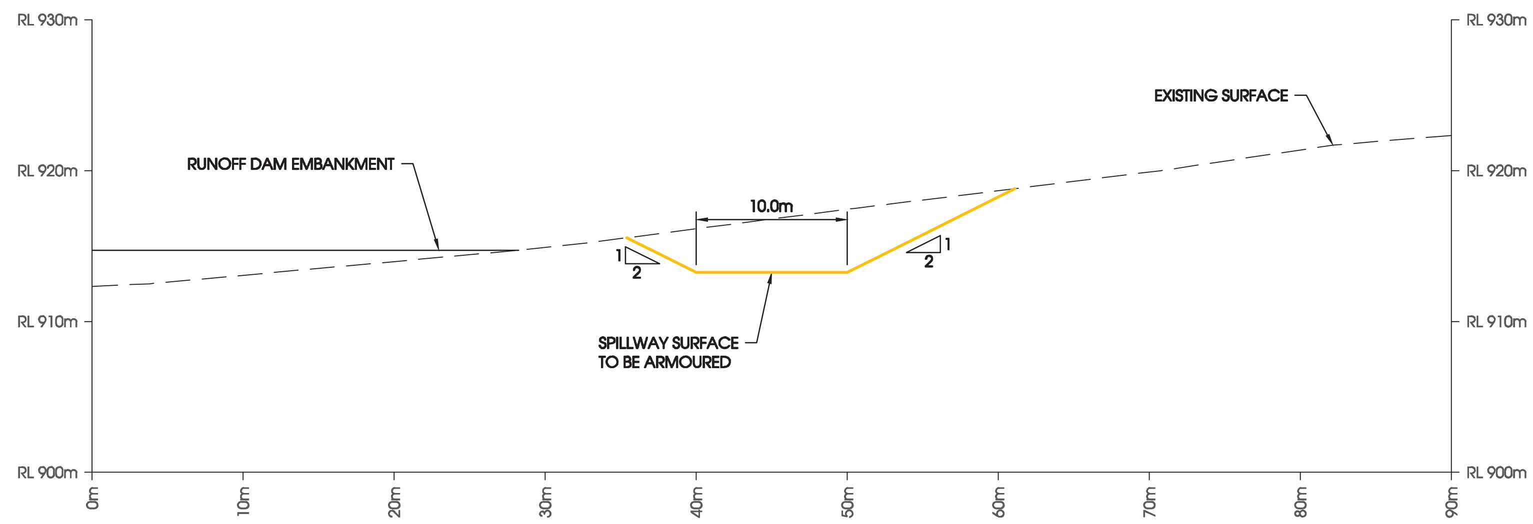
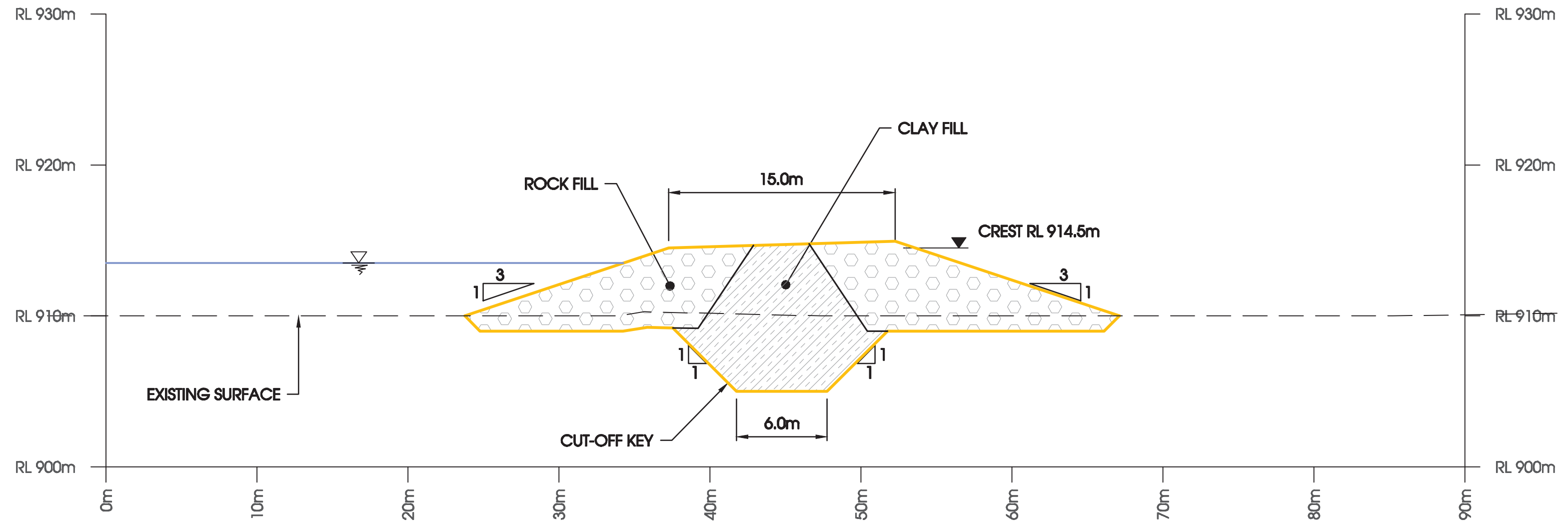


SECTION 11 SPILLWAY
SCALE: 1:500



SECTION 10 RUNOFF DAM EMBANKMENT
SCALE: 1:500

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF RUNOFF INTERSECPTION DAM
PLAN AND SECTIONS

1000-240

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 11:01:16 Plotted By: MichealL

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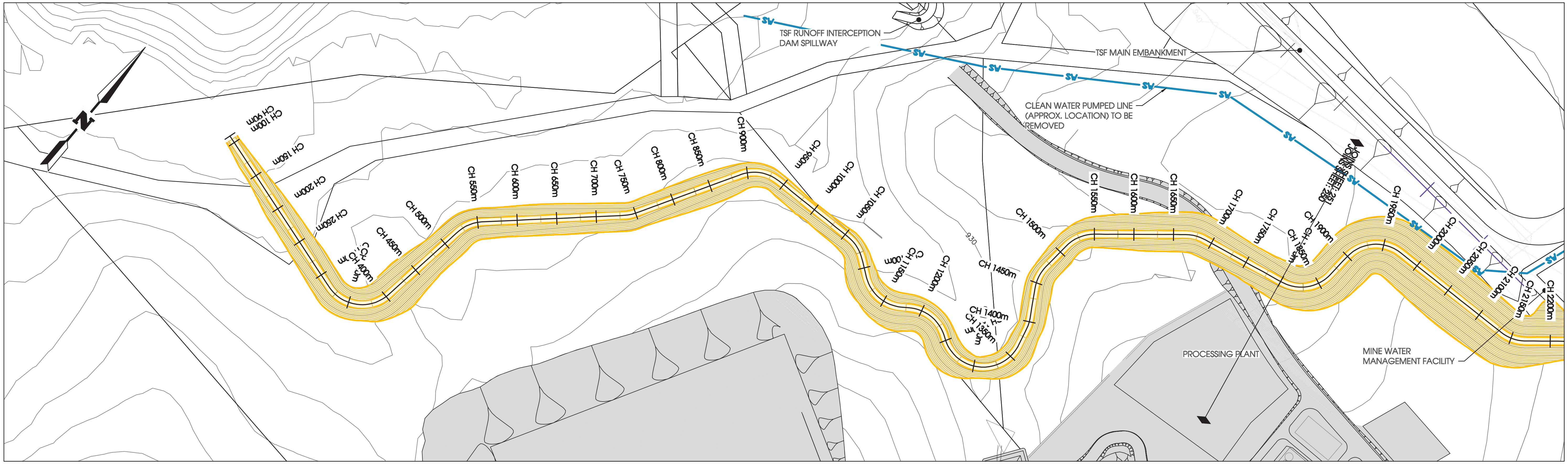
PLAN



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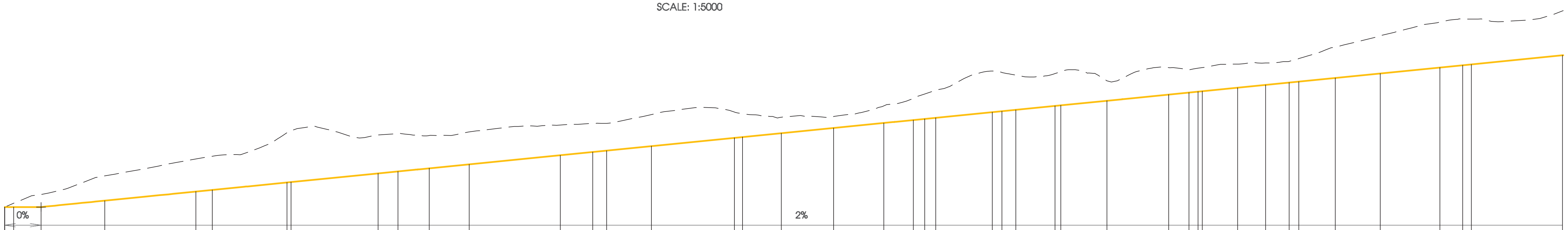

Vertical Geometry Grade (%): 0% | 2%

DATUM RL 885

HORIZONTAL CURVE RADIUS (m): R -50m, R 50m, R -50m, R 50m, R 50m, R -50m, R 50m, R -50m, R -50m, R 50m, R 50m, R 50m

MINE WATER MANAGEMENT FACILITY EMB: –

CONTROL LINE CHAINAGE	DESIGN SURFACE (EASTERN DIVERSION DRAIN)	EXISTING SURFACE
90		901.00
90.15		901.00
100	901.00	901.00
130	901.00	903.77
200	902.40	907.88
300	904.40	911.59
318.04	904.76	912.18
400	906.40	917.38
404.33	906.49	917.76
500	908.40	916.88
521.69	908.83	917.21
556.2	909.52	916.75
600	910.40	917.53
700	912.40	919.04
735.51	913.11	919.43
750.84	913.42	919.41
800	914.40	921.36
891.07	916.22	921.90
900	916.40	921.53
942.68	917.25	920.77
1000	918.40	920.92
1055.19	919.50	923.28
1087.61	920.15	924.94
1100	920.40	925.90
1112.1	920.64	926.68
1174.1	921.88	930.93
1184.68	922.09	930.63
1200	922.40	930.03
1243.02	923.26	930.38
1249.44	923.39	930.83
1300	924.40	928.80
1367.76	925.76	931.69
1390.03	926.20	931.24
1400	926.40	931.58
1404.77	926.50	931.70
1443.58	927.27	932.47
1474.12	927.88	932.70
1500	928.40	933.05
1510.7	928.61	933.68
1550.67	929.41	936.25
1600	930.40	938.74
[illegible]	931.71	941.73
[illegible]	932.21	942.41
[illegible]	932.40	942.38
[illegible]	934.40	944.18

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EASTERN DIVERSION DRAIN
HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:1000

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	REF
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

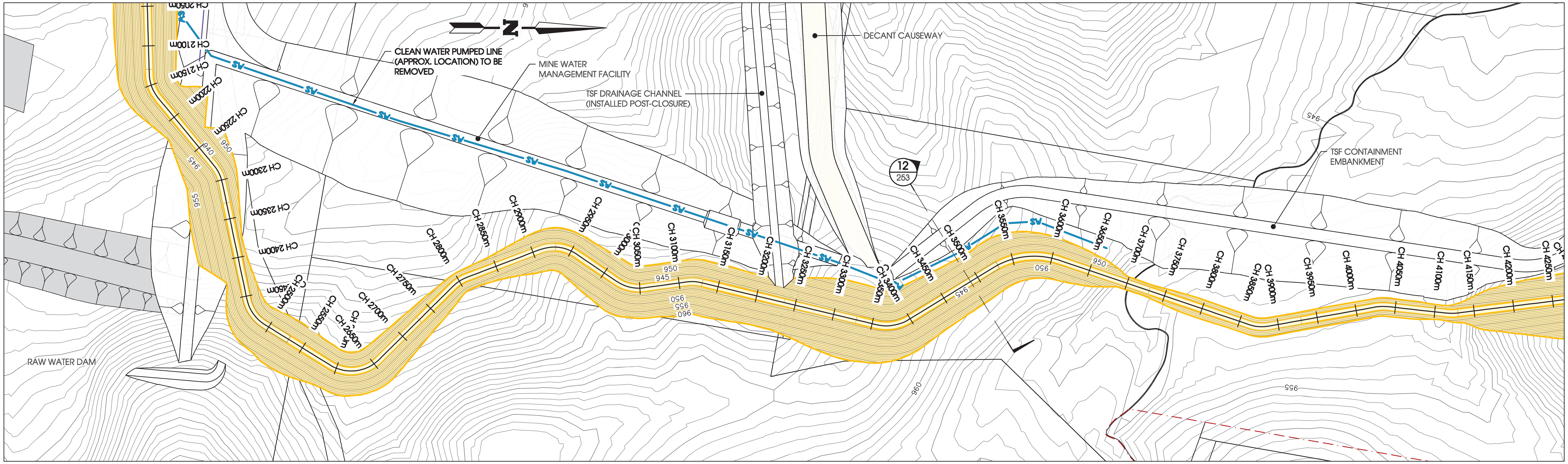
EASTERN DIVERSION DRAIN PLAN AND LONG SECTIONS 1 OF 3

1000-250

SHEET SIZE A3 | Rev. A

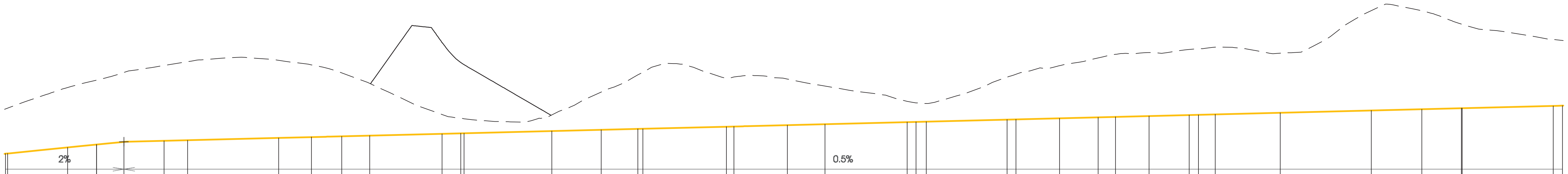
SHEET 1 OF 2

Plotted By: MichealL Plotted Time: 11:01:47 Plotted Date: 22/07/20



PLAN

SCALE: 1:5000



Vertical Geometry Grade (%): 2%, 0.5%

DATUM RL 885

HORIZONTAL CURVE RADIUS (m): R -50m, R 50m, R -50m, R 50m, R -50m, R -50m, R 50m, R 50m, R -50m, R 50m, R -55m

CONTROL LINE CHAINAGE	DESIGN SURFACE (EASTERN DIVERSION DRAIN)	EXISTING SURFACE	MINE WATER MANAGEMENT FACILITY EMBANKMENT
1800	934.40	944.18	
1802.33	934.45	944.36	
1868.22	935.76	948.88	
1899.91	936.40	950.50	
1900	936.40	950.50	
1930	937.00	952.18	
1974.04	937.22	953.69	
2000	937.35	954.53	
2100	937.85	954.82	
2136.09	938.03	953.83	
2169.23	938.20	952.07	
2200	938.35	949.77	
2279.41	938.75	942.98	958.75
2300	938.85	942.14	954.33
2303.55	938.87	942.05	953.88
2400	939.35	942.87	
2454.18	939.62	947.90	
2494.56	939.82	951.67	
2500	939.85	952.23	
2591.83	940.31	950.92	
2600	940.35	951.20	
2658.64	940.64	950.74	
2700	940.85	949.21	
2790.23	941.30	945.86	
2800	941.35	945.53	
2811.21	941.41	945.39	
2900	941.85	951.16	
2909.8	941.90	951.79	
2957.78	942.14	953.67	
3000	942.35	955.33	
3019.2	942.45	956.14	
3055.92	942.63	956.53	
3100	942.85	957.22	
3110.15	942.90	957.32	
3128.79	942.99	957.72	
3200	943.35	956.40	
3300	943.85	965.69	
[illegible]	944.13	965.66	
[illegible]	944.34	962.74	
[illegible]	944.35	962.67	
[illegible]	944.85	959.38	
[illegible]	944.90	959.18	

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EASTERN DIVERSION DRAIN

HORIZONTAL SCALE 1:5000

VERTICAL SCALE 1:1000

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	REF
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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

EASTERN DIVERSION DRAIN
PLAN AND LONG SECTIONS 2 OF 3

1000-251

SHEET SIZE A3 | Rev. A

SHEET 2 OF 2

Plotted Date: 22/07/20 Plotted Time: 11:02:20 Plotted By: MichealL
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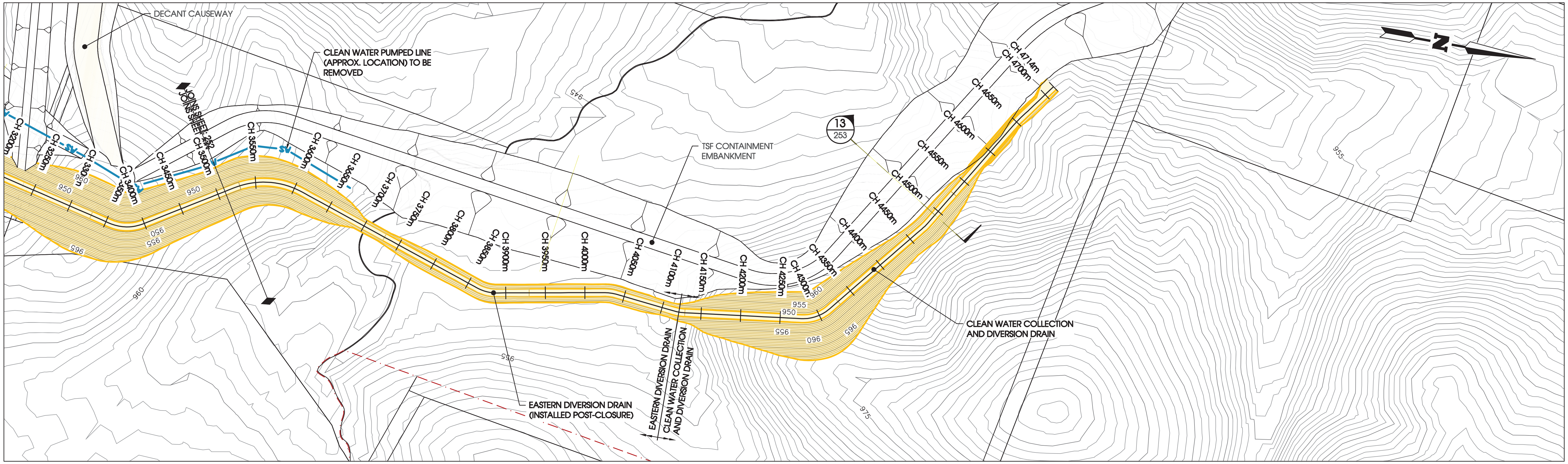
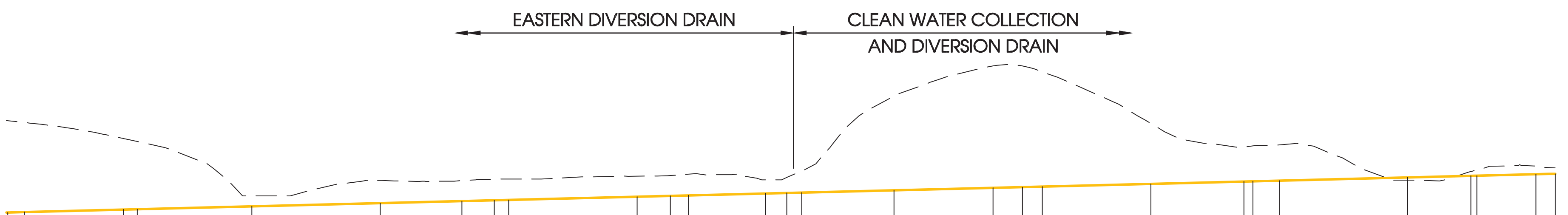


PLAN
SCALE: 1:5000



Vertical Geometry Grade (%): 0.5%

DATUM RL 885

MINE WATER MANAGEMENT FACILITY EMB

CONTROL LINE CHAINAGE	HORIZONTAL CURVE RADIUS (m)	DESIGN SURFACE (EASTERN DIVERSION DRAIN)	EXISTING SURFACE
3510		944.90	959.18
3522.93	R 100m	944.96	958.91
3600		945.35	956.43
3610.81		945.40	955.96
3700		945.85	947.50
3800		946.35	949.88
3863.54	R -50m	946.67	949.86
3888.75		946.79	950.09
3900		946.85	950.10
4000		947.35	950.55
4025.82	R 50m	947.48	950.66
4040.1		947.55	950.87
4100		947.85	950.00
4116.54	R -50m	947.93	950.34
4128.14		947.99	951.35
4200		948.35	963.06
4277.24	R -50m	948.74	967.73
4300		948.85	967.73
4315.47		948.93	966.81
4400		949.35	958.79
4472.62	R -50m	949.71	955.07
4479.52		949.75	955.28
4500		949.85	955.42
4600		950.35	949.94
4649.31	R 50m	950.60	951.27
4653.9		950.62	951.54
4700		950.85	952.11
4715			951.85

EASTERN DIVERSION DRAIN
HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:1000

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	REF
CHECKED	RH
APPROVED	GS

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MCPHILLAMYS GOLD PROJECT

EASTERN DIVERSION DRAIN
PLAN AND LONG SECTIONS 3 OF 3

1000-252

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 11:02:54 Plotted By: MichealL

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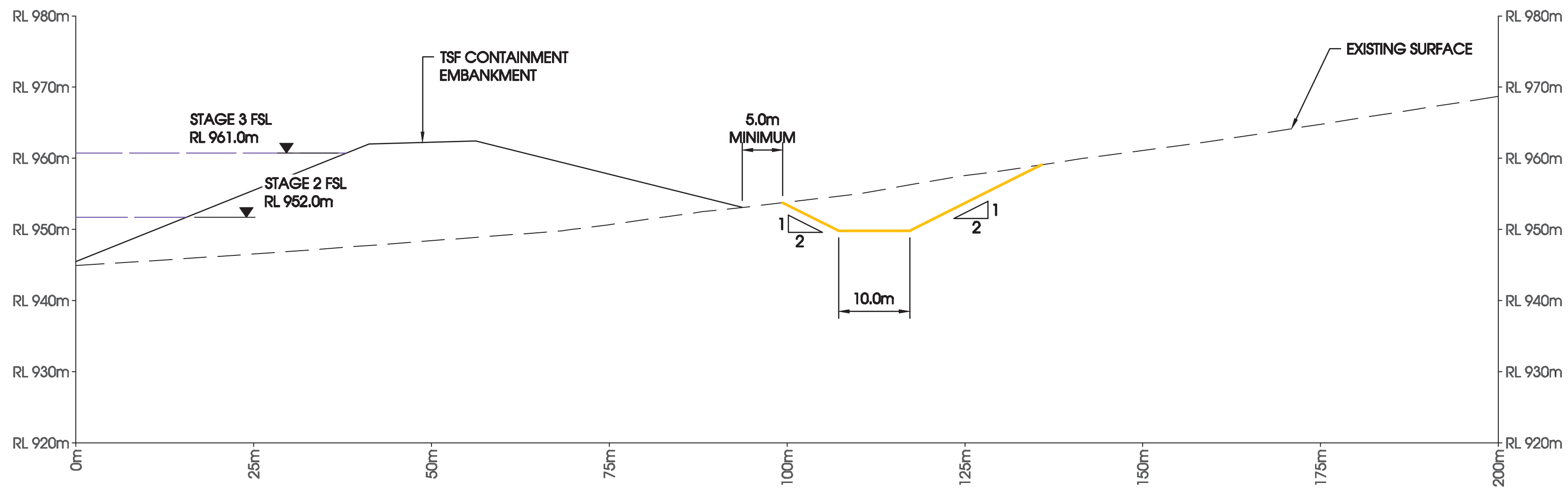
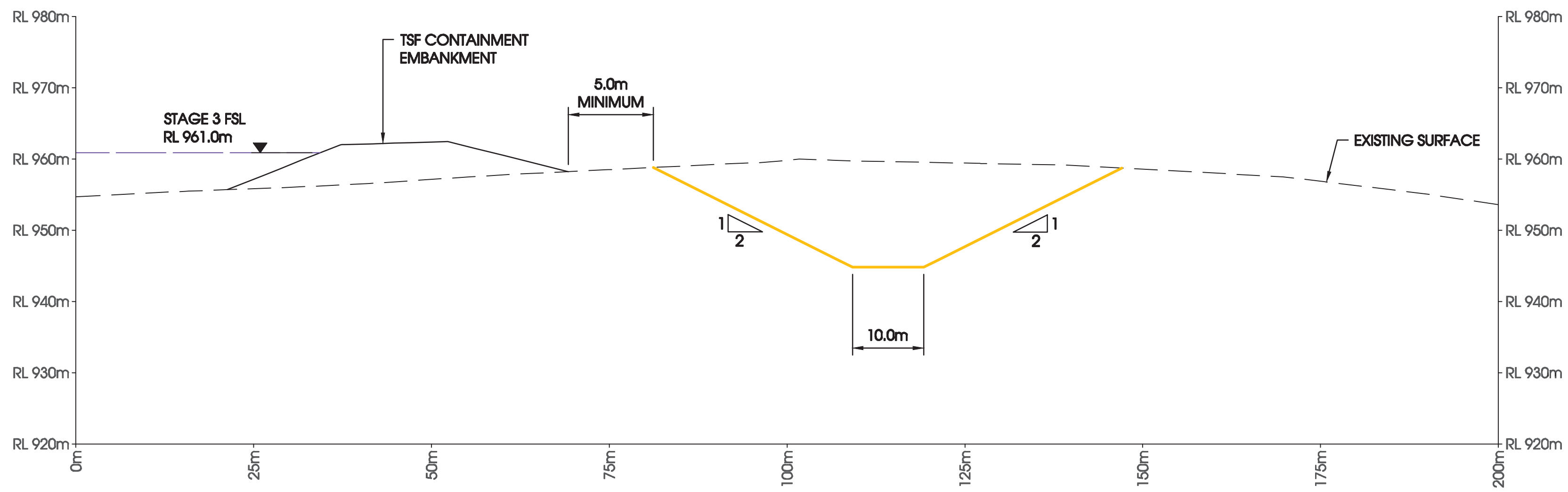


SECTION 13 CLEAN WATER COLLECTION AND DIVERSION
SCALE: 1:1000 252



SECTION 12 EASTERN DIVERSION CHANNEL
SCALE: 1:1000 251

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	REF
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

EASTERN DIVERSION DRAIN
SECTION AND DETAILS

1000-253

SHEET SIZE A4 Rev. A

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SHEET 1 OF 1

Plotted Date: 22/07/20 Plotted Time: 11:03:23 Plotted By: MichealL

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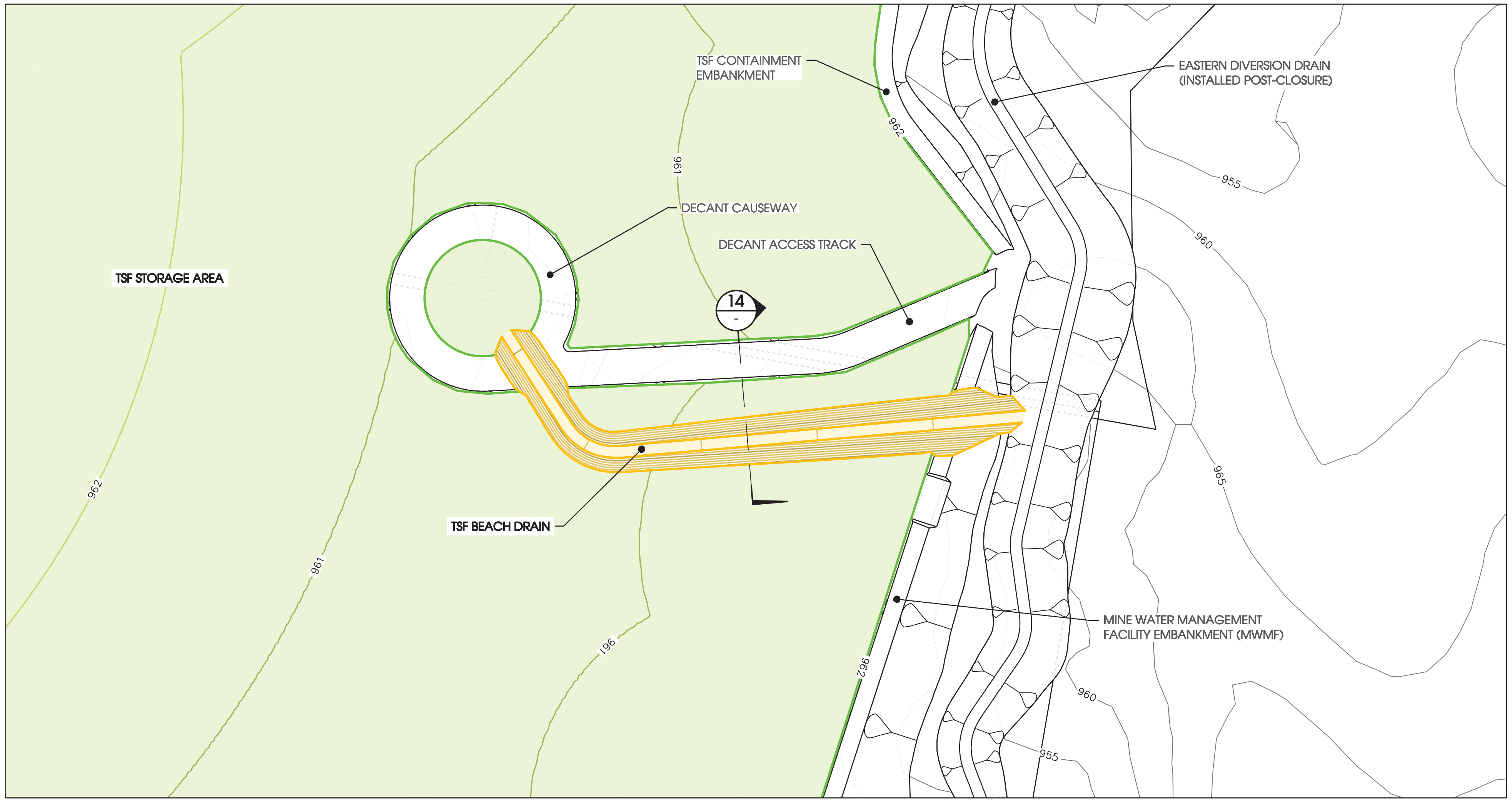
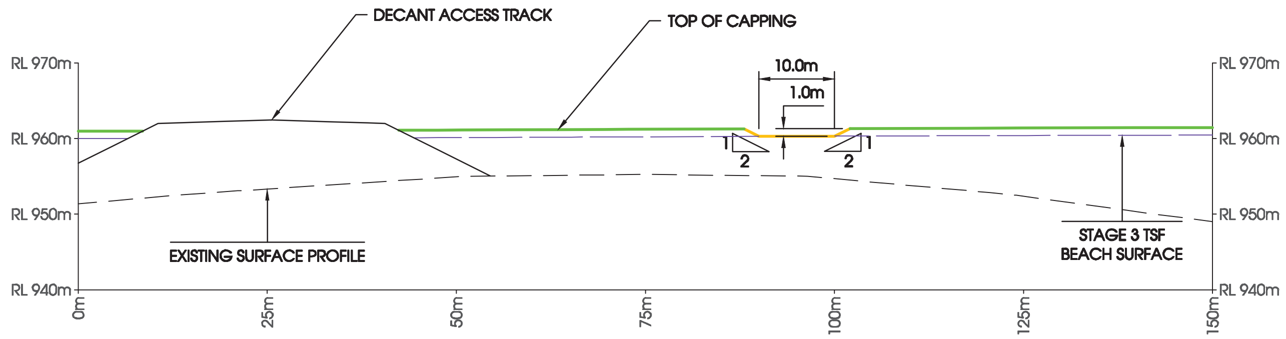


PLAN
SCALE: 1:5000



SECTION 14 TSF BEACH DRAIN
SCALE: 1:1000

FOR TENDER PURPOSES ONLY

NOT FOR CONSTRUCTION

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE: 1:5000	
JOB No.	113272-02
DATE	MAR.2020
DESIGN	MRL
DRAWN	REF
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

TSF BEACH DRAIN
PLAN AND SECTIONS

1000-260

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted Date: 28/07/20 Plotted Time: 13:32:36 Plotted By: MarkC

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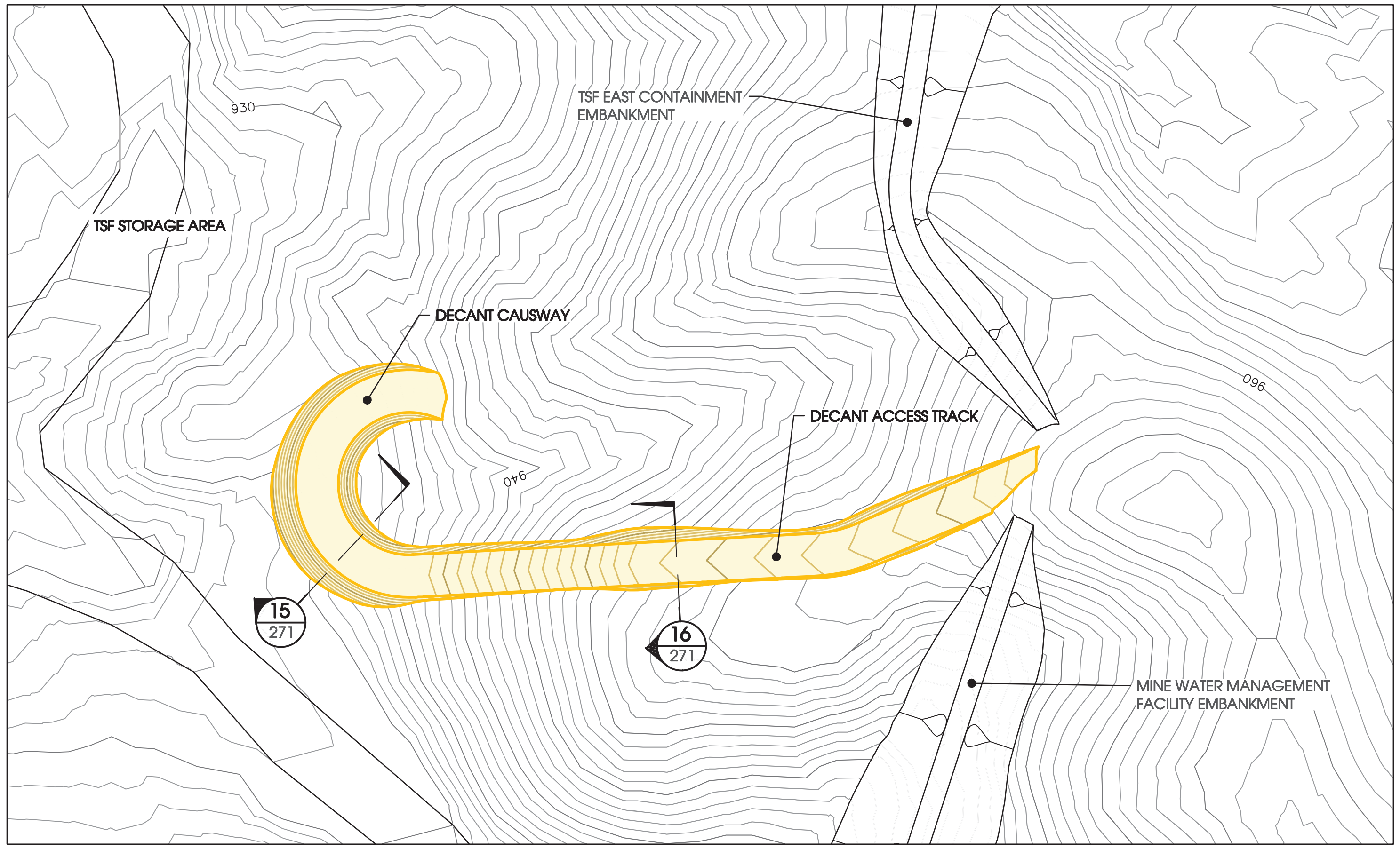
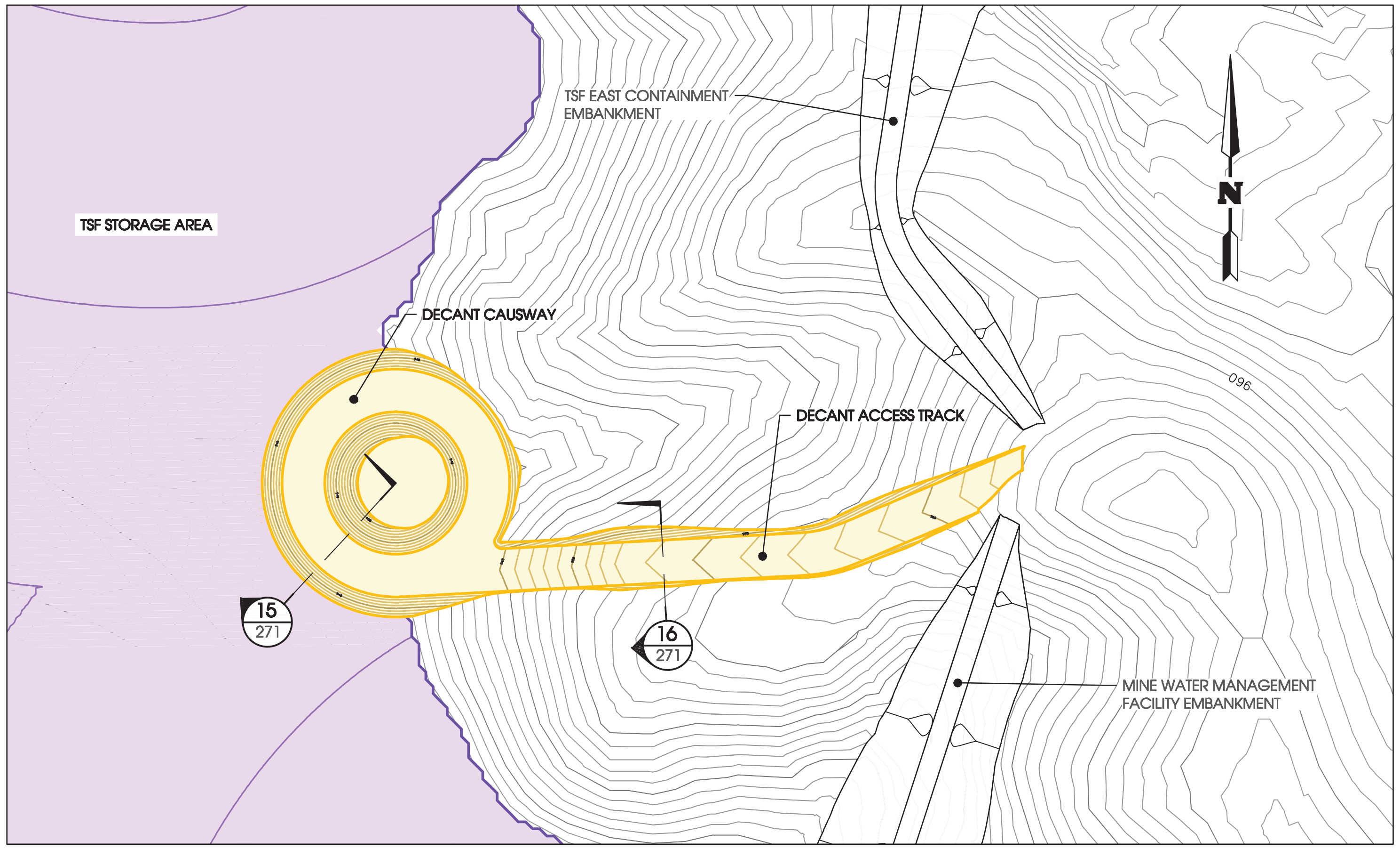
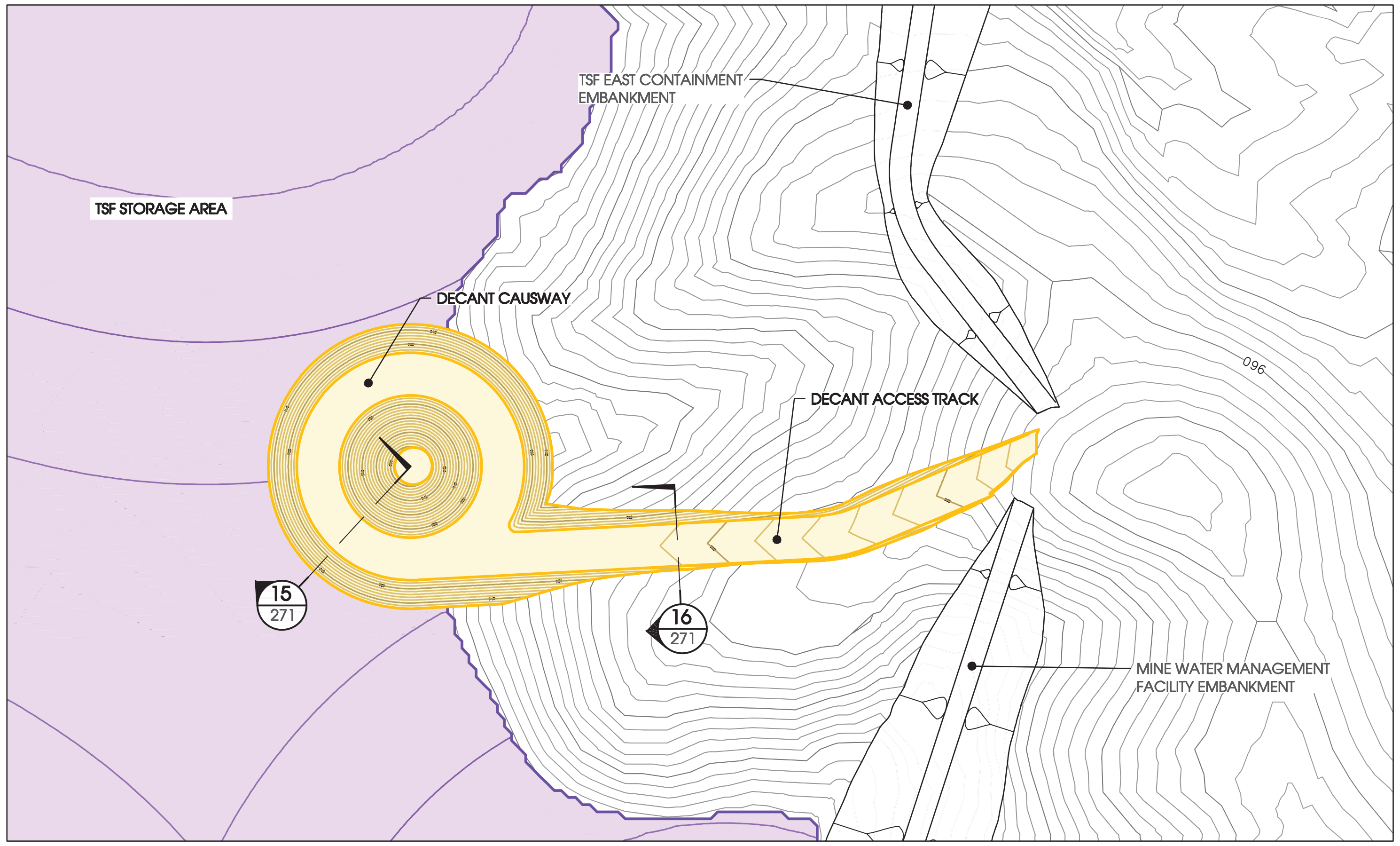


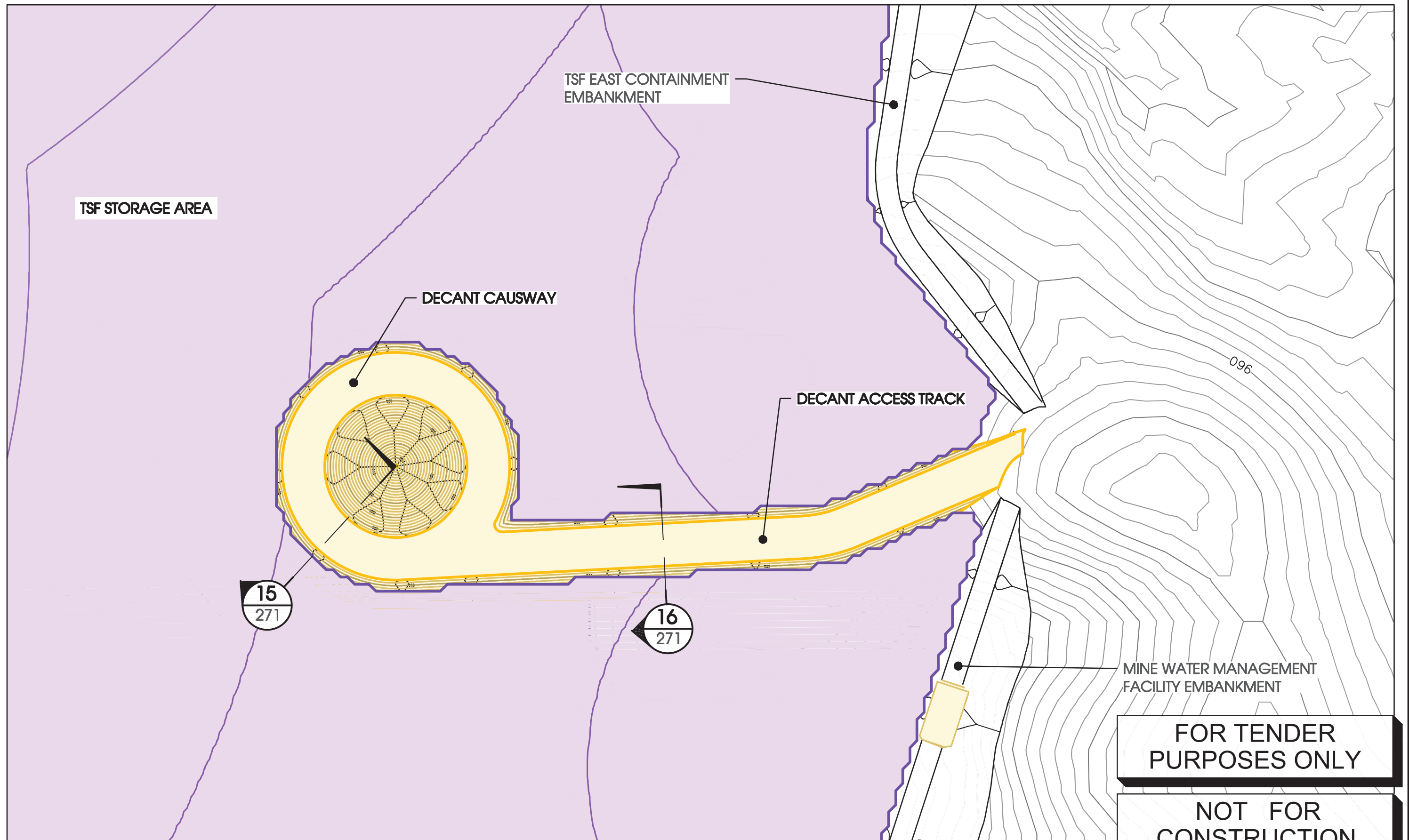
STAGE 1A



STAGE 1B



STAGE 2



STAGE 3

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE: 1:500	
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

DECANT CAUSEWAY
LAYOUT PLAN

1000-270

SHEET SIZE A3 | Rev. A

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SHEET 1 OF 1

Plotted Date: 28/07/20 Plotted Time: 13:34:18 Plotted By: MarkC

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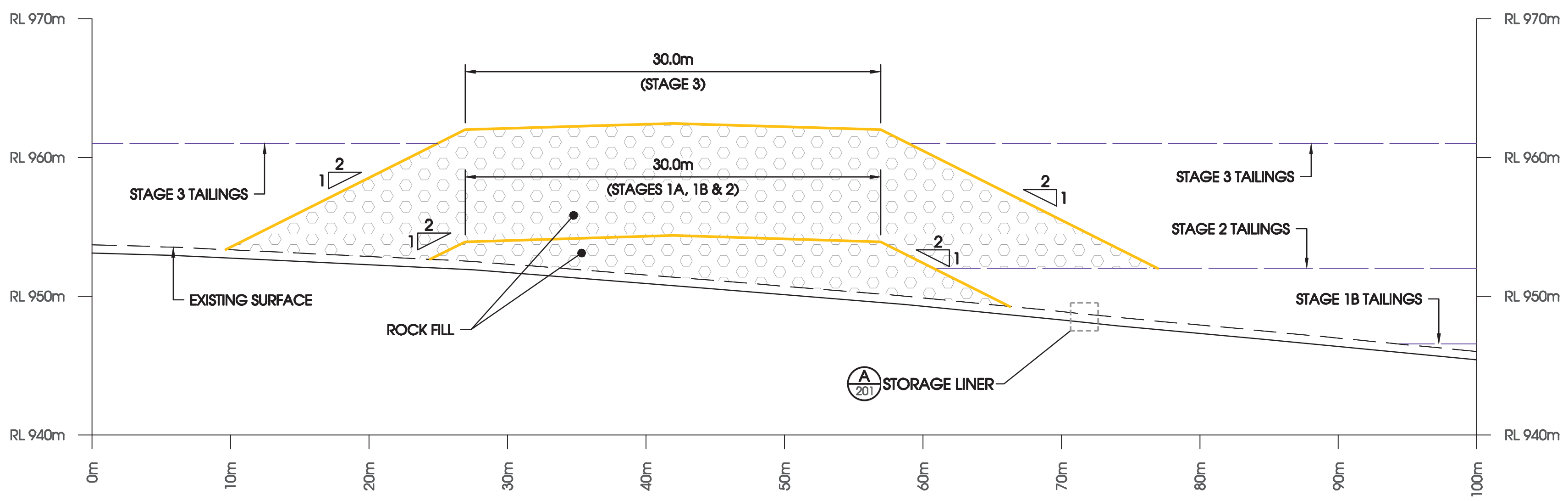
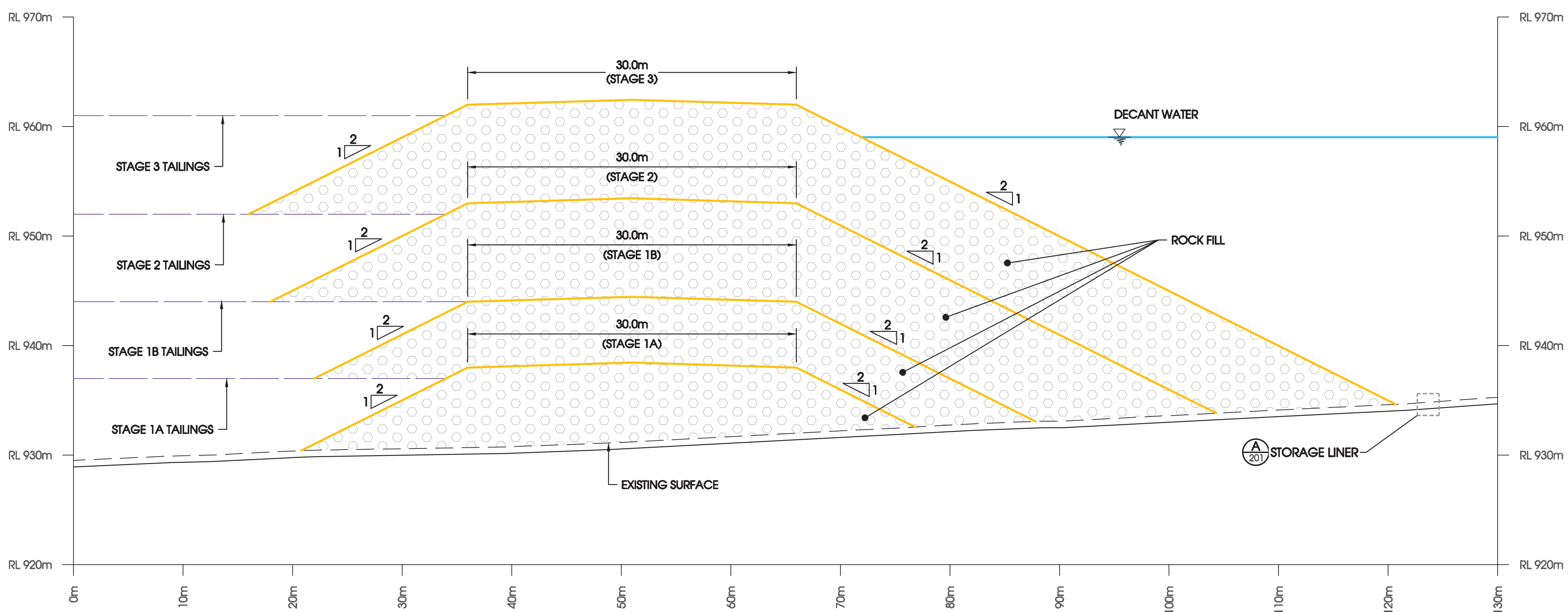


SECTION (16) DECANT ACCESS TRACK
SCALE: 1:500



SECTION (15) DECANT CAUSEWAY
SCALE: 1:500

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE: 1:500	
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

DECANT CAUSEWAY
SECTIONS

1000-271

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

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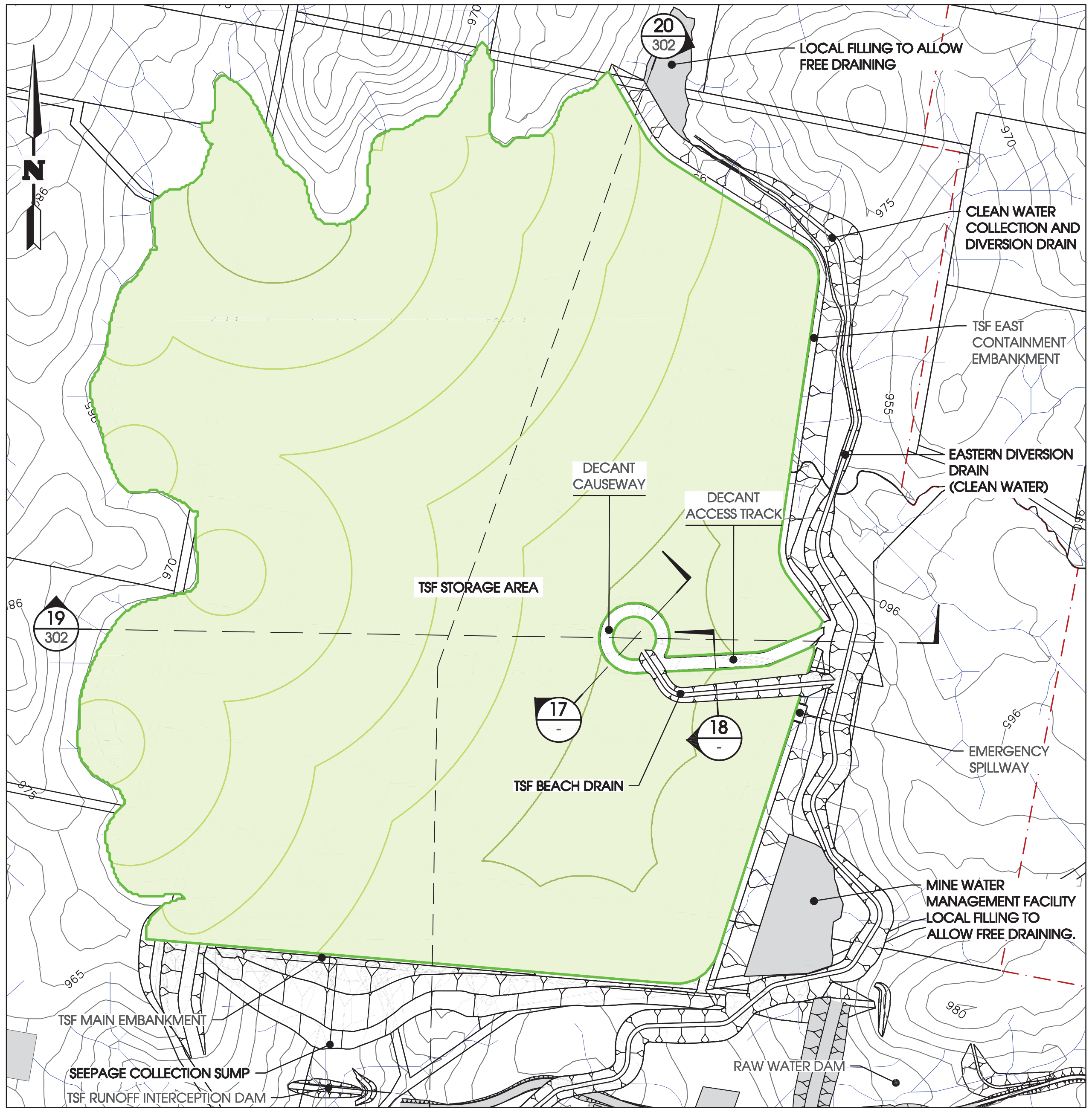
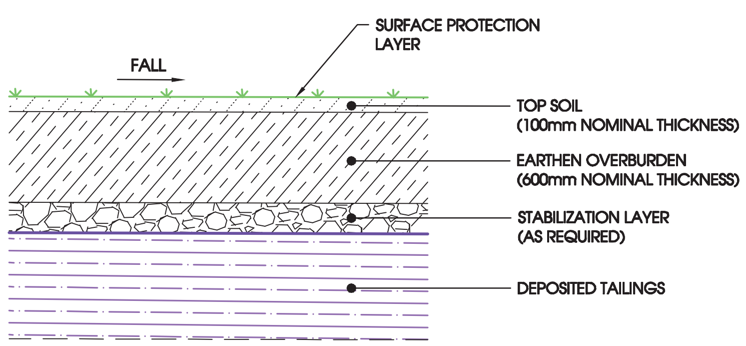
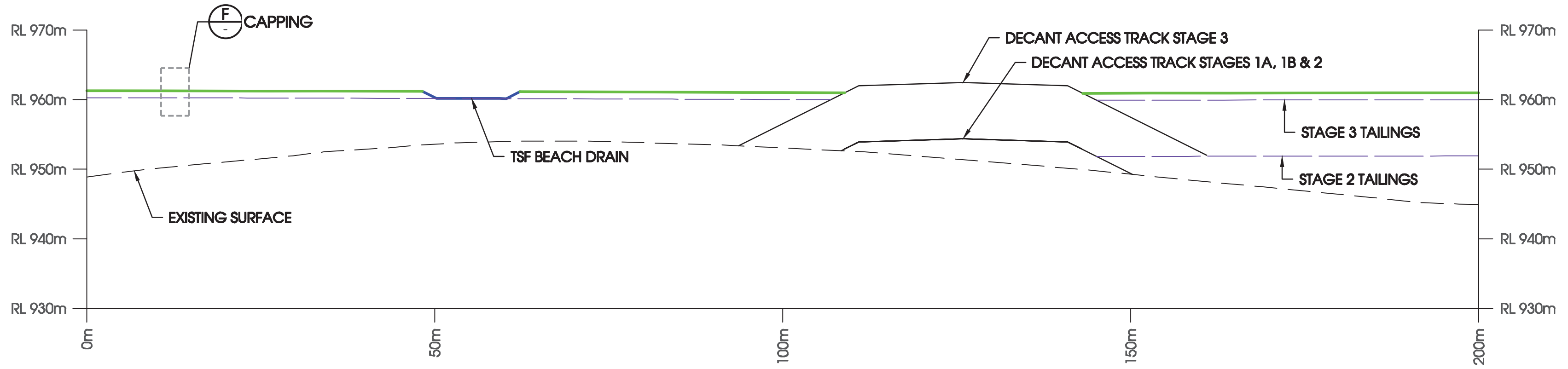
Plotted Date: 22/07/20 Plotted Time: 11:04:18 Plotted By: MichealL



PLAN
SCALE: 1:15,000



DETAIL F CAPPING
302
SCALE: 1:50



SECTION 18 DECANT ACCESS TRACK
SCALE: 1:1000

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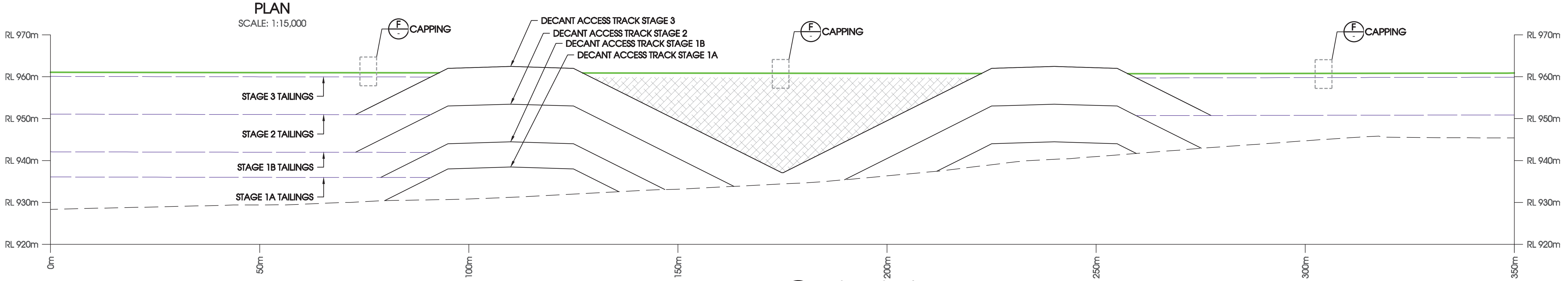

SECTION 17 DECANT CAUSEWAY
SCALE: 1:1000

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

POST CLOSURE
LAYOUT PLAN

1000-301

SHEET SIZE A6 Rev. A

SHEET 1 OF 1

Plotted By: MarkC Plotted Time: 13:36:07 Plotted Date: 28/07/20

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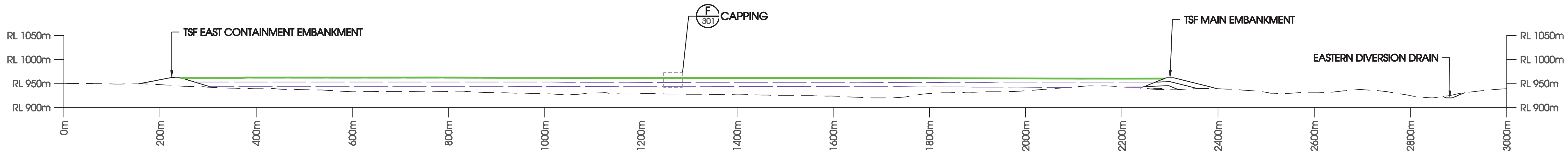

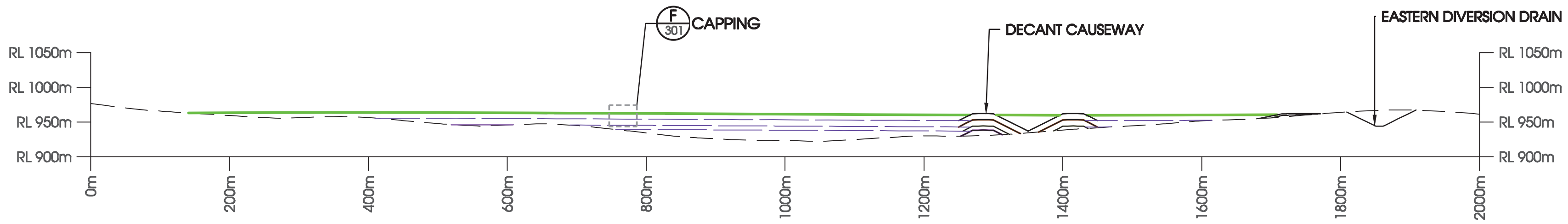

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No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

POST CLOSURE
DETAILS

1000-302

SHEET SIZE A3 Rev. A

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SHEET 1 OF 1

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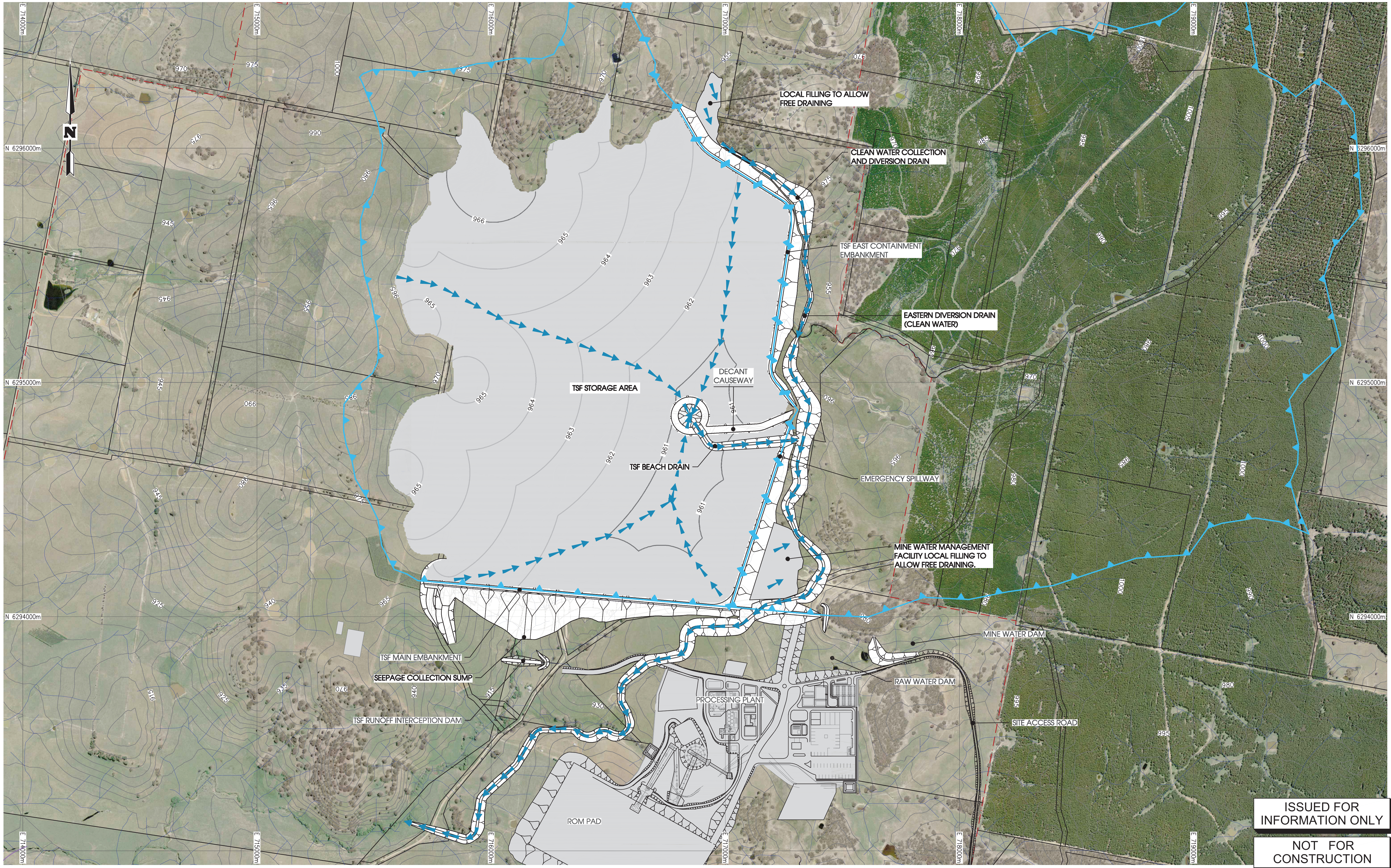

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D
A	ISSUED FOR REVIEW	22/07/20	MJC	RH	GS

SCALE:	AS SHOWN
JOB No.	113272-02
DATE	MAR. 2020
DESIGN	MJC
DRAWN	MJC
CHECKED	RH
APPROVED	GS

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REGIS RESOURCES
MCPHILLAMYS GOLD PROJECT

WATER MANAGEMENT
LAYOUT PLAN AND DETAILS

1000-401

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

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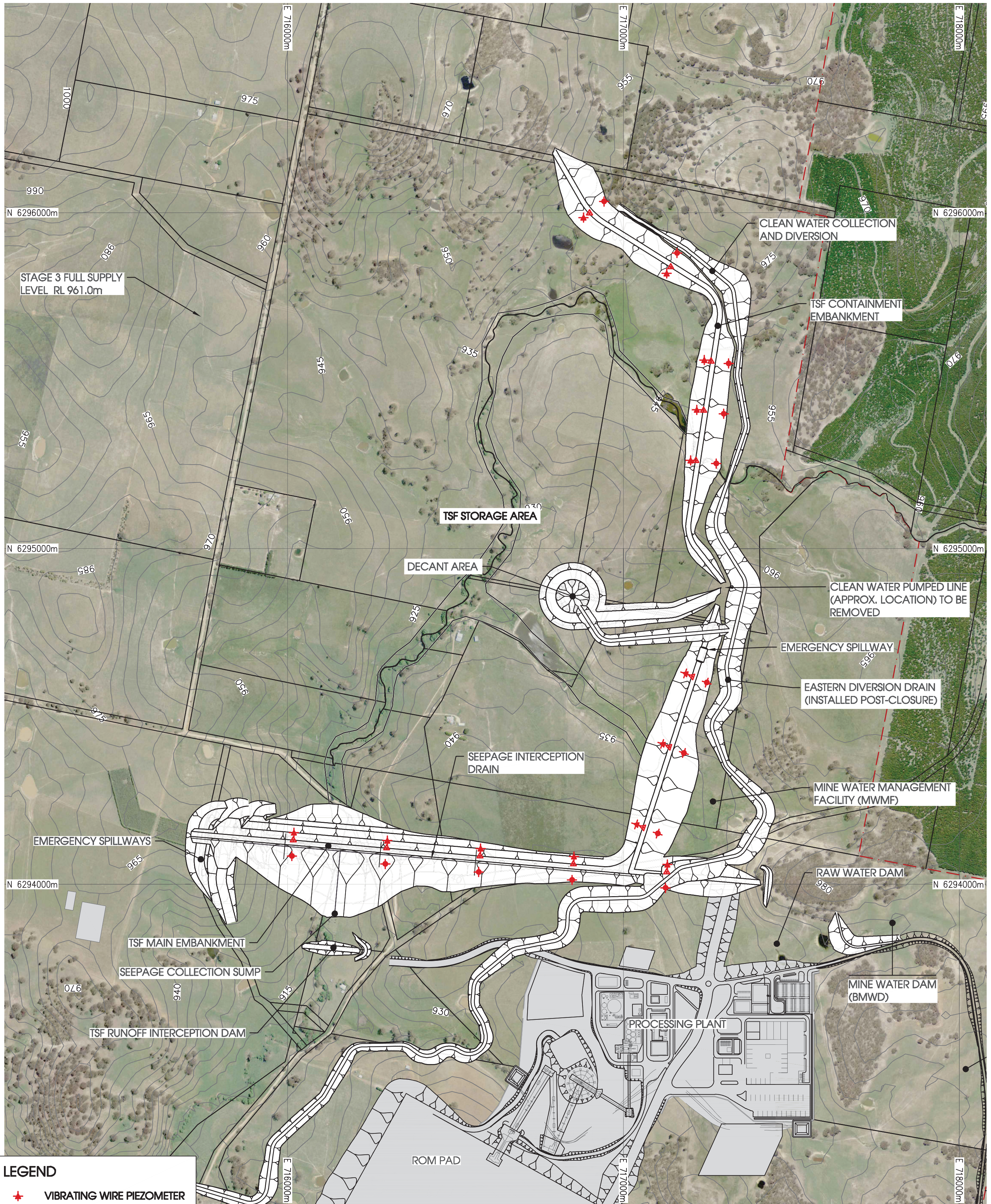
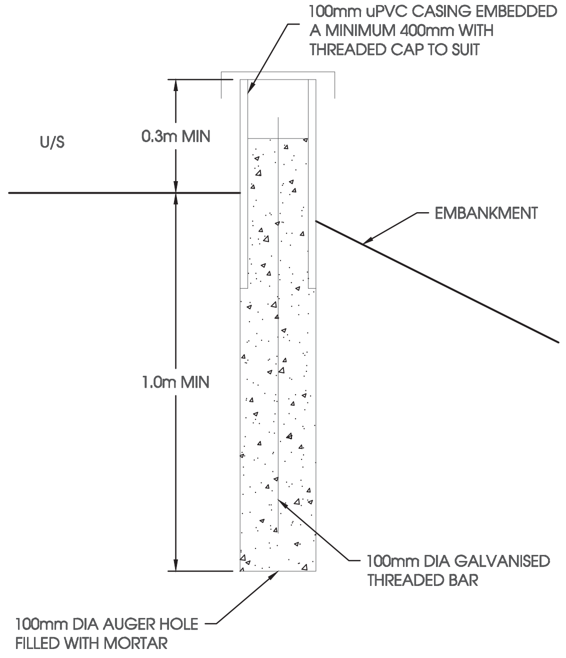
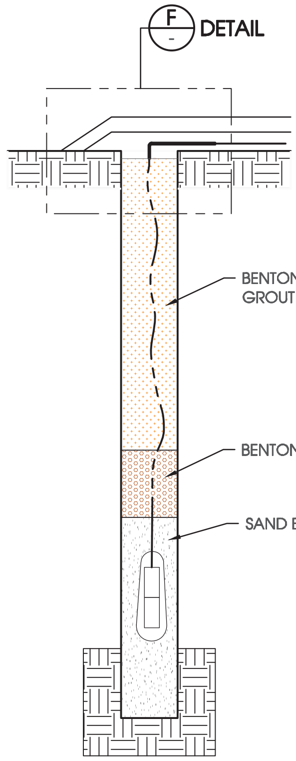


LEGEND
- VIBRATING WIRE PIEZOMETER
- FOUNDATION PIEZOMETER
- SETTLEMENT MONUMENT

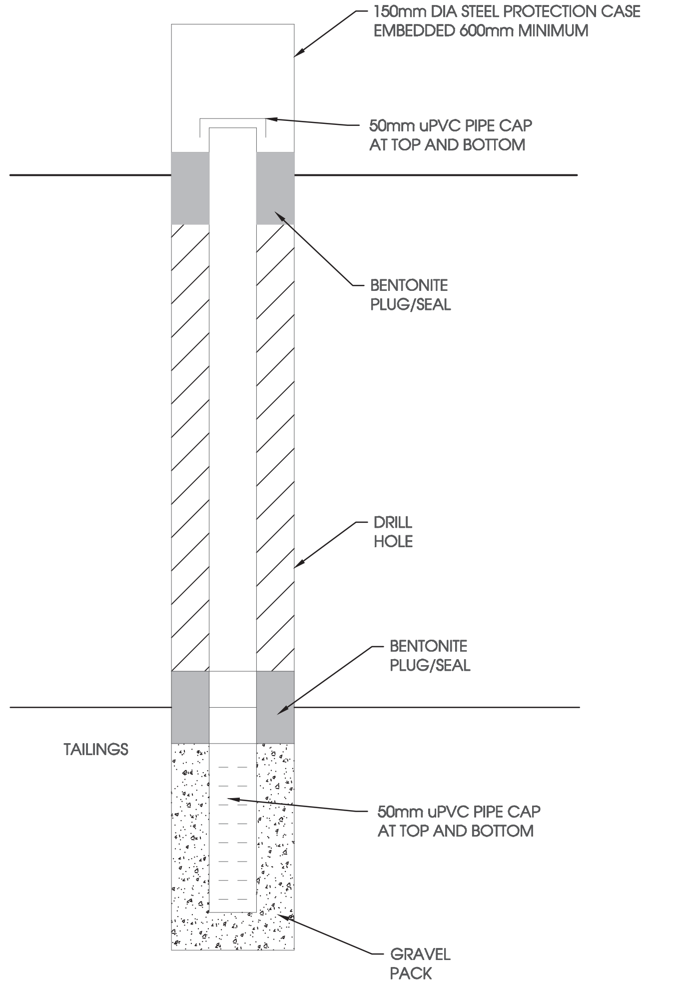
INSTRUMENTATION LAYOUT
SCALE 1:15,000



DETAIL ? SETTLEMENT MONUMENT
SCALE: N.T.S



DETAIL ? VIBRATING WIRE PIEZOMETER
SCALE: 1:100



DETAIL ? PIEZOMETER COMPLETED WITH FOUNDATIONS
SCALE: N.T.S

NOTE:
1) LOCATION OF SETTLEMENT MONUMENTS & VIBRATING WIRE PIEZOMETER TO BE CONFIRMED BY SUPERINTENDANT

FOR TENDER PURPOSES ONLY

NOT FOR CONSTRUCTION

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A	ISSUED FOR REVIEW	22/07/20	REF	RH	GS

SCALE:	1:15,000
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INSTRUMENTATION
LAYOUT PLAN AND DETAILS

1000-501

SHEET SIZE A3 Rev. A

SHEET 1 OF 1

Plotted Date: 28/07/20 Plotted Time: 13:38:29 Plotted By: MarkC

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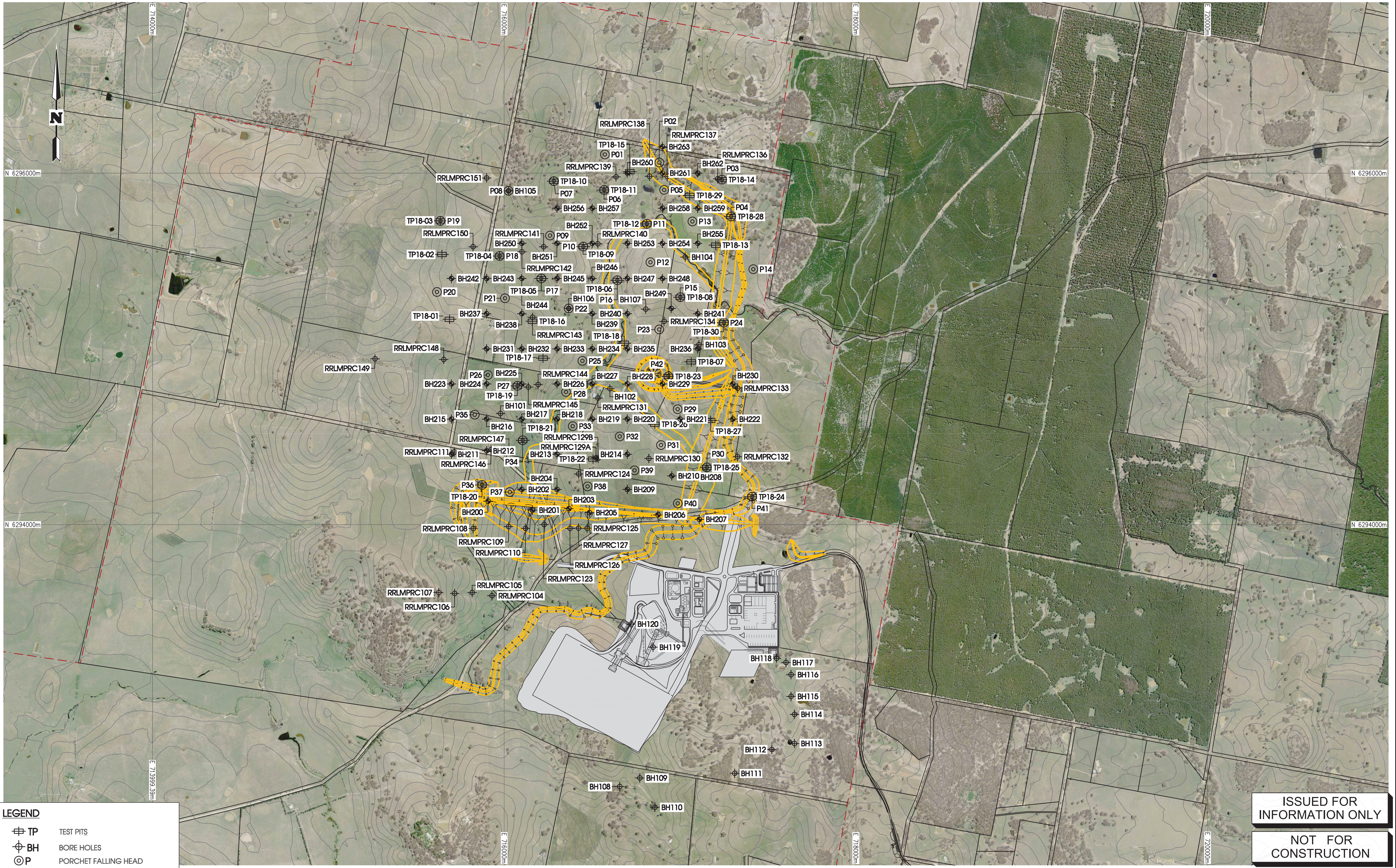

LEGEND

TP	TEST PITS
BH	BORE HOLES
P	PORCHET FALLING HEAD

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A	ISSUED FOR REVIEW		MJC		

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JOB No.	113272-02
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	INITIALS	SIGN	DATE
1. DRAFTER			
2. CHECKER			
3. PROJECT MANAGER			

ALTERATIONS REQUIRED SHOWN IN RED PEN
INFORMATION FOR ENGINEER / DRAFTER IN BLUE PEN
CORRECTED / ACTIONS ITEMS HIGHLIGHTED IN BLUE BY DRAFTER
CORRECTED / ACTIONS ITEMS HIGHLIGHTED IN YELLOW BY ENGINEER

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GEOTECHNICAL
TSF INVESTIGATIONS

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SHEET 1 OF 1

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Plotted Time: 15:09:22
Plotted Date: 10/06/20

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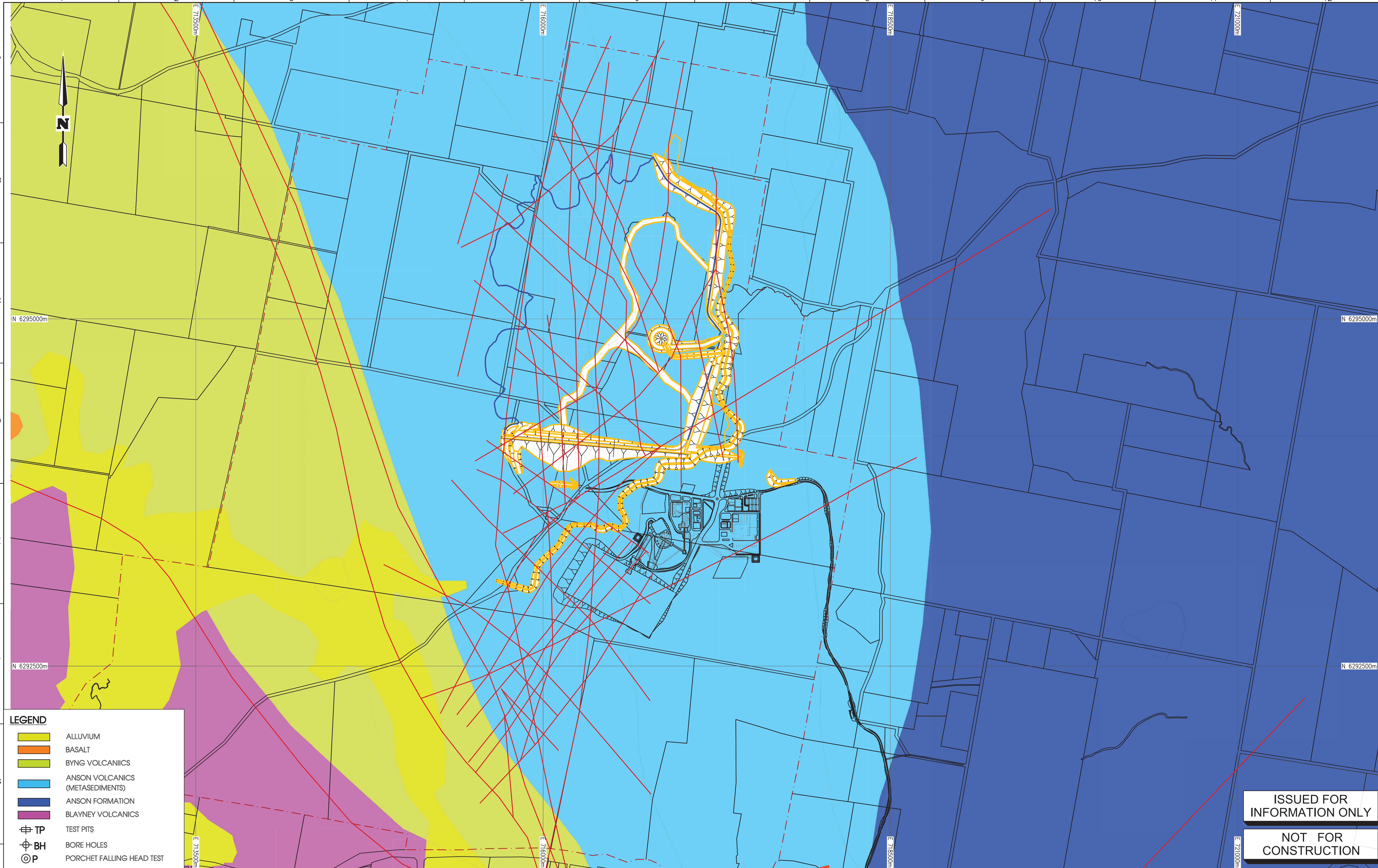

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DATE	MAR. 2020
DESIGN	
DRAWN	MJC
CHECKED	
APPROVED	

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PRELIMINARY
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	INITIALS	SIGN	DATE
1. DRAFTER			
2. CHECKER			
3. PROJECT MANAGER			

ALTERATIONS REQUIRED SHOWN IN RED PEN
INFORMATION FOR ENGINEER / DRAFTER IN BLUE PEN
CORRECTED / ACTIONS ITEMS HIGHLIGHTED IN BLUE BY DRAFTER
CORRECTED / ACTIONS ITEMS HIGHLIGHTED IN YELLOW BY ENGINEER

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MCPHILLAMYS GOLD PROJECT

SURFACE GEOLOGY

1000-701

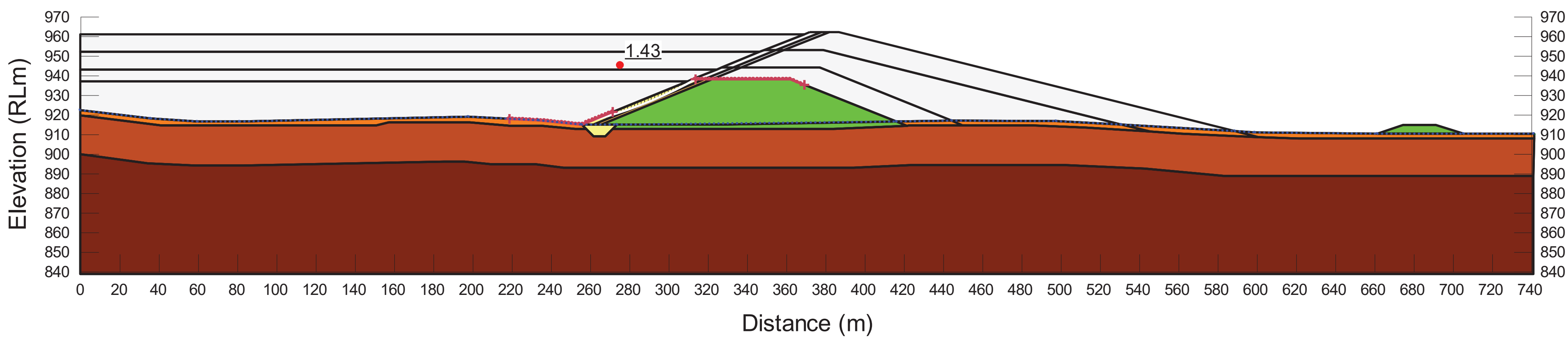
SHEET SIZE A6 Rev. A

SHEET 1 OF 1

APPENDICES

APPENDIX A

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line	B-bar	Add Weight
	Eff Clay Core	Mohr-Coulomb	18	1	28	0	1	0	Yes
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0	1	1	No
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0	1	0	No
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0	1	1	No
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0	1	0	No



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

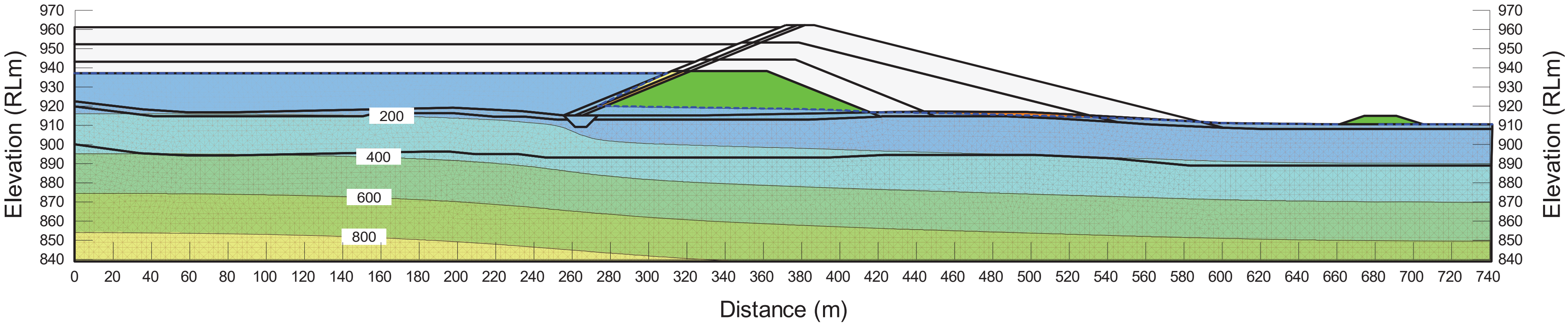
RL 938.0 m END OF CONSTRUCTION UPSTREAM

Date: 31 March, 2020 Job No: 113272.02

Attachment A-1

Note:
- Contours represent Pore Water Pressure (kPa)

Color	Name	Model	Sat Kx (m/sec)	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	Eff Clay Core	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Cut-Off Key	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Fresh Rock (Anson Formation)	Saturated Only	2.31e-08			0.5	0	0	0
	Eff Rock Fill	Saturated Only	1e-06			1	0	0	0
	Eff Surface Soils	Saturated Only	5e-08			1	0	0	0
	Eff Tailings	Saturated / Unsaturated		Tailings	Tailings k = 1e-07m/s	0.1	0		
	Eff Transition Zone	Saturated Only	1e-06			1	0	0	0
	Eff Weathered Rock	Saturated Only	1e-08			1	0	0	0



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MCPHILLAMYS GOLD PROJECT - TSF

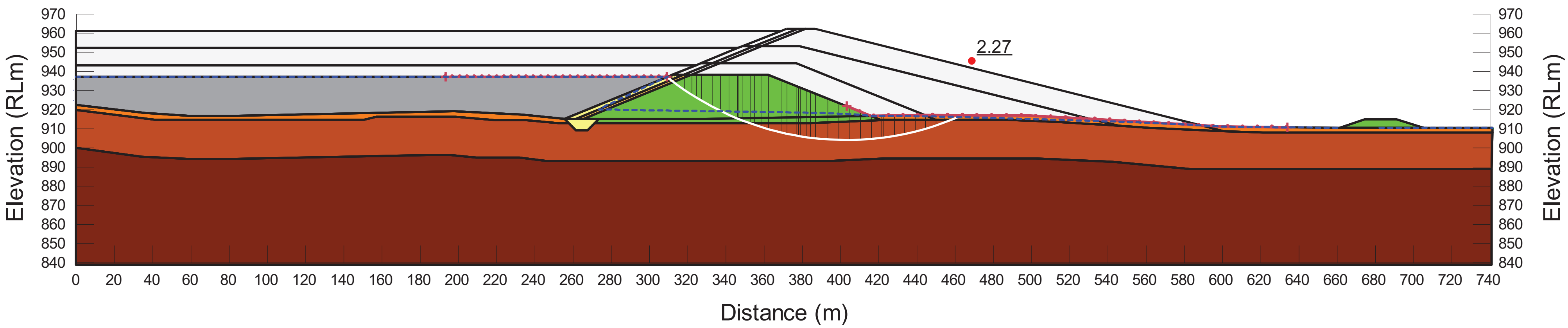
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 938.0 m STEADY STATE SEEPAGE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-2

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Clay Core	Mohr-Coulomb	18	1	28	0
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0
	Eff Tailings	Mohr-Coulomb	17	0	25	0
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

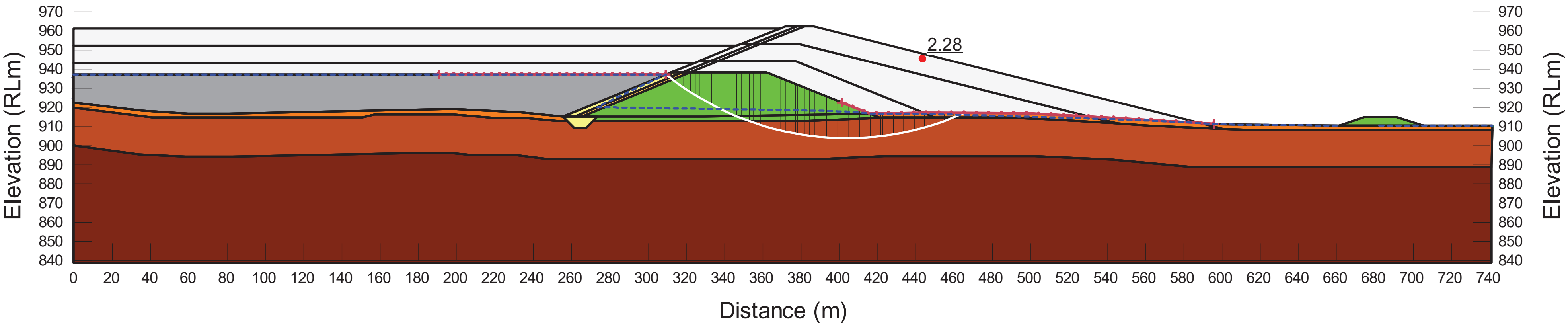
RL 938.0 m LONG-TERM STABILITY

Date: 31 March, 2020 Job No: 113272.02

Attachment A-3

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

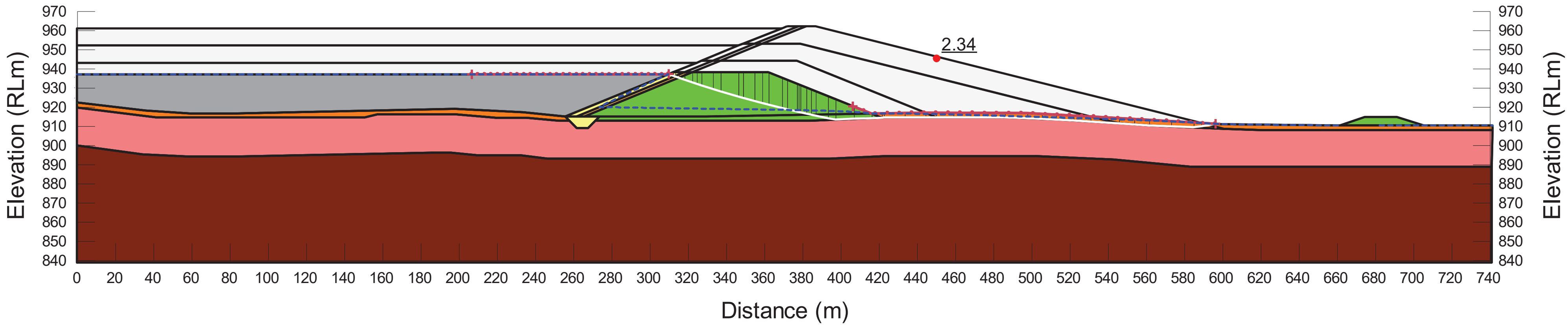
RL 938.0 m SEISMIC OBE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-4

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

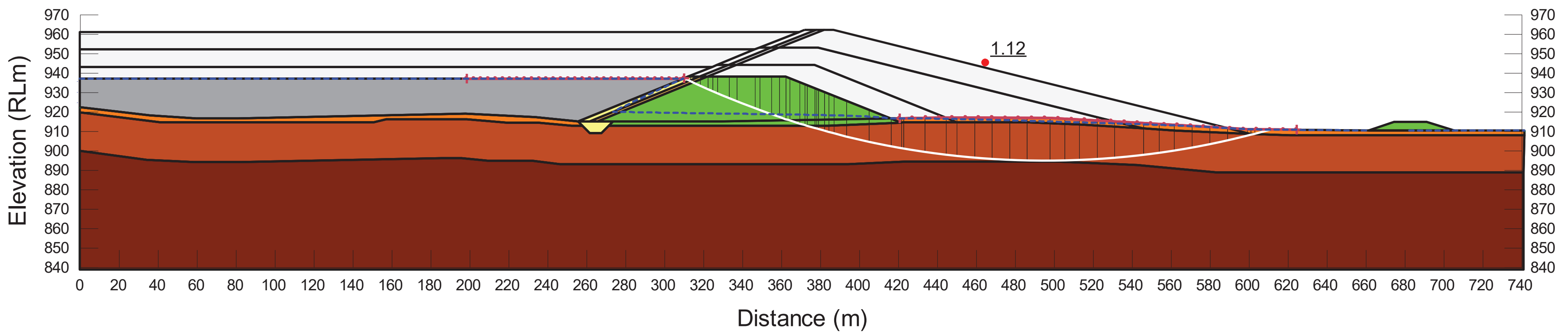
RL 938.0 m SEISMIC OBE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-5

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

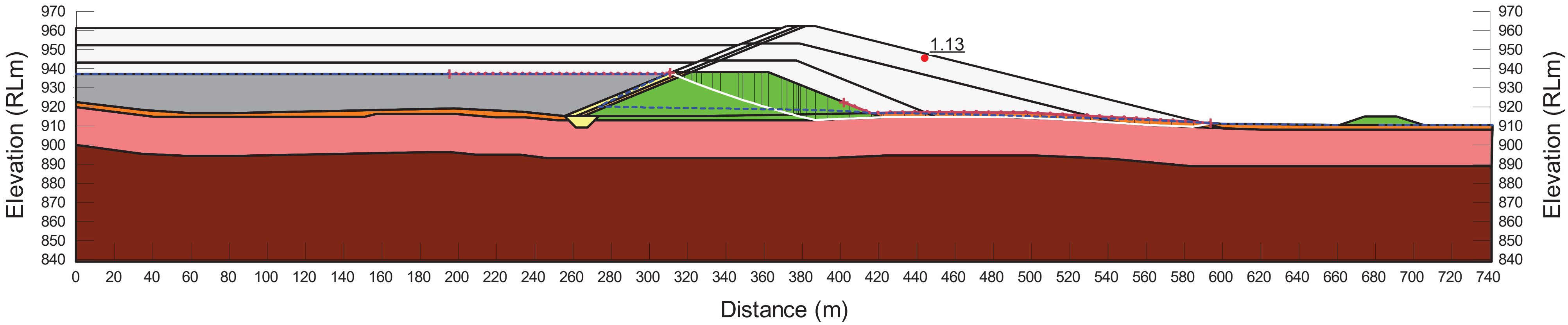
RL 938.0 m SEISMIC SEE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-6

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

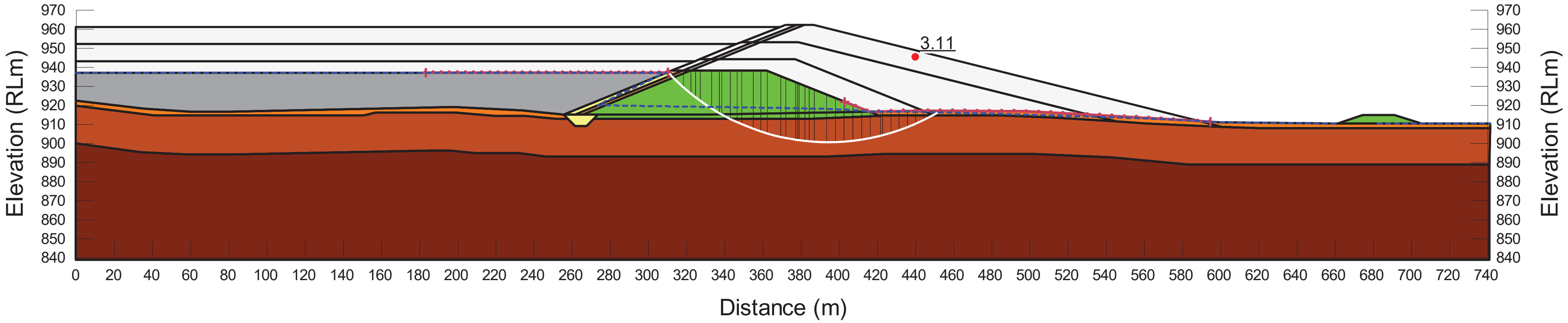
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 938.0 m SEISMIC SEE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-7

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	Eff/SR Weathered Rock	Mohr-Coulomb	22				0	32	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

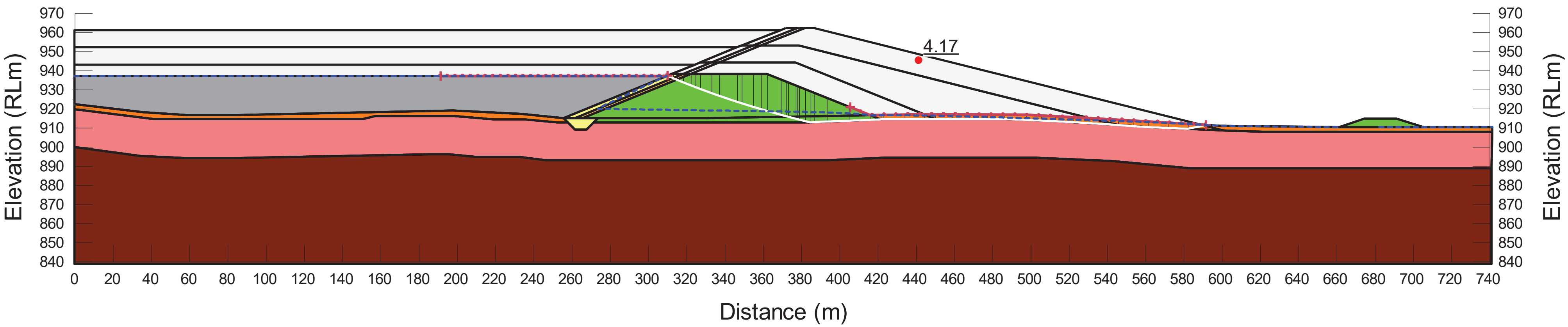
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 938.0 m POST-SEISMIC

Date: 31 March, 2020 Job No: 113272.02

Attachment A-8

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

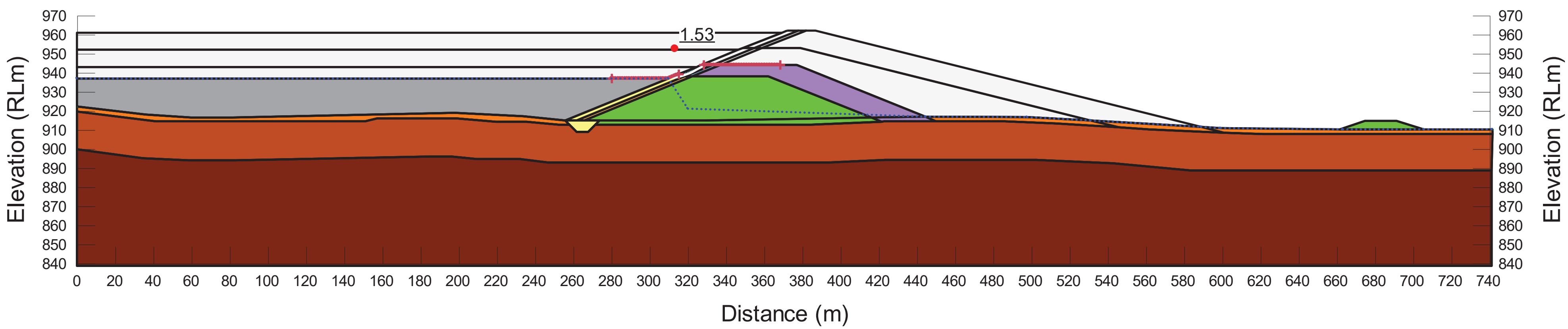
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 938.0 m POST-SEISMIC (IMPENETRABLE WEATHERED ROCK)

Date: 31 March, 2020 Job No: 113272.02

Attachment A-9

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line	B-bar	Add Weight
	Eff Clay Core	Mohr-Coulomb	18	1	28	0	1	1	No
	Eff Clay Core (New Material)	Mohr-Coulomb	18	1	28	0	1	0	Yes
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0	1	1	No
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0	1	0	No
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0	1	0	No
	Eff Rock Fill (New Material)	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0	1	1	No
	Eff Tailings	Mohr-Coulomb	17	0	25	0	1	0	No
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0	1	0	No
	Eff Transition Zone (New Material)	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0	1	0	No



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

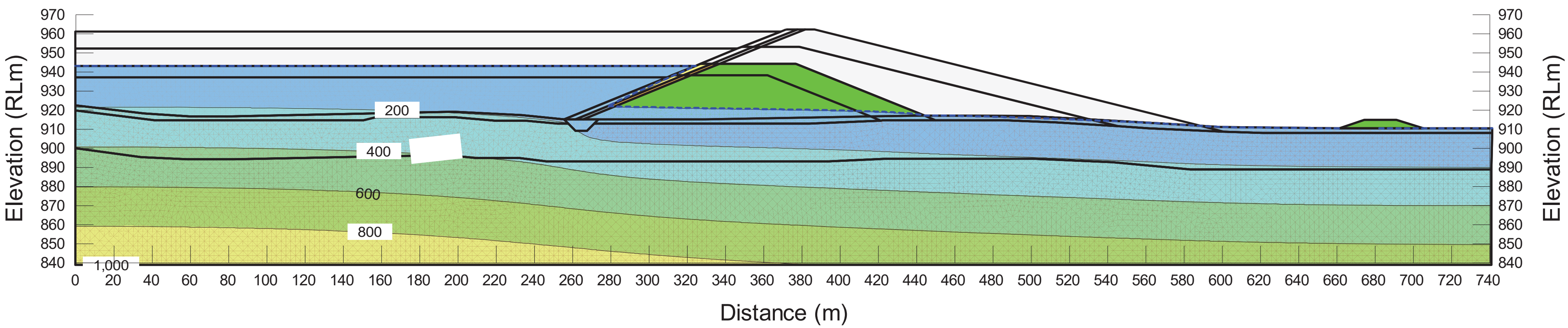
RL 944.0 m END OF CONSTRUCTION UPSTREAM

Date: 31 March, 2020 Job No: 113272.02

Attachment A-10

Color	Name	Model	Sat Kx (m/sec)	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	Eff Clay Core	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Cut-Off Key	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Fresh Rock (Anson Formation)	Saturated Only	2.31e-08			0.5	0	0	0
	Eff Rock Fill	Saturated Only	1e-06			1	0	0	0
	Eff Surface Soils	Saturated Only	5e-08			1	0	0	0
	Eff Tailings	Saturated / Unsaturated		Tailings	Tailings k = 1e-07m/s	0.1	0		
	Eff Transition Zone	Saturated Only	1e-06			1	0	0	0
	Eff Weathered Rock	Saturated Only	1e-08			1	0	0	0

Note:
- Contours represent Pore Water Pressure (kPa)



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MCPHILLAMYS GOLD PROJECT - TSF

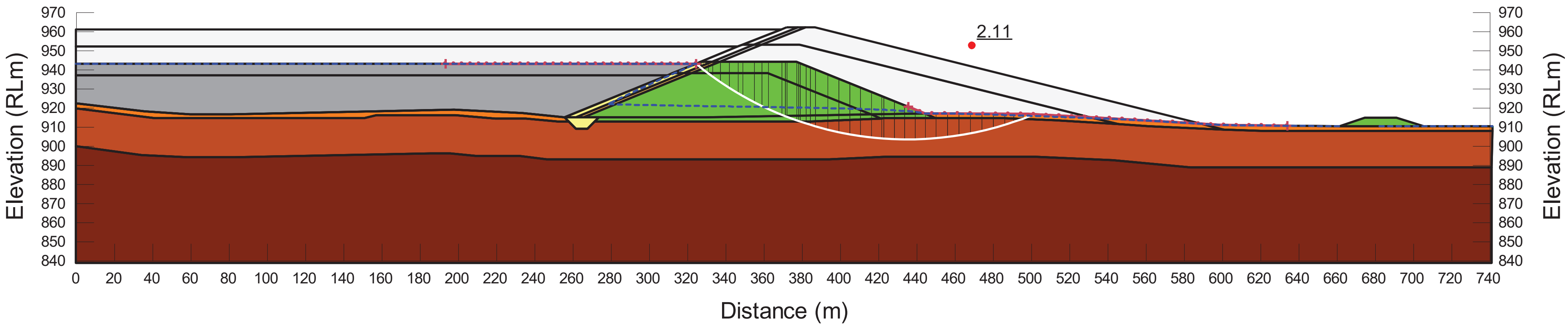
TAILINGS STORAGE FACILITY - SEEPAGE AND STABILITY ANALYSIS

RL 944.0 m STEADY STATE SEEPAGE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-11

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Clay Core	Mohr-Coulomb	18	1	28	0
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0
	Eff Tailings	Mohr-Coulomb	17	0	25	0
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

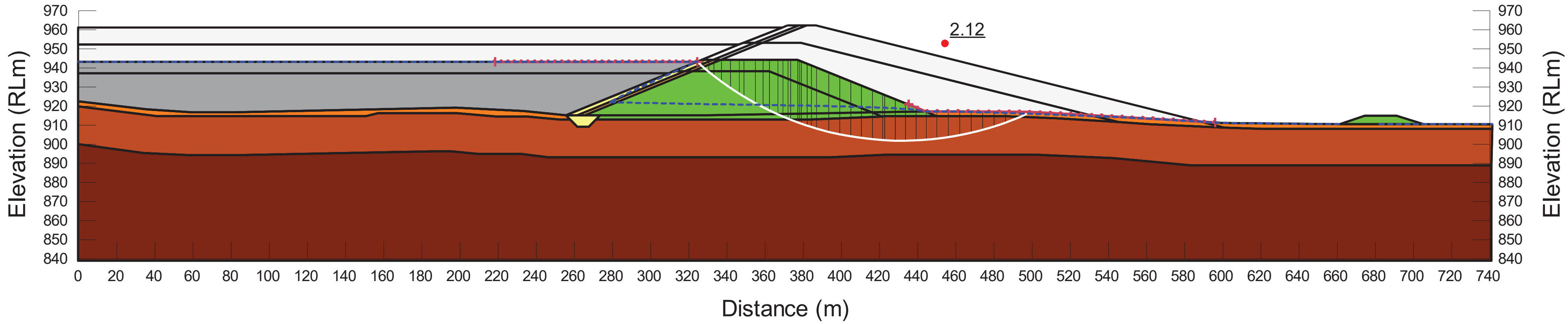
RL 944.0 m LONG-TERM STABILITY

Date: 31 March, 2020 Job No: 113272.02

Attachment A-12

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

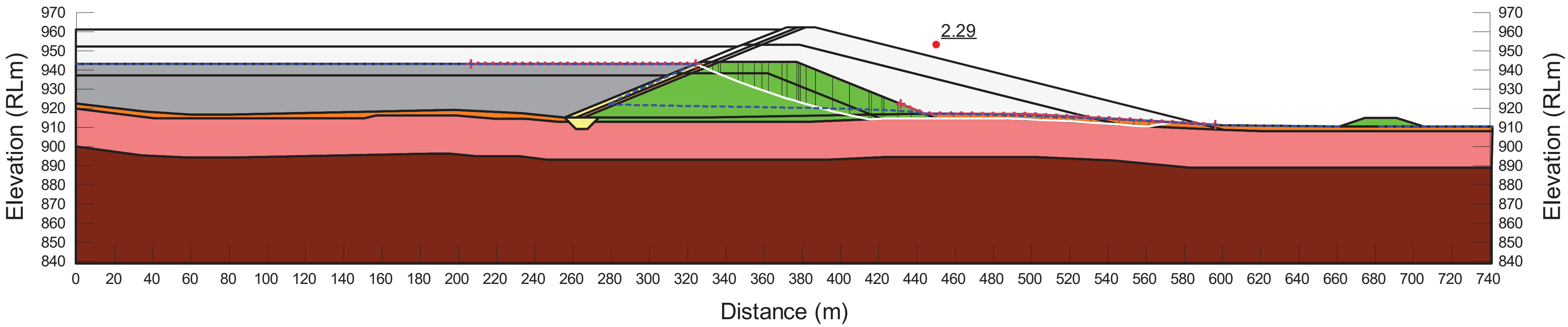
RL 944.0 m SEISMIC OBE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-13

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

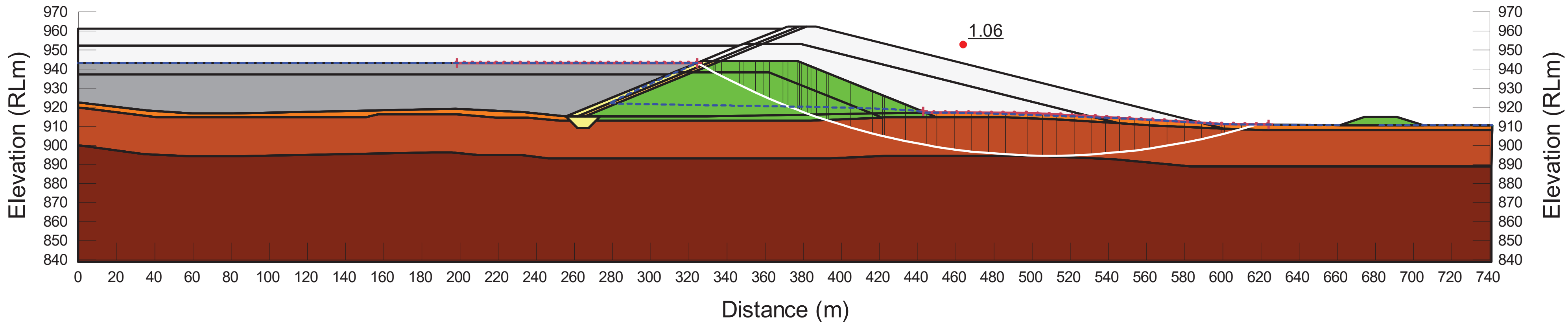
RL 944.0 m SEISMIC OBE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-14

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

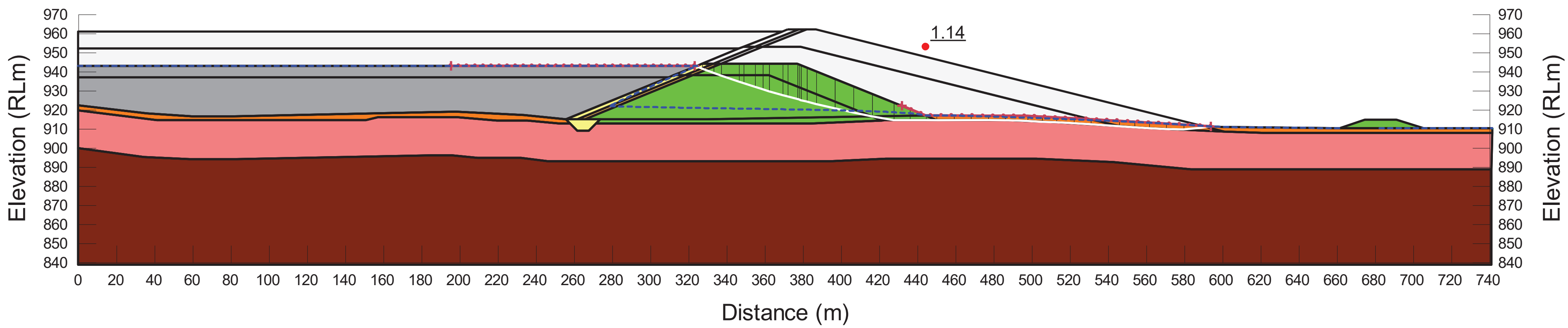
RL 944.0 m SEISMIC SEE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-15

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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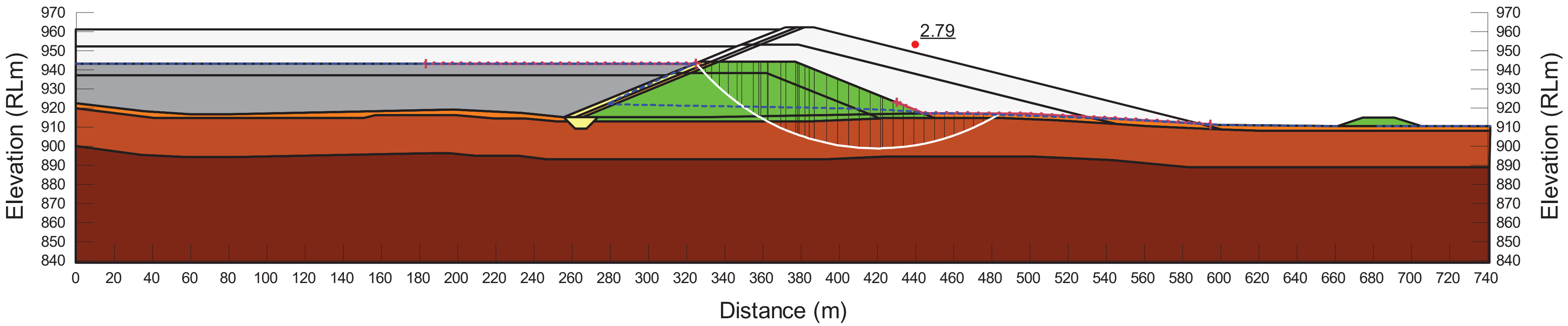
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 944.0 m SEISMIC SEE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-16

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	Eff/SR Weathered Rock	Mohr-Coulomb	22				0	32	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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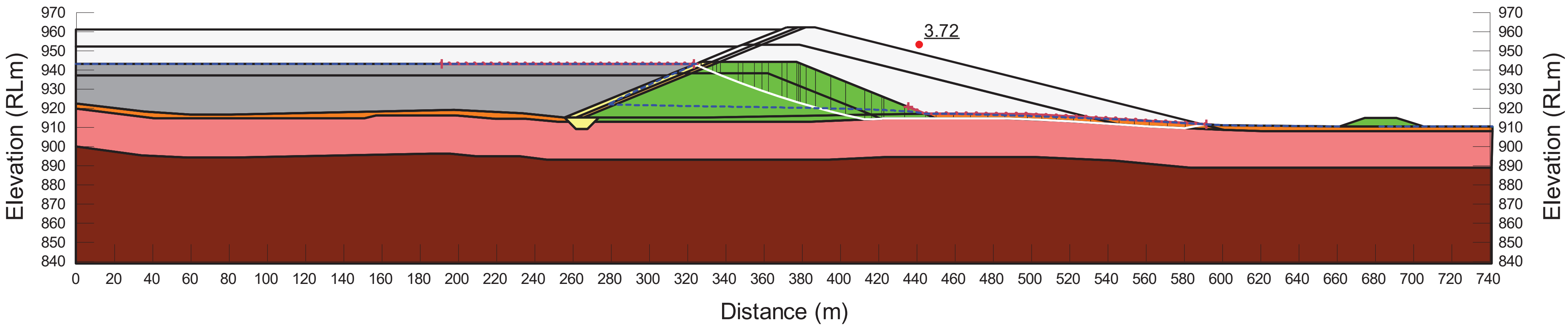
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 944.0 m POST-SEISMIC

Date: 31 March, 2020 Job No: 113272.02

Attachment A-17

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

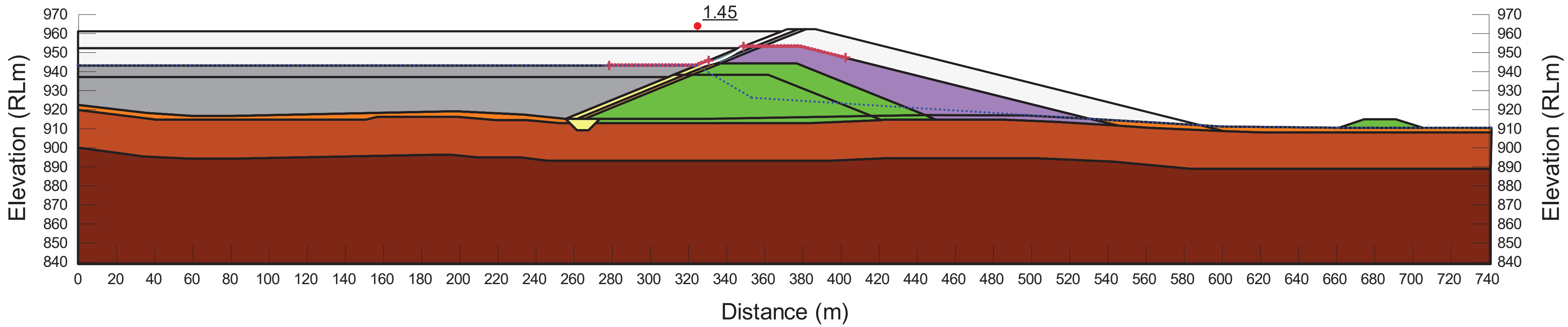
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 944.0 m POST-SEISMIC (IMPENETRABLE WEATHERED ROCK)

Date: 31 March, 2020 Job No: 113272.02

Attachment A-18

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line	B-bar	Add Weight
	Eff Clay Core	Mohr-Coulomb	18	1	28	0	1	1	No
	Eff Clay Core (New Material)	Mohr-Coulomb	18	1	28	0	1	0	Yes
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0	1	1	No
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0	1	0	No
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0	1	0	No
	Eff Rock Fill (New Material)	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0	1	1	No
	Eff Tailings	Mohr-Coulomb	17	0	25	0	1	0	No
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0	1	0	No
	Eff Transition Zone (New Material)	Mohr-Coulomb	20	0	42	0	1	0	Yes
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0	1	0	No



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

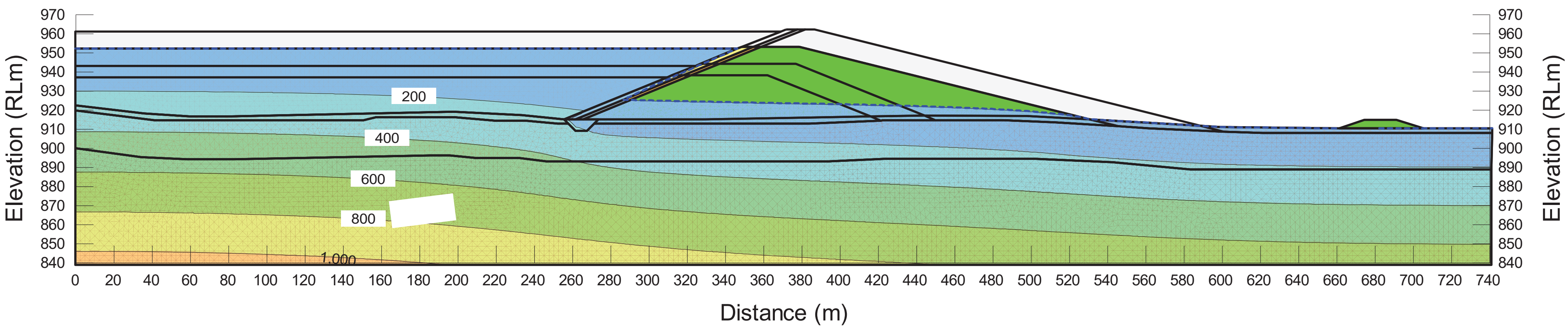
RL 953.0 m END OF CONSTRUCTION UPSTREAM

Date: 31 March, 2020 Job No: 113272.02

Attachment A-19

Color	Name	Model	Sat Kx (m/sec)	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	Eff Clay Core	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Cut-Off Key	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Fresh Rock (Anson Formation)	Saturated Only	2.31e-08			0.5	0	0	0
	Eff Rock Fill	Saturated Only	1e-06			1	0	0	0
	Eff Surface Soils	Saturated Only	5e-08			1	0	0	0
	Eff Tailings	Saturated / Unsaturated		Tailings	Tailings k = 1e-07m/s	0.1	0		
	Eff Transition Zone	Saturated Only	1e-06			1	0	0	0
	Eff Weathered Rock	Saturated Only	1e-08			1	0	0	0

Note:
- Contours represent Pore Water Pressure (kPa)



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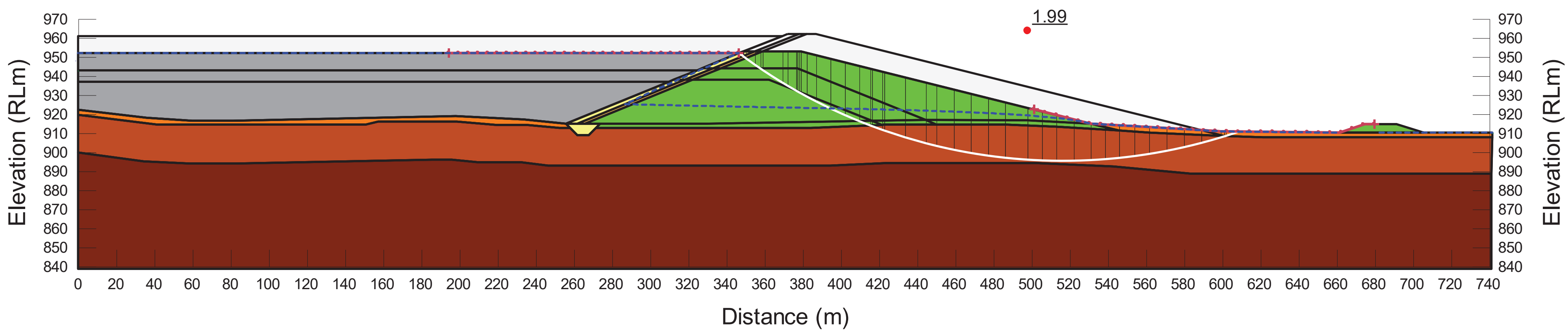
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 953.0 m STEADY STATE SEEPAGE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-20

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Clay Core	Mohr-Coulomb	18	1	28	0
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0
	Eff Tailings	Mohr-Coulomb	17	0	25	0
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

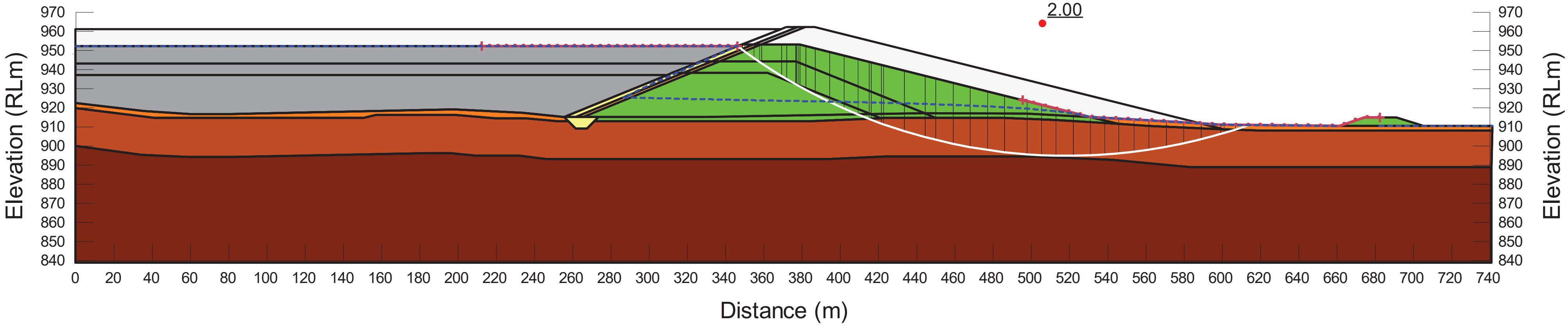
RL 953.0 m LONG-TERM STABILITY

Date: 31 March, 2020 Job No: 113272.02

Attachment A-21

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

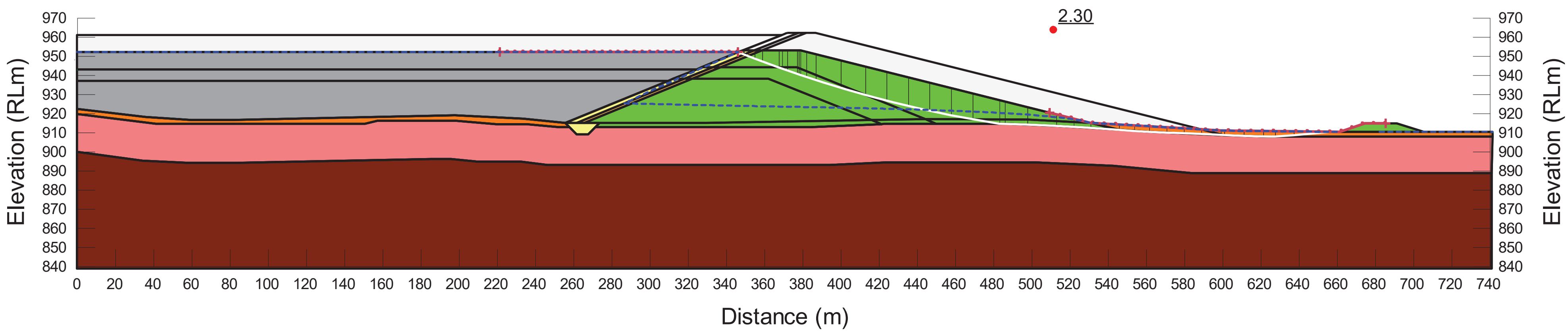
RL 953.0 m SEISMIC OBE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-22

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

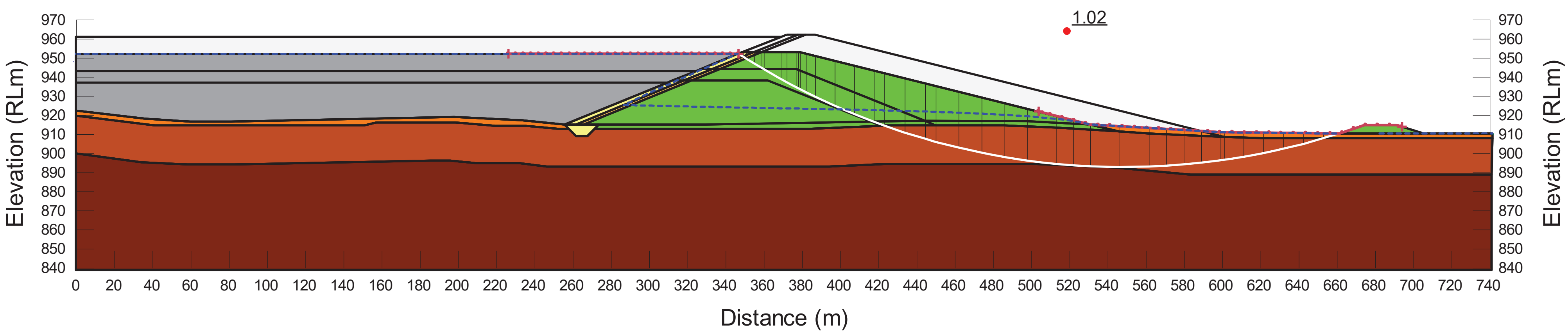
RL 953.0 m SEISMIC OBE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-23

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

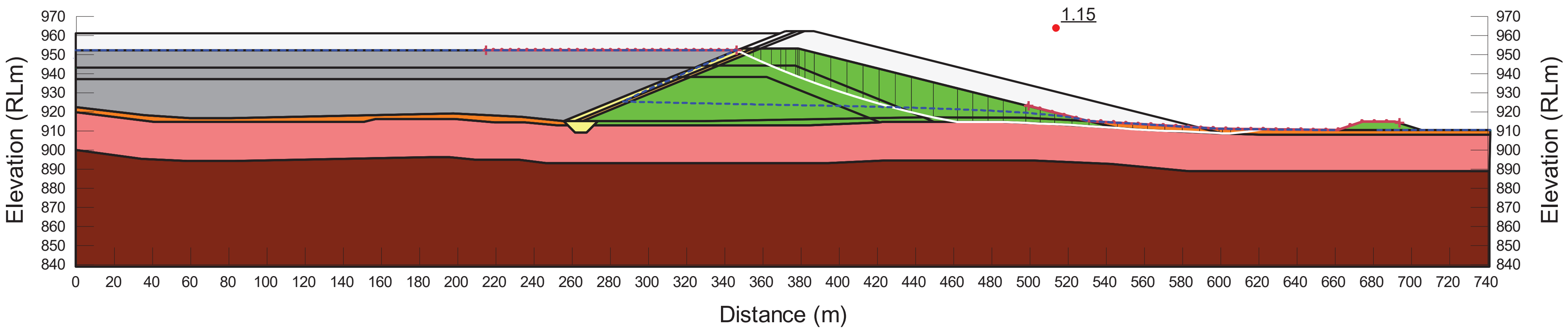
RL 953.0 m SEISMIC SEE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-24

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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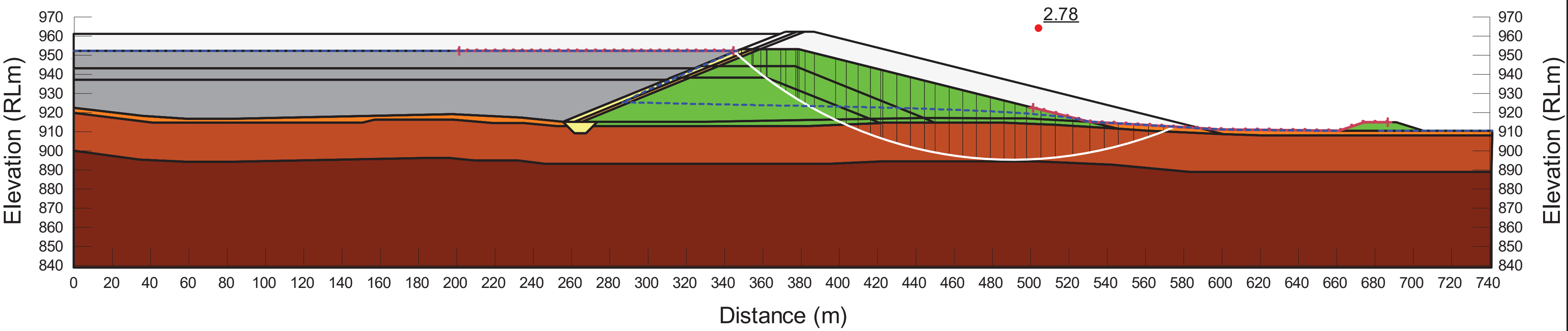
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 953.0 m SEISMIC SEE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-25

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	Eff/SR Weathered Rock	Mohr-Coulomb	22				0	32	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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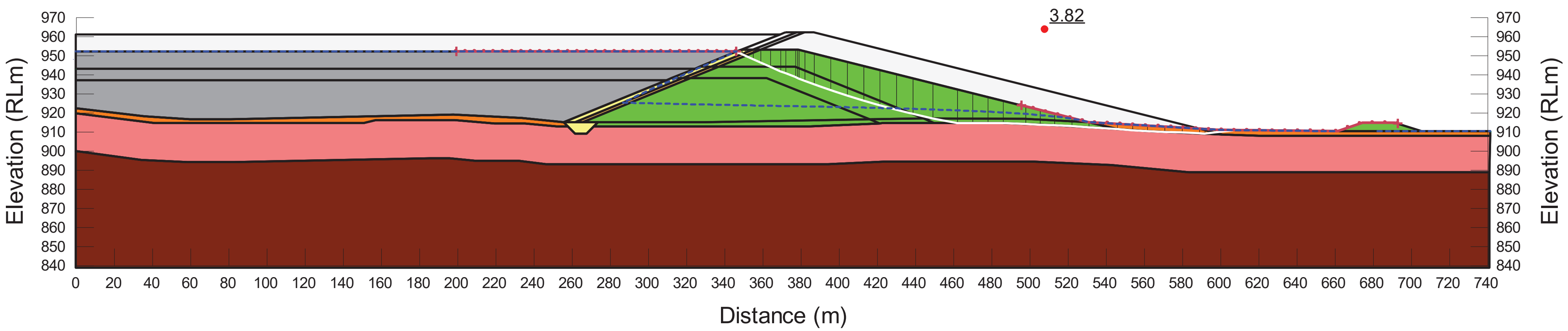
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 953.0 m POST-SEISMIC

Date: 31 March, 2020 Job No: 113272.02

Attachment A-26

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

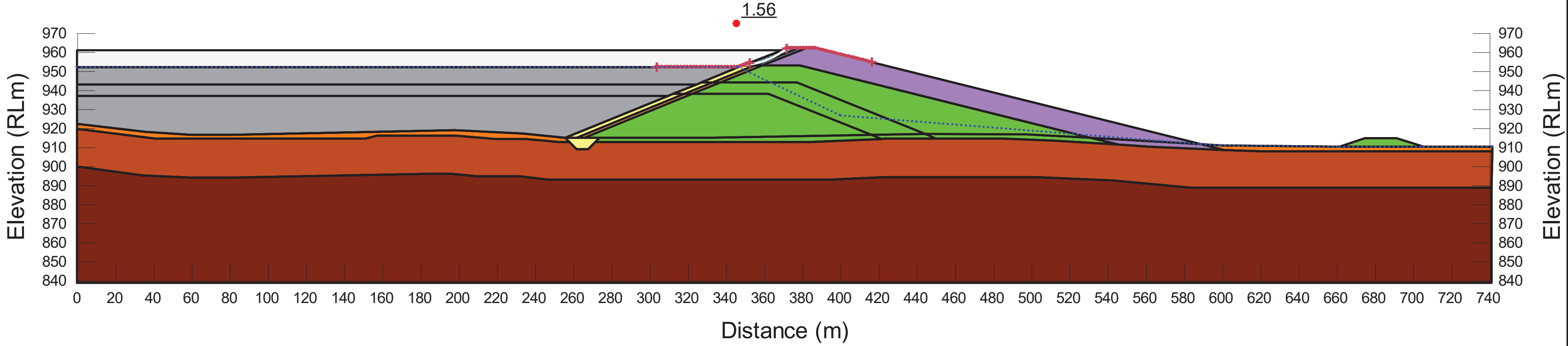
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 953.0 m POST-SEISMIC (IMPENETRABLE WEATHERED ROCK)

Date: 31 March, 2020 Job No: 113272.02

Attachment A-27

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line	B-bar	Add Weight
	Eff Clay Core	Mohr-Coulomb	18		1	28	0	1	1	No
	Eff Clay Core (New Material)	Mohr-Coulomb	18		1	28	0	1	0	Yes
	Eff Cut-Off Key	Mohr-Coulomb	18		1	28	0	1	1	No
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26		10	45	0	1	0	No
	Eff Rock Fill	Mohr-Coulomb	20		0	42	0	1	0	No
	Eff Rock Fill (New Material)	Mohr-Coulomb	20		0	42	0	1	0	Yes
	Eff Surface Soils	Mohr-Coulomb	18		0	28	0	1	1	No
	Eff Tailings	Mohr-Coulomb	17		0	25	0	1	0	No
	Eff Transition Zone	Mohr-Coulomb	20		0	42	0	1	0	No
	Eff Transition Zone (New Material)	Mohr-Coulomb	20		0	42	0	1	0	Yes
	Eff Weathered Rock	Mohr-Coulomb	22		0	40	0	1	0	No
	UD Clay Core	Undrained (Phi=0)	18	110				1	0	No



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

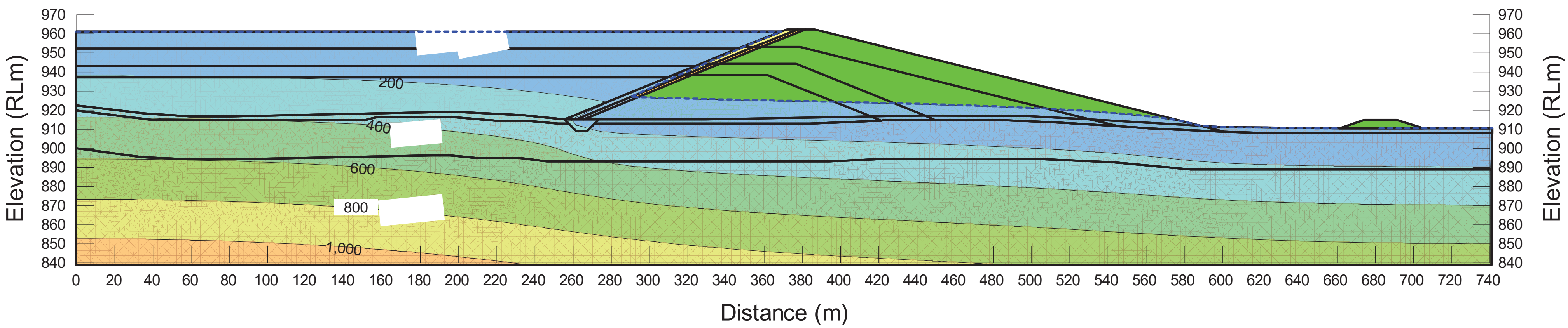
RL 962.0 m END OF CONSTRUCTION UPSTREAM

Date: 31 March, 2020 Job No: 113272.02

Attachment A-28

Color	Name	Model	Sat Kx (m/sec)	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)	Volumetric Water Content	Compressibility (/kPa)
	Eff Clay Core	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Cut-Off Key	Saturated / Unsaturated		Clay Earthfill	Clay k = 1e-09m/s	1	0		
	Eff Fresh Rock (Anson Formation)	Saturated Only	2.31e-08			0.5	0	0	0
	Eff Rock Fill	Saturated Only	1e-06			1	0	0	0
	Eff Surface Soils	Saturated Only	5e-08			1	0	0	0
	Eff Tailings	Saturated / Unsaturated		Tailings	Tailings k = 1e-07m/s	0.1	0		
	Eff Transition Zone	Saturated Only	1e-06			1	0	0	0
	Eff Weathered Rock	Saturated Only	1e-08			1	0	0	0

Note:
- Contours represent Pore Water Pressure (kPa)



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MCPHILLAMYS GOLD PROJECT - TSF

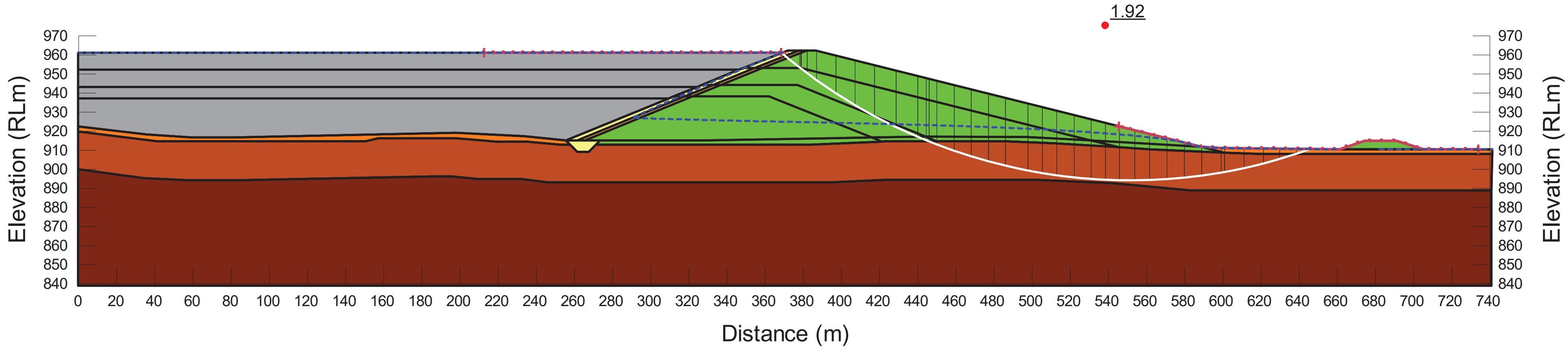
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 962.0 m STEADY STATE SEEPAGE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-29

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Clay Core	Mohr-Coulomb	18	1	28	0
	Eff Cut-Off Key	Mohr-Coulomb	18	1	28	0
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26	10	45	0
	Eff Rock Fill	Mohr-Coulomb	20	0	42	0
	Eff Surface Soils	Mohr-Coulomb	18	0	28	0
	Eff Tailings	Mohr-Coulomb	17	0	25	0
	Eff Transition Zone	Mohr-Coulomb	20	0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22	0	40	0



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

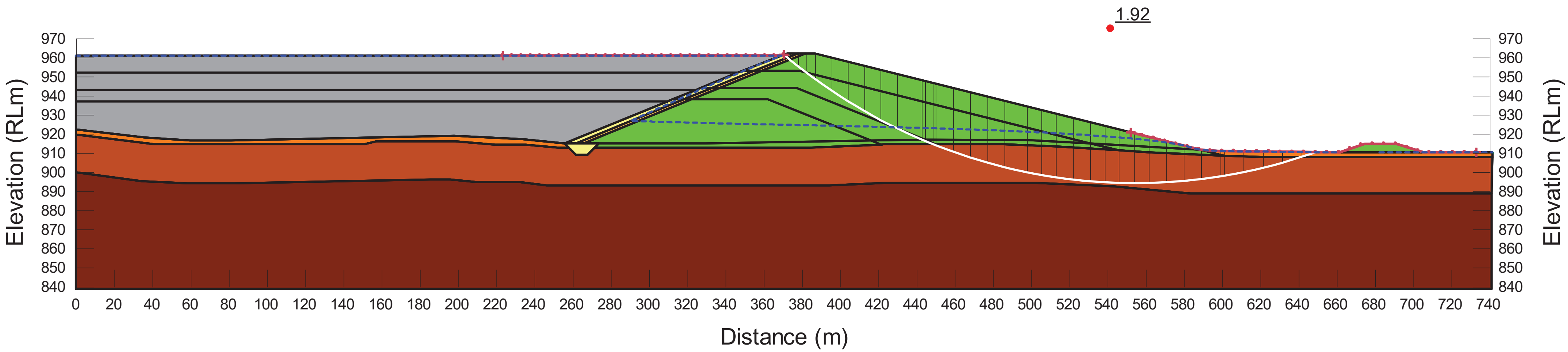
RL 962.0 m LONG-TERM STABILITY

Date: 31 March, 2020 Job No: 113272.02

Attachment A-30

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

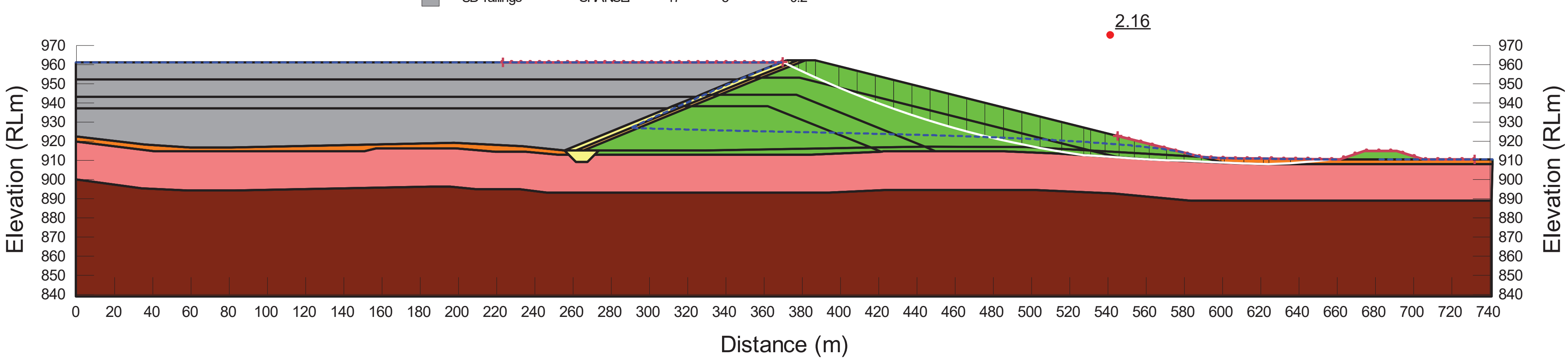
RL 962.0 m SEISMIC OBE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-31

Note:
- Seismic OBE PGA = 0.13g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

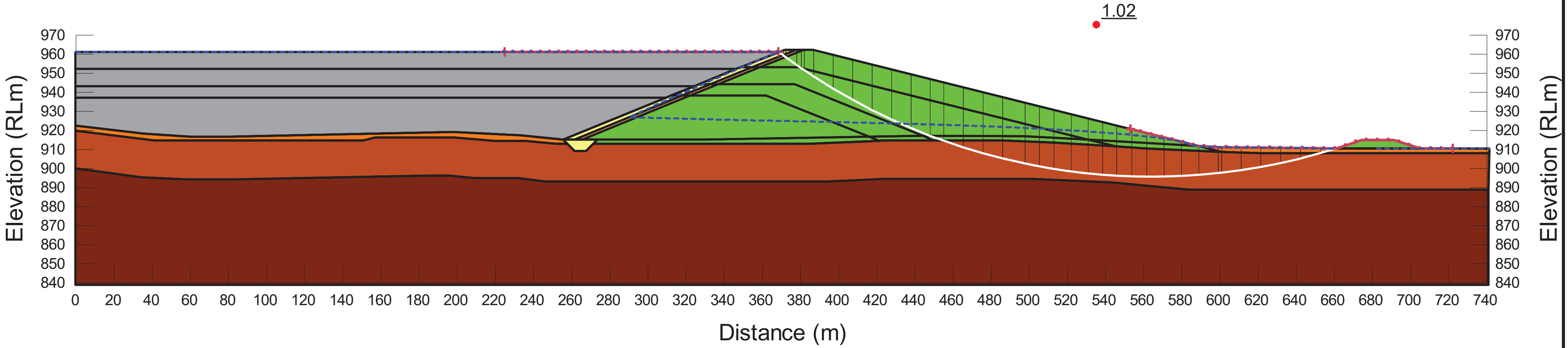
RL 962.0 m SEISMIC OBE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-32

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock	Mohr-Coulomb	22				0	40	0
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

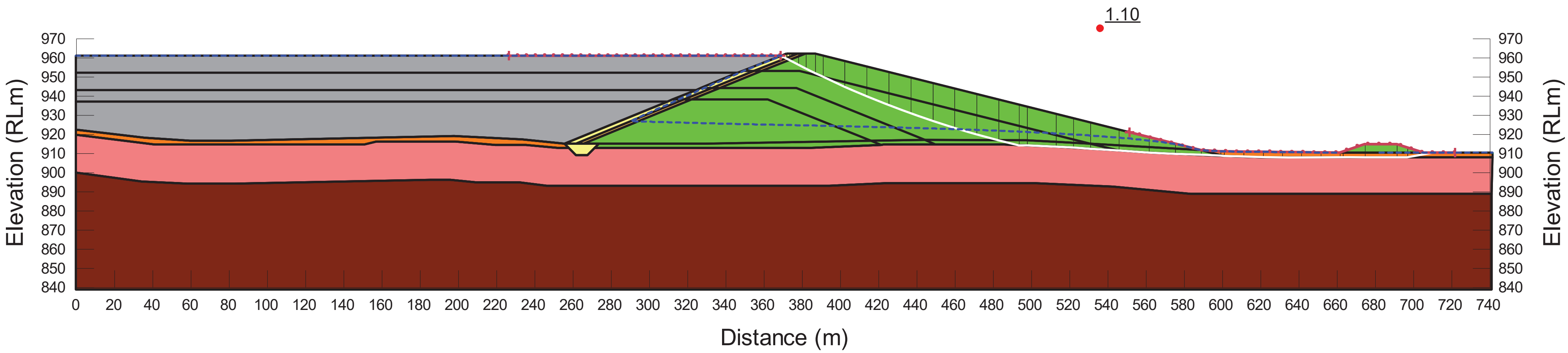
RL 962.0 m SEISMIC SEE

Date: 31 March, 2020 Job No: 113272.02

Attachment A-33

Note:
- Seismic SEE PGA = 0.40g

Color	Name	Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Surface Soils	Mohr-Coulomb	18				0	28	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	UD Clay Core	Undrained (Phi=0)	18			110			
	UD Cut-Off Key	Undrained (Phi=0)	18			110			
	UD Tailings	SHANSEP	17	5	0.2				



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MCPHILLAMYS GOLD PROJECT - TSF

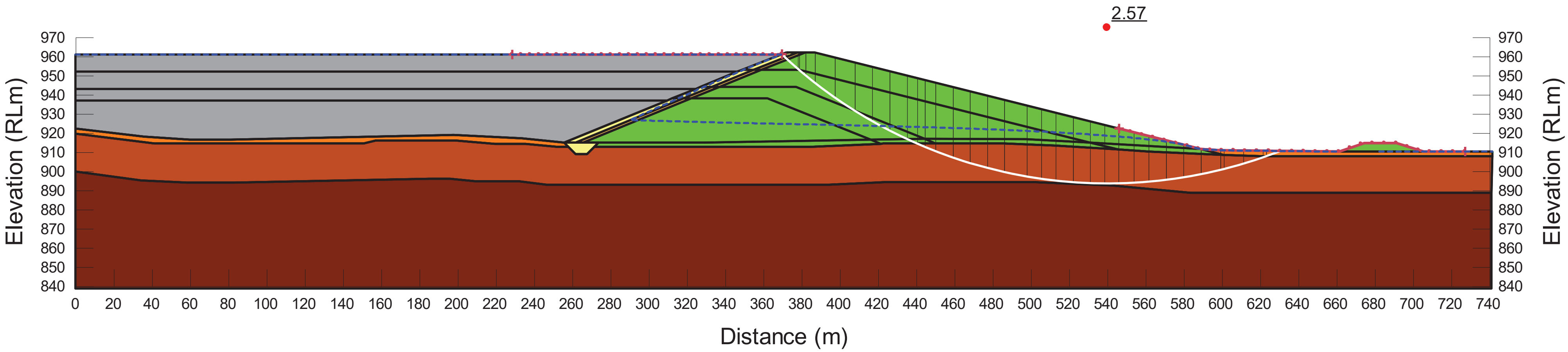
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 962.0 m SEISMIC SEE IMPENETRABLE WEATHERED ROCK

Date: 31 March, 2020 Job No: 113272.02

Attachment A-34

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	Eff/SR Weathered Rock	Mohr-Coulomb	22				0	32	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

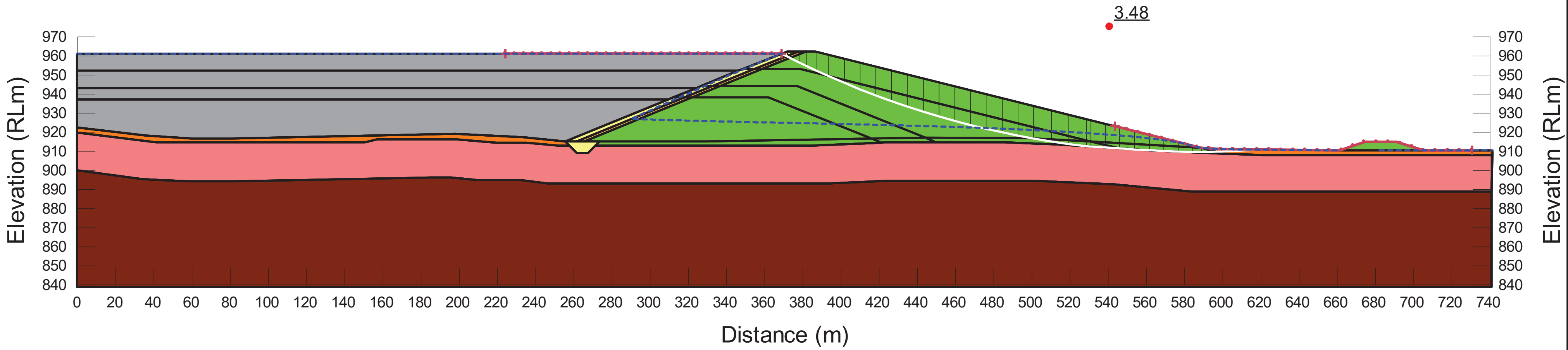
TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 962.0 m POST-SEISMIC

Date: 31 March, 2020 Job No: 113272.02

Attachment A-35

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Cohesion' (kPa)	Phi' (°)	Phi-B (°)
	Eff Fresh Rock (Anson Formation)	Mohr-Coulomb	26				10	45	0
	Eff Rock Fill	Mohr-Coulomb	20				0	42	0
	Eff Transition Zone	Mohr-Coulomb	20				0	42	0
	Eff Weathered Rock (Impenetrable)	Bedrock (Impenetrable)							
	Eff/SR Surface Soils	Mohr-Coulomb	18				0	22.4	0
	LIQ Tailings	SHANSEP	17		0	0.04			
	UD/SR Clay Core	Undrained (Phi=0)	18	88					
	UD/SR Cut-Off Key	Undrained (Phi=0)	18	88					



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MCPHILLAMYS GOLD PROJECT - TSF

TAILINGS STORAGE FACILITY – SEEPAGE AND STABILITY ANALYSIS

RL 962.0 m POST-SEISMIC (IMPENETRABLE WEATHERED ROCK)

Date: 31 March, 2020 Job No: 113272.02

Attachment A-36

APPENDIX B

REPORT

REGIS RESOURCES LIMITED

MCPHILLAMYS GOLD PROJECT

Kings Plains, NSW

Proposed Tailings Storage Facility (TSF)

Construction Quality Assurance (CQA) Plan

August 2020

Report Number: 113272-02R007

Document History and Status

Title: Proposed TSF Construction Quality Assurance

Job Number/Extension: 113272.02

Document Number: 113272.02_R07a - DRAFT

Project Office: Brisbane

File Path: M:\Synergy\Projects\113\113272 McPhillamys Gold Project\02 Tailings and Water DFS\Reports\R007\Text\113272-02R007.docx

Author: Hubert Ayanu/ Charl Ludick
Reviewer: Ralph Holding
Job Manager: Ralph Holding

Rev.	Status	Issued to	Issue Date	Signatures	
				Author	Reviewer
A	Draft	Regis	23/07/2020	HAA/ CL	RH

IMPORTANT NOTICE
Please refer to our Conditions of Investigation and Report

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2. This report is based in part on information which was provided to us by the client and/or others and which is not under our control. We do not warrant or guarantee the accuracy of this information.

3. We believe the conclusions and recommendations contained herein were reasonable and appropriate at the time of issue of the report. However, the user is cautioned that fundamental input assumptions upon which this report is based may change with time. It is the user's responsibility to ensure that input assumptions remain valid.

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Appendix B	Inspection Test Checklists
Appendix C	Daily Site Diary
Appendix D	Non-Conformance Report

1 INTRODUCTION

As part of the proposed McPhillamys Gold Project, Regis Resources Limited (Regis) propose to develop an open cut mining operation with associated CIL process plant, waste rock dumps, water management infrastructure, tailings storage facility (TSF) and associated infrastructure at their McPhillamys leases (mining lease application: MLA0574). The site is located in Kings Plains NSW and is approximately 27 kilometres south west of Bathurst and approximately 8km north east of Blayney in the Central Tablelands of NSW. The site is accessed off the Mid-Western Highway.

As part of the project development Feasibility Design and to address request for information as part of the EIS responses, ATC Williams Pty Ltd (ATCW) have prepared a typical Quality Construction Quality Assurance (CQA) Plan for the construction aspects of the TSF.

The CQA Plan summarises minimum testing and inspection frequencies in order to satisfy Construction Quality Assurance requirements. Specific details on CQA objectives including material properties, construction standards and tolerances, test methodologies and frequencies will be provided in the detailed Design Report.

The scope of TSF construction works is summarised as follows:

- General earthworks to form TSF embankment;
- Installation of the storage liners;
- Construction of the emergency spillway; and
- Construction of the decant structure.

Principally, the CQA Plan establishes the methods to be adopted to attain and maintain consistent high quality in all construction activities. The CQA Plan would generally be prepared to complement the Technical Specification and to re-emphasise control procedural aspects. The CQA Plan indicates what observations and tests will be made during construction to verify that criteria outlined in the Design Report and Technical Specification are met.

The procedures outlined herein are necessary to provide a level of confidence that the completed works will meet Technical Specification requirements and current construction industry standards. Observations and documentation of activities are a primary emphasis in implementation of this CQA Plan, as these activities will provide evidence that construction was performed according to the Technical Specification. These organised activities assist in identifying problems that may occur before and during construction, and provide evidence that problems were addressed and corrected before the construction was completed.

It is possible that a review of construction methods and/or materials used during the course of the works will be required, as a result of innovation, unexpected physical conditions of the site or to improve cost effectiveness. This CQA Plan may therefore require revisions/addendums during construction.

All parties associated with proposed TSF construction should be provided with and be familiar with this CQA Plan.

1.1 Related Documentation

The CQA plan shall be used in conjunction with the following documents:

- Detailed Design Report;
- Construction Drawings; and
- Inspection Test Plans and Checklists

1.2 Responsibilities

ATCW will provide full time construction supervision. Key parties referenced in this CQA Plan and the responsibilities of these parties are summarised in **Table 1**.

Table 1
Role and Responsibilities

	Role	Responsibilities
Regis Resources	Principal/Superintendent	• Construction supervision • Liaison with Designer's Representative
ATC Williams	Designer's Representative	• Inspections as per hold points summarised in **Table 9**.
Contractor	Earthworks testing	• Testing as per Technical Specification • Review results against specification and provide feedback/results to Superintendent and Designer's Representative
	Earthworks	• Clay fill placement • Rock Fill (PAF and NAF) fill placement • Construction of decant structure
	Lining contractor	• Installation of Liner • Geosynthetics sampling and testing

1.3 Construction Standards

The following construction standards shall be achieved as a minimum requirement:

- Materials and workmanship shall comply with the requirements of current standards and Codes of Practice of the Standards Association of Australia (Standards Australia) as appropriate. All materials and workmanship not covered by a Standards Australia standard shall be of such kind as is used in first class work, suitable for the environment and conditions under which the works are to be constructed.
- All field and laboratory test work (as applicable) shall be carried out by suitably qualified technicians from National Association of Testing Authorities (NATA) or similarly registered laboratories. The CQA for the laboratory test work shall be carried out in accordance with NATA (or related) requirements, details of which shall be maintained by the laboratory.

1.4 Construction Documentation

Documents and records completed and benchmarked against this CQA Plan shall be maintained, controlled and archived in accordance with a Document System developed by the Superintendent/Contractor. Copies of quality records shall be made available to any regulatory bodies on request at any time during the works. Collation of the quality records will be performed progressively through the works. At the completion of the works, the quality records will be compiled and filed.

At the completion of construction works, the following documentation and records will be compiled:

- Daily construction reports;
- CQA results - including Inspection Test Plans (ITPs) and Inspection Test Checklists (ITCs); and
- As-constructed survey for the works in the form of as constructed drawings and plans.

All documentation outlined in **Table 2** will be checked for accuracy and consistency and be submitted to the Designer's Representative as a record of construction works completed.

Table 2
Manufacturing and Construction Documentation

<table>
<tr><th colspan="2">Role</th><th>Documentation</th></tr>
<tr><td colspan="2">Superintendent</td><td>• Daily Diary
• ITPs & ITCs</td></tr>
<tr><td rowspan="3">Contractor</td><td>Earthworks testing</td><td>• Material classification test results
• In-situ density testing and laboratory compaction and moisture content relationship</td></tr>
<tr><td>Earthworks</td><td>• Construction diaries</td></tr>
<tr><td>Lining contractor</td><td>• Manufacturing Quality Assurance documentation for HDPE Liner
• ITCs/ITPs
• HDPE Liner
  o Panel layout
  o Repair log
  o Non-destructive test results
  o Destructive test results</td></tr>
<tr><td colspan="2">Surveyor</td><td>Survey of the following construction aspects:
• Foundation sub excavation
• Embankment
• Spillway</td></tr>
</table>

1.5 Construction Planning and Communication

Technical benchmarks to be achieved during construction shall include the following, as a minimum requirement:

- Compliance with expectations of Regulator in relation to design configuration and performance both during and after construction;
- Compliance with control testing requirements for construction materials, to be completed by a NATA accredited laboratory; and
- Compliance with all requirements of the CQA Plan and Technical Specification, which will include photographic evidence/history of all works.

A pre-construction meeting shall be held between the Principal, Superintendent and Contractor that will address the following:

- Establish lines of communication with those involved in the construction;
- Introduction and overview the CQA Plan;
- Co-ordinate CQA works (i.e. establishing time frames from notification to testing, etc.); and
- Discuss the proposed arrangements for the carrying out of the construction works.

2 MONITORING AND MEASUREMENT OF WORKS

The key role defined by this CQA Plan is the Designer's Representative, who will provide full-time surveillance/monitoring of the works and complete appropriate CQA documentation, including Inspection Test Plans and Checklists.

The principal technical aspects related to the construction works will be as follows:

- Suitability of foundation excavation and preparation works;
- Suitability of excavation of emergency spillway according to the Technical Specification and Drawings;
- Suitability of material used in storage area lining, including Clay Fill and imported engineered products;
- Suitability of material used in embankment construction including Clay Fill, Rock Fill and Select Rock Fill; and
- Suitability of embankment completion works including batter trimming and crest profiling.

The general requirements for monitoring/inspections and measurement of the works carried out are as follows:

- The Contractor to complete required documentation on readiness of any work area for inspection/testing;
- The Designer's Representative to select particular materials and locations to be inspected/tested; and
- The Designer's Representative to assess the outcome of tests and inspections and any remedial works necessary as a result of these outcomes, with the Contractor to facilitate these remedial works accordingly.

2.1 Inspection Test Plans (ITPs)

2.1.1 Purpose and Scope

The purpose of an ITP is to assemble in a single document a record of all inspection and testing requirements relevant to a specific construction process, and in this case, being the construction of the TSF. An ITC accompanies the ITP, as a prompt for CQA requirements, notifications and timing.

An ITP, accompanied by an ITC, identifies the items of materials and work to be inspected or tested, by whom and at what stage or frequency. The ITP also identifies Hold Points (described in the relevant sections of the CQA Plan), references to relevant standards, acceptance criteria and the records to be maintained. ITPs, when properly implemented, help ensure that, and verify whether work has been undertaken to the required standard and requirements, and that records are kept.

2.1.2 Definitions

Hold Point	-	A hold point defines a point beyond which work may not proceed without the authorisation of a designated authority.
Surveillance	-	Intermittent monitoring of any stage of the work in progress (whether by the Contractor or Superintendent).
Self-inspection	-	Where the Contractor performing the work verifies the quality progressively - often with the aid of checklists.
Work area (Lots)	-	A discrete section of the whole work, usually defined by location, where construction activities are discretely tracked from a CQA perspective.
Non-Conformance		Record prepared for a non-conformance encountered as part of the CQA process, with recommendations for corrective action to be defined.

2.1.3 Roles and Responsibilities

The Superintendent is responsible for ensuring that all the required ITP’s are prepared, including those covering work or processes to be carried out by the Contractor.

The approved delegate of the Contractor shall be responsible for approving ITPs, and any subsequent amendments, prior to their submission or submission of compliance/conformity certification.

2.1.4 Project Particulars

The following project particulars shall be recorded on each of the ITPs: -

- Project Name
- Location
- Lot number
- Description of process/activities for that particular ITP.

2.1.5 Inspection and Testing Frequencies

The frequency of inspections and tests, and any associated sampling process shall be in accordance with the Technical Specification. Inspections by the Designer’s Representative shall be undertaken at key hold points in addition to daily inspections.

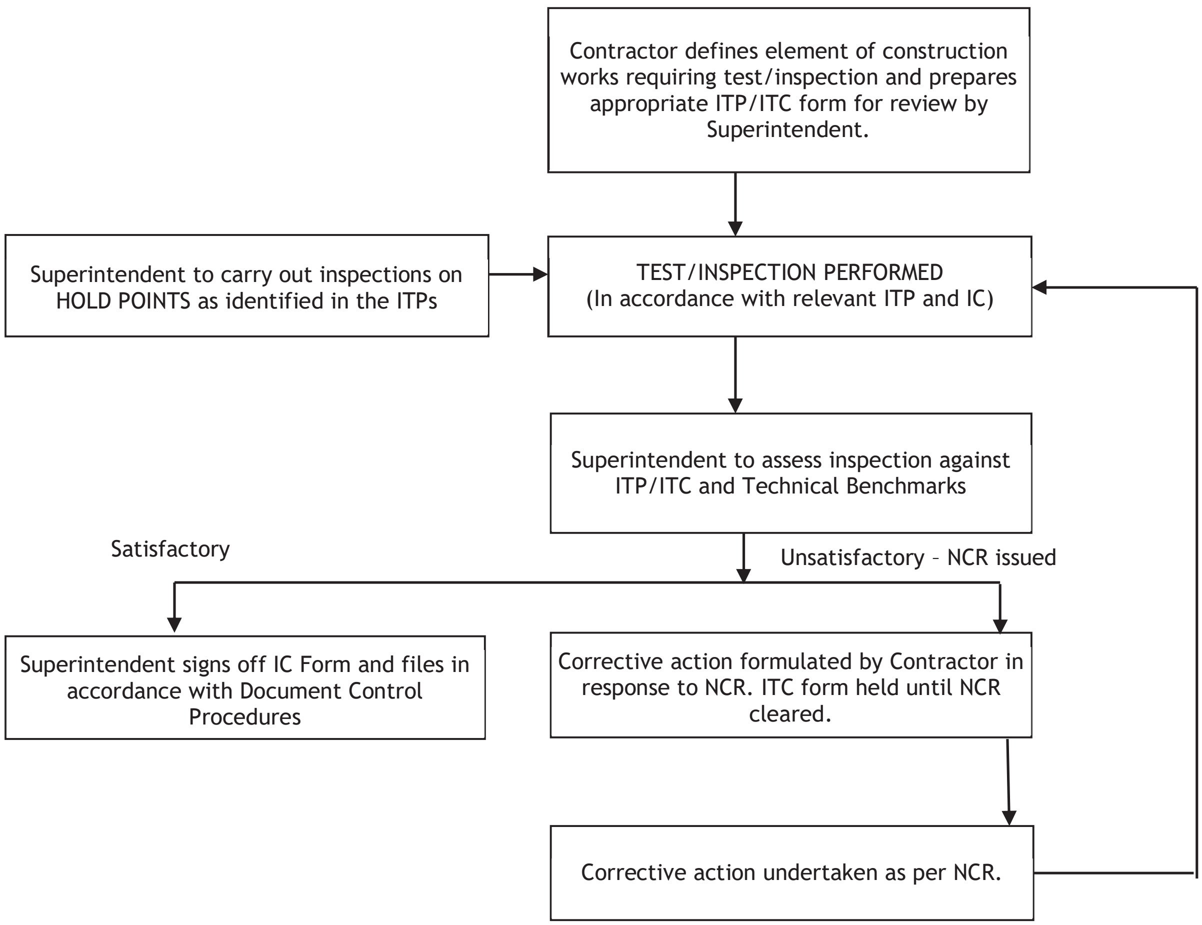
The Contractor shall carry out preliminary inspection (or tests if required) to assist in obtaining an early indication of conformity.

Inspection and testing frequencies may be either increased and processes reviewed for ‘problem’ work activities and decreased where consistent conformity was evidenced.

2.1.6 Uses of ITPs

- ITPs will be utilised to monitor and record progress of activities, inspections and approvals during the construction works; and
- Additional ITPs and ITCs may be developed during the construction program should the scope and nature of works be expanded or changed. Such ITPs and ITCs will be submitted to the Superintendent for review and acceptance at least 5 days prior to the programmed date for commencement of that specific activity.

The procedure for inspections/test-work is such that the works shall be carried out in accordance with the Technical Specification and any required corrective actions shall be completed in accordance with the following flowchart.



2.1.7 Acceptance Criteria

Acceptance criteria related to CQA requirements is defined in the Technical Specification (either directly or by reference to other standards such as Australian Standards), or by relevant technical benchmarks outlined in the Project Execution Plan. Where this is not the case, the Contractor, Superintendent and Designer’s Representative shall identify and possibly reach an agreement.

2.1.8 Checklists

The Contractor or Superintendent shall set up checklists to carry out surveillance on a continuous basis and documented daily. Any activities and conditions outside the scope of works at the time of surveillance shall be highlighted and agreed between Superintendent and Contractor in terms of actions in relation to these works to be undertaken.

2.2 Adherence to Hold Points

Where the Specification and/or the relevant Checklist require the presence, inspection and approval of the Superintendent or Designer's Representative for Hold Points, the Contractor shall ensure that these points are adhered to unless otherwise agreed in writing by the Superintendent or Designer's Representative.

At the time of each hold point, and any others as identified by the Superintendent through the course of the works, arrangements shall be made for inspection and/or testing to take place. Satisfactory inspection and approval by the Superintendent as appropriate will be a pre-requisite to advancing to any subsequent stages of construction.

A selection of hold points requiring inspection by the Designer's Representative are described in **Section 4**. It should be noted that this does not necessarily constitute all defined hold points for the construction works. All hold points are defined in the ITPs and ITCs.

3 CQA REQUIREMENTS

Table 3 to **Table 8** outlines minimum CQA aspects to be completed and documented.

3.1 Foundation Sub-Excavation

Table 3
Foundation Sub-Excavation CQA

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Excavation depth (HOLD POINT)	At base of excavation	Superintendent/ Designer's Representative	• Excavation of existing natural material and loose/soft material to be removed.
Survey	At base of excavation	Contractor	• Survey provided to Designer's Representative.
Review of Survey **(HOLD POINT)**	Following completion of excavation, prior to backfilling.	Superintendent/ Designer's Representative	• Levels and grades in accordance with Drawings.

3.2 Rock Fill

Table 4
Rock fill CQA

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Material classification test work	Prior to use	Contractor/ Superintendent	• Material classification per the Technical Specification
Placement and compaction	At regular intervals during placement	Contractor/ Superintendent	• Specified number of passes using the spreading plant (minimum D10 Dozer or equivalent would be typical)
Survey	Following completion of Rock Fill	Contractor	• Survey of rockfill extents
Review of Survey **(HOLD POINT)**	Following completion of Rock Fill	Designer's Representative	• Minimum grades per specification

3.3 Clay Fill

Table 5
Clay fill CQA

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Material classification test work	Prior to use	Contractor/ Superintendent	• Material classification per Technical Specification
Placement and compaction	At regular intervals during placement	Contractor/ Superintendent	• Moisture Content and Compaction testing as per Technical Specification
Survey	Following completion of Clay Fill	Contractor	• Survey of Clay Fill extents
Review of Survey **(HOLD POINT)**	Following completion of Clay Fill	Designer's Representative	• Minimum grades per Technical Specification
Inspection of final surface **(HOLD POINT)**	Following completion of Clay Fill	Designer's Representative	• Smooth surface with no protrusions or abrupt changes in grade

3.4 Liner (GCL)

Table 6
Liner CQA (GCL)

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Manufacturer's Quality Assurance documentation (**HOLD POINT)**	Prior to installation	Contractor to provide to Superintendent and Designer's Representative	• In accordance with Technical Specification
Sampling for third party	Prior to installation	Contractor to arrange testing. Results provided to Superintendent and Designer's Representative	• In accordance with Technical Specification
Subgrade Preparation Inspection	Prior to installation	Contractor to arrange. Inspection by Superintendent and Designer's Representative	• In accordance with Technical Specification • Smooth surface with no protrusions or abrupt changes in grade
Overlaps and Seaming	All seams	Contractor to arrange inspections by Superintendent or Designer's Representative	• In accordance with Technical Specification
Final inspection	Prior to installation of protection geotextile	Designer's Representative	• Defects and holes repaired • Installers CQA documentation supplied

3.5 Spillway

Table 7
Spillway CQA

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Excavation of spillway channel	Following excavation of channel	Contractor/Superintendent	• Spillway dimensions in accordance with Technical Specification and Issued for Construction (IFC) Drawings
Rock fill armouring	Following completion of Rock Fill	Contractor/Superintendent	• Material characteristics in accordance with Technical Specification
Survey	Following excavation of channel and completion of Rock Fill armouring	Contractor	• Survey of rock fill armouring extents
Review of Survey **(HOLD POINT)**	Following completion of excavation and placement of rock fill armouring	Designer's Representative	• Minimum grades per specification • Spillway width per specification

3.6 Seepage Collection System

Table 8
Seepage Collection System CQA

Item	Inspection Frequency	Responsibility	Acceptance Criteria
Excavation of Trenches	Following excavation of channel	Contractor/Superintendent	• Spillway dimensions in accordance with Technical Specification and Issued for Construction (IFC) Drawings
Pipe Material Properties	Prior to Installation	Contractor/Superintendent	• Material characteristics in accordance with Technical Specification
Drainage Aggregate Material Properties	Prior to Installation	Contractor/Superintendent	•
Survey	Following excavation of channel and completion of Rock Fill armouring	Contractor	• Survey of rock fill armouring extents
Review of Survey **(HOLD POINT)**	Following completion of excavation and placement of rock fill armouring	Designer's Representative	• Minimum grades per specification • Spillway width per specification

4 HOLD POINTS

Hold points are outlined in **Table 9** below. At each hold point, inspection by the Designer's Representative is required. It is the responsibility of the Superintendent to ensure the Designer's Representative is notified at each hold point.

Table 9
Hold points

Item	Aspect
Clearing and preparation	• Clearing undertaken in accordance with Technical Specification
Sub-excavation	• At the base of excavation, unsuitable soils removed and free of local areas of soft or loose materials • Survey required
Clay Fill	• Review of compaction and moisture content results at regular intervals • Survey required
Rockfill	• Survey required
Storage Liner	• Manufacturer's QA • Surface Preparation • Panel placement and seams
Spillway	• Survey grade • Spillway channel width • Invert level • Channel grade
Seepage Collection System	• Trench Excavation and grade • Manufacturer's QA • survey

5 MONITORING AND MEASUREMENT REPORTS

Documentation of construction activities and control testing is a major component for providing a level of confidence that the works are constructed according to the Technical Specification. These documents will become part of the project files and may be used to provide information concerning:

- Construction procedures and control test results;
- Corrective Actions;
- Non-conformance reports and actions;
- Types and properties of materials installed and approved; and
- Other pertinent information necessary to describe that the construction of the works was performed in accordance with the relevant documentation.

Details of relevant construction documentation are provided in the following sections.

5.1 Daily Site Diary

The Superintendent will complete a Daily Site Diary outlining the observations for each day of construction activities. Generally, this report will be completed by the following morning for the preceding day's activities. A Daily Site Diary template is provided in **Appendix C**.

5.2 Non-Conformance Reports

When work that does not conform to the Technical Specification and this CQA Plan is observed, a Non-Conformance Report (NCR) will be prepared by the Superintendent. A log of all NCRs will be kept and reviewed periodically by the Superintendent to ensure that all corrective actions are reported and signed off. Such corrective actions will be formulated in accordance with the Inspection and Test work Procedure as outlined in the relevant section of the CQA Plan. A typical NCR form is presented in **Appendix D**.

5.3 Inspection Test Plans (ITPs) and Inspection Test Checklists (ITCs)

ITPs and ITCs are to be used to assist in recording of construction checking. Templates for ITPs and ITCs are provided in **Appendices A** and **B**, respectively.

APPENDICES

APPENDIX A
INSPECTION TEST PLANS

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**INSPECTION & TEST PLAN**	
PROJECT NAME:	TSF	**FOR:**	**Construction Preparation and Foundation Preparation**

Ref	Operating or Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Contractor	Superintendent /Inspector	Designer
1	Setout of the works	In accordance with Drawings/as directed	Prestart	ITC	Drawings	-	Visual/Check Survey	X	H	-
2	Locate services	Location of Power, Water, Telephone and other cables	Prestart	Survey Plan	Relevant Authorities			X	S	-
3	Environmental controls	As directed by Superintendent/ Inspector	Prestart	ITC	As directed by Superintendent/Inspector	Correct controls	Visual	X	S	-
4	Clearing	Removal of debris, trees, stumps, scrub and fallen timber	Each Lot	ITC	4.2.2	Clay surface free of organic matter	Visual	X	H	H
5	Foundation Sub-excavation	To Specification	Each lot	Survey	4.2.3	To RL205.6m or to intersection with existing embankment	Visual & Survey	X	H	H
6	Check works complete	Area completed, clean & tidy	Each lot	ITC and Survey	Drawings/As directed	Drawings & Spec	Visual	X	H	-

S:	Surveillance or monitoring
H:	Hold Point (Mandatory not to proceed without approval)
X:	Self inspection by performer of work

Approved by:	Date of Issue: July 20	Revision No: 0 (For Review)	ATC Williams

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**INSPECTION & TEST PLAN**	
PROJECT NAME:	TSF	**FOR:**	Clay Fill

Ref	Operating or Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification Reference/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Contractor	Superintendent /Inspector	Designer
1	Setout of the works	In accordance with Drawings/As directed	Prestart	ITC	Drawings	-	Visual/Check Survey	X	S	-
2	Environmental Controls	As directed by Superintendent/ Inspector	Prestart	ITC	As directed by Superintendent/ Inspector	Correct controls	Visual	X	S	-
3	Fill Placement	Layer thickness and conditioning (moisture content)	Each lot	ITC	4.3.3.2	conditioned to appropriate moisture content Embankment layer thickness <300mm pre-compaction; Liner In situ thickness 450mm	Visual& Survey	X	H	S
4	Moisture/Density Tests	To specification	2,500m^3	Attach test certificate and survey test location	4.3.3.2	-5 to +0 of optimum moisture content 98% standard compaction	Independent Lab	-	S	S
5	Extent of Fill Works	To drawings and tolerances	Each lot	As-built Plans	4.3	Within tolerances	Visual & Survey	X	H	H
6	Check works complete	Area completed, clean & tidy	Each lot	ITC	Drawings/as directed	Drawings & Spec	Visual	X	H	-

S:	Surveillance or monitoring
H:	Hold Point (Mandatory not to proceed without approval)
X:	Self inspection by performer of work

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**INSPECTION & TEST PLAN**	
PROJECT NAME:	TSF	**FOR:**	Rock Fill

Ref	Operating or Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification Reference/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Contractor	Superintendent/Inspector	Designer
1	Setout of the works	In accordance with Drawings/As directed	Prestart	ITC	Drawings	-	Visual/Check Survey	X	S	-
2	Source material	In accordance with Specification	Each Lot	ITC	4.3.2.2	maximum particle size of 300mm and not greater than 5% fines	Visual	X	S	-
3	Fill Placement	In accordance with Specification	Each lot	ITC	4.3.3.3	In accordance with Specification	Visual	X	S	-
4	Extent of Fill Works	To drawings and tolerances	Each lot	As-built Plans	4.3.6	Within tolerances	Visual & Survey	X	H	H
5	Check works complete	Area completed, clean & tidy	Each lot	ITC	Drawings/as directed	Drawings & Spec	Visual	X	H	-

S: Surveillance or monitoring

H: Hold Point (Mandatory not to proceed without approval)

X: Self inspection by performer of work

CLIENT: Regis Resources Ltd – McPhillamys Gold Project **INSPECTION TEST PLAN**

PROJECT NAME: TSF **FOR:** **HDPE Liner**

Ref	Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Constructor	Superintendent /Inspector	Designer's Representative
1	Setout of the works	In accordance with Drawings/ Specification	Prestart/ Ongoing	ITC	-	Panel Layout Plan	Survey	X	S	-
2	Material Properties	In accordance with Specification	Each lot	ITC	2.4	As per specification	Third party testing	X	H	H
3	Inspection/ Storage	In accordance with Specification	Each lot	ITC	2.2	As per specification	Visual	X	S	S
4	Installation	In accordance with Specification	Each lot	ITC	3.0	As per specification	Visual	X	S	S
5	Trial welds	In accordance with Specification	Prestart/ ongoing	ITC	3.4	As per specification	Visual	X	S	S
6	Destructive Testing	In accordance with Specification	Per Specification	ITC	3.8	As per specification	Third party testing	X	H	S
7	Pressure Testing	In accordance with Specification	Each Seam	ITC	3.7	As per specification	Pressure testing	X	H	S
8	Defects & Repairs	In accordance with Specification	Each lot	ITC	3.8.8	As per specification	Pressure testing	X	H	S
9	Check Works Complete	In accordance with Specification	Each lot	ITC	-	Works complete	Survey/Visual	X	H	S

S:	Surveillance or monitoring
H:	Hold Point (Mandatory not to proceed without approval)
X:	Self inspection by performer of work

CLIENT: Regis Resources Ltd – McPhillamys Gold Project **INSPECTION & TEST PLAN**

PROJECT NAME: TSF **FOR:** Emergency Spillway

Ref	Operating or Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification Reference/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Contractor	Superintendent/Inspector	Designer
1	Setout of the works	In accordance with Drawings/As directed	Prestart	ITC	Drawings	-	Visual/Check Survey	X	S	-
2	Channel Excavation	To drawings and tolerances	-	Survey	Drawings	Within tolerances	Visual/Check Survey	X	H	H
3	Rock Fill Placement	In accordance with Specification	Each lot	ITC	Drawings	Layer thickness <1.0m pre-compaction;	Visual/Check Survey	X	H	S
4	Extent of Fill Works	To drawings and tolerances	Each lot	As-built Plans	4.3.6	Within tolerances	Visual & Survey	X	H	S
5	Concrete Canvas Material Properties	In accordance with Specification	Each Lot	Manufactures Supply Certificates	4.4.2	Drawings & Spec	Manufactures Supply Certificates	S	S	-
6	Concrete Canvas Installation	Installed in accordance with manufactures guidelines	Each Lot	As-built Plans	Manufactures guidelines	Manufactures guidelines	Visual	X	S	S
7	Check works complete	Area completed, clean & tidy	Each lot	ITC	Drawings/as directed	Drawings & Spec	Visual	X	H	-

S: Surveillance or monitoring
H: Hold Point (Mandatory not to proceed without approval)
X: Self inspection by performer of work

CLIENT:	Regis Resources Ltd - McPhillamys Gold Project	**INSPECTION & TEST PLAN**	
PROJECT NAME:	TSF	**FOR:**	**Decant Structure**

Ref	Operating or Stage of Work Requiring Inspection or Test		Stage/ Frequency	Records	Specification Reference/ Standard	Acceptance Criteria	Inspection/ Test Procedure	Inspection by		
	Description	Characteristics						Contractor	Superintendent/Inspector	Designer
1	Setout of the works	In accordance with Drawings/As directed	Prestart	ITC	Drawings	-	Visual/Check Survey	X	S	-
2	Surface preparation	Free of excessive dust and other foreign material	Prestart	ITC	4.5.1	Surface free of foreign material	Visual	X	S	H
3	Geotextile installation	In accordance with Drawings	Each lot	ITC	4.5.1	In accordance with Drawing	Visual	X	S	S
4	Clay Fill	To drawings and tolerances	Each lot	As-built Plans	4.5.2	Within tolerances	Visual & Survey	X	S	H
5	Rock Fill	In accordance with Drawings	Each Lot	As-built Plans	4.5.3	Within tolerances	Visual	X	S	S
6	Concrete Riser and Footing	In accordance with Drawings	-	As-built Plans	-	-	Visual	X	S	-
7	Check works complete	Area completed, clean & tidy	Each lot	ITC	Drawings/as directed	Drawings & Spec	Visual	X	H	-

S:	Surveillance or monitoring
H:	Hold Point (Mandatory not to proceed without approval)
X:	Self-inspection by performer of work

APPENDIX B

INSPECTION TEST CHECKLISTS

INSPECTION & TEST CHECKLIST
(To be completed by the person(s) directly responsible for the work)

CLIENT: Regis Resources Ltd – McPhillamys Gold Project

FOR: **Construction Preparation and Foundation Preparation**

PROJECT NAME: TSF

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works (**Require Inspector Approval**)	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Locate Services	Services located (Dial before you dig) Location of services marked on ground	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Environmental Controls	Erosion and sediment controls in place?	-		
	Dust controls in place?	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Clearing (**Require Inspector & Designer Approval**)	Removal of debris, trees, stumps, scrub and fallen timber	4.2.2		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Foundation Sub-excavation (**Require Inspector & Designer Approval**)	To RL205.6m or to intersection with existing embankment	4.2.3		
	loose/soft material removed			
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (**Require Inspector**)	Area completed, clean and tidy.	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

INSPECTION & TEST CHECKLIST

(To be completed by the person(s) directly responsible for the work)

CLIENT: Regis Resources Ltd – McPhillamys Gold Project **FOR:** **Clay Fill**

PROJECT NAME: TSF1

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Environmental Controls	Erosion and sediment controls in place	-		
	Dust control undertaken	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Fill Placement (**Require Inspector & Designer Approval**)	Material compacted using ________________ ________________________(specify plant)	4.3.4		
	Fill material uniformly conditioned to appropriate moisture content	4.3.3, 4.3.4		
	Loose layer thickness <300mm (pre-compaction)	4.3.3		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Moisture/Density Tests (**Require Designer Approval**)	Moisture content testing results in accordance with specification.	4.3.4		
	Minimum density testing as per specification.	4.3.4		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Extent of Fill Works (**Require Inspector & Designer Approval**)	Fill placement in accordance with the construction drawings, with as-built geometry surveyed and attached. Within tolerances: Level of embankment crest: +100 to -0mm Embankment slopes: +/-2% of specified Clay floor surface – maximum variation from a 4m long edge placed in any direction on the surface to be lined.	4.3.3		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (**Require Inspector Approval**)	Clay Fill in accordance with Drawings	4.3		
	Area completed, clean and tidy.	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

INSPECTION & TEST CHECKLIST
(To be completed by the person(s) directly responsible for the work)

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**FOR:**	Rock Fill
PROJECT NAME:	TSF		

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Source Material	well graded and durable material with a maximum particle size of 300mm and not greater than 5% fines	4.3.2.2		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Fill Placement	In accordance with Specification	4.3.6		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Extent of Fill works (**Require Inspector and Designer Approval**)	To lines and levels in Drawings	4.3.5		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (**Require Inspector Approval**)	Area completed, clean and tidy.	4.3		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

INSPECTION & TEST CHECKLIST
(To be completed by the person(s) directly responsible for the work)

CLIENT: Regis Resources Ltd – McPhillamys Gold Project **FOR:** **HDPE Liner**

PROJECT NAME: TSF

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works (Require Supt. Rep's Approval)	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Material Properties (**Require Designer Approval**)	Polymer Resin MQA data supplied by manufacturer and is in accordance with specification	2.4		
	Manufacturer MQA data supplied and is in accordance with specification	2.4		
	Third Party Testing has been undertaken of virgin geomembrane material	2.4		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Inspection, storage	Liner to be inspected for damage. Roll numbers recorded.	2.2		
	Liner stored in a dry, flat location, no higher than four rolls high, and under a plastic cover to prevent ripping, UV exposure and degradation	2.2		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Installation	Supply and installation of liner undertaken in accordance with construction specification	3.0		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Trial Welds	Trial weld frequency in accordance with specification	3.4		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Destructive Testing (**Require Inspector and Designer Approval**)	Destructive testing undertaken using frequencies outlined in the construction specification	3.8		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Pressure Testing (**Require Inspector Approval**)	Air testing undertaken on all seams in accordance with specification	3.7		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Defects and Repairs	The location of any repairs to the liner shall be tested by the contractor	3.8.8		

(**Require Inspector Approval**)	The location of all repairs tested with vacuum box			
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (**Require Inspector Approval**)	Check works completed			
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

INSPECTION & TEST CHECKLIST
(To be completed by the person(s) directly responsible for the work)

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**FOR:**	Emergency Spillway
PROJECT NAME:	TSF		

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Channel Excavation (Require Inspector & Designer Approval)	To lines and levels as shown in the Drawings	Drawings		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Rock Fill Placement (Require Inspector & Designer Approval)	To lines and levels as shown in the Drawings	Drawings		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Extent of Fill Works (Require Inspector Approval)	Detailed survey undertaken of Spillway Channel and reviewed by Designer.	4.3.6		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Concrete Canvas Material Properties	In accordance with Specification	4.4.2		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Concrete Canvas	Installed in accordance with manufactures guidelines	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (Require Inspector Approval)	Area completed, clean and tidy.	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

INSPECTION & TEST CHECKLIST

(To be completed by the person(s) directly responsible for the work)

CLIENT:	Regis Resources Ltd – McPhillamys Gold Project	**FOR:**	**Decant Structure**
PROJECT NAME:	TSF	**WORK AREA:**	

Work	Items/Activities to be Verified	Spec Ref	Initial OK	Comments
Setout of the Works (**Require Inspector Approval**)	Approved survey/bench marks used	-		
	Structures located in accordance with the Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Surface preparation (**Require Inspector & Designer Approval**)	Free of excessive dust and other foreign material	4.5.1		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Geotextile installation	In accordance with Drawings	4.5.1		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Clay Fill (**Require Inspector & Designer Approval**)	In accordance with Drawings	4.5.2		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Rockfill	In accordance with Drawings	4.5.3		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Concrete Riser and Footing	In accordance with Drawings	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		
Check Works Complete (**Require Inspector & Designer Approval**)	Area completed, clean and tidy.	-		
I have carried out all necessary inspections and verify that the above items/activities conform to the specification.		Name: Signature: Date:		

APPENDIX C
DAILY SITE DIARY

Daily Site Diary

CLIENT:	Regis Resources Ltd	**DAY AND DATE:**	
SITE:	McPhillamys Gold Project	**NAME OF SUPERINTENDENT:**	
PROJECT NAME:	Tailings Storage Facility	**SIGNATURE:**	

Weather Conditions

AM: ____________________

PM: ____________________

Rainfall previous 24 hours (mm) ____________________

Plant and Personnel Applied to Construction:

Construction Activities:

Site Instructions/Meetings/Site Communications:

Health and Safety Issues/Incidents:

Environmental Issues/Incidents:

Testwork Results (as required)	
Test Carried out (and Sample No.):	Location (Lot No., Chainage, Centre Line Offset and RL)

CQA Observations (Embankment Foundation/Embankment Fill/Emergency Spillway)

Additional Comments

APPENDIX D

NON-CONFORMANCE REPORT

Non-Conformance Report

CLIENT: Regis ResourcesPty Ltd

SITE: McPhillamys Gold Project

PROJECT NAME: Tailings Storage Facility

DAY AND DATE:

TIME:

Subject of Report/Summary Description of Problem:

____

____

____

Location/Lot No.: ______________________________

Equipment/Personnel: ______________________________

Weather Conditions: ______________________________

Suggested Corrective Action: ______________________________

____

____

Applicable Method Statement Clause/Section: ______________________________

Samples Obtained/Conditions Encountered: ______________________________

Author: ______________________________

Signature: ______________________________

Date: ______________________________

Distribution:

☐ Principal

☐ Contractor

☐ Designer's Representative

(This section is to be completed by the Superintendent / Designer's Representative as appropriate once the remedial work has been carried out and is inspected)

Acceptability of Work/Corrective Actions Taken: ______________________________

____

Distribution:

Superintendent /Designer's Representative ______________________________

Signature: ______________________________

Date ______________________________

☐ Principal

☐ Contractor

☐ Designer's Representative

APPENDIX C

26 July 2019 Document Ref: PER2018-0320AC Rev 0

Regis Resources Ltd
Level 2, 516 Hay Street,
Subiaco WA 6008

Attention: Rod Smith

Dear Rod

RE: TECHNICAL REVIEW

TSF DESIGN

MCPHILLAMYS GOLD PROJECT

1 INTRODUCTION

This report presents the results of the technical review of the tailings storage facility design for the McPhillamys Gold Project in NSW. McPhillamys Gold Project is located approximately 27 km south west of Bathurst and 8km north east of Blayney in the Central West of NSW.

The project comprises :

- Development of an open cut mine and a processing plant.
- The processing plant will utilise CIL methods and have an approximate through-put of 7 Mtpa.
- Approvals seek a 15 year project life.

The design was developed as part of a definitive feasibility study and the TSF design report forms part of the environmental Impact statement (EIS). Previous drafts of the TSF design report were reviewed by CMW and comments were provided via emails dated 20 August 2018 and 31 January 2019.

Wade Stephenson of Regis Resources Limited (Regis) commissioned this technical review via purchase order 60022299 dated 21 August 2018.

2 INFORMATION SUPPLIED

The following information was supplied by Regis as part of this review:

- ATC Williams (July 2019), *McPhillamys Gold Project, Blayney NSW, Tailings Storage Facility Definitive Feasibility Study*, dated July 2019, report number 113272-02R002. A geotechnical investigation report, tailings laboratory testwwork and drawings complete the report.

CMW also conducted a site visit on the 4 February 2019 in order to conduct a site reconnaissance and discussions. An email dated 6 February 2019, provided notes on the site visit.

3 DESIGN GUIDES AND CRITERIA

The design was compiled based on NSW DSC guide (DSC3F) and ANCOLD Guidelines (2012) *'Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure'.* The design also reference the EPA tailings Dam Liner Policy and EPA guideline of solid waste landfills.

The TSF design report also was required to address the following environmental approval requirements:

- Waste management strategy
- Risk assessment
- Potential impacts downstream
- Liner hydraulic conductivity to be 1x10^{-9} m/s or less, 1 m thick, or the equivalent.

The TSF design was based on a tailings design density of 1.5 t/m^3 (dry) (based on testing) and a storage capacity of 70 Mt of tailings (i.e. 46.7 Mm^3). It is further understood that the tailings are potentially PAF. During operations any acid generation may be neutralised by ANC in the tailings, seepage may have elevated SO_4, F and Se. As part of closure a store and release water shedding cover will be required to reduce ingress of water into the tailings.

4 DESIGN REVIEW

4.1 Options Study

The site selected for the TSF was based on a options study. Four areas were selected for consideration. The sites were assessed for the following issues and the sites ranked.

- Environmental impacts
- Community impacts
- Engineering suitability

Environment and community impacts form 50% of the ranking and Engineering 50%. The preferred site was Area 1 (i.e. the site documented in the design). The ranking of the site was appropriate and the site visit by CMW confirmed the TSF site proposed is feasible to be taken to detailed design.

In addition, CMW provided in-put into the project risk assessment that considered other disposal options, such as slurry, paste (thickened tailings) and dry stacking. Greater than 50 risk issues were identified, and a risk register compiled. It was concluded the proposed disposal option, a conventional slurry option with downstream embankment raising, was of acceptable risk for the McPhillamys project.

4.2 TSF Design

The TSF will be a valley storage form by construction of a main embankment and embankments in the north east area of the site to prevent runoff from upstream entering the TSF site.

The embankments will be constructed in three stages. The starter embankment will be constructed to store the first two years of tailings production. The embankments will raised using downstream methods and mine waste. The main embankment is zoned with an upstream clay fill zone, a downstream rockfill zone and a filter/transition zone between the upstream and downstream zones. The clay fill will be sourced from within the TSF or the pit operations. The downstream and transition materials will be sourced from pit operations. The other embankments on the north eastern side of the TSF are also zoned embankments.

The design concept includes:

- A pumped decant within a rock filter wall

- Drainage diversion of the catchment to the east. A pump and pipeline will be utilised during operations. A diversion channel will be required at closure.
- Emergency spillways at each stage crest level.
- Instrumentation including settlement monuments, vibrating wire piezometers and standpipe piezometers within the embankment foundation
- A Secondary water management facility (WMF) to the north west of the TSF.
- A runoff inception dam below the TSF main embankment

Seepage management is an important aspect of the design and relies on:

- A cut-off under the embankments
- Clay lining ($1x10^{-9}$ m/s permeability material, 1m thick or equivalent)
- Targeted storage lining at drainage lines and decant
- A seepage recover system
- Managed tailings deposition and decant recovery

The TSF design has been based on a consequence category of ‘Extreme’ based on a PAR of greater than 100 and severity of damage of $100m to $1Billion. This category is appropriate, noting that a formal dam break study will need to be performed as part of the detailed design.

The spillway design and embankment design has taken the adopted category into account. Spillway design utilises a probable maximum precipitation (PMP) event. The embankment design considered a maximum design earthquake (MDE) OF 0.4g.

4.3 Geotechnical investigations

The TSF site is located on Anson Volcanic (meta sediments). The investigation indicate the ground conditions at the TSF site comprise topsoil, overlying low to medium plasticity Clay over overlying weathered rock. Permeability testing was performed at the site on several mobilisations and included:

- Field permeability testing
- Weathered basement permeability testing
- Laboratory permeability testing on remoulded samples

The results of the most recent permeability testing on samples from boreholes to 1.5m deep and remoulded in the laboratory to 98% of SMDD are summarised below:

- permeability would range between nominally 10^{-8} to 10^{-10} m/s.
- The estimated average of the tests is 4.5×10^{-9} m/s.
- 17 of the 36 tests (or 47%) had permeabilities greater than 10^{-9} m/s.
- Plotting of the results with permeabilities greater than 10^{-9} on an investigation plan indicates that higher permeability areas are randomly distributed across the site.

4.4 Stability and Seepage analyses

Seepage analyses were conducted for 11 options/scenarios in order to assess the most effective way of achieving the EPA equivalent permeability criteria. The permeability parameters utilised in the analyses were based on testing. These analyses appeared to indicate the options examined were similar, however it was noted the model extended to greater than 100m below the ground surface and hence there was significant flow modelled through the weathered and fresh rock strata below the TSF.

Embankment stability analyses were performed for nine cases. The material parameters utilised in the analyses were assessed to be reasonable. The cases included effective stress analyses (4 no.), pseudo static analyses at MDE of 0.4g (3 no.) and post seismic liquefaction (2 no.). The factors of safety obtained in the analyses were generally adequate. An exception was the pseudo static earthquake case at the MDE, which recorded a FoS of 0.9 and 1.0, indicating that some embankment deformation can be expected during a large earthquake. *Comment: No short term undrained strength analyses were presented, as required in ANCOLD (2012). These analyses should be presented in the detailed design stage.*

Deformation of the embankment subject to an earthquake was analysed using the Makdisi and Seed (1978) method. The estimated deformation of 10mm appears to be an underestimate. A check by CMW using the Swaisgood (1998) method and a PGA of 0.4, an earthquake magnitude of 8.0 and an embankment height of 51m indicates a deformation of approx. 0.18m.This deformation is acceptable as the embankment freeboard at the main embankment will be at least 0.3m.

4.5 Comments on seepage management

The storage floor to a minimum depth of 0.3m will be compacted to a chieve a permeability of less than 3.3 x 10^{-10} m/s (i.e. equivalent of 1 x 10^{-9} m/s, 1m thick), refer Section 4.2.6.2 and 7.1.5. However the permeability testing carried out to date indicates that this cannot be readily achieved. Based on lab testing on the clay materials compacted to 98% of SMDD liner, the permeability would range between nominally 10^{-8} to 10^{-10} m/s. The estimated average of the tests is 4.5 x 10^{-9} m/s (ie the target of 3.3 x 10^{-10}m/s is not met).

This is problematic as it is suggests that artificial liners or clay fill imported to provide a thicker compacted clay layer would be required over a large percentage of the site.

Alternatively, a relaxed permeability requirement for the TSF floor could be proposed and an EPA compliant liner proposed for the drainage lines and decant areas (and areas adjacent to the decant), where seepage is likely to be most active. For example, the relaxed requirement for the TSF floor could be a minimum permeability of 10^{-8}m/s and the average permeability of the compacted layer should be at least 3 x 10^{-9}m/s. This should lead to satisfactory environmental outcomes as the compacted clay is founded over low permeability geology and other seepage mitigation methods are being proposed including embankment cut-offs and downstream seepage recovery. Refer also to Section 4.6 below.

4.6 Other Comments

The following gaps/inconsistencies were identified in the design report:

- The spillway is quoted as 15m wide on page 29 Section 3.5.2 and 30m in Table 24 page 84 Section 7.2.2. (the flows reported in the table appear to be correct). The drawing 114 shows 30 m wide spillways.
- Section 6 TSF water management: comment needs to be provided on the % water return expected from the TSF (i.e. as a % of slurry water inflow). The return water system capacity in m^3/day or the equivalent should also be provided.
- Table 20: further investigation of the permeability of the clays at the TSF site is suggested as part of detailed design. *Comment: it will likely be difficult to identify discrete areas for foundation improvement from additional testing, as higher permeability areas appear to be somewhat randomly distributed across the site.*

- Table 27 page 91, minor error in Item 5.0 Storage Blanket, Stage 1 quantity greater than total quantity. The quantities for liners provide for a compacted 0.3 m thick clay layer on the floor of the TSF and importing 120,000m^3 of clay fill to form a liner in the drainage lines (not including decant areas?).
- Tailings deposition practices: Tailings deposition will utilise sub-aerial techniques. It is suggested that 'over-drying' of tailings may be an issue (despite the rate of rise being approx. 2m at the end of the life of the facility). Disposal of excess water on the TSF should be approached with caution as this will increase seepage from the facility. It is recommended that tailings are deposited in thinner lifts if dusting is an issue, rather than disposing excess water on the TSF.
- Page 99 Section 9.4.4, the tailings are described as benign in the 3^{rd} paragraph when in fact they may be PAF (refer section 5.7.5). This has implications particularly for TSF closure design. A store and release cover which will be water shedding to a spillway is proposed. This concept should be adequate, however, the proposed cover will require modelling by a closure specialist at the time of compiling a closure plan for the TSF.
- Drawings:
  - The seepage interception drain is shown under the embankment (drawings 103, 104, 109, 111) with a pipe outfall grading to a concrete lined sump (there is also a runoff interception dam downstream of the main embankment toe which seepage bypassing the seepage system will report to). These types of drains are typically located immediately downstream of the embankment to allow visual inspection. In addition there will be a requirement for more than one sump as the proposed alignment goes across a depression towards the eastern abutment. This should be reviewed at the detailed design stage.
  - It was noted that the TSF does not have an underdrainage system within the TSF. It is understood that this is not favoured even though seepage analyses presented in the report indicate this may have a lower seepage flow than use of other seepage controls. If an alternative liner specification is possible, then use of underdrainage along the drainage lines coupled with a clay liner may lead to more optimal environment outcomes (and would be more cost effective as well). Noting that, reducing the head over a liner will reduce the seepage through the liner. In other words reducing the head over a liner from say 10m head to 1 m head has the same effect on seepage as an order of magnitude reduction in liner permeability (i.e. equivalent of reducing liner permeability from 10^{-8} m/s to 10^{-9} m/s).

5 CONCLUSION

It is concluded that the McPhillamys TSF design is robust and does not have fatal flaws, and hence can be taken to detailed design and ultimately construction. Seepage management will be critical, and liner/underdrainage design and specification will need to be confirmed.

We trust the above meets your requirements, should you have any queries please do not hesitate to contact the undersigned.

For and on behalf of CMW Geosciences

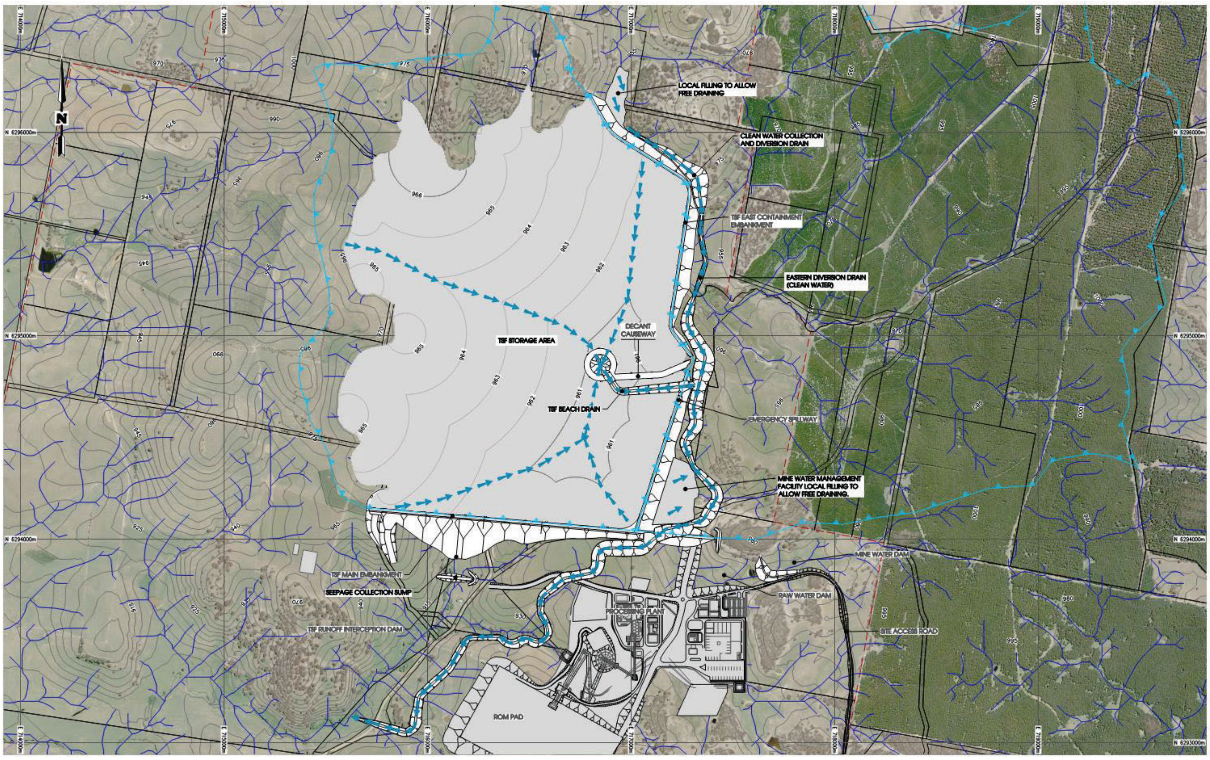
Christopher Hogg

Principal Tailings Engineer

Distribution: 1 electronic copy to Regis Resources via email

Original held at CMW Geosciences

INDEPENDENT EXPERT TECHNICAL REVIEW
REGIS – MCPHILLAMYS GOLD PROJECT
TAILINGS SOLUTION DESIGN, OPERATION AND CLOSURE



Report prepared by

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27 July 2020

EXECUTIVE SUMMARY

Regis and their consultants are commended for having gone beyond leading practice in their very comprehensive Feasibility Study for the Tailings Storage Facility (TSF) of the McPhillamys Gold Project. Their approach has been to select the optimal upper catchment siting for the TSF, and the optimal disposal method for the site of thickened tailings. They have adopted the most conservative 'Extreme' basis of design, conservative design parameters, and downstream construction of the embankment. Under this conservative approach, they have proposed a very stable tailings embankment, with a margin of stability well in excess of that required by the governing Guidelines that will be maintained throughout operations and post-closure. They have proposed a multi-barrier approach to seepage minimisation and capture, including the lining of the TSF inundation footprint and dam equivalent to EPA requirements, plus seepage interception and monitoring, and provision for seepage collection, should it be needed. The end result is that any seepage is expected to be less than 1% of the average annual rainfall for the site, an estimated 0.01% of the Belubula River streamflow under this average annual rainfall, and less than 1% of the lowest streamflow under extended dry conditions. In addition, Regis and their consultants have proposed a very robust surface water management system. Their proposed tailings and water management accommodate well both operations and closure requirements, and their proposed cover will limit any uptake of contaminants from the tailings into the cover, prevent exposure of the tailings, and allow a post-closure grazing land use.

The siting and design of the McPhillamys Gold TSF has been a focus of concern of regulators, particularly the NSW Resources Regulator, the EPA and the Department of Planning, Industry and Environment (DPIE) Water. The TSF has also been of concern to nearby residents, the local action group (Belubula Headwaters Protection Group), and various environmental groups from Orange, Bathurst and Lithgow. To best meet these concerns, the TSF has been located in the upper catchment of the Belubula River, which is furthest from nearby residents, and minimises the potential impact of the TSF on surface and ground waters.

At the feasibility stage of the McPhillamys Gold Project, sub-aerial, thickened slurry tailings disposal was found to best meet the assessment criteria, which included water use, liner/seepage complexity, cyanide breakdown rate, acid and metalliferous drainage (AMD) risk, tailings stability, energy use, tailings footprint, location suitability, capital cost, and operating cost. Paste tailings are better suited to underground backfill, and the filtration of tailings is expensive, difficult to scale-up, technically difficult, and hence carries a high risk. Co-disposing filtered tailings and waste rock would require crushing of the waste rock to make it handleable, and would add to haulage, impacting the local community through extra traffic, noise and dust.

The minimisation and management of seepage from the TSF is a key concern of stakeholders, and Regis has proposed a comprehensive multi-barrier approach, both to minimise seepage and to collect much of the seepage that does occur, comprising the following:

1. *TSF liner:*
    a. *A 1,000 mm compacted clay liner over the weathered base of the TSF, with a focus on the creek beds, having a permeability of 1 x 10^{-9} m/s,*

   b. *A minimum of 300 mm compacted clay liner on the side slopes of the TSF, with a permeability of 3.3 x 10^{-10} m/s, and*

   c. *A geosynthetic clay liner (GCL) on areas devoid of suitable clay;*

2. *A compacted clay cut off key beneath the upstream toe of the TSF embankment;*
3. *A compacted clay liner on the upstream face of the TSF embankment (with an underlying sand filter to prevent piping);*
4. *An underdrain beneath the TSF embankment to intercept seepage;*
5. *A seepage collection sump at the downstream toe of the TSF embankment;*
6. *Monitoring and seepage collection bores immediately downstream of the TSF embankment (with recirculation to the decant pond or directly to the processing plant);*
7. *A lined TSF runoff pond; and*
8. *Further seepage collection bores downstream of the monitoring bores as an extra backup.*

Modelling demonstrates that a 300 mm thick compacted clay liner with a permeability of 3.3 x 10^{-10} m/s overlying a minimum 700 mm of natural clay, an engineered GCL, and an embankment underdrain all restrict seepage to the same or a greater degree than the EPA's requirement for a 1,000 mm thick compacted clay liner with a permeability of 1 x 10^{-9} m/s. In fact, the embankment underdrain is seen to have more impact on the estimated seepage than the various liners, and the thickness of the liner is seen to have a negligible effect. All liner systems are expected to limit seepage rates to about 6 mm/year, which is less than 1% of the average annual rainfall for the site, an estimated 0.01% of the Belubula River streamflow under this average annual rainfall, and less than 1% of the lowest streamflow under extended dry conditions.

The multi-barrier approach proposed by Regis is feasible and expected to be effective in limiting seepage at least as well as the liner specified by the EPA, as well as collecting much of the seepage that does occur. The proposed multi-barrier approach will mitigate the risk of seepage impacting the downstream environment to a degree greater than that achievable using the EPA specified liner alone.

The TSF embankment will be developed in four stages constructed downstream using inert rockfill from the mine, with an upstream compacted clay cut off key and liner on the upstream face. The downstream embankment slope will be constructed at 2.5 horizontal:1 vertical (2.5H:1V) for the first two stages, flattening to 4H:1V for the last two stages, with a 2.5H:1V upstream slope, and a crest width of 15 m. For each stage, an emergency spillway will be constructed at the south-west corner of the TSF. Benches will not be constructed on the downstream slope, since these are not sustainable on post-closure landform slopes.

Stage 1 (starter) construction of the TSF embankment will be prior to the start of processing and will be sufficient to store the first 2 years of tailings production, plus stormwater. Stage 2 will accommodate a further 3 years of tailings production plus stormwater, and Stage 3 will accommodate the remaining tailings production plus stormwater.

*The most conservative **Extreme** Dam Failure Consequence Category rating has been adopted for the TSF embankment, requiring the most stringent design criteria, construction management, operational supervision and closure. The Likelihood of dam failure is extremely low, making the overall Risk Ranking of the TSF embankment very low.*

*The TSF embankment geometry involves a flattening of the downstream slope from 2.5H:1V for Stages 1A and 1B to 4H:1V for Stages 2 and 3. As a result, geotechnical stability under static and OBE loading is maintained above 2.0 (between 2.0 and 3.6) for all stages, for the conservative **Extreme** Dam Failure Consequence Category rating. This is well in excess of the minimum value of 1.5 recommended by ANCOLD (2019), and much higher than that of the embankment at Cadia Valley Operations that failed during the construction of a raise (having a factor of safety of only 1.2). The factor of safety under the maximum (SEE) earthquake loading was calculated to be greater than the minimum value of 1.0 recommended by ANCOLD (2019), for the conservative **Extreme** Dam Failure Consequence Category rating. The calculated permanent deformation under SEE loading would be insignificant and insufficient to cause the release of water or tailings.*

The deposited tailings are expected to settle and consolidate to a dry density of 1.5 t/m^3, which corresponds to a gravimetric moisture content of about 30%, with 20 to 25% gravimetric moisture content likely to be the optimum for compaction of the tailings. The tailings will undergo long-term settlement, and will tend to 'dish' towards the greatest depth of tailings, potentially leading to differential settlement that could affect final landform surface drainage paths and lead to localised ponding of rainfall runoff. Settlements will be monitored and modelled post-closure to assess the potential for differential settlement and develop steps to accommodate them, if required.

After reshaping following closure, the TSF landform will be capped by store and release or water-shedding covers to suit the climate and final topography, avoiding the ponding of water, and maintaining the rainfall runoff capacity of the site. The cover will have a 'store and release function' capable of supporting revegetation to provide erosion protection and support livestock, while allowing the runoff of excess rainfall during intense heavy rainfall events.

The cover on the tailings will include a capillary break layer of NAF waste rock approximately 500 mm thick, which will also serve as a trafficking layer. The capillary break layer will minimise the potential for capillary rise of salinity and metals into the growth medium placed above, which will comprise a minimum 600 mm thickness of subsoil overlain by 100 mm of topsoil. The capillary break layer will also provide a self-healing layer should the growth medium be compromised locally by erosion or volunteer trees, allowing ready repair of the growth medium. The surface of the cover will be profiled to shed excess rainfall runoff.

Land and Soil Capability Class 4 will be re-established on the capped surface of the TSF, comparable to the current LSC, allowing a grazing post-closure land use. It is recommended that any drinking water ponds for livestock be not located on tailings to avoid potential seepage through the tailings. As with all grazing land, some ongoing maintenance will be required.

The monitoring and seepage collection bores will be maintained post-closure. Post-closure maintenance will include rehabilitation monitoring and weed management.

TABLE OF CONTENTS

1 INTRODUCTION

Dr David Williams was commissioned by Andrew Wannan of Regis Resources Limited to carry out an Independent Expert Technical Review of the Tailings Solution Design, Operation and Closure for the McPhillamys Gold Project near Blayney in the Central-West of New South Wales.

This review will be used as a reference document in the development of the Response to Submissions Report (RTS) and will likely be tabled during the expected proceedings of the NSW Independent Planning Commission (IPC).

1.1 Scope

The scope of the Review is to:

- Provide a high-level summary of the proposed tailings management system for use within the introduction to the RTS chapter, which addresses tailings management in a form and manner suitable for a non-technical audience.
- Address each of the matters raised by Government Agencies and Organisations with regard to the validity of the concerns (with a particular focus on the NSW Environmental Protection Authority's (EPA) concerns regarding tailings storage facility (TSF) liner options and compliance with solid waste guidelines).
- Provide commentary to assist Regis in demonstrating that the multi-barrier approach is appropriate for the proposed McPhillamys TSF considering the nature of the operation, location, climate, topography, and geology.
- Provide commentary addressing the level of risk associated with the proposed multi-barrier approach with regard to potential seepage impacts during operations and post-closure.
- If appropriate, benchmark the proposed approach against industry standards/practices. It may be of benefit to reference successful examples (operational and trials) of seepage management in operations of a similar scale and/or conditions.

Regis and their Geotechnical Consultant ATC Williams have made some design changes, including the relocation of the secondary water management facility from a proposed position in the north-west of the TSF to a location in the south-east; and a water diversion from the north of the TSF around the eastern embankment for closure. These changes potentially provide both environmental and engineering benefits, are considered in this Review, and will form part of the amended project report submitted with the RTS to the regulator.

1.2 Background

McPhillamys Gold Project (MGP) has a 15-year project life, including approximately 10 years of mining to produce approximately 2 M ounces of gold and indicative rehabilitation timeframes. Up to 8.5 Mtpa of ore will be mined, with processing of up to 7 Mtpa and the stockpiling of low grade ore for possible future processing. The ore will be processed using a carbon-in leach (CIL) circuit, comprising a ROM pad, grinding circuit, leach tanks, cyanide destruction and a TSF.

The TSF will be developed in three stages within the upper catchment of the Belubula River, approximately 8 km upstream of the small town of Blayney and 65 km upstream of Carcoar Dam. The Belubula River is a tributary of the Lachlan River, which is located within the Murray Darling Basin. The primary water supply for the mine will be excess mine and process water from the Western Coalfields and Mt Piper Power Station near Lithgow, delivered by a 90 km pipeline, which will limit the need for local fresh water.

The mine project application area (excluding the area of the pipeline corridor) is approximately 2,513 ha, with a mine lease application (MLA) area of approximately 1,813 ha, including the TSF, which will have an ultimate inundation footprint of approximately 273 ha.

1.2.1 Tailings Storage Facility

Figure 1 shows the location of the proposed ultimate TSF footprint. Siting and design of the TSF has been a focus of concern of regulators, particularly the NSW Resources Regulator, the EPA and the Department of Planning, Industry and Environment (DPIE) Water. The TSF has also been of concern to nearby residents, the local action group (Belubula Headwaters Protection Group), and various environmental groups from Orange, Bathurst and Lithgow. To best meet these concerns, the TSF has been located in the upper catchment of the Belubula River, which is furthest from nearby residents, and minimises the potential impact of the TSF on surface and ground waters.

The minimisation and management of seepage from the TSF is a key concern of stakeholders, and Regis has proposed a multi-barrier approach, as shown schematically in Figure 2, comprising:

1. TSF liner:
    a. A 1,000 mm compacted clay liner over the weathered base of the TSF, with a focus on the creek beds, having a permeability of 1×10^{-9} m/s,
    b. A minimum of 300 mm compacted clay liner on the side slopes of the TSF, with a permeability of 3.3×10^{-10} m/s, and
    c. A geosynthetic clay liner (GCL) on areas devoid of suitable clay;
2. A compacted clay cut off key beneath the upstream toe of the TSF embankment;
3. A compacted clay liner on the upstream face of the TSF embankment (with an underlying sand filter to prevent piping);
4. An underdrain beneath the TSF embankment to intercept seepage;
5. A seepage collection sump at the downstream toe of the TSF embankment;
6. Monitoring and seepage collection bores immediately downstream of the TSF embankment (with recirculation to the decant pond or directly to the processing plant);
7. A lined TSF runoff pond; and
8. Further seepage collection bores downstream of the monitoring bores as an extra backup.

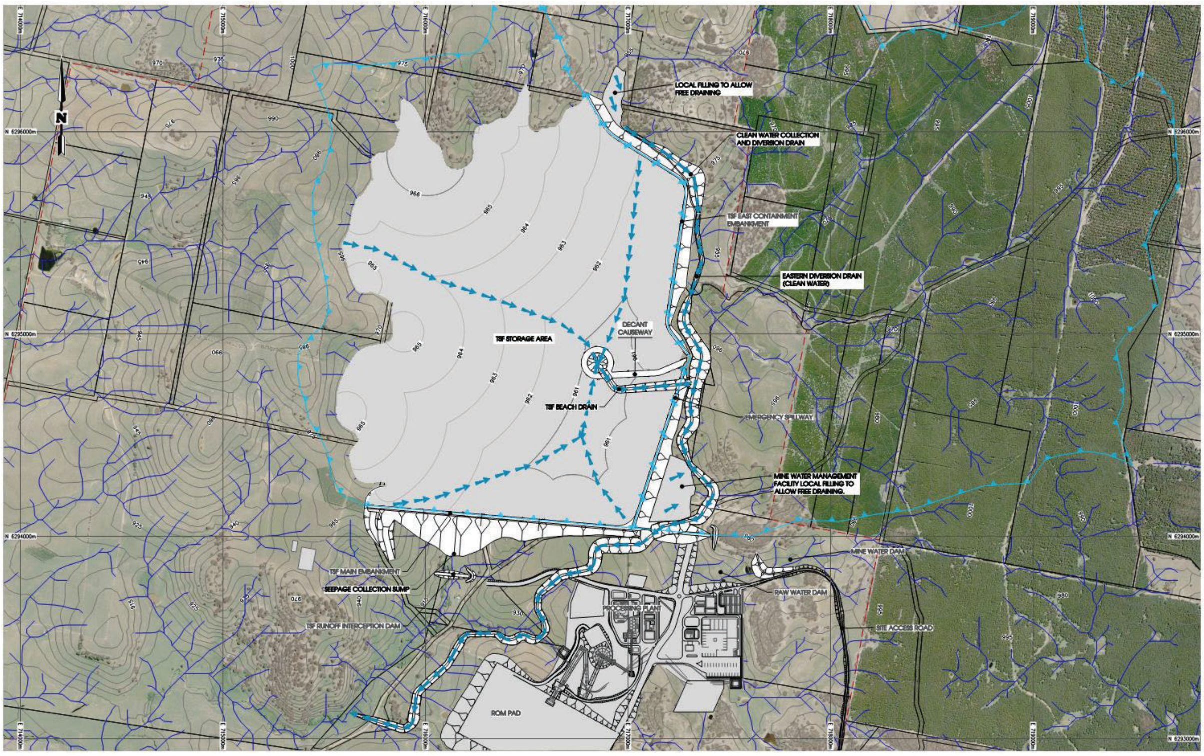

Figure 1 Location of proposed ultimate TSF footprint on Mine Lease area, shown at closure *(source: Plate 1 of ATC Williams, June 2020)*

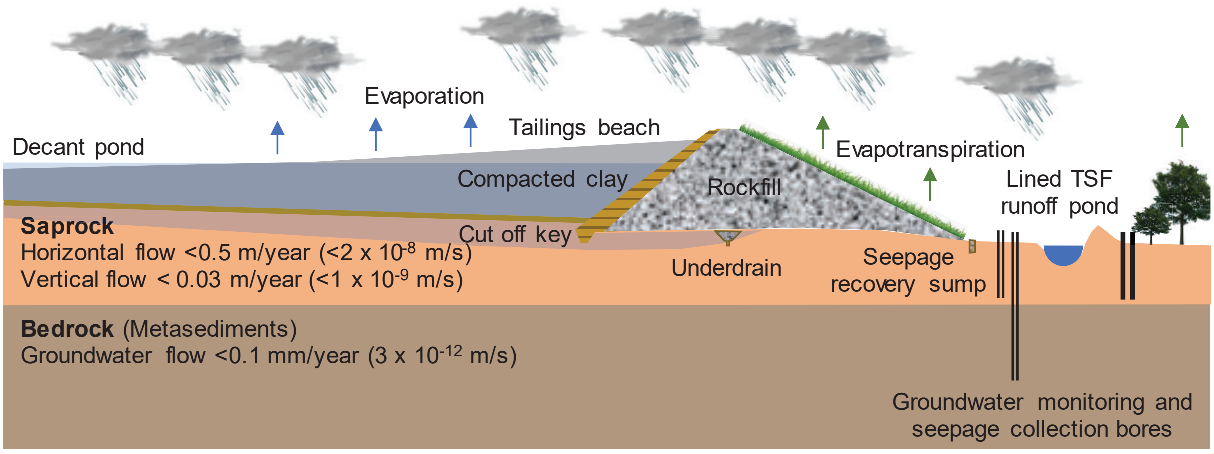

Figure 2 Schematic of multi-barrier TSF seepage management *(adapted from EMM, 2019)*

1.2.2 Environmental Protection Authority TSF Responses

The EPA provided, in a letter dated 20 August 2018, its environmental assessment requirements for the TSF to the DPIE.

The EPA has a Tailings Dam Liner Policy 2016 (the Tailings Dam Policy), which adopts a benchmark requirement for TSF liners to achieve a permeability of 1 x 10^{-9} m/s using a compacted clay liner 1,000 mm thick, or a GCL. The Tailings Dam Policy does permit the proponent to propose a liner system alternative to the benchmark, however this requires a robust hydrogeological investigation and impact assessment to prove the efficacy of the alternative liner system and/or natural geology to demonstrate the prevention of water pollution. The Tailings Dam Policy also states that in the event that the tailings pose a high risk to the water environment, a liner system that provides a higher level of protection than the benchmark is likely to be required. The EPA therefore expects the proponent to propose a TSF liner system that satisfies the Tailings Dam Policy.

The Australian Government Leading Practice Handbook on Tailings Management (2016) provides guidance on world leading practice in tailings management; including new and advanced methods of tailings disposal. These methods include thickened and paste disposal, dry stacking. co-disposal of coarse wastes and tailings, and integrated disposal of coarse wastes and tailings, along with backfilling open-pits, with the aim of producing tailings with far less moisture. Paste or filtered tailings have the advantages of improved water and process chemical recovery, potentially reduced tailings storage volume, reduced seepage, potentially more stable landforms, and reduced chance of overtopping, although they come at a high financial and management cost. The management of tailings worldwide is increasingly moving towards in-plant thickening and filtering of tailings, with some increase in surface paste tailings disposal and the co-disposal of tailings and coarse-grained wastes. The EPA expects that this proposal will utilise best tailings management practice.

The Tailings Management Leading Practice Handbook (2016) is based on the following principles:

- Optimal tailings strategies are site specific.
- The TSF needs to be managed effectively over its full life cycle, with sufficient detail to manage potential risks within acceptable limits.
- Tailings storage depends on:
    - The physical and chemical nature of tailings, including processing chemicals;
    - Site climate, with an estimated average annual rainfall of 705 mm and a range from perhaps 500 to 1,500 mm (www.bom.gov.au);
    - Site topography, which is gently undulating;
    - Site seismicity, which is generally low, but with a significant in perpetuity risk;
    - Regulations and environmental constraints; and
    - The socio-economic context in which the mining operations and processing plant are located
- Leading practice tailings management is underpinned by a risk-based approach to the planning, design, construction, operation, closure and rehabilitation of TSFs.

At the feasibility stage of the McPhillamys Gold Project, sub-aerial, thickened slurry tailings disposal best meets the assessment criteria, which include water use, liner/seepage complexity, cyanide breakdown rate, acid and metalliferous drainage (AMD) risk, tailings stability, energy use, tailings footprint, location suitability, capital cost, and operating cost.

The EPA requests that the proponent undertake a tailings risk assessment based on the estimated tailings composition. The risk assessment should contain sufficient information to enable the EPA to carry out an independent assessment to determine if the tailings pose a high risk to the environment, as defined by the Tailings Dam Policy, and therefore require a higher level of protection. The risk assessment should include detailed discussion of options to dispose of, and handle tailings as described above.

The Environmental Assessment Requirements (EARs) require that the siting, design, management and rehabilitation of the TSF address a number of matters, which are summarised below and have been included in the EIS:

- A waste (overburden, tailings, etc.) management strategy.
- A strategic justification of the development focusing on site selection and the suitability of the proposed sites.
- A tailings risk assessment based on the tailings composition and identification, quantification, and classification of the potential waste streams likely to be generated during construction and operation, including and not limited to non-production waster, reagent materials and cyanide compounds.
- Landscape Management Strategy providing a detailed overview of the final land-use and closure criteria for the development, including both the mine site and raw water pipeline, and identification and discussion of opportunities to improve rehabilitation and environmental outcomes for existing disturbed areas within the project site.

Regis and its consultants met with the EPA's Regional Manager (Sandie Jones) and Central West Unit Head (Darryl Clift) on 14 May 2019 to further discuss the proposed tailings solution, prior to the formal submission of the Project EIS on 27 August 2019.

The EPA submission on the project application and associated EIS outlined the following issues in a letter dated 24 October 2019, which repeated many of their previous requirements, and did not confirm their previous acknowledgement that the proposed TSF construction and associated seepage measures appeared to have merit:

- The primary risk of impacts to groundwater comes from the proposed TSF.
- The EIS proposes to line the TSF facility using a hybrid solution of clay, conditioned soils and a GCL; however, the spatial distribution of these lining systems is not presented in the EIS, which makes assessment of the proposal and validation of the claimed efficacy of the liner difficult.
- The assessment includes limited information on the location of the network of groundwater monitoring and seepage collection bores, but is not considered adequate for the purposes of assessing these potential impacts and the efficacy of mitigation measures.
- The proposed spatial distribution of these alternate liner methods across the TSF is not presented in the EIS. The EPA requires a permeability of 1×10^{-9} m/s over a 1,000 mm depth to be considered suitable to protect receiving environments as a containment barrier system (Environmental Guidelines: Solid Waste Landfills, 2016).
- The proposal of compacted, low permeability clays, where suitable, to thicknesses that are less than 1,000 mm, is not considered suitable for the preferred TSF site. The identified site of the TSF incorporates the headwaters

of the Belubula River and adjacent weathered slopes. This alternative TSF lining method of scarifying/ripping, moisture conditioning and compacting native clays across a heterogenous weathered profile is not favoured by the EPA at this site due to full reliance on the modelled performance of this method to mitigate the risk of seepage.

- The EPA believes a full depth liner, of at least 1,000 mm thickness is required across this TSF footprint to adequately mitigate the risk of seepage.
- The host geology and its weathering variability increases the potential for a weakness or high permeability zone to compromise TSF seepage containment. For this option to be efficient, all risk variables must be mitigated, as the likelihood of a seepage containment failure increases in relation to variables in the TSF construction. If conditioning is proposed, it should be to a recommended guideline minimum thickness of 1,000 mm.
- Pollutants with the potential to degrade the quality of groundwater, although identified as low in the tailings assessment, must not migrate through strata over the life of the TSF. The proposed TSF lining options and seepage recovery, as described in the EIS, do not meet this requirement, nor do they consider contingency management actions in the event that seepage rates exceed those produced by the assessment modelling.
- The EPA maintains a preference for an engineered impervious seal of at least 1,000 mm thickness, with a permeability of $1 \times I0^{-9}$ m/s, to prevent contained leachate migrating to underlying strata.

The EPA recommended to the DPIE assessments team that:

- The proponent revises the assessment(s) to provide further information regarding the TSF design, liner options and spatial distribution and the prevention of seepage to the underlying strata.
- The proponent revises the assessment(s) to provide more detailed information regarding the availability of 'suitable clay material'.
- The proponent revises the assessment(s) to provide more detailed information regarding the Quality Assurance/Quality Control procedures to be used for determining the suitability of clay material for use in the non-compliant 300 mm thick liner option.
- The proponent revises the assessment(s) to provide more detailed information regarding the acceptance testing regime that will be implemented to ensure the liner has been installed correctly and without material error and will meet the proposed seepage prevention specifications for all options.
- The proponent revises the assessment(s) to provide more detailed information regarding the number of proposed monitoring bores at the TSF, waste rock emplacements, and water storages and the proposed sampling program to be undertaken.
- The proponent revises the assessment(s) to provide more detailed information regarding contingency planning for unexpected rates of seepage from the TSF and the maintenance of zero-discharge operations.

- The proponent revises the assessment(s) to provide more detailed information regarding seepage management and mitigation plans post TSF closure.

The EPA maintains that:

"It is noted that in some areas where the TSF is to be placed, a liner with an equivalent permeability of 1 x 10^{-9} m/s is proposed (3.3 x 10^{-10} m/s).

'Equivalent' does not abide by the Solid Waste Guidelines the EPA adopts when the application of liners is proposed. Regardless of the permeability of 'suitable' clays, the EPA standardises the use of liners with a specific permeability capacity.

So far, it is understood that the proponent is entirely reliant on the cut off key, interception systems, and storage liner to prevent seepage losses to the environment.

It has not been clarified if alternative methods have been proposed and evaluated as other methods of seepage prevention.

The EPA is seeking additional evidence to support the proposal that the cut off key and interception systems, will contain seepage caused as a result of the clay liner not adopting the standard EPA requirement for liner thickness and permeability. Further, it is understood that given the weathered profile of the subsurface, seepage losses would not entirely be contained by the proposal."

The EPA's response with respect to the multi-barrier approach proposed by Regis appears to negate the possibility of alternative performance-based approaches offered by the Guideline. The multi-barrier approach proposed by Regis incorporates both liners and seepage interception, monitoring and collection, if necessary, which provide superior performance to the prescribed 1,000 mm compacted clay liner. Regis seeks to explain better their multi-barrier approach and its effectiveness in meeting the performance required by the EPA.

1.3 Sources of Information

Sources of information pertaining to this Review included:

- EIS:
    - **Main EIS Report**, in particular:
        - 2.5.7 **TSF construction**
        - 2.9 **Tailings Storage Facility**
        - 6.7.1 **Tailings disposal options**
        - 6.7.2 **TSF location options**
    - Appendix D – **TSF Definitive Feasibility Study**
    - Appendix F – **TSF Risk Assessment**
    - Appendix U – **TSF rehabilitation**
- McPhillamys Gold Project, Tailings Storage Facility, **Design Review and Response to submissions** received in relation to the Development Application and associated EIS, prepared by ATC Williams, dated June 2020, Report Number 113272.02R06, and associated drawings.

2 REVIEW

The Review covers, in the following sections, the proposed tailings management system, matters raised by Government Agencies and Organisations, the appropriateness and risk level of the multi-barrier approach, benchmarking the proposed approach, and relocation of the secondary water management system.

2.1 High-Level Summary of Proposed Tailings Management System

A high-level summary of the proposed tailings management system is given in the following sections.

2.1.1 Section 2.5.5 of Main EIS Report – TSF Construction

The proposed staged development of the TSF is appropriate and preferred, and the proposed liners are appropriate for the different domains of the TSF footprint.

The TSF is being developed in stages to minimise the extent of disturbance and to synchronise with the progressive development of the open cut and the availability of waste rock suitable for use in the construction of the TSF embankments. Construction of the TSF will involve the development of borrow pits within the TSF footprint, embankment construction, and lining of the TSF footprint.

In drainage features and other areas with weathered geology, a 1,000 mm compacted clay liner with a permeability of 1×10^{-9} m/s will be constructed. In other areas where suitable clay is available, the surface will be ripped, moisture-conditioned and compacted to a minimum depth of 300 mm and a permeability of 3.3×10^{-10} m/s (equivalent to a 1,000 mm compacted clay liner with a permeability of 1×10^{-9} m/s). In the remaining areas, if insufficient suitable clay is available, a GCL will be applied, equivalent to a 1,000 mm compacted clay liner with a permeability of 1×10^{-9} m/s.

2.1.2 Section 2.9 of Main EIS Report – TSF Design

The objectives of the TSF design, the TSF risk assessment, the expected tailings geochemical characteristics, the tailings quantities and storage requirements, the TSF design criteria, the TSF design, the expected operation of the TSF, and TSF seepage management are described.

The objectives of the TSF design are to efficiently store tailings, while maintaining an operational and post-closure landform that is stable and minimises contamination of the environment. The TSF will be located in the upper tributaries of the Belubula River valley, having very low to low ground permeability that will protect the catchment downstream, is furthest and shielded from the nearest properties, and provides a relatively efficient storage in terms of embankment construction, tailings rate of rise and control of seepage.

The independently-facilitated TSF risk assessment concluded that that the identified risks associated with the TSF were in the lowest category (that is, acceptable), as described in Section 2.1.4.

The expected low concentration of cyanide released with the tailings is expected to be below that affecting bird life (due to cyanide gas that forms), and will readily and rapidly break down in sunlight and through natural degradation.

The cyanide detoxified tailings are anticipated to be elevated in sulphate, selenium and fluorine relative to ANZECC-ARMCANZ (2000) livestock drinking water guidelines. As a result of the elevated sulphate, the tailings are expected to be classified as potentially acid forming, and may oxidise on exposed tailings beach, with the potential for acid and metalliferous runoff and drainage. To limit oxidation, the tailings will be maintained moist to limit oxygen ingress. Also, any acidity may be neutralised by the alkaline water from cyanide processing.

The expected average annual production of tailings over the 10-year mine life is 7 Mtpa, requiring a total tailings storage volume of about 47 Mm^3, assuming a settled dry density of the tailings of 1.5 t/m^3, which is typically achieved for hard rock gold tailings. A settled dry density of 1.5 t/m^3 corresponds to a gravimetric moisture content of about 30%, with 20 to 25% gravimetric moisture content likely to be the optimum for compaction of the tailings.

The TSF design criteria are those stipulated by Dam Safety NSW (formerly the NSW Dam Safety Committee), briefly:

- Risks to the community are identified, assessed, properly managed, reduced when necessary, and reviewed.
- Risks to public safety meet the Dam Safety NSW guidelines.
- Other risks with a potential adverse effect on the community meet criteria set by the owner and agreed with Dam Safety NSW.

The most conservative **Extreme** Dam Failure Consequence Category rating has been adopted for the TSF embankment, requiring the most stringent design criteria, construction management, operational supervision and closure. The Likelihood of dam failure is extremely low, making the overall Risk Ranking of the TSF embankment very low. The EPA's liner requirements (1,000 mm of compacted clay with a permeability of 1×10^{-9} m/s) are based on the Environmental Guidelines: Solid Waste Landfills (EPA, 2015). An alternative liner system requires a hydrogeological investigation and impact assessment, which Regis has undertaken. In addition, Regis proposes a multi-barrier approach, involving not only an equivalent TSF liner, but also seepage monitoring and collection, if required.

The region has a low level of historical seismicity, with no active faults identified. Faults running north-south underlie the proposed TSF embankment. The TSF site is predominantly underlain by residual saprolitic clays, with layers of sandy clay/clayey sand in creek beds and floodplains.

There are no permanent continuous aquifers present within 20 m depth of the ground surface, although perched water tables exist. The Anson Formation underlying the TSF has low horizontal permeability (2×10^{-8} m/s) and very low vertical permeability (1×10^{-9} m/s). The soil profile underlying the TSF is generally of high strength, of low permeability if compacted, and moderately dispersive (erodible). The clay fraction is typically >60%, and of medium to high plasticity.

The expected maximum height of the main TSF embankment is 49 m and its expected maximum length is 2,450 m. The expected ultimate inundation footprint of the TSF is approximately 273 ha, containing up to 47 Mm^3 of tailings with a maximum average depth of 17.2 m, with storage for over 5,000 ML of water. The rate of rise of tailings will approach 20 m in the first year, but have an average rate of 2.5 m/year, and <2 m/year towards the end of the mine life.

Other features of the TSF are sufficient storage to accommodate the rate of rise of tailings, a decant structure to recover process water, downstream seepage monitoring and collection bores, if required, an emergency spillway to handle extreme flood inflows, a clean runoff collection and diversion system upstream, and a TSF runoff interception system downstream.

The TSF embankment will be developed in four stages constructed downstream using inert rockfill from the mine, with an upstream compacted clay cut off key and liner on the upstream face (with an underlying sand filter to prevent piping), as shown in Figure 3. The downstream embankment slope will be constructed at 2.5 horizontal:1 vertical (2.5H:1V) for the first two stages, flattening to 4H:1V for the last two stages, with a 2.5H:1V upstream slope, and a crest width of 15 m. Benches will not be constructed on the downstream slope, since these are not sustainable on post-closure landform slopes.

Stage 1 (starter) construction of the TSF embankment will be prior to the start of processing and will be sufficient to store the first 2 years of tailings production, plus stormwater. Stage 2 will accommodate a further 3 years of tailings production plus stormwater, and Stage 3 will accommodate the remaining tailings production plus stormwater.

The tailings will be discharged as a thickened slurry sub-aerially, from multiple points (via spigots) around the perimeter of the TSF. Deposition will be cycled between spigots to limit the deposited layer thickness and allow time for consolidation and desiccation of each layer, while maintaining the tailings surface sufficiently wet from fresh tailings to limit dusting and potential oxidation. Supernatant water released from the tailings will flow to the decant pond, from which it will be recovered for re-use in the processing plant. The operation and condition of the TSF will be kept under regular surveillance and monitored.

The management of seepage from the TSF will include a liner to meet the EPA's permeability requirements, in addition to a compacted clay cut off key beneath the upstream toe of the TSF embankment, a compacted clay liner on the upstream face of the TSF embankment, an underdrain beneath the TSF embankment to intercept seepage, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup.

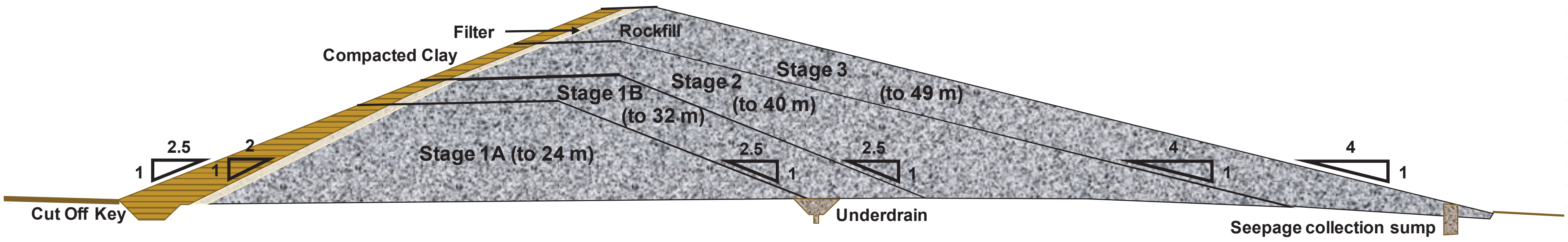

Figure 3 Schematic of TSF embankment *(adapted from ATC Williams Drawing No. 1000-210 and ATC Williams, June 2020)*

2.1.3 Section 6.7.1 of Main EIS Report – Tailings Disposal Options

Sub-aerial, thickened slurry tailings disposal best meets the assessment criteria, and the sulphur dioxide/air method of cyanide detoxification is the most appropriate method.

The tailings disposal options considered were: (i) thickened slurry disposal, (ii) paste disposal, (iii) filtered tailings, and (iv) co-mixing of crushed waste rock with filtered tailings. Overall, sub-aerial, thickened slurry tailings disposal best meets the assessment criteria.

The sulphur dioxide/air method of cyanide detoxification was selected, being a proven technology (used at Cowal and Tomingley gold mines within NSW), well-suited to high tonnage/low grade gold deposits.

2.1.4 Section 6.7.2 of Main EIS Report – Selection of TSF Location

The choice of location of the TSF in the headwaters of the Belubula River valley is the preferred location due to its low permeability, visual shielding and engineering efficiency.

Four locations for the TSF were considered: (i) valley-type TSF in the headwaters of the Belubula River valley, (ii) side-valley turkey's nest, (iii) side-valley TSF at the top of the catchment, and (iv) valley-type TSF on a tributary of the Belubula River to the south. The first option was preferred, primarily due to the low foundation permeability, but also due to its preferred visual shielding and its engineering efficiency.

2.1.5 Appendix D of EIS – TSF Feasibility Study

A detailed Feasibility level study of the TSF has been completed.

Appendix D of the EIS details the Feasibility Study of the TSF, covering the TSF development proposal, the engineering criteria applied, the design background, TSF water management, engineering analyses, TSF construction, operations and closure, and surveillance and monitoring of the TSF. Comments on the Feasibility Study related to this Review are:

- The breakdown of waste rock types, which is relevant to the selection of waste rock suitable for TSF embankment construction, is anticipated to be:
  - Non-acid forming (NAF) waste rock: 130 Mt (60%)

    (potentially suitable for TSF embankment construction).
  - Potentially acid forming (PAF) waste rock: 87 Mt (40%)

    (unsuitable for TSF embankment construction).
- Staging of the TSF embankment (as updated in ATC Williams, June 2020):
  - The Stage 1A to be constructed to a maximum height of 24 m, with upstream and downstream slopes of 2.5H:1V.
  - The Stage 1B to be constructed downstream to a maximum height of 32 m, with upstream and downstream slopes of 2.5H:1V.

  - Stage 2 to be constructed downstream to a maximum height of 40 m, with an upstream slope of 2.5H:1V and a downstream slope of 4H:1V.
  - Stage 3 to be constructed downstream to a maximum height of 49 m, with an upstream slope of 2.5H:1V and a downstream slope of 4H:1V.
  - For each stage, an emergency spillway will be constructed at the south-west corner of the TSF.
- Erosion will be minimised by restricting clean rainfall runoff onto the construction site, with erosion sediment captured.
- TSF rehabilitation will be directed at creating a stable and sustainable final landform, compatible with the surrounding landform, that minimises long-term environmental impact; that is, non-polluting.
- The landform will be capped by store and release or water-shedding covers to suit the climate and final topography, avoiding the ponding of water, and maintaining the rainfall runoff capacity of the site.
- Surveillance and monitoring of the TSF will comply with ANCOLD (2019), and in addition include groundwater monitoring, downstream surface water quality monitoring, and monitoring of tailings operations.

2.1.4 Appendix F of EIS – TSF Risk Assessment

The broadly-based risk assessment is more than adequate for the Feasibility stage of the TSF design.

Appendix F of the EIS includes a broadly-based Risk Assessment of the TSF according to the ANCOLD (2003) Guidelines on Risk Assessment, as part of the Preliminary Environmental Assessment.

2.1.5 Appendix U of EIS – TSF Rehabilitation

The proposed rehabilitation of the TSF is feasible and appropriate, and will achieve close to the pre-existing land and soil capability post-closure.

Appendix U of the EIS details the Rehabilitation of the TSF, covering the final land and soil capability of the capped TSF, and measures proposed to address the key risks with the TSF. Comments on the TSF Rehabilitation related to this Review are:

- Land and Soil Capability (LSC) Class 4 will be re-established on the capped surface of the TSF, comparable to the current LSC, allowing a grazing post-closure land use.
- The key risks with the TSF are acid and metalliferous seepage, capillary rise of salinity and metals into the cap, inadequate bearing capacity of the tailings to support the placement of the cap, and inadequate capping materials.
- Seepage from the TSF will be minimised by constructing the compacted clay key into rock beneath the embankment, the compacted clay zone on the upstream slope of the embankment, and lining the floor of the TSF.

- Tailings deposition will be cycled to facilitate consolidation and desiccation, while minimising the duration of tailings exposure to oxygen to reduce the potential for oxidation.
- The ultimate downstream slope of the TSF embankment will be revegetated early.
- At closure, the tailings will be allowed to desiccate to improve their strength, and will be covered with a capillary break layer of NAF waste rock approximately 500 mm thick, which will also serve as a trafficking layer. The capillary break will minimise the potential for capillary rise of salinity and metals into the growth medium placed above, which will comprise a minimum 600 mm thickness of subsoil overlain by 100 mm of topsoil.
- The surface of the cover will be profiled to shed excess rainfall runoff.
- Post-closure maintenance will include rehabilitation monitoring and weed management.

2.1.6 Design Review and Response to Submissions

> *The comprehensive design review of the TSF, partially in response to submissions, has led to a much improved TSF scheme. The design has adopted a conservative* ***Extreme*** *Dam Failure Consequence Category and conservative design parameters and has been shown to satisfy design criteria through to post-closure and in perpetuity.*

<u>Design Review:</u>

ATC Williams prepared a Design Review and Response to Submissions covering the TSF. Comments on the design review related to this Review are:

- The robustness of the TSF design has been enhanced, particularly in relation of surface water management during operations and post-closure as shown in Figures 1 and 4, including.
    - Relocation of the Mine Water Management Facility from the north-west to the south-east perimeter of the TSF to facilitate the diversion of clean rainfall runoff post-closure.
    - Refinement of the northern TSF embankment to maximise the diversion of clean rainfall runoff and minimise the inundation of trees.
    - Relocation of the decant pond more centrally, towards the east, to better tie into the post-closure surface drainage of the TSF.
    - Amendment to the tailings beach profile to drain to the east at closure.
    - Relocation of the TSF post-closure discharge and diversion channel, avoiding a drop structure.
    - Refinement of the staging of TSF embankment construction over a longer period, made possible by a revised mining plan.

  - Improved understanding of clay availability within the TSF footprint, including greater depths (up to 4.5 m) of suitable clay being expected beyond the depths previously investigated, and clays covering a greater areal extent of the footprint.

- The permeability of the Anson Formation underlying the TSF has been assessed as significantly lower than previously modelled, which is expected to reduce seepage from the tailings.
- The areas of the TSF footprint requiring lining in addition to the natural clays has been refined and reduced from previous estimates.
- For the conservative **Extreme** Dam Failure Consequence Category, the Operating Basis Earthquake (OBE) for a 1 in 1,000-year return interval earthquake has been assessed as having a peak ground acceleration (PGA) of 0.13g, on the borderline of potentially triggering the liquefaction of susceptible tailings (loose and near-saturated; Williams, 1992). The Safety Evaluation Earthquake (SEE) for a 1 in 10,000 year return interval (often taken to represent in perpetuity for closure) earthquake has been assessed as having a PGA of 0.40g, likely to trigger the liquefaction of susceptible tailings.
- ATC Williams has adopted generally conservative material strength parameters and permeability values for their stability and seepage analyses of the TSF embankment stages, with a post-liquefaction shear strength ratio of 0.04 adopted for the tailings.
- The seepage analyses carried out by ATC Williams indicate that the phreatic surface is likely to be largely drawn down within the upstream clay zone, and further drawn down within the rock fill comprising the remainder of the embankment.
- The TSF embankment geometry shown in Figure 3 involves a flattening of the downstream slope from 2.5H:1V for stages 1A and 1B to 4H:1V for stages 2 and 3. As a result, geotechnical stability under static and OBE loading is maintained above 2.0 (between 2.0 and 3.6) for all stages, for the conservative **Extreme** Dam Failure Consequence Category rating. This is well in excess of the minimum value of 1.5 recommended by ANCOLD (2019), and much higher than that of the embankment at Cadia Valley Operations that failed during the construction of an upstream raise (implying that the factor of safety reduced to 1). The factor of safety under SEE loading was calculated to be greater than the minimum value of 1.0 recommended by ANCOLD (2019), for the conservative **Extreme** Dam Failure Consequence Category rating. The calculated permanent deformation under SEE loading would be insignificant and insufficient to cause the release of water or tailings.
- The impact on the TSF embankment of the nearby explosives magazine exploding has been assessed as insignificant.
- On closure, rainfall runoff from the rehabilitated TSF will report to the clean water diversion channel to the east of the TSF (see Figure 4), having a grade of 0.5 to 4%.

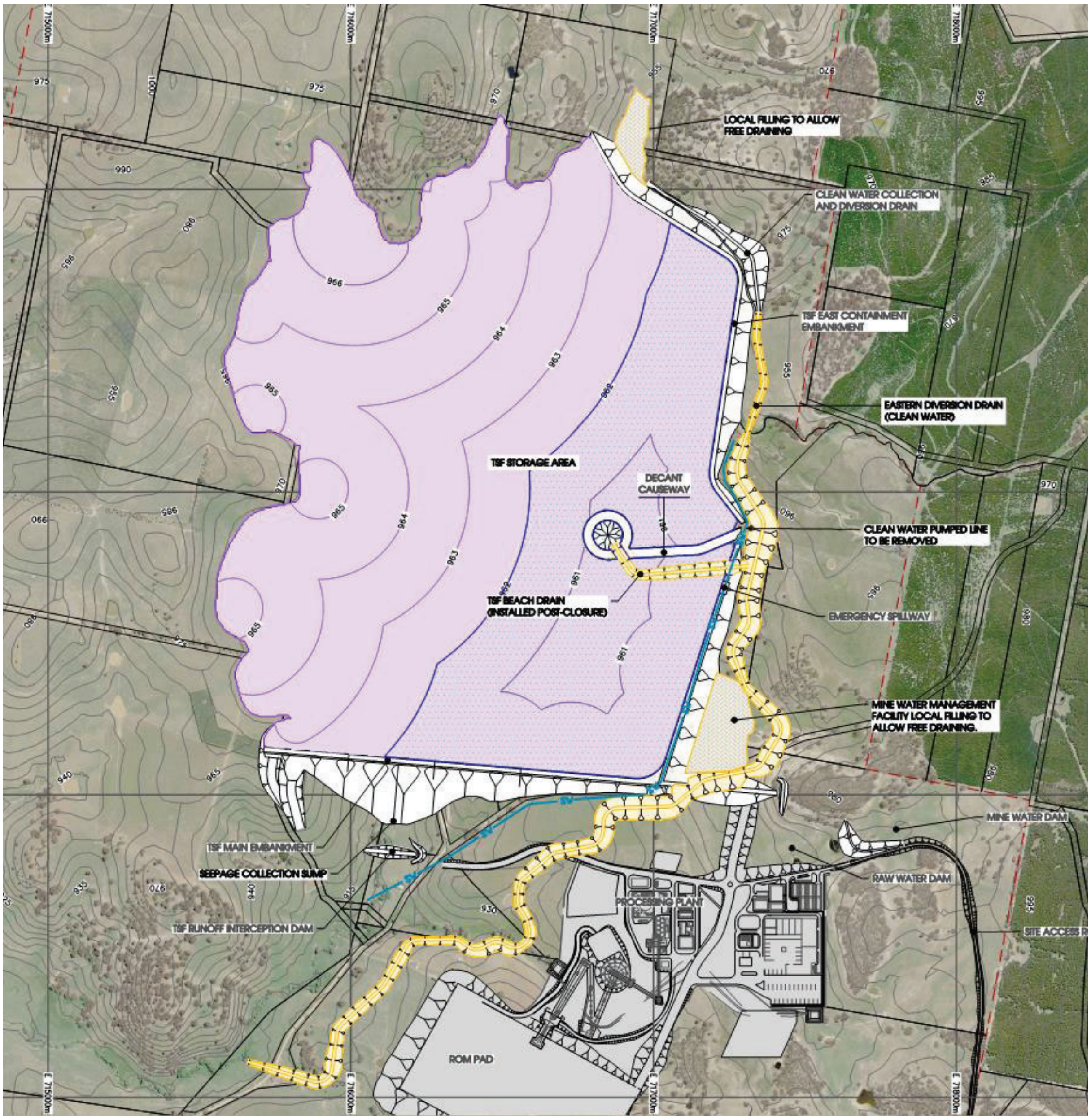

Figure 4 Enhanced TSF design *(source: Plate 2 of ATC Williams, June 2020)*

<u>Response to Submissions:</u>

The submissions from the EPA and the Resources Regulator on the proposed TSF siting, design, and construction come under:

1. TSF seepage management (specifically the TSF liner system).
2. TSF construction and water management.
3. Options for tailings disposal and long-term management.
4. TSF closure and rehabilitation.

Comments on the ATC Williams response to submissions by the EPA related to this Review are:

- In relation to the liner system, modelling demonstrates that a 300 mm thick compacted clay liner with a permeability of 3.3 x 10^{-10} m/s overlying a minimum 700 mm of natural clay, an engineered GCL, and an embankment underdrain, are all found to restrict seepage to the same or a greater degree than the EPA's requirement for a 1,000 mm thick compacted clay liner with a permeability of 1 x 10^{-9} m/s (see Figure 5). In fact, the embankment underdrain is seen to have more impact on the estimated seepage than the various liners, and the thickness of the liner is seen to have a negligible effect. All liner systems are expected to limit seepage rates to about 6 mm/year, which is less than 1% of the average annual rainfall for the site, an estimated 0.01% of the Belubula River streamflow under this average annual rainfall, and less than 1% of the lowest streamflow under extended dry conditions.

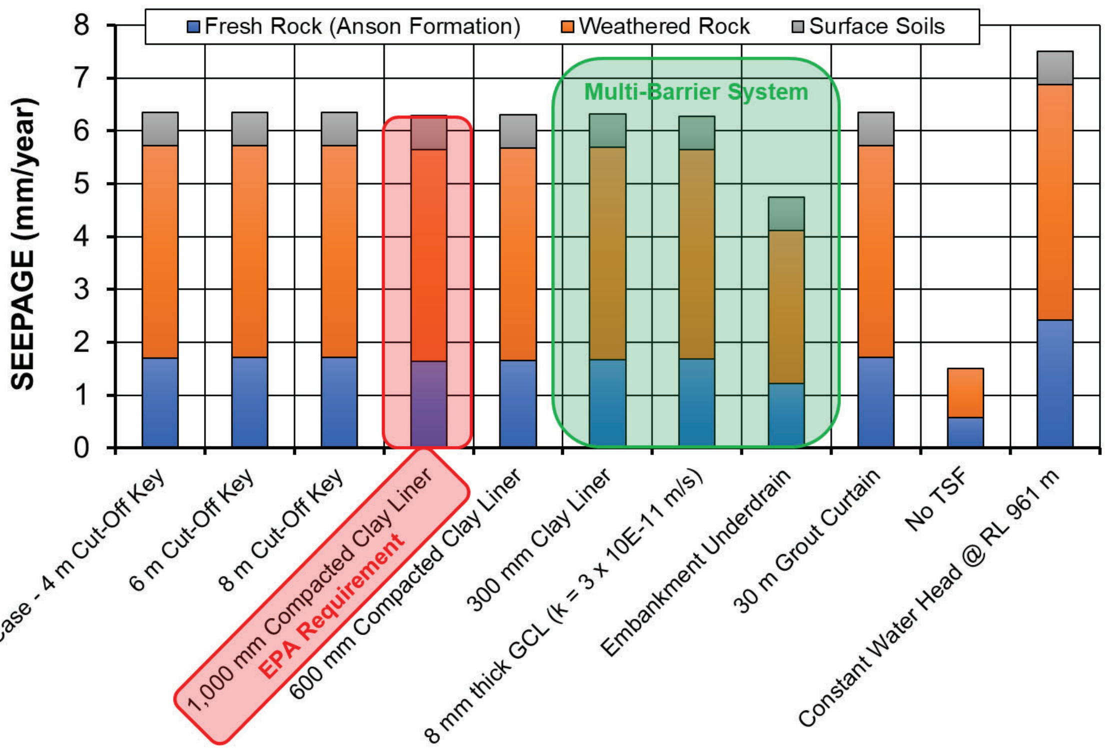

Figure 5 Enhanced TSF design *(source: Plate 2 of ATC Williams, June 2020)*

- The site clays on laboratory compaction have been shown to be capable of achieving more than acceptable permeability, with test values in the range from 1 x 10^{-10} to 9 x 10^{-9} m/s.

- The depth of natural clay beneath the TSF footprint is greatest towards the revised location of the decant pond, which will limit seepage from this source (see Figures 4 and 6). Further, the depth of natural clay is expected to be greater than previously expected, since many test pits did not penetrate it.

- The depth of natural clay is least around the south-western and central northern perimeters of the ultimate inundation footprint of the TSF, where the final depth of tailings will be minimal, and hence the source of seepage is minimal (see Figure 6).

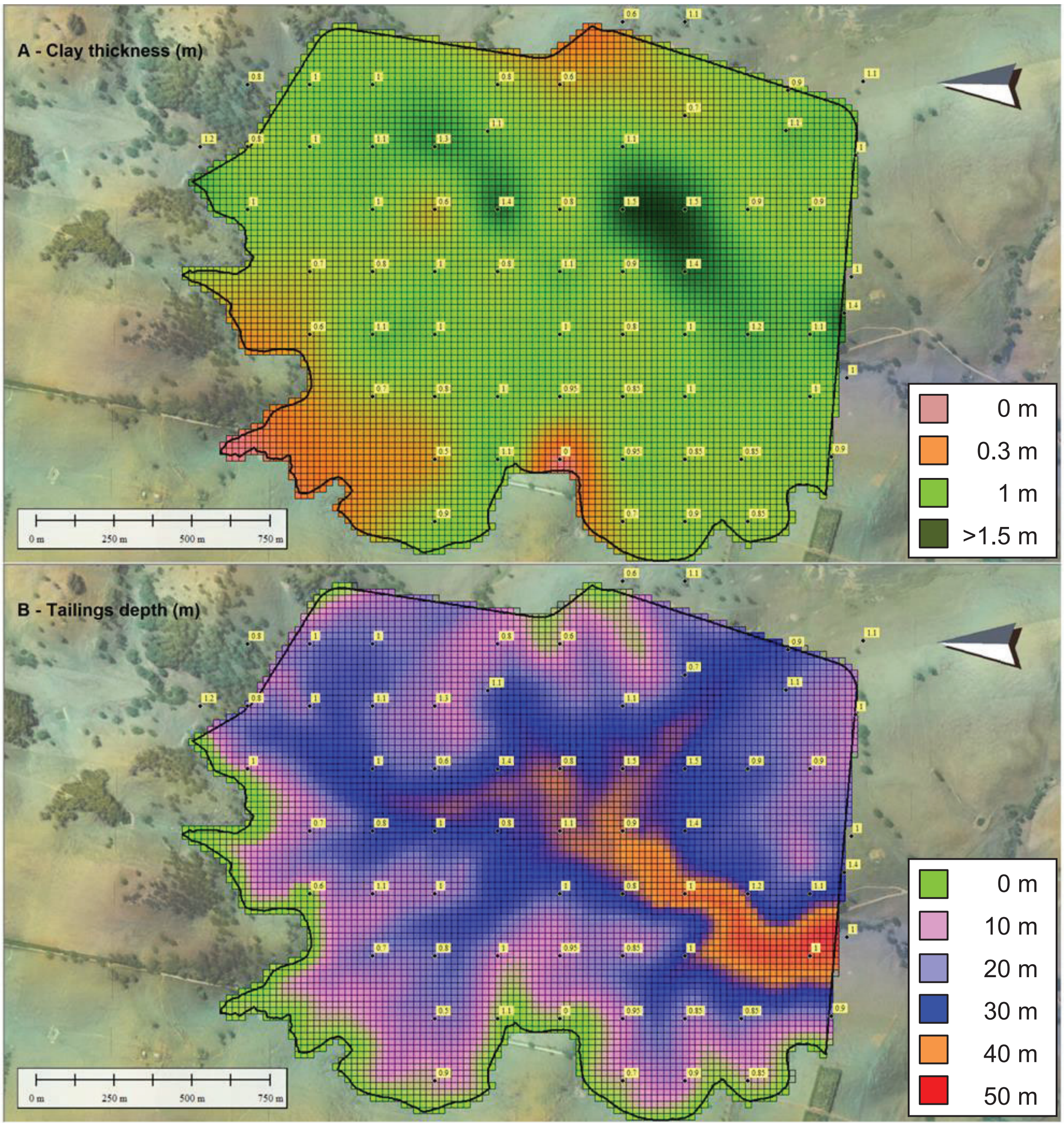

Figure 6 Estimated: (A) natural clay thickness, and (B) final tailings depth, over the ultimate inundation TSF footprint *(source: Plate 25 of ATC Williams, June 2020)*

- The permeability of settled tailings is expected to be approximately 1 x 10^{-7} m/s, with lower permeabilities in the vertical direction due to layering on beaching.
- The availability of clay suitable for a compacted liner of the TSF footprint, and for low permeability embankment zones, has been identified:
  - Natural clays are expected to provide a suitable liner material on moisture conditioning and compaction of the upper 300 mm to a permeability of 3.3 x 10^{-10} m/s, underlain by at least 700 mm of natural clay (equivalent to 1,000 mm of compacted clay with a permeability of 1 x 10^{-9} m/s), over an estimated 66% of the TSF footprint.
  - An engineered GCL, with the underlying clays moisture-conditioned and compacted, and with a nominal 300 mm thick protection layer on top, is expected to be required over an estimated 30% of the TSF footprint.

  - Existing drainage features, particularly where erosion or geological structure is evident, will require a minimum 1,000 mm thickness of clay compacted to achieve a permeability of 1×10^{-9} m/s, and expected to comprise 4% of the TSF footprint.
- The location of the TSF in the headwaters of the Belubula River minimises the impact on clean rainfall runoff and the need for its diversion.
- In addition to the lining of the TSF footprint and the sealing of the embankment, downstream groundwater monitoring with seepage collection capability is proposed as a secondary control measure to detect and capture any inevitable small seepage flows.
- Detailed QA/QC will be developed as part of the detailed TSF design, to be applied during the construction, operation and closure of the TSF. It will include testing to confirm that the design permeability of the TSF liner system is achieved.
- Ongoing seepage controls will include: (i) the TSF liner and sealing of the embankment to contain seepage, (ii) thickening the tailings and minimising the storage of water on the TSF to minimise the sources of seepage, (iii) monitoring and seepage collection, (iv) capping the tailings at closure to promote evapotranspiration and the runoff of excess rainfall, and (v) maintaining monitoring and seepage collection bores post-closure.
- Detailed erosion and sediment controls will be developed as part of the detailed TSF design, to be applied during the construction, operation and closure of the TSF.

Comments on the ATC Williams response to submissions by the Resources Regulator related to this Review are:

- Detailed plans and cross-sections will be developed as part of the detailed TSF design.
- A comprehensive assessment has been made of the possible TSF disposal options, demonstrating that sub-aerial, thickened slurry tailings disposal best meets the assessment criteria.

Comments on the ATC Williams response to submissions by the Community related to this Review are:

- A comprehensive monitoring program will be implemented, including upstream and downstream bores to assess groundwater levels and quality, downstream shallow seepage monitoring, and surface water monitoring.
- TSF seepage and stability have been demonstrated to be more than adequately addressed and catered for at the current feasibility stage of design, with appropriately conservative conditions and parameters adopted.

2.2 Matters raised by Government Agencies and Organisations

> *The Government Agencies and Organisations have raised a number of issues that have led to Regis improving their TSF design, including improvements to the design of the different liner systems, improvements to construction and water management, optimisation of tailings disposal and long-term management, and upfront planning for TSF closure and rehabilitation.*

The matters raised by Government Agencies and Organisations are:

1. In relation to the TSF liner system, the key issue of concern is the functionality of the alternative liners proposed by Regis compared with that specified by the EPA, which will dictate their seepage performance. Regis has demonstrated through analyses that their alternative liner systems are expected to perform at least as well as the liner specified by the EPA, and permeability testing will be carried out during construction to confirm the expected permeabilities.
2. TSF construction and water management:
    a. Construction management:
        i. The TSF is being developed in stages to minimise the extent of disturbance and to synchronise with the progressive development of the open cut and the availability of waste rock suitable for use in the construction of the TSF embankments.
        ii. Construction of the TSF will involve the development of borrow pits within the TSF footprint, embankment construction, and lining the TSF footprint.
        iii. Detailed construction QA/QC will be developed as part of the detailed TSF design.
    b. Improved water management:
        i. Sulphur dioxide/air cyanide detoxification will be applied to the tailings, being a proven technology (used at Cowal and Tomingley gold mines within NSW), well-suited to high tonnage/low grade gold deposits.
        ii. The expected low concentration of cyanide released with the tailings is expected to be below that affecting bird life (due to cyanide gas that forms), and will readily and rapidly break down in sunlight and through natural degradation.
        iii. The cyanide detoxified tailings are anticipated to be elevated in sulphate, selenium and fluorine relative to ANZECC-ARMCANZ (2000) livestock drinking water guidelines. As a result of the elevated sulphate, the tailings are expected to be classified as potentially acid forming, and may oxidise on exposed tailings beach, with the potential for acid and metalliferous runoff and drainage. To limit oxidation, the tailings will be maintained moist to limit oxygen ingress. Also, any acidity may be neutralised by the alkaline water from cyanide processing.

iv. Supernatant water released from the tailings will flow to the decant pond, from which it will be recovered for re-use in the processing plant.

v. Relocation of the Mine Water Management Facility from the north-west to the south-east perimeter of the TSF to facilitate the diversion of clean rainfall runoff post-closure.

vi. Refinement of the northern TSF embankment to maximise the diversion of clean rainfall runoff and minimise the inundation of trees.

vii. Relocation of the decant pond more centrally, towards the east, to better tie into the post-closure surface drainage of the TSF.

viii. Amendment to the tailings beach profile to drain to the east at closure.

ix. Relocation of the TSF post-closure discharge and diversion channel, avoiding a drop structure.

x. The management of seepage from the TSF will include a liner to meet the EPA's permeability requirements, The management of seepage from the TSF will include a liner to meet the EPA's requirements, in addition to a compacted clay cut off key beneath the upstream toe of the TSF embankment, a compacted clay liner on the upstream face of the TSF embankment, an underdrain beneath the TSF embankment to intercept seepage, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup.

xi. Additional seepage controls will include thickening the tailings and minimising the storage of water on the TSF to minimise the sources of seepage, capping the tailings at closure to promote evapotranspiration and the runoff of excess rainfall, and maintaining monitoring and seepage collection bores post-closure.

xii. Detailed erosion and sediment controls will be developed as part of the detailed TSF design, to be applied during the construction, operation and closure of the TSF.

3. Options for tailings disposal and long-term management:

   a. Tailings disposal:

      i. The tailings will be discharged sub-aerially as a thickened slurry from multiple points (via spigots) around the perimeter of the TSF, to best meet the assessment criteria, including water use, liner/seepage complexity, cyanide breakdown rate, AMD risk, tailings stability, energy use, tailings footprint, location suitability, capital cost, and operating cost.

ii. Deposition will be cycled between spigots to limit the deposited layer thickness and allow time for consolidation and desiccation of each layer, while maintaining the tailings surface sufficiently wet from fresh tailings to limit dusting.

iii. Supernatant water released from the tailings will flow to the decant pond, from which it will be recovered for re-use in the processing plant.

iv. The operation and condition of the TSF will be kept under regular surveillance and monitored.

b. Long-term management:

i. Surveillance and monitoring of the TSF will be maintained in compliance with ANCOLD (2019), with assessment against triggers developed for the TSF and embankment.

ii. Monitoring of downstream surface water quality will be continuous.

iii. The monitoring and seepage collection bores will be ongoing.

iv. Erosion and sediment controls will be ongoing.

v. The ultimate downstream slope of the TSF embankment will be revegetated early.

vi. The tailings will undergo long-term settlement, and will tend to 'dish' towards the greatest depth of tailings, potentially leading to differential settlement that could affect final landform surface drainage paths and lead to localised ponding of rainfall runoff. Settlements will be monitored and modelled post-closure to assess the potential for differential settlement and develop steps to accommodate them, if required.

4. TSF closure and rehabilitation:

a. At closure, the tailings will be allowed to desiccate to improve their strength and provide sufficient bearing capacity to allow the placement of a cover.

b. TSF rehabilitation will be directed at creating a stable and sustainable final landform, compatible with the surrounding landform, that minimises long-term environmental impact; that is, non-polluting.

c. The TSF landform will be capped by store and release or water-shedding covers to suit the climate and final topography, avoiding the ponding of water, and maintaining the rainfall runoff capacity of the site. The cover will have a 'store and release function' capable of supporting revegetation to provide erosion protection and support livestock, while allowing the runoff of excess rainfall during intense heavy rainfall events.

d. The cover on the tailings will include a capillary break layer of NAF waste rock approximately 500 mm thick, which will also serve as a trafficking layer.

e. The capillary break layer will minimise the potential for capillary rise of salinity and metals into the growth medium placed above, which will comprise a minimum 600 mm thickness of subsoil overlain by 100 mm of topsoil.

f. The rocky capillary break will also provide a self-healing layer should the growth medium be compromised locally by erosion or volunteer trees, with the coarse-grained rock readily filling any opening and allowing ready repair of the growth medium.

g. The surface of the cover will be profiled to shed excess rainfall runoff.

h. Land and Soil Capability Class 4 will be re-established on the capped surface of the TSF, comparable to the current LSC, allowing a grazing post-closure land use. It is recommended that any drinking water ponds for livestock be not located on tailings to avoid potential seepage through the tailings. As with all grazing land, some ongoing maintenance will be required.

i. The monitoring and seepage collection bores will be maintained post-closure.

j. Post-closure maintenance will include rehabilitation monitoring and weed management.

2.3 Commentary on Appropriateness of Multi-Barrier Approach

The multi-barrier approach proposed by Regis to control seepage involves lining the TSF footprint to the equivalent of the EPA specified liner, in addition to a compacted clay cut off key beneath the upstream toe of the TSF embankment, a compacted clay liner on the upstream face of the TSF embankment, an underdrain beneath the TSF embankment to intercept seepage, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup. This multi-barrier approach will both limit seepage rates and collect much of the seepage that does occur.

Natural clay covers much of the TSF footprint, with a depth of as much as 4.5 m towards the revised location of the decant pond, which will limit seepage from this source. The clays within the TSF footprint have been shown to be capable of achieving on laboratory compaction more than acceptable permeability, with test values in the range from 1×10^{-10} to 9×10^{-9} m/s.

The depth of natural clay is least around the south-western and central northern perimeters of the ultimate inundation footprint of the TSF of approximately 273 ha, where the final depth of tailings will be minimal, and hence the source of seepage is minimal.

The multi-barrier approach proposed by Regis for the TSF footprint includes three different liner systems for different parts of the footprint, including:

1. Where deep natural clays exist, the upper 300 mm thickness will be moisture conditioned and compacted to achieve a permeability of 3.3 x 10^{-10} m/s, which will be underlain by at least 700 mm of natural clay. This liner system is expected to be appropriate for 66% of the TSF footprint.
2. On the sides of the TSF footprint, an engineered GCL will be applied, with the underlying clays moisture-conditioned and compacted, and with a nominal 300 mm thick protection layer on top. This liner system is expected to be appropriate over an estimated 30% of the TSF footprint.
3. Along existing drainage features, particularly where erosion or geological structure is evident, a minimum 1,000 mm thickness of clay compacted to achieve a permeability of 1 x 10^{-9} m/s is proposed. This liner system is expected to be limited to about 4% of the TSF footprint.

Regis has demonstrated through analyses that their alternative liner systems are expected to perform at least as well as the liner specified by the EPA, and permeability testing will be carried out during construction to confirm the expected permeabilities.

In addition, Regis proposes a compacted clay cut off key beneath the upstream toe of the TSF embankment, and a compacted clay liner on the upstream face of the TSF embankment to limit seepage through the embankment. Further, Regis proposes to collect much of the seepage that does occur by an underdrain beneath the TSF embankment, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup.

2.4 Commentary on Level of Risk of Multi-Barrier Approach

The multi-barrier approach proposed by Regis is feasible and expected to be effective in limiting seepage at least as well as the liner specified by the EPA, as well as collecting much of the seepage that does occur. The proposed multi-barrier approach will mitigate the risk of seepage impacting the downstream environment to a degree greater than that achievable using the EPA specified liner alone.

Demonstration that the different liner systems achieve their specified permeability values will ensure that they are at least as effective as the liner specified by the EPA in limiting seepage from the tailings, achieving the same level of risk mitigation. The compacted clay cut off key beneath the upstream toe of the TSF embankment, the compacted clay liner on the upstream face of the TSF embankment, the underdrain beneath the TSF embankment, the seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, the lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores will further contribute to seepage risk mitigation.

These additional features are prudent additions, and would be highly desirable for any liner system, including the liner system specified by the EPA. No liner system would completely eliminate seepage, including an HDPE. A small amount of seepage will occur as the tailings consolidate and drain, which will be captured. The proposed multi-barrier approach will provide a high level of risk mitigation.

2.5 Benchmarking Proposed Approach

The proposed TSF embankment has a stability margin up to twice as high as that of typical TSF embankments in Australian conditions.

Regis have proposed a TSF embankment constructed by the downstream method with a relatively flat ultimate downstream slope of only 14^{o} (4H:1V). This embankment geometry is far flatter and more robust than typical TSF embankments, which generally have downstream slopes of about 22^{o} (2.5H:1V), and are often raised by the upstream method, founded partially on beached tailings, under Australian conditions. The downstream construction method is inherently more robust than the upstream construction method, and the flatter downstream slopes make the proposed embankment even more robust, with a stability margin up to twice as high as typical TSF embankments. The proposed TSF embankment will be a very effective and stable containment for the tailings, and is designed and constructed for the more demanding closure return intervals for flooding and earthquake loadings, at the outset. In addition, the ultimate downstream slope of the TSF embankment will be revegetated early.

Lining TSF footprints is not the norm in Australia, and is generally only considered for projects close to local residents, or in landscapes of high value. Regis proposes a multi-barrier approach, including a liner system over the entire TSF footprint, which is expected to match or exceed the liner system specified by the EPA, and goes several steps further by adding a compacted clay cut off key beneath the upstream toe of the TSF embankment, a compacted clay liner on the upstream face of the TSF embankment, an underdrain beneath the TSF embankment, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup.

2.6 Commentary on Relocation of Mine Water Management Facility

The relocation of the Mine Water Management Facility is a marked improvement.

The relocation of the Mine Water Management Facility from the north-west to the south-east perimeter of the TSF will facilitate the diversion of clean rainfall runoff both during operations and post-closure, and is a far preferred location, with both engineering and environmental benefits.

3 REVIEW CONCLUSIONS

The key conclusions of the Review are given in the following sections.

3.1 Tailings Dam Stability

Tailings dam stability is an understandable community concern, given recent tailings dam failures, including that not far away at Cadia. However, the community can be reassured that the proposed TSF embankment will be a very effective and stable containment for the tailings, and is designed and constructed for the more demanding closure return intervals for flooding and earthquake loadings, at the outset. The TSF embankment is designed to have a margin of stability up to twice as high as typical TSF embankments under Australian conditions. In addition, the ultimate downstream slope of the TSF embankment will be revegetated early.

3.2 Potential Seepage from TSF

The EPA has a specified liner system that they need to be convinced will be matched in performance and risk mitigation by the proposed alternative liner systems. Lining TSF footprints is not the norm in Australia, and is generally only considered for projects close to local residents, or in landscapes of high value. Regis proposes a multi-barrier approach including a liner system over the entire TSF footprint that is expected to match or exceed the liner system specified by the EPA, and goes a step further by adding a compacted clay cut off key beneath the upstream toe of the TSF embankment, a compacted clay liner on the upstream face of the TSF embankment, an underdrain beneath the TSF embankment to intercept seepage, a seepage collection sump at the downstream toe of the TSF embankment, monitoring and seepage collection bores immediately downstream of the TSF embankment, a lined TSF runoff pond, and further seepage collection bores downstream of the monitoring bores as an extra backup.

3.3 Rehabilitation of TSF

The Resources Regulator will have ultimate responsibility for approving the closure of the TSF, and the relinquishment of the site. Regis has designed the TSF to comply with post-closure design criteria from the outset, and proposes to revegetate the ultimate downstream slope of the TSF embankment early. The rehabilitation of the TSF is designed to achieve close to the pre-existing land and soil capability post-closure.

4 RECOMMENDED FURTHER WORK

Further work in the detailed design stage is recommended to cover the expected tailings characteristics, the suitability and quality of available fill materials, constructability and quality assurance/quality control (QA/QC), and a detailed semi-quantitative tailings risk assessment.

4.1 Expected Tailings Characteristics

The tailings characteristics will need to be characterised geotechnically, chemically and, possibly biologically. This will require ore samples to be put through simulated processing to produce sample for laboratory characterisation and parameter testing.

4.2 Suitability and Quantity of Available Fill Materials

For the Feasibility stage of the design, considerable borrow material sampling and testing has already been completed, which was beneficial in demonstrating the extent and expected permeability of compacted site clays. Further borrow materials sampling and laboratory testing will be required to enable detailed design of the TSF embankment and liner systems.

4.3 Constructability and QA/QC

Constructability and QA/QC studies will be aimed at optimising the sequencing of construction materials, both from the pit and the TSF footprint, construction schedules, and ensuring an appropriate standard of construction of the TSF embankment and associated surface water management structures.

4.4 Detailed Tailings Risk Assessment

It is noted that a broadly-based risk assessment was undertaken appropriate for the Feasibility Study of the TSF and reported in Appendix F of the EIS (referred to in Section 2.1.4 herein).

A detailed tailings risk assessment will be carried out for the preferred tailings solution design, operation and closure for the McPhillamys Gold Project for the purpose of addressing possible risks and identifying effective controls (prevention and mitigation) at each stage of the project, including:

- design;
- construction, including satisfying QA/QC, dust and noise control;
- operation, including tailings deposition, water management, seepage and potential oxidation of the tailings; and
- closure.

The detailed risk assessment will include engagement with the Community and Regulators, at appropriate stages, seeking their input and comment. A choice will need to be made about the preferred risk assessment methodology to be applied, which is likely to be a choice between the qualitative Failure Modes Effects Analysis (FMEA) and the semi-quantitative Fault-Event Tree approach, which is probably preferred.

The detailed risk assessment will identify the key risks, for which preventative and mitigation measures will be identified and tested. The effectiveness of the different measures in addressing the overall Risk Ranking will be assessed by re-running the risk assessment, and converted to a cost-effectiveness rating for each measure. This will support the selection of the most effective controls. The selection, application and effectiveness of these controls will be reported to regulators through the mining operations plan (MOP), as required by the Lease conditions, Dam Safety NSW, and in annual reporting as a requirement of the planning approval. If controls are effective then remedial measures will not be required.

5 REFERENCES

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APPENDIX A – Curriculum Vitae

Professor David J Williams

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Professor David Williams is a Chartered and Registered Professional Engineer with over 40 years of experience. His discipline area is Geotechnical Engineering, and he is internationally recognised for his expertise and experience in mine waste management and mine closure. He is particularly recognised for his expertise in tailings dams, and the closure and rehabilitation of tailings dams and waste rock dumps, including the design of covers. He carries out high-level reviews of and provides expert advice and opinion on tailings dam designs, tailings and waste rock facility closure, and the closure and rehabilitation of open pits.

He authored in 2016 the Tailings Management Handbook, as part of the Commonwealth Leading practice sustainable development program for the mining industry. He is on the Working Party for the Australian National Committee for Large Dams Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure published in 2012 with an Addendum in 2019.

QUALIFICATIONS

1979	PhD, Soil Mechanics	University of Cambridge, England
1975	BE (Hons I), Civil Engineering	Monash University, Australia

AWARDS/DISTINCTIONS/FELLOWSHIPS

1996	Japan Society for the Promotion of Science Fellow
1995	The University of Queensland Collaborative Research Travel Grant
1995	Australian Minerals and Energy Environment Foundation (AMEEF) Travelling Scholarship
1993	Australian Research Fellow (Industry)
1992	AMEEF Environmental Excellence Award (Individual)
1990	Masuda Fellow for Collaborative Research in Japan, Jan-Feb
1989	The University of Queensland Collaborative Research Travel Grant

MEMBERSHIPS

From 2015	Member, Australasian Institute of Mining and Metallurgy
From 2015	Registered Professional Engineer of Queensland (RPEQ)
1986-1987	Member, National Committee, Australian Geomechanics Society
2007-2008	
From 1984	Member, Queensland Committee, Australian Geomechanics Society, Chair in 1986
From 1980	Member, Australian Geomechanics Society
From 1980	Member then Fellow, Institution of Engineers, Australia

EMPLOYMENT HISTORY

2007 – Present	Professor of Geotechnical Engineering Founder and Director of Geotechnical Engineering Centre Manager of the Large Open Pit Project School of Civil Engineering The University of Queensland
1994 – 2007	Associate Professor of Geomechanics Department of Civil Engineering The University of Queensland
1990 – 1994	Senior Lecturer in Geomechanics Department of Civil Engineering The University of Queensland
1983 – 1989	Lecturer in Geomechanics Department of Civil Engineering The University of Queensland
1980 – 1983	Geotechnical Engineer Melbourne and Brisbane Golder Associates Pty Ltd
1979 – 1980	Engineer Country Roads Board (CRB) of Victoria
1976 – 1979	Research Student University of Cambridge, England
1972 – 1976	Engineer, Cadet Engineer, CRB, Victoria

SUMMARY OF CONSULTING COMMISSIONS

Board and Expert Panel Memberships

- Independent Member of the Alcoa Impoundments Lead Team from 2020
- Chair of Independent Technical Review Board for Minera Escondida-BHP, Chile from 2019
- Geotechnical Advisor to Aguamarina, Chile from 2019
- Member of Expert Panel commissioned to investigate the technical causes of the failure of Tailings Dam I at the Córrego de Feijão Mine in the State of Minas Gerais, Brazil on 25 January 2019
- Member of Independent Technical Review Board for Rio Tinto Alcan Yarwun Residue Management Area Embankment Raise Designs from 2016
- Member of Independent Technical Review Panel of Life-of-Mine Tailings Storage Facility at Glencore's McArthur River Mine, Northern Territory, Australia from 2015
- Member of Northern Territory EPA Board, from 2012 to 2014

Peer Reviews of Major Projects

- Sole Independent Expert Geotechnical Reviewer for Unity Mining Limited from 2016
- Sole Independent Expert Geotechnical Reviewer for Bluestone Mines Tasmania JV Pty Ltd from 2015
- Sole Reviewer of Proposed Integrated Waste Landform Design for Central Eyre Iron Project in 2015
- Sole Independent Expert Geotechnical Reviewer for Rio Tinto Alcan Gove Residue Disposal Area from 2015
- Sole Independent Expert Geotechnical Reviewer and Annual Dam Inspections for QAL Residue Disposal Area and Ash Dams from 2013
- Sole Independent Expert Geotechnical Reviewer for Rio Tinto Alcan Yarwun Residue Management Area from 2013
- Led International Peer Review for the South Deposit TSF at Savage River Mine in Tasmania in 2012/13
- Sole Independent Expert Geotechnical Reviewer for Rio Tinto Alcan Weipa Tailings Storage Facilities in 2012 and 2014
- Peer Review of Harvey Creek Non-Erodable Waste Rock Dump Design for Ok Tedi Mining Limited in 2010/11
- Member of Expert Peer Review Team for Rio Tinto Alcan Weipa Tailings Storage Facilities from 2009
- Member of the International Technical Advisory Group reporting to the South Australian Government on Rehabilitation of Brukunga Pyrite Mine from 2007
- Led International Peer Reviews for the Savage River Rehabilitation Project in Tasmania in 2002, 2005, 2009 and 2013

- Led International Peer Review on handling acid generating waste rock dumping and dump closure strategies at Cadia Hill Gold Mine in New South Wales in 2002/3
- Member of the Peer Review Team for Stage 2 of the Stuart Oil Shale Project at Gladstone in Queensland in 2004
- Peer Reviewer of the rehabilitation of the San Manuel Copper Mine tailings facility in Arizona, USA in 2004
- Member of the 2005 Peer Review Team that reviewed future red mud disposal, containment and rehabilitation at QAL at Gladstone in Queensland in 2005
- Geotechnical Reviewer of the breach of the co-disposal dam at Burton Coal in Queensland in 2005
- Peer Reviewer of the conceptual closure plan for Worsley Alumina red mud storage in Western Australia in 2005
- Peer Reviewer for waste rock dump covers for Century Mine in North Queensland from 2007
- During 2006, David was an Expert Advisor to the EIS team for the Olympic Dam Expansion Project in South Australia, providing expert input on disposal, hydrology and closure issues for both waste rock and tailings

Expert Witness

- Expert witness through Corrs Chambers Westgarth Lawyers, in relation to coal washery rejects used as filling for residential sub-division purposes
- Expert witness through McCullough Robertson Lawyers, in relation to the failure of a concrete arch reclaim tunnel beneath a coal stockpile
- Expert witness in relation to professional misconduct cases brought by the Queensland Professional Engineers Registration Board
- Numerous expert witness commissions related to residential and commercial building footing failures and slope instability

Consultancies

Professor David John Williams is widely sought for his expert input, in particular to mine waste disposal and mine site rehabilitation and remediation at operating mines throughout Australia and overseas. In Australia, he has consulted on numerous coal mines throughout Queensland and New South Wales; on Red Dome Gold Mine closure, Kidston closure, Osborne waste disposal, Ivanhoe Cloncurry mine closure, Phosphate Hill gypsum disposal, QERL processed waste storage facility closure, and Century Zinc Mine waste rock dumping in Queensland; Cadia Hill Gold Mine waste rock dumping and dump closure in New South Wales; Mt Morgans Gold Mine co-disposal, WMC Resources' nickel operations tailings closure and Minara heap leaching in Western Australia; waste disposal issues at the Ballarat East and Heathcote gold mines in Victoria; and a review of ARD treatments at Savage River Mine in Tasmania. Overseas he has consulted on tailings depositional design and water balance for the Kori Kollo Mine in Bolivia, a review of co-disposal of tailings and waste rock at Porgera Gold Mine and the closure of Misima Gold Mine in PNG, waste disposal design for the Goro Nickel project in New Caledonia, and advice on co-disposal for the Martabe Project in Indonesia.

David has been involved in material characterisation testing and the design of numerous mine waste covers throughout Australia, and the design, installation and monitoring of lysimeters and mine waste covers at Kidston Gold Mines, WMC Resources' Mt Keith Nickel Operations, QERL's Stuart Oil Shale Project, a large-scale trial waste rock dump at Cadia Hill Gold Mine, and a large-scale trial tailings cell at Jubilee Nickel Mine.

David has been invited to visit numerous mining regions and individual mines throughout Australia, and in Canada, the USA, Brazil, South Africa, UK, China, Chile, PNG, New Caledonia, Spain and Mozambique.

MAJOR RESEARCH ACHIEVEMENTS

From 1989, Professor Williams carried out research under NERDDC and ACARP Projects on the characterisation of the deposit formed on the pumped co-disposal of combined washery wastes, which has since been adopted at numerous coal mines in Australia and Indonesia.

From 1996, David developed the store/release cover system suited to seasonally dry climates, for application to covering acid generating rock dumps at Kidston Gold Mine in north Queensland, and has had a long-term involvement in researching and monitoring this cover system, as evidenced by his numerous papers on his research on this topic. The store/release cover system on the tops of the Kidston rock dumps has been shown to limit percolation to less than 1% of rainfall, and to support a sustainable vegetation cover comparable to that occurring along water courses in the area. He was also involved in the development of a rehabilitation strategy for the side slopes of the rock dumps at Kidston designed to maximise geotechnical and erosional stability while promoting vegetation, and analysed the wetting up by rainfall infiltration and subsequent drain-down of and seepage from the rock dumps. Store/release covers have now been adopted at numerous mine sites in dry climates worldwide.

From 1999 to 2001, David led ACARP Project C8039 to develop a risk assessment and cost-effectiveness analysis for the rehabilitation of Bowen Basin coal mine spoil. The results of the project were reported in a Literature Review and Commentary and Project Final Report, plus a spreadsheet-based risk assessment and cost-effectiveness analysis, available at: www.uq.edu.au/civil/. In 2006, David undertook a closure study for Xstrata's new Rolleston Coal Project in the Bowen Basin Coalfields.

David has since 2000 been involved in the closure design for the waste rock dump at Cadia Hill Gold Mine in New South Wales, including studies on the use of mixtures of benign trafficked rock and tailings as an alternative cover material, to overcome the shortage of suitable natural materials. In 2002/3, he led an international peer review of the rock dumping operation and closure plan. In 2004, David was successful in an ARC Linkage grant application with Cadia totalling over $ 700,000 over 3 years, which has led to the construction of a 15 m high, world-class, demonstration, instrumented rock dump covering 7,000 m^2. The instrumentation includes a full weather station, 24 lysimeters at the base of the dump to monitor seepage, lysimeters on the top surface to monitor rainfall infiltration and three store/release trial covers constructed using natural and mine waste materials. To date it has shown that about 70% of the rainfall incident on the traffic-compacted top of the dump infiltrates, with the majority going into storage within the dump during the first year, and only small amounts percolating to the base of the dump. The behaviour of the cover trials has to date been dominated by the moisture state at which they were constructed. Monitoring of the instrumented rock dump is expected to continue for at least 10 years.

From 2000 to 2003, David was a principal researcher into the physical and geochemical nature of acid generating waste rock dumps in Southern Carolina, USA (Rio Tinto's Ridgeway Mine) and Sudbury, Canada (Inco's Whistle Dump), sampled as they were being excavated and moved to a pit.

From 2001 to 2005, David led an ARC Spirt research project with industry partner WMC Resources focussed on an assessment of the long-term seepage and runoff from mine tailings storage facilities, to facilitate lease surrender. This included the monitoring of trial covers on tailings over the duration of the project and large-scale laboratory column testing and numerical analyses. Natural salt pan and rocky slope analogues under the same climatic and similar geochemical conditions were also studied to point to sustainable approaches for rehabilitating the tailings storage facilities.

From 2010, David has led three ACARP Projects, C19022, C20047 and C25040, investigating the settlement and stability of high coal mine spoil, the behaviour of problematic clay-rich coal mine tailings, and the behaviour of 'mud' derived from spoil on wetting-up.

David has been sponsored by mining companies and consultants to visit numerous mining regions and mine sites worldwide, both to impart and extend his knowledge. Since 2000, he has developed a relationship with the International Network for Acid Prevention (INAP), and has contributed to INAP-sponsored research and development projects and workshops involving mine sites in the USA, Canada, Australia and PNG.

Research funding has totalled over $10 million, including funding from ARC, ARC-SPIRT, ARC Linkage, NERDDC, ACARP-AMIRA, ACARP, MIM CRA-ATD, Kidston Gold Mines, BHP Coal and WMC Resources, Cadia Holdings, Jubilee Mines NL.

PUBLICATIONS

Professor Williams has over 300 refereed publications, including five book chapters, over 100 refereed journal articles and over 200 refereed conference publications, plus numerous research and consulting reports. About two-thirds of these publications are in the mine waste field.