Report

04 July 2023

[redacted]

Dear Nicholas,

1. Introduction

1.1 Background

Due to construction and logistical challenges, the completion of the starter embankment for Tailings Storage Facility (TSF) 4 Cell 1 has been delayed. These challenges have resulted in construction extending into the winter which has caused further delays due to rainfall saturating construction material, with limited solar drying due to reduced winter evaporation rates.

TSF2 is expected to reach capacity in September 2023 and, to prevent interruption to operations, Talison proposes to construct and commission the TSF4 Cell 1 starter embankment in two stages. The two-stage construction of the Cell 1 starter embankment will comprise:

– Stage 1a: Starter embankment constructed to < RL 1265
– Stage 1: Starter embankment constructed to RL 1265

A Critical Containment Infrastructure Report (CCIR) for Cell 1 Stage 1a is planned to be submitted in September 2023, with commissioning (Time Limited Operations – TLO) commencing in October 2023. Construction of the Cell 1 Stage 1 starter embankment will continue during Stage 1a TLO, with a CCIR for Cell 1 Stage 1 planned to be submitted in November 2023. Cell 1 is planned to receive tailings nominally for one year to allow adequate time to complete construction of Cell 2.

To further expedite construction of the Stage 1a work the clay liner will be replaced with Bituminous Geomembrane (BGM) at locations where the clay liner has not been installed at the time of writing this report, as BGM can be installed during inclement weather provided the subgrade is firm and unaffected by the inclement weather.

This report has been prepared to provide information supporting an application for amended Works Approval (WA) to install a BGM liner over part of the TSF4 Cell 1 Stage 1a to the Department of Water and Environmental Regulation (DWER).

1.2 Purpose of this report

The purpose of this report is to provide information to assist with the submission of the revised WA approval to support the partial substituting of the TSF4 Cell 1 clay liner with BGM and the commissioning of TSF4 Cell 1 at a crest level < RL 1265. The report focuses on technical risks to the integrity of Cell 1 and potential impacts to the environment.

1.3 Scope of work

The scope of work comprises:

– Assessing the impacts of partial substitution of the clay liner with BGM
– Identifying risks to the integrity of Cell 1 resulting from the partial substitution of the clay liner with BGM
– Identifying risks to the environment resulting from the partial substitution of the clay liner with BGM

1.4 Limitations

This report has been prepared by GHD for Talison Lithium Pty Ltd and may only be used and relied on by Talison Lithium Pty Ltd for the purpose agreed between GHD and Talison Lithium Pty Ltd as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Talison Lithium Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.5 Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.6 Assumptions

This report assumes that the TSF4 design philosophy remains unchanged, and that the completed construction of Cell 1 has been undertaken in accordance with the design.

2. Revised containment system design

2.1 Design overview

The clay liner will be replaced with a BGM in locations where the installation of the clay liner has been delayed by inclement weather.

2.2 Location of BGM

BGM will be installed in the northern and north-eastern portions of Cell 1 in areas where the construction of the clay liner has been delayed. The clay liner will be replaced with BGM for 12.8 hectares of the 64.3 hectares of the floor of Cell 1 (20% of floor clay liner area). The extent of the replacement BGM in Cell 1 is shown in Drawing 61-37226-C061 in Appendix A.

2.3 BGM material

A single BGM will be installed on the subgrade to replace the clay liner in areas where the construction of the clay liner has been delayed. The details of the available BGM material that will be used to replace the clay liner in Cell 1 are provided in Table 1. Manufacture data sheets for the BGM are provided in Appendix B.

Table 1 BGM Material

Material	Thickness (mm)	Surface Mass (kg/m²)	Use
Coletanche ES2	4.0	4.85	BGM installed on the floor
Coletanche ES3	4.8	5.8	BGM installed on the floor
Coletanche ES4	5.6	6.4	BGM installed on the floor
Coletanche ES2 HFA	4.0	4.85	High friction angle BGM installed on the embankments
Coletanche ES3 HFA	4.8	5.8	High friction angle BGM installed on the embankments
Coletanche ES4 HFA	5.6	6.4	High friction angle BGM installed on the embankments

2.4 Quality control lots

Cell 1 has been divided into several clay liner lots for quality assurance (QA) and quality control (QC) purposes. The QA/QC lots are provided in Figure 1 and in Drawing 61-37226-C061 in Appendix A. The clay liner will be replaced with BGM in QA/QC lots CL08A, CL09A, CL11A, CL11B, CL11C, CL12A and CL12B.

Figure 1 QA/QC lots

2.5 Subgrade preparation

2.5.1 Partial clay lined

In areas where the construction of the clay liner has commenced but has not been completed (CL11A), the upper 200 mm will be removed, and the residual clay liner will be tested to confirm that the moisture content of the clay liner is -2% to +2% of Optimum Moisture Content (OMC) and clay liner has been compacted to 95% Modified Maximum Dry Density (MMDD). If the clay liner meets these requirements, the surface will be trimmed and rolled with a flat drum in preparation for the installation of BGM.

Pebbles on the surface will not be angular and will not have a diameter greater than 20 mm to ensure the integrity of the BGM under load. The prepared subgrade will be visually inspected before the BGM is installed to ensure that the subgrade complies with this requirement.

If the clay liner does not meet the requirements, it will be removed, and the subgrade will be prepared in accordance with Section 2.5.2.

2.5.2 Foundation preparation

Areas where the foundation preparation (clearing, grubbing, topsoil stripping and proof rolling) has been completed in accordance with the Technical Specifications (CL08A, CL09A, CL12A and CL12AB) or where foundation preparation has been completed and the area has been approved for clay placement (CL11B and CL11C) will be trimmed and rolled with a flat drum in preparation for the installation of BGM. Pebbles on the surface will not be angular and will not have a diameter greater than 20 mm.

2.5.3 Natural ground

If natural ground is encountered, it will be prepared for BGM installation in accordance with the requirements for foundation preparation in the technical specifications. Prepared foundations will be trimmed and rolled with a flat drum in preparation for the installation of BGM. Pebbles on the surface will not be angular and will not have a diameter greater than 20 mm.

2.5.4 Non Structural Fill

General fill along the TSF1 southern embankment (CL08A, CL09A, CL11C AND CL12B) to raise the elevation to the tailings underdrainage level will be constructed in accordance with the original design. Once the fill has been placed, it will be trimmed and rolled with a flat drum in preparation for the installation of BGM. Pebbles on the surface will not be angular and will not have a diameter greater than 20 mm.

2.6 BGM installation

2.6.1 Installation

The BGM will be installed from the top of the embankment (highest elevation) to the floor (lowest elevation) to minimise the potential for water to seep underneath the BGM during the installation. The BGM will be anchored in an anchor trench located on the RL 1268 m powerline corridor on the southern TSF 1 embankment and on the crest of north-eastern TSF4 embankment.

The anchor trench will be excavated using an excavator and will be 600 mm (W) by 600 mm (D) to provide sufficient resistances (0.36 m^3 of clay per m, 615 kg/m at 1,710 kg/m^3) to retain the BGM during tailings deposition. Once the BGM has been placed in the anchor trench in accordance with the design drawings, the anchor trench will be backfilled with the excavated spoil and compacted to 95% MMDD at -2% to +2% OMC. High friction angle BGM will be used on the embankments to further prevent the BGM from slipping down the embankment during deposition.

The anchor trench details are provided in Drawing 61-37226-C062 in Appendix A.

BGM panels will be joined by overlapping the edges by 200 mm and torch welding the overlapped BGM together to form a watertight seam. BGM will be installed by a competent and appropriately qualified installer.

2.6.2 Tie-in into clay liner

The BGM will be tied into the placed clay liner by removing the 200 mm sand cover and excavating a 3.0 m wide and 0.3 m deep tie-in trench into the clay liner with a volume of 0.9 m^3 of clay per m (1,539 kg/m at 1,710 kg/m^3). The BGM will be placed in the clay liner tie-in trench and the tie-in trench will be backfilled with the excavated clay and compacted to 95% MMDD at -2% to +2% OMC.

The clay liner tie-in details are provided in Drawing 61-37226-C063 in Appendix A.

2.6.3 Embankment tie-in

The leading edges of the BGM will be tied into the embankments in CL08A west, CL09A east, CL11C east and CL12 south in a 1.0 m wide and 0.6 m deep anchor trench (0.6 m^3 of soil per m, 615 kg/m at 990 kg/m^3 at 1,650 kg/m^3). The anchor trench will be excavated into the embankment and once the BGM has been placed in the anchor trench the embankment anchor trench will be backfilled with the excavated soil and compacted to 95% MMDD at -2% to +2% OMC.

The embankment anchor details are provided Drawing 61-37226-C063 in Appendix A.

2.7 Revised embankment design

To enable TSF4 Cell 1 to receive tailings by October 2023 and to allow sufficient time for the DWER approval process, the starter embankment design for Cell 1 has been amended to Cell 1 Stage 1a (RL 1261) and Cell 1 Stage 1 (RL 1265).

The clay liner on the Stage 1a north-eastern embankment will be replaced with BGM (refer to Drawing 61-37226-C061 in Appendix A). The permeability of the BGM is four orders of magnitude lower that the clay and a clay core is no longer required to prevent seepage migration through the outer embankment. The geometry of the north-eastern embankment has been adjusted accordingly by replacing the clay core with a 5 m wide clay facing (refer to Drawing 61-37226-C063 in Appendix A).

The north-eastern embankment will be constructed from mine waste rock with a 5.0 m wide clay facing with a 1(V):3(H) upstream slope to enable the placement of BGM. The dimensions of the north-eastern embankment have been retained.

The results of the stability analysis for the original north-eastern embankment design are summarised in Table 2 and provided in Figure 2 and Figure 3.

Table 2 Summary of north-eastern embankment stability results

Location	Condition	ANCOLD Requirement	Factor of Safety Original Design	Factor of Safety Revised Design
North-easter embankment	Long term	1.5	1.847	1.84
North-easter embankment	Post seismic	1.0	1.404	1.41
North-easter embankment	Undrained with liquefaction	1.0	n/a	1.40

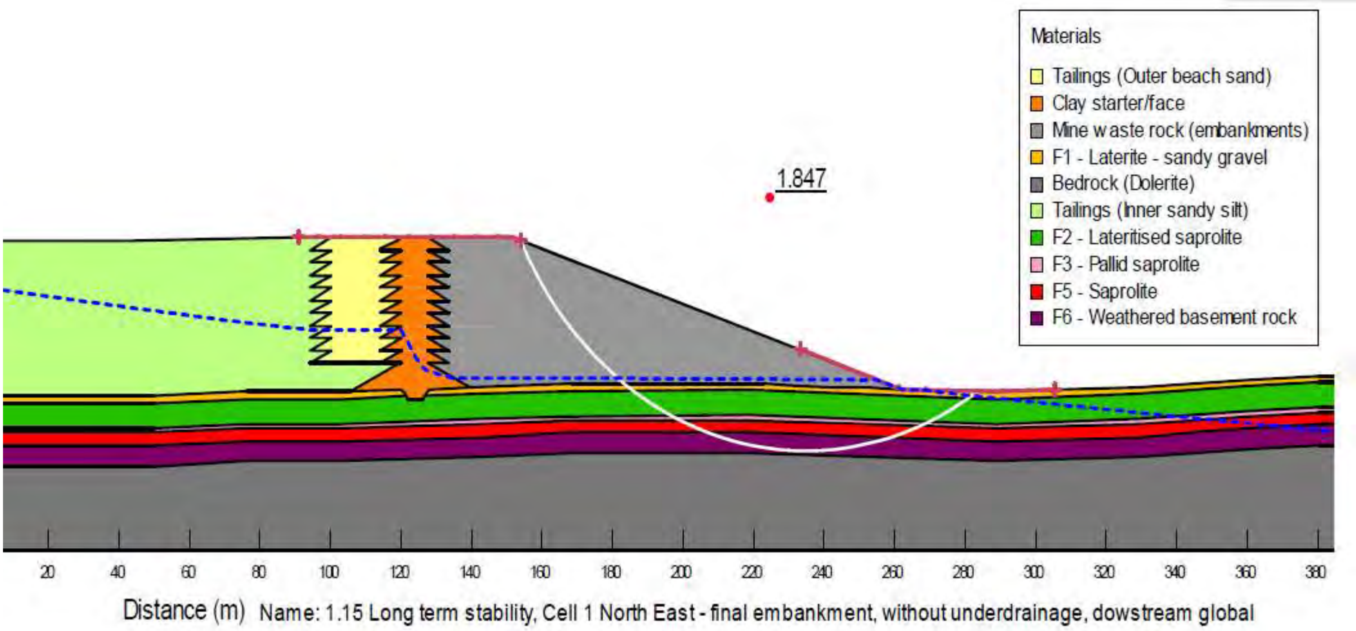


Figure 2 ***Stability analysis result for original north-eastern embankment – long term***

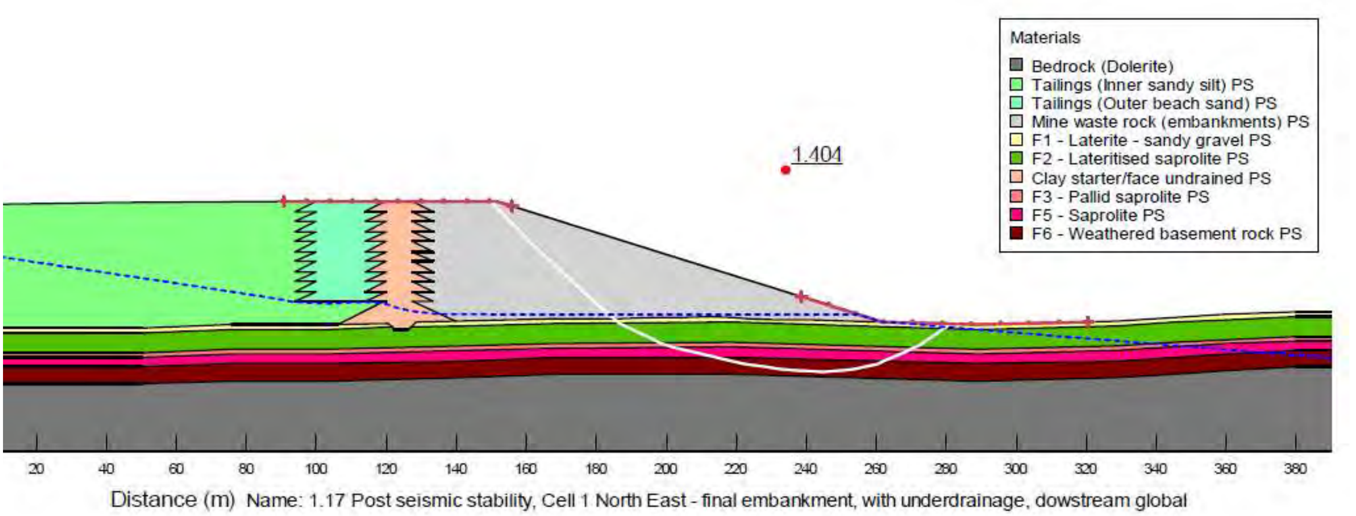
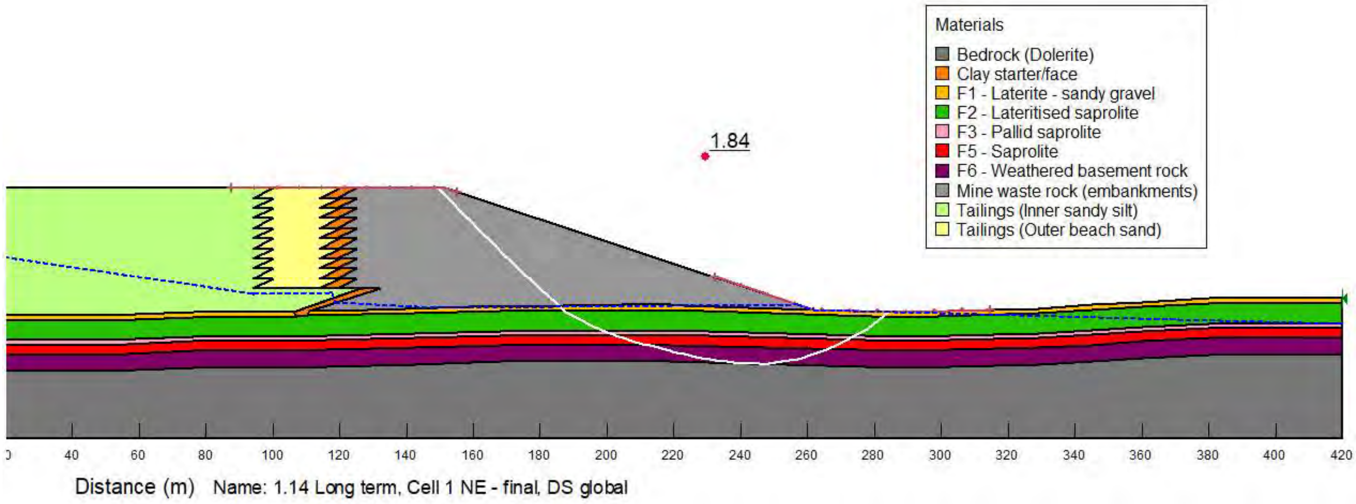


Figure 3 ***Stability analysis result for original north-eastern embankment – post seismic***

The results of the stability analysis for the revised north-eastern embankment is provided in Figure 4, Figure 5 and Figure 6 and the revised north-eastern embankment design is provided in Drawing 61-37226-C063 in Appendix A

Stability analyses of the revised embankment design has confirmed that change to geometry does not affect the integrity of the north-eastern embankment.



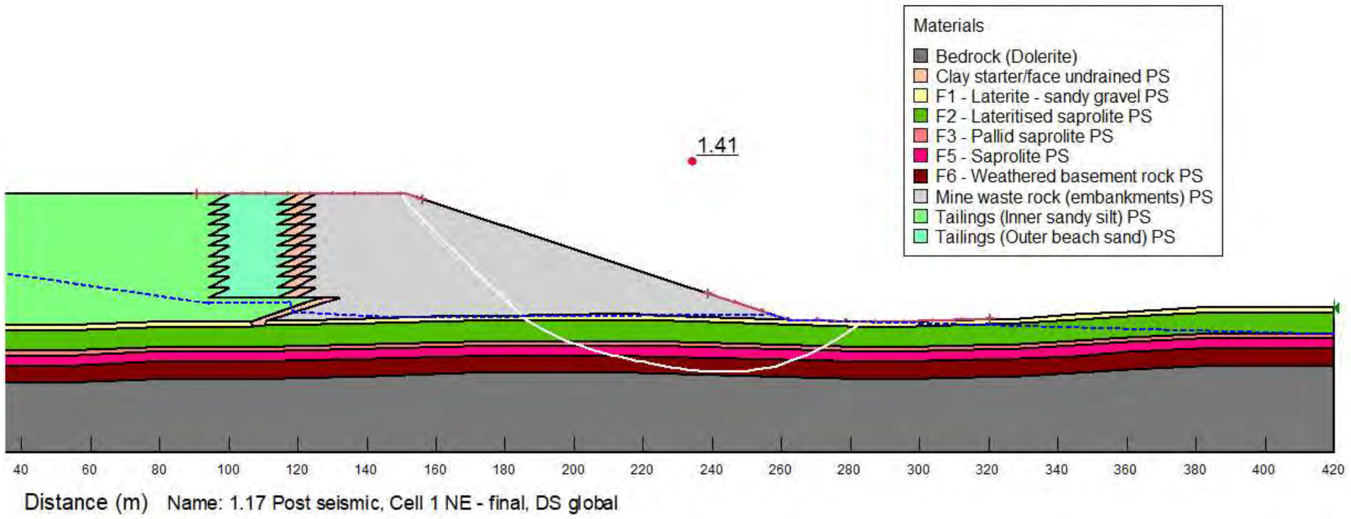


Figure 4 ***Stability analysis result for revised north-eastern embankment – post seismic***

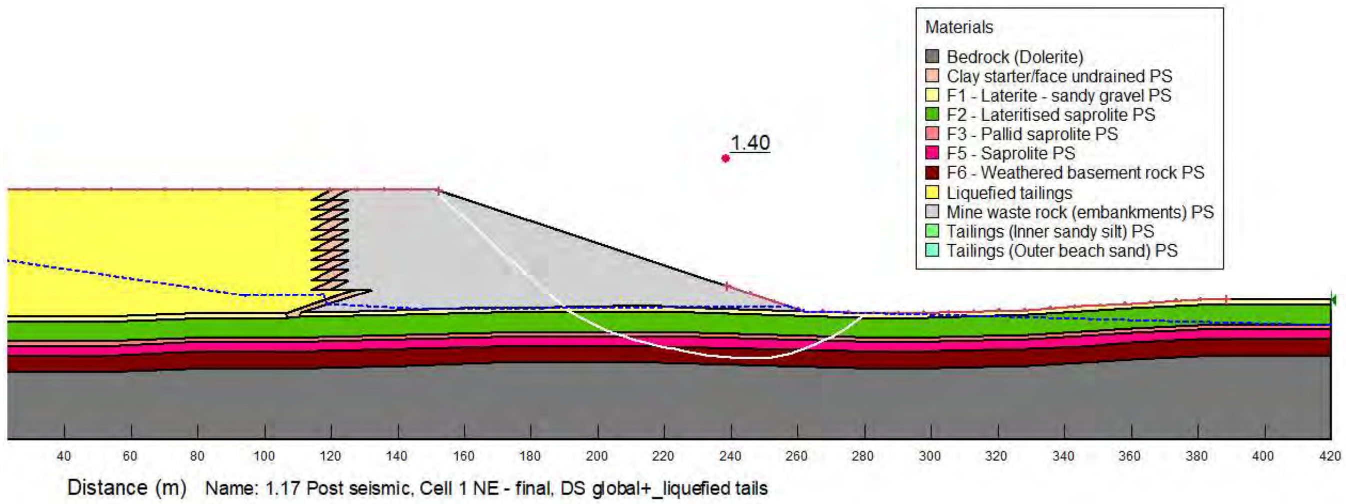


Figure 5 ***Stability analysis result for revised north-eastern embankment – undrained conditions with liquefaction (conservative conditions assuming tailing underdrain not performing as designed)***

3. Impacts of BGM on the TSF4 design

3.1 Vertical seepage

The permeability of BGM is 6×10^{-14} m/s which is four orders of magnitude lower than the 1×10^{-9} m/s permeability of the clay liner. The decrease in permeability is equivalent to a reduction of 99% in theoretical Darcy Flux through the containment system.

To determine the actual reduction in vertical seepage through a BGM containment system an allowance for construction defects must be included in the calculation. The BGM surface mass ranges from 4.85 to 6.4 kg/m^2 and is not prone to the formation of wrinkles and is in good contact with the subgrade once installed. Assuming five defects per hectare with a defect area of 1 cm^2 and using Giroud and Bonaparte's equation for calculating the rate of leakage through geomembranes due to circular defects for large heads the vertical seepage is reduced by 97% when the clay liner is replaced with BGM that is installed in accordance with a robust quality management plan.

The calculation of the seepage rate through the BGM due to installation defects, according to Giroud and Bonaparte's equation, are provided in Table 3.

Table 3 Seepage rate through BGM due to installation defects

Item	Description	Value
Giroud and Bonaparte equation	$Q=C_{qo}\,[1+0.1(h/t_s)^{0.95}]\,a^{0.1}\,h^{0.9}\,k_s^{0.74}$	
C_{qo}	Contact quality factor for good contact	0.21
h	Liquid head	39.7 m
t_s	Thickness of saprolitic clay	10 m
a	Circular defect area	1 cm2
k_s	Permeability of saprolitic clay	4.75×10^{-03} m/d
Q	Rate of liquid migration per defect	2.86×10^{-01} m^3/m^2/d
n	Number of defects per Hecate	5
Q	Rate of liquid migration per hectare	1.43 m^3/d/h
A	Hectare	10,000 m^2
Q	Rate of liquid migration	1.43×10^{-04} m/d

Based on the calculated seepage and using the Darcy flux equation the normalised permeability of the BGM for 5 x 1 cm^2 defects per hectare is 1.69×10^{-13} m/s.

Replace the clay liner with BGM reduces the seepage by 97% and replacing 12.8 hectares of the 64.3 hectares clay liner with BGM will reduce the total vertical seepage from Cell 1 by 19%.

3.2 Underdrainage

3.2.1 Clay liner underdrainage

The clay liner underdrainage design for Cell 1 was based on seepage modelling using the GeoStudio SEEP/W software package. The seepage modelling was undertaken for steady state conditions for the final embankment height (RL 1295 m) for Cell 1 considering the following three sections:

– Cell 1 NE Final, representing the northern embankment (common adjoining TSF1)
– Cell 1 NE 25 m High Wall, representing the southern half of the eastern embankment
– Cell 1 S Final, representing the remainder of the external perimeter and dividing embankment.

The results of the seepage modelling for a clay liner and a combined clay (80%) and BGM (20%) liner is provided in Table 4 and Table 5 respectively. The locations of the modelled clay liner underdrainage sections are shown in Figure 7.

Table 4 Summary of Cell 1 seepage modelling – clay liner

Item	Unit	Cell 1 NE Final	Cell 1 NE 25 m High Wall	Cell 1 S Final
Flux to underdrains	$m^3/s/m$	4.21E-08	3.27E-07	4.41E-07
Representative length	m	500	550	800
Flow to underdrains	m^3/s	2.10E-05	1.80E-04	3.53E-04
Flow to underdrains	$m^3/year$	663	5,666	11,137
Total	**$m^3/year$**	**17,466**		

Table 5 Summary of Cell 1-seepage modelling – combined clay and BGM liner

Item	Unit	Cell 1 NE Final	Cell 1 NE 25 m High Wall	Cell 1 S Final
Flux to underdrains	$m^3/s/m$	1.38E-09	3.27E-07	4.41E-07
Representative length	m	500	550	800
Flow to underdrains	m^3/s	6.91E-07	1.80E-04	3.53E-04
Flow to underdrains	$m^3/year$	22	5,666	11,137
Total	**$m^3/year$**	**16,825**		

The clay liner underdrainage consists of two MEG450G Megaflo drains and was designed to collect and drain the seepage through a clay liner. The capacity of the clay liner underdrainage is 71,000 m^3/year which is greater than the anticipated-seepage for both a clay liner and a combined clay and BGM liner.

Partially replacing the clay liner with BGM will reduce the vertical seepage through for Cell 1 by 19%, increases the redundancy of the clay liner underdrainage and will improve the performance of the clay underdrainage.

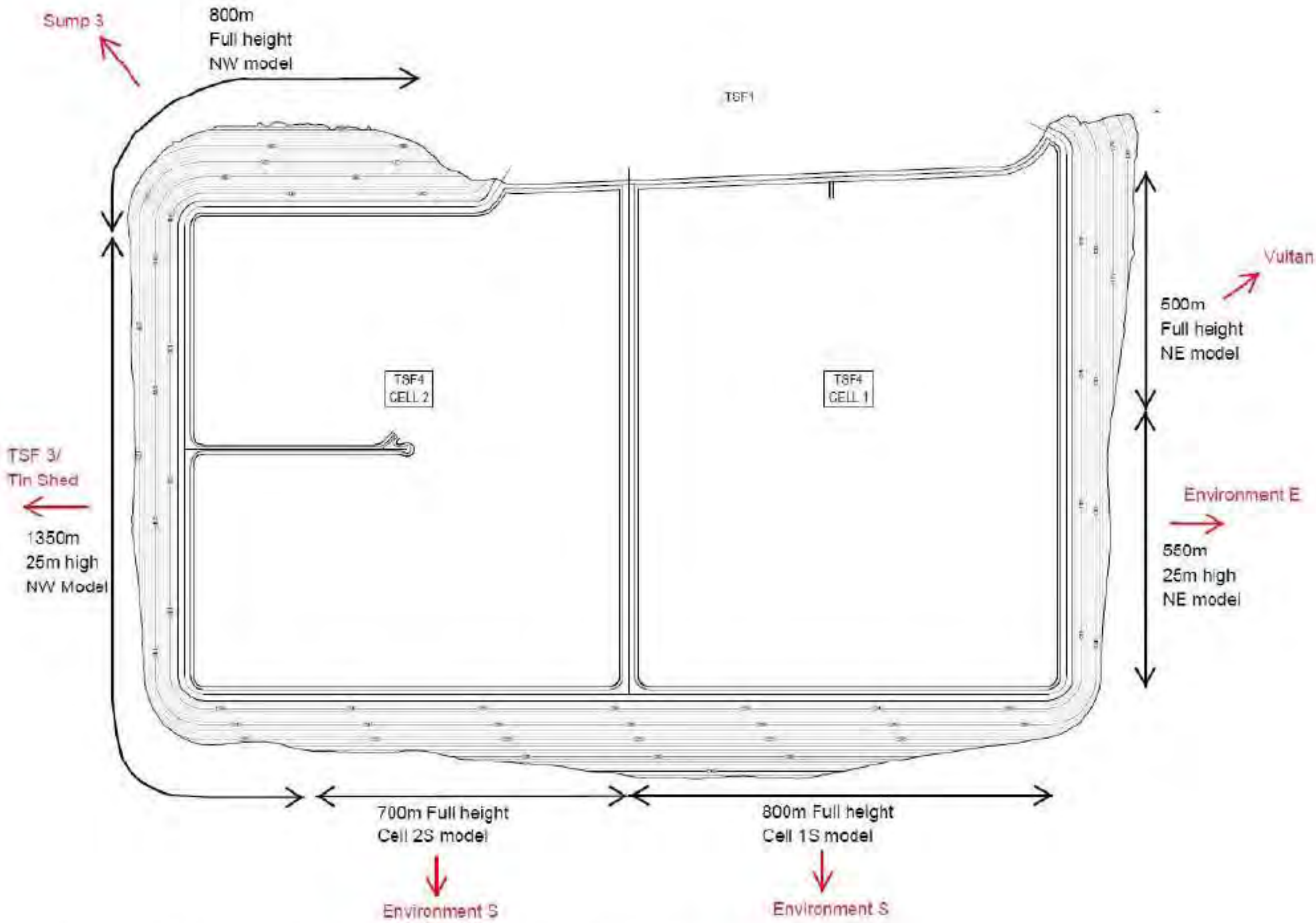


Figure 6 Locations of clay liner seepage modelling sections

3.2.2 Tailings underdrainage

The tailings underdrainage design for Cell 1, which is located above the containment systems (clay liner or BGM) was based on seepage modelling using the GeoStudio SEEP/W software package. The seepage modelling for the tailings underdrainage was undertaken for the same conditions, height and sections as the clay liner seepage modelling.

The results of the tailings seepage modelling for a clay liner and a combined clay and BGM liner are summarised in Table 6 and Table 7 respectively. The locations of the modelled underdrainage sections are shown in Figure 8.

Table 6 Summary of Cell 1 tailings drainage modelling – clay liner

Item	Unit	Cell 1 NE Final	Cell 1 NE 25 m High Wall	Cell 1 S Final
Flux to underdrains	$m^3/s/m$	1.89E-06	1.20E-06	1.59E-06
Representative length	m	1340	470	1400
Flow to underdrains	m^3/s	2.53E-03	5.64E-04	2.22E-03
Flow to underdrains	$m^3/year$	79,831	17,781	70,024
Total	**$m^3/year$**	**167,635**		

Table 7 *Summary of Cell 1 tailings drainage modelling – combined clay and BGM liner*

Item	Unit	Cell 1 NE Final	Cell 1 NE 25 m High Wall	Cell 1 S Final
Flux to underdrains	$m^3/s/m$	3.72E-06	1.20E-06	1.59E-06
Representative length	m	1340	470	1400
Flow to underdrains	m^3/s	4.99E-03	5.64E-04	2.23E-03
Flow to underdrains	$m^3/year$	157,340	17,786	70,199
Total	**$m^3/year$**	**245,326**		

Partially replacing the clay liner with BGM retains 81% of the seepage above the BGM which equates to an additional 77,472 m^3/year. The total tailings seepage for Cell 1 when the clay liner is replaced with BGM is 245,326 m3/year at full height. The underdrainage system consists of two Draincoil DN160 pipes located within a gravel trench along the upstream toe of TSF4 Cell 1. The underdrainage system has been sized to accommodate a flow of 311,900 m^3/year, which is greater than the anticipated full height seepage. Replacing the clay liner with BGM removes the redundance that was allowed for in the original design.

Partially replacing the clay liner with BGM will increase the seepage retained above the BGM but the tailings underdrainage has sufficient capacity to drain the additional retained seepage at full height and does not impact the performance of the tailings underdrainage.

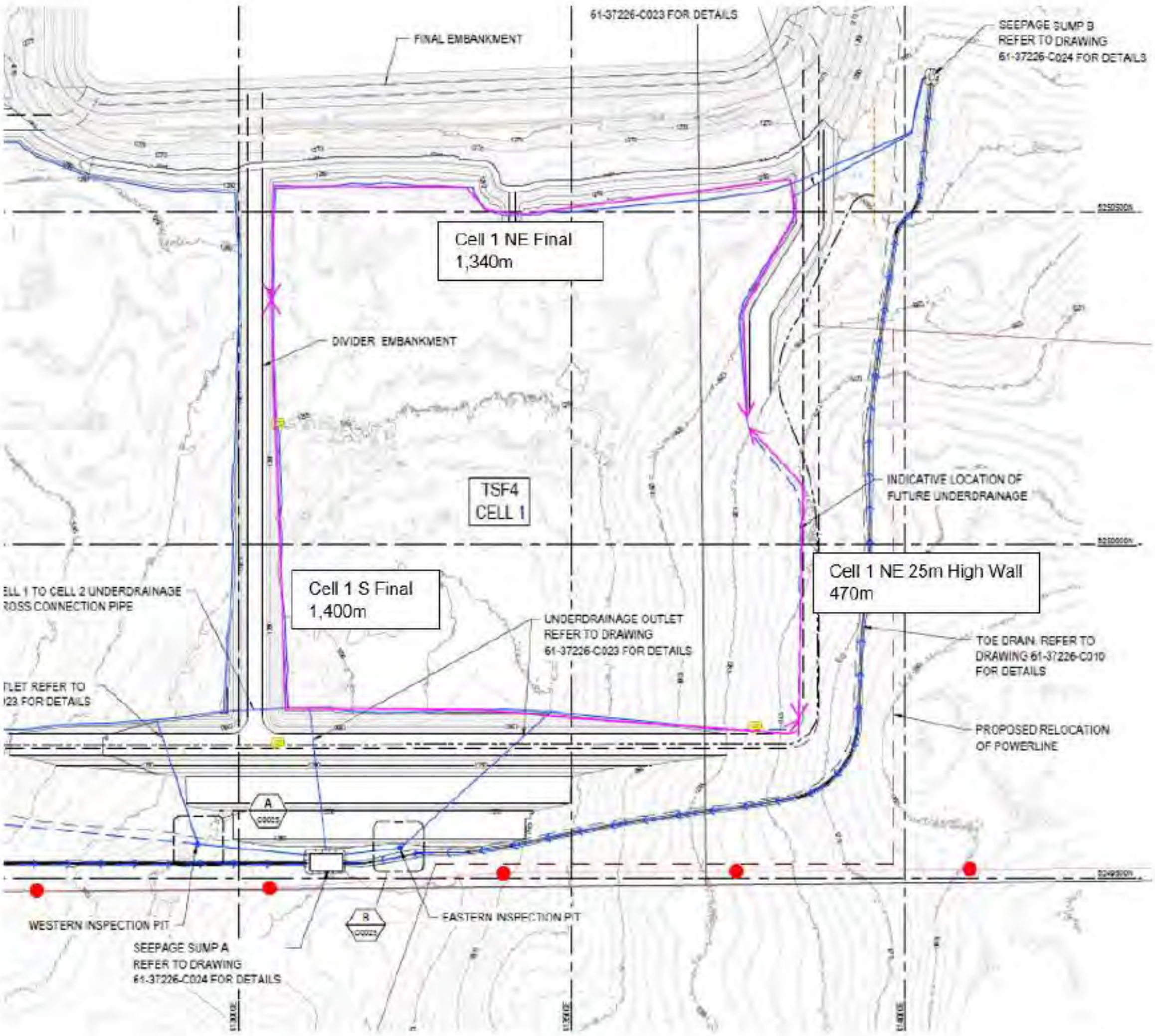


Figure 7 ***Locations of seepage modelling sections***

3.3 Stability

The TSF4 design is based on the coarser tailings adjacent to the embankments being effectively drained by the underdrainage at full height and mitigating the risk of static or seismic liquefaction of the tailings.

The capacity of the underdrainage system is greater than the increase in seepage associated with the partial replacement of the clay liner with BGM and is not expected to affect the performance of the underdrainage. The geotechnical conditions for TSF4 remain unchanged and therefore the partial replacement of the clay liner with BGM is not expected to impact the stability of TSF4.

The geotechnical conditions (strength, behaviour, etc.) for the Stage 1a and Stage 1 Cell 1 starter embankment are not changed by reducing the Cell 1 embankment height or the partial replacement of the clay liner with BGM and the stability of the Stage1a and Stage 1 Cell 1 starter embankment are not affected.

In addition, as per the design, an observational approach has been adopted to the operation and construction of TSF4 and vibrating wire piezometers will be installed at TSF4 and the pore pressure within the tailings will be monitored during operation to confirm that the coarser tailings are draining effectively. If the monitoring indicates that the tailings are not draining effectively additional drainage will be included in the subsequent raise designs, as necessary.

To assess the impact on stability if the underdrainage did not perform as designed, a supplementary upstream stability assessment of a typical section assuming undrained behaviour and liquefaction of the all the tailings has been undertaken. The supplementary stability assessment confirmed that TSF4 meets the stability requirements (FoS=1.76) in this conservative and unlikely scenario. The stability assessments for the design conditions (drained conditions with strain softening) are summarised in Table 8 and provided in Figure 9 and the stability assessment for undrained conditions with liquefaction are provided in Figure 10.

Table 8 Starter embankment stability results

Location	Condition	ANCOLD Requirement	Factor of Safety
Starter Embankment	Long term	1.5	3.708
Starter Embankment	Undrained with liquefaction	1.0	1.759

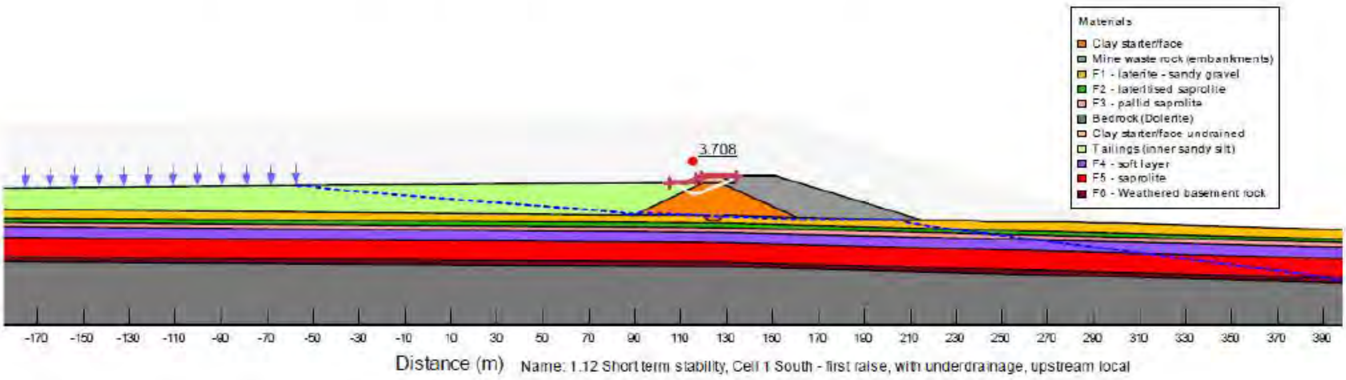


Figure 8 Upstream stability assessment for design conditions

Color	Name	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Cohesion (kPa)	Piezometric Line
	Bedrock (Dolerite)							1
	clay starter/face undrained PS	19					96	1
	F1 - silty/clayey gravel	21			0	35		1
	F2 - saprolite/ferricrete	20			0	38		1
	F3 - silty clay (firm/stiff)	18			0	32		1
	F4 - silty clay (firm)	18			0	30		1
	Mine waste rock (embankments)	21			0	40		1
	Tailings liquefied	14	0	0.05				1

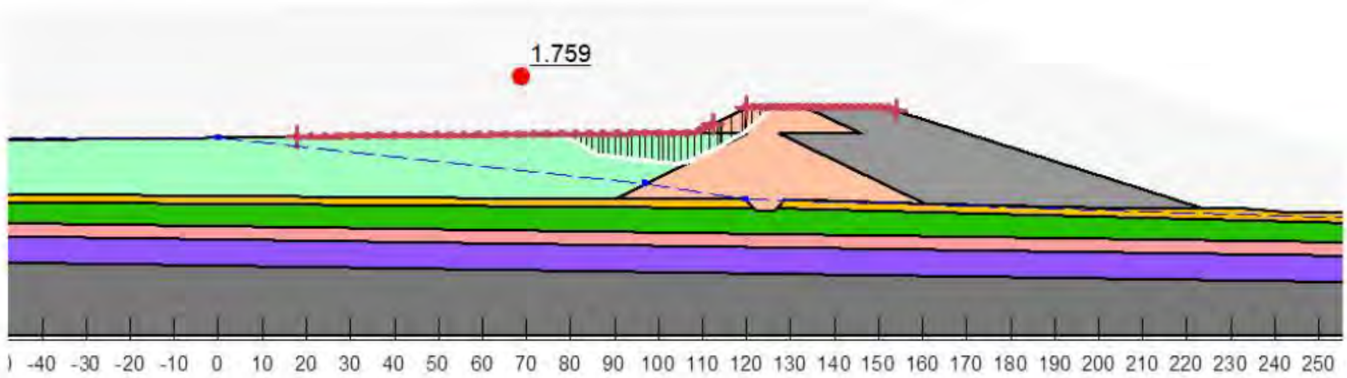


Figure 9 *Upstream stability assessment for undrained conditions with liquefaction*

With regards to the stability of the downstream slope, stability modelling has confirmed that the failure surface does not intercept the tailings. Therefore, the stability of the downstream slope is not impacted by the changes to the design.

A review of the stability has confirmed that the partial replacement of the clay liner with BGM is not expected to affect the stability of TSF4.

3.4 Freeboard

Freeboard will not be affected and will be maintained for both tailings and water as per original design:

– Tailings beach will not exceed 0.3 m below crest elevation
– Pond will not exceed 0.9 m below crest elevation

3.5 Decant

Decanting of supernatant from TSF4 Cell 1 will be increased due to the partial replacement of the clay liner with BGM. The updated design decant rates for TSF4 are summarised in Table 9.

Table 9 *Summary of design decant rates for TSF4*

Item	Average decant rate (m^3/h)	Maximum decant rate (m^3/h)
"Dry" year	935	1,425
Average year	948	1,461
"Wet" year	1,037	1,593

The partial replacement of the clay liner with BGM will increase the decant rate by a maximum of 20 m^3/hr, assuming 100% of the vertical seepage is retained and decanted. The increase decant rate due to the partial replacement of the clay liner with BGM are summarised in Table 10.

Table 10 Summary of increased decant rates due to the partial replacement of the clay liner with BGM

Item	Average decant rate (m^3/h)	Maximum decant rate (m^3/h)
"Dry" year	955	1,425
Average year	968	1,461
"Wet" year	1,057	1,593

The design decant pumping of 1,800 m^3/h was based on the maximum wet decant rate with an allowance for a 1:1000 year flood event.

The design decant pumping system capacity is greater than the increase in the average decant rate and therefore the increased decant rates does not impact the design or the integrity of TSF4.

3.6 Construction staging

3.6.1 Overview

An embankment elevation of RL 1261 m, for the Stage 1a starter embankment for Cell 1 will provide the following:

- Approximately 6 month of storage capacity
- Tailings beach area of ~57 hectare
- Rate of rise of 6.5 m/year when nearing RL 1261 m

3.6.2 Perimeter embankments

The starter embankment of TSF4 will be constructed and commissioned in stages. First, the construction of Cell 1 Stage 1a to RL 1261 will be completed. Cell 1 Stage 1a will be commissioned (TLO) and Cell 1 Stage 1 (RL 1265) and the Cell 2 starter embankment (RL 1265) will be constructed. Deposition will commence in Cell 1 after the completion of the Cell 1 Stage 1 construction in accordance with the approved Stage 1a TLO and will change to Cell 2 once the Cell 2 starter embankment construction has been completed. Cell 2 will be filled to the maximum storage elevation and deposition will then revert to Cell 1. Cell 1 will receive tailings until the maximum storage elevation of RL 1265 is reached. Following the initial deposition, subsequent raises will be constructed annually using a centreline raising methodology and will alternate between Cell 1 and Cell 2 to the final embankment crest elevation of RL 1295 m.

3.6.3 Dividing embankment

The divider embankment will be constructed using a staged centreline raising methodology. The initial construction comprises a clay starter embankment with general rockfill placed on the eastern side. The starter embankment will be keyed into the hard clay foundation with a 4 m wide cut-off trench. An underdrainage system will lower the phreatic surface within the tailings and ensure the tailings surface is adequately drained for subsequent embankment raise construction.

Each lift above RL 1265 will be nominally 5 m high and will be constructed along the same centreline with a 5 m wide clay zone. Cell 2 will be raised ahead of Cell 1 and therefore the raising of the dividing embankment will be undertaken in two stages (Stage A and Stage B). The Stage A construction comprises the construction of the clay zone to the full raise height while deposition occurs in Cell1. Once the full Stage A raise height has been reached deposition will revert to Cell 2 to allow the construction of Stage B raise. The Stage B construction consist of the construction of the mine waste rockfill to the full raise height. The clay zone has been designed to be on the Cell 2 side although Cell 1 will be commissioned first. The staged raising of the dividing embankment allows for continuous tailings deposition during construction by moving the pipeline to the raised zone as required.

The changes to the initial construction staging because of the partial replacement of the clay liner with BGM does not impact the design or the integrity of TSF4.

3.7 Containment considerations

Based on the site topography, the floor footprint of TSF4 is expected to develop until the RL 1275 m raise (assuming 5 m raises) as shown in Appendix A. Raise RL 1280 m onwards, until the final stage (RL 1295), will only require embankment raising.

The extent of the tailings for RL 1261, RL 1265, RL 1270 and >RL 1275 is provided in Appendix A.

The changes to the embankment design due to the staged construction the Cell 1 starter embankment do not impact the design or the integrity of TSF4.

3.8 Impact on concurrent construction

Concurrent construction of Cell 1 and deposition into Cell 1 is not expected. The construction and deposition sequencing are as follows:

– Cell 1 to be constructed to RL 1261 m, followed by Critical Containment Infrastructure Report to RL 1261 (with as constructed drawings)
– Construction to continue to final RL 1265 m
– Approval to commence Time Limited Operations for Stage 1a
– Operation of Cell 1a to commence with pipelines at RL 1261 m, with freeboards maintained in reference to RL 1261 crest (while approval to operate Cell 1 at RL 1265 is being obtained)

4. Environmental impacts and risks

Reducing the crest height of the starter embankment or replacing 20% of the clay liner with BGM does not change the design of TSF4 Cell 1. In particular the changes will improve the effectiveness of the containment system by reducing the loading to the environment. Therefore, the changes to the design will reduce the impacts to the environment.

5. Risks to the integrity of Cell 1

The changes to the TSF4 Cell 1 starter embankment design and the staged construction of TSF4 Cell 1 do not change the design principles and consequently the integrity of Cell 1 is not expected to be affected.

6. Conclusion

Construction of the TSF4 Cell 1 starter embankment in stages and replacing 20% of the clay liner with BGM does not materially change the design of TSF4 and will have no additional impact on the receiving environment. Anticipated impacts are in line with what has already been predicted, notably seepage and the source – pathway – receptor assessment. The staged construction will not impact the structural integrity of Cell 1.

Project name	Talison Commissioning TSF4 Stage 1a						
Document title	Report | TSF4 Cell 1 Initial advice on replacing clay liner with BGM						
Project number	12611486						
File name	12574082-REP_Initial advice on replacing the clay liner with BGM TSF4 Cell1.docx						
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
[redacted]							

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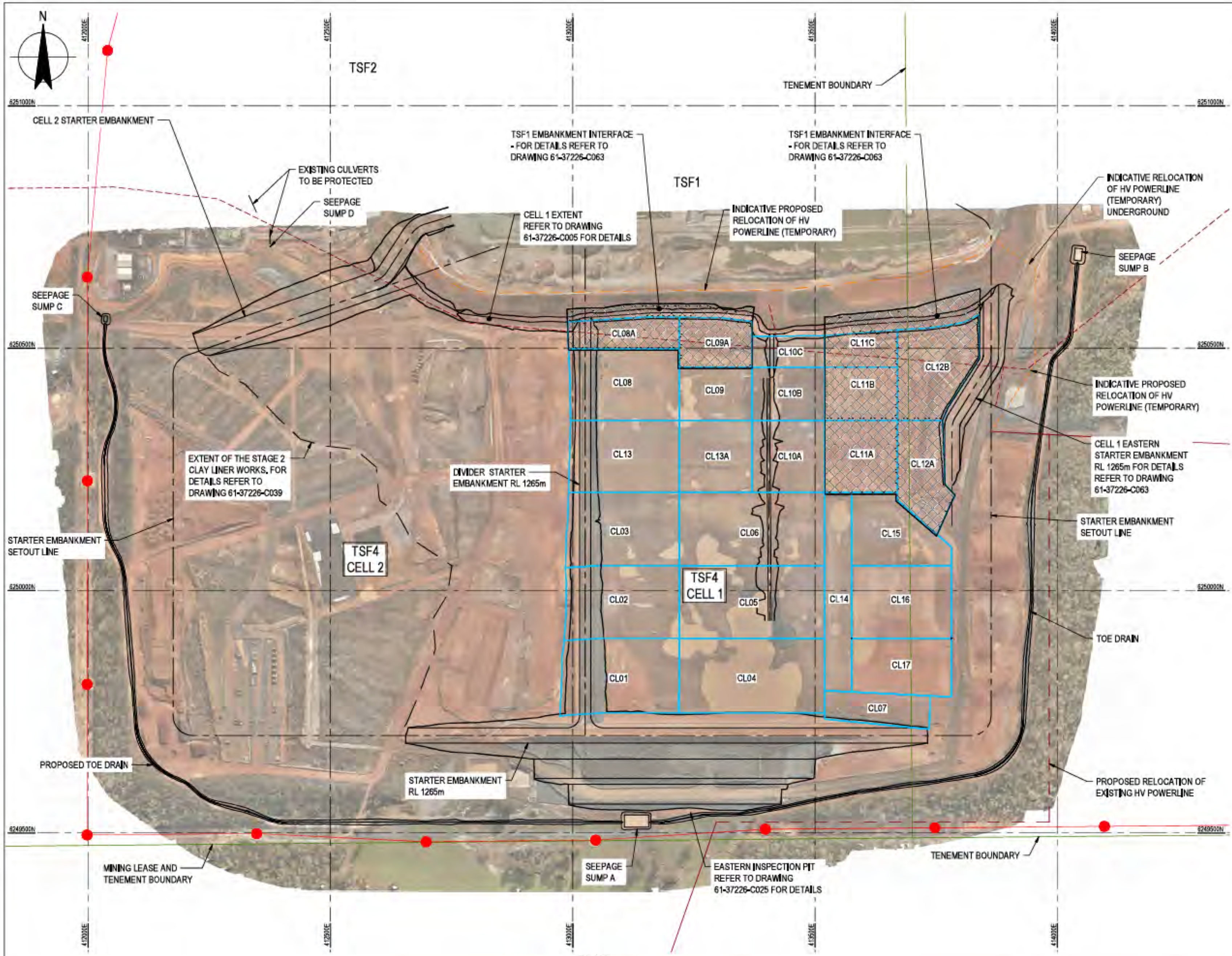
Appendix A

Drawings and Figures



PLAN
SCALE 1:4000

NOTES:

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE NOTED.
2. ALL RL's ARE IN METRES TO LOCAL MINE DATUM (m).
3. FOR UNDERDRAINAGE DETAILS AND SET OUT REFERENCE REFER TO DRAWING 61-37226-C021 TO 61-37226-C025.
4. FOR SETOUT REFER TO 61-37226-1-TSF4 STARTER EMBANKMENT MODEL CELL 2.
5. DRAWING TO BE PRINTED IN COLOUR.
6. BITUMINOUS GEOMEMBRANE (BGM).
7. AERIAL IMAGE RECEIVED JUNE 2023.

LEGEND:

- EXISTING HV POWERLINE TO REMAIN
- PROPOSED RELOCATION OF EXISTING HV POWERLINE (BY OTHERS)
- PROPOSED RELOCATION OF EXISTING HV POWERLINE (TEMPORARY) BY OTHERS
- PROPOSED RELOCATION OF EXISTING HV POWERLINE (TEMPORARY TO BE PLACED UNDERGROUND) BY OTHERS
- PROPOSED 132kV POWERLINE (BY OTHERS)
- SECONDARY ACCESS TRACK (INDICATIVE)
- CL13 — CLAY LINER LOTS (ORIGINAL DESIGN)
- BGM EXTENTS (PROPOSED)

BASE SURVEY SUPPLIED BY:
TALISON LITHIUM PTY LTD
RECEIVED ON: 28 JULY 2021
CO-ORDINATE GRID: MGA 94-50
LEVEL DATUM: MINE DATUM

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR COMMENT	BG			04/07/23

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 40 80 120 160 200m
SCALE 1:4000 AT ORIGINAL SIZE

TALISON LITHIUM

GHD
Level 10, 999 Hay Street Perth WA 6000
PO Box 3106 Perth WA 6832 Australia
T 61 8 6222 8222 F 61 8 6222 8555
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DO NOT SCALE

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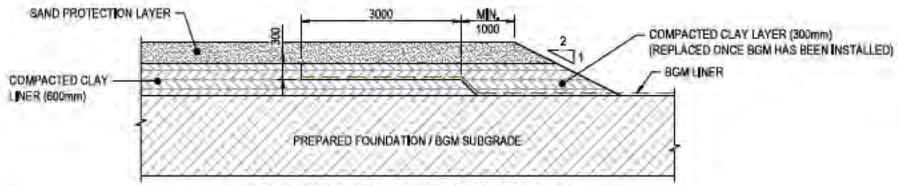
Drawn	B. GAUNSON	Designer	S. WALDEK
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:4000	This Drawing must not be used for Construction unless signed as Approved	

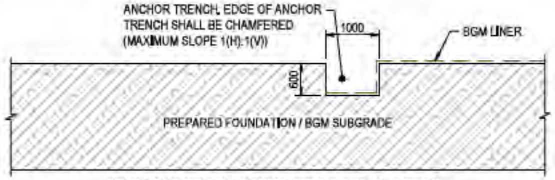
Client: **TALISON LITHIUM PTY LTD**
Project: **TSF4 - STARTER EMBANKMENT**
Title: **GENERAL ARRANGEMENT BGM EXTENTS - CELL 1**
Original Size: **A1**
Drawing No: **61-37226-C061**
Rev: **A**

Plot Date: 3 July 2023 - 9:26 PM   Plotted by: Brendan Gaunson   Cad File No: C:\12d\NWdata\F-06-12D-001\61-37226 - Talison TSF4 DD_1307\CADD\Drawings\61-37226-C061.dwg



COMPACTED CLAY TIE-IN DETAIL FOR BGM

SCALE 1:50

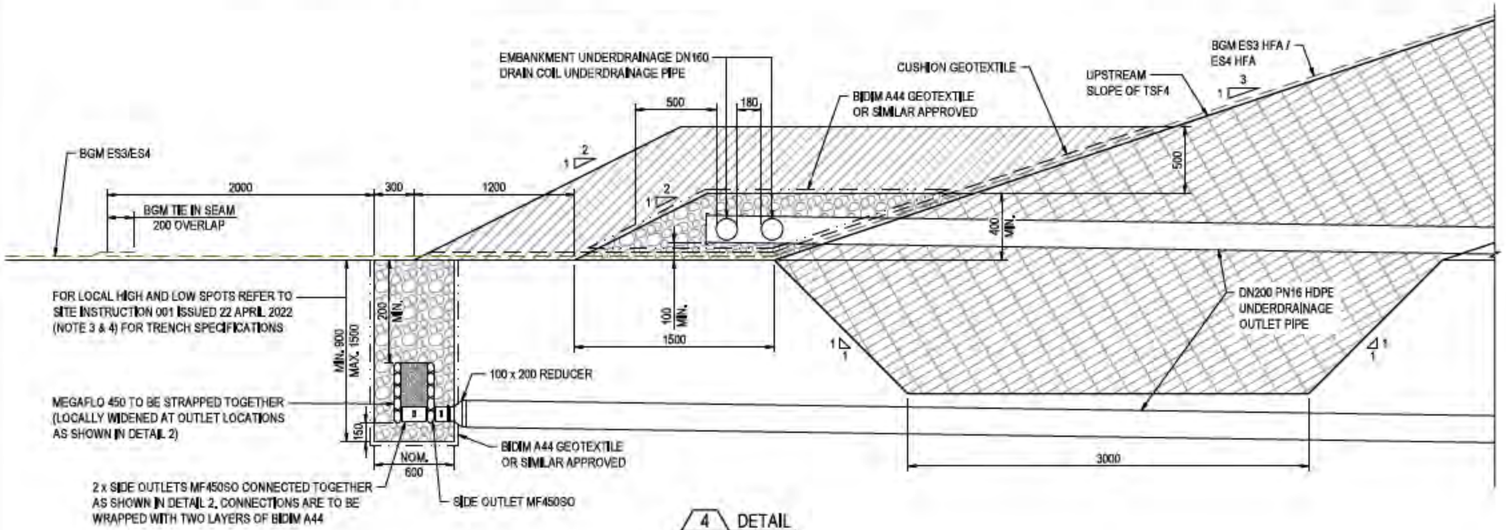


EMBANKMENT LEADING EDGE TIE-IN DETAIL

SCALE 1:50

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES (mm) UNLESS OTHERWISE NOTED.
2. ALL RL's ARE IN METRES TO LOCAL MINE DATUM (m).
3. WINDROWS TO INCLUDE BREAKS EVERY 40m FOR DRAINAGE.
4. STARTER EMBANKMENT HAS WIDER CREST THAN THE FINAL DAM, HENCE SET OUT LINE (INCLUDED IN STARTER DAM MODELS) IS OFFSET FROM THE FINAL DAM CENTRELINE. STARTER EMBANKMENT SETOUT LINE TO BE USED FOR STARTER DAM CONSTRUCTION.
5. EDGE OF ANCHOR TRENCH SHALL BE CHAMFERED (MAXIMUM SLOPE 1(H):1(V).
6. BITUMINOUS GEOMEMBRANE (BGM).



4 C063 DETAIL

SCALE 1 : 20

LEGEND:

- GENERAL ROCK FILL
- MINE WASTE ROCK
- SELECT MINE WASTE ROCK
- CLEAN TAILINGS SAND
- COMPACTED CLAY LINER
- PREPARED FOUNDATION / BGM SUBGRADE
- BGM
- SAND PROTECTION
- WEARING COURSE
- ZONE 1A
- ZONE 1B
- ZONE 2B (GRAVEL)
- ROCK LINING

BASE SURVEY SUPPLIED BY TALISON LITHIUM PTY LTD
RECEIVED ON: 28 JULY 2021
CO-ORDINATE GRID: MGA 94-50
LEVEL DATUM: MINE DATUM

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR COMMENT	BG			04/07/23

0 200 400 600 800 1000mm SCALE 1:20 AT ORIGINAL SIZE

0 500 1000 1500 2000 2500mm SCALE 1:50 AT ORIGINAL SIZE

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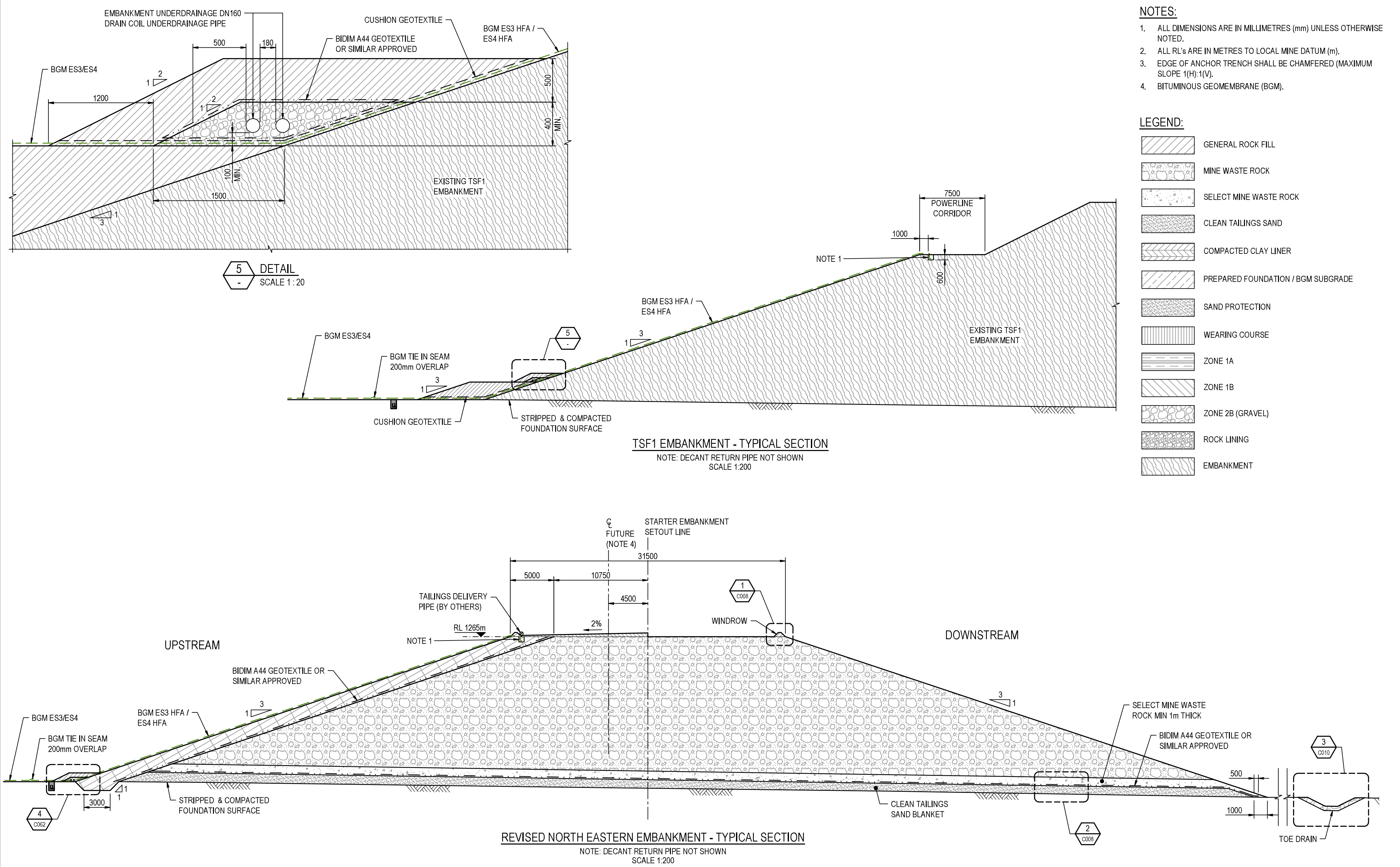
Drawn: B. GAUNSON | Designer: S.WALDEK
Drafting Check | Design Check
Approved (Project Director)
Date
Scale: AS SHOWN
This Drawing must not be used for Construction unless signed as Approved

Client: TALISON LITHIUM PTY LTD
Project: TSF4 - STARTER EMBANKMENT
Title: TIE IN DETAILS
Original Size: A1
Drawing No: 61-37226-C062
Rev: A

Plot Date: 5 July 2023 - 10:02 PM   Plotted by: Brendan Gaunson   Cad File No: C:\12DS\Wdata\61-37226\61-37226 - Talison TSF4\DD_1\07\CADD\Drawings\61-37226-C062.dwg



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES (mm) UNLESS OTHERWISE NOTED.
2. ALL RL's ARE IN METRES TO LOCAL MINE DATUM (m).
3. EDGE OF ANCHOR TRENCH SHALL BE CHAMFERED (MAXIMUM SLOPE 1(H):1(V).
4. BITUMINOUS GEOMEMBRANE (BGM).

LEGEND:

- GENERAL ROCK FILL
- MINE WASTE ROCK
- SELECT MINE WASTE ROCK
- CLEAN TAILINGS SAND
- COMPACTED CLAY LINER
- PREPARED FOUNDATION / BGM SUBGRADE
- SAND PROTECTION
- WEARING COURSE
- ZONE 1A
- ZONE 1B
- ZONE 2B (GRAVEL)
- ROCK LINING
- EMBANKMENT

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR COMMENT	BG			04/07/23

Note: * indicates signatures on original issue of drawing or last revision of drawing

SCALE 1:20 AT ORIGINAL SIZE (0 200 400 600 800 1000mm)

SCALE 1:200 AT ORIGINAL SIZE (0 2000 4000 6000 8000 10000mm)

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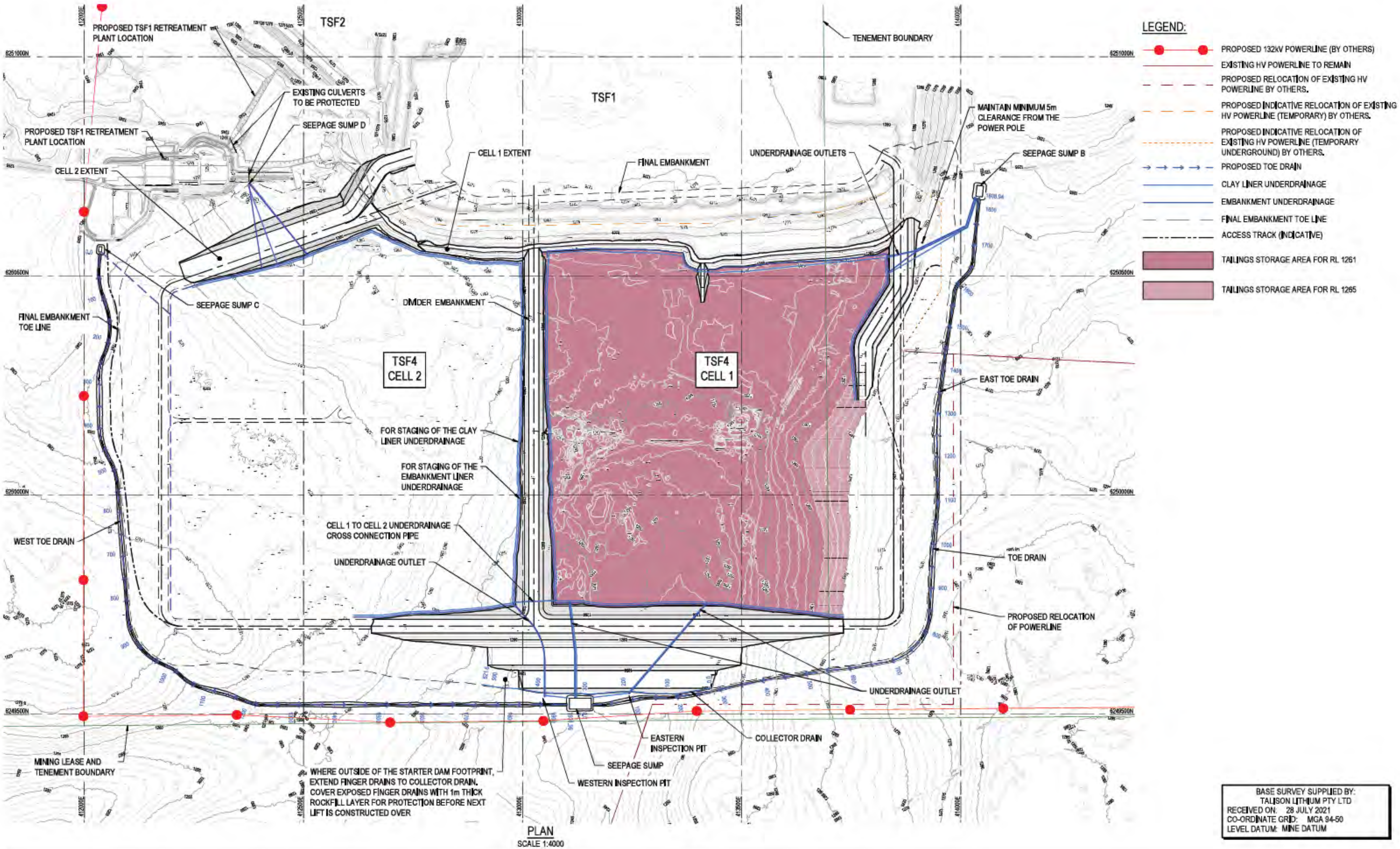
Drawn: B. GAUNSON | Designer: S.WALDEK
Drafting Check | Design Check
Approved (Project Director)
Date
Scale: AS SHOWN

This Drawing must not be used for Construction unless signed as Approved

Client: TALISON LITHIUM PTY LTD
Project: TSF4 - STARTER EMBANKMENT
Title: TYPICAL SECTIONS

Original Size: A1 | Drawing No: 61-37226-C063 | Rev: A

Plot Date: 3 July 2023 - 10:04 PM Plotted by: Brendan Gaunson Cad File No: C:\12d\SWdata\P-00-12D-001\61-37226 - Talison TSF4 DD_1307\CADD\Drawings\61-37226-C063.dwg

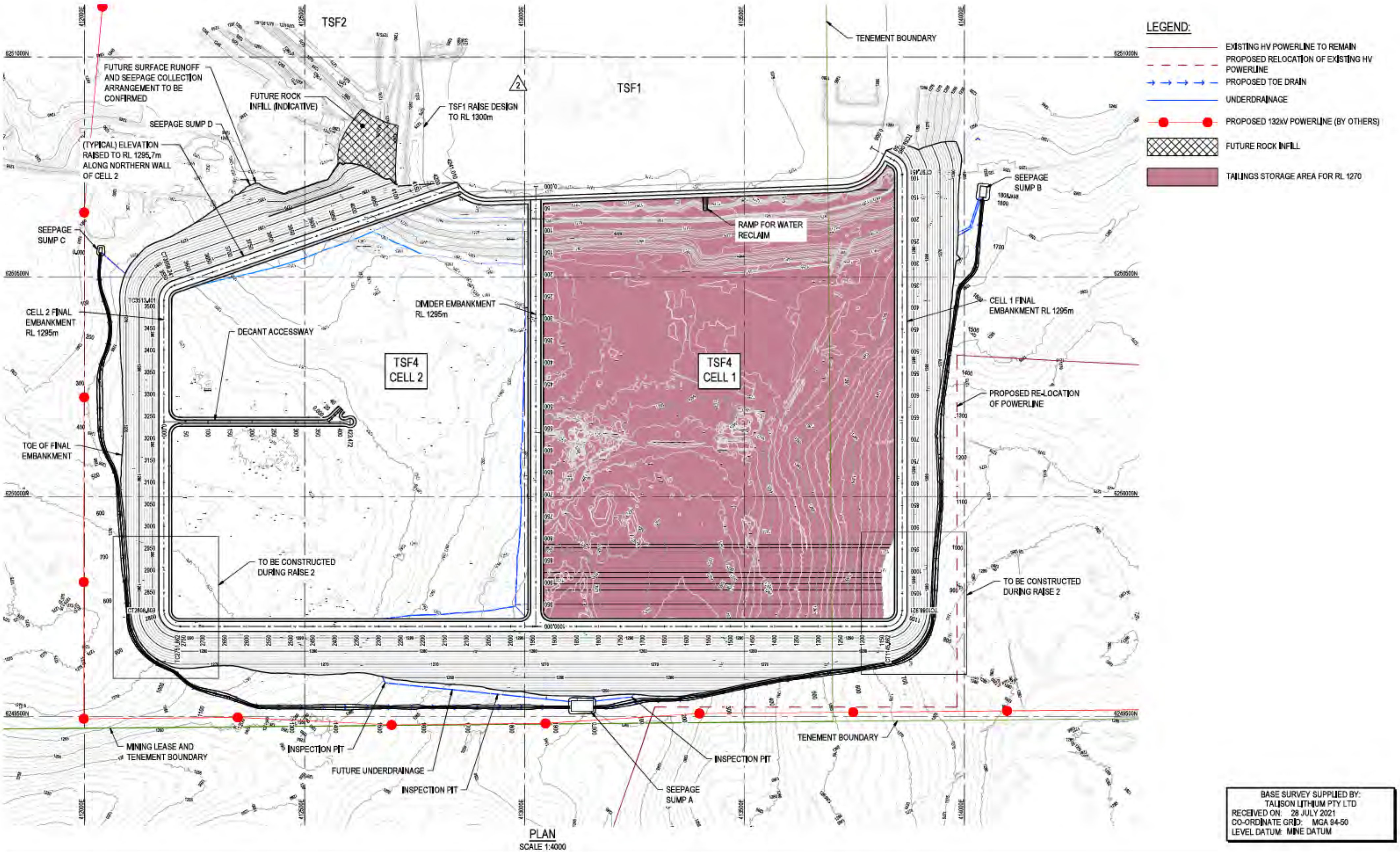


BASE SURVEY SUPPLIED BY:
TALISON LITHIUM PTY LTD
RECEIVED ON: 28 JULY 2021
CO-ORDINATE GRID: MGA 94-50
LEVEL DATUM: MINE DATUM

Talison Lithium Pty Ltd
Talison TSF4 Expansion Project
Commissioning TSF4 Cell 1 at RL1261
Starter Embankment Staging

Job Number	12574082
Revision	A
Date	July 2023

Figure 01



Talison Lithium Pty Ltd
Talison TSF4 Expansion Project
Commissioning TSF4 Cell 1 at RL1261

Embankment Staging Raise 1 (RL1270)

Job Number	12574082
Revision	A
Date	July 2023

Figure 02

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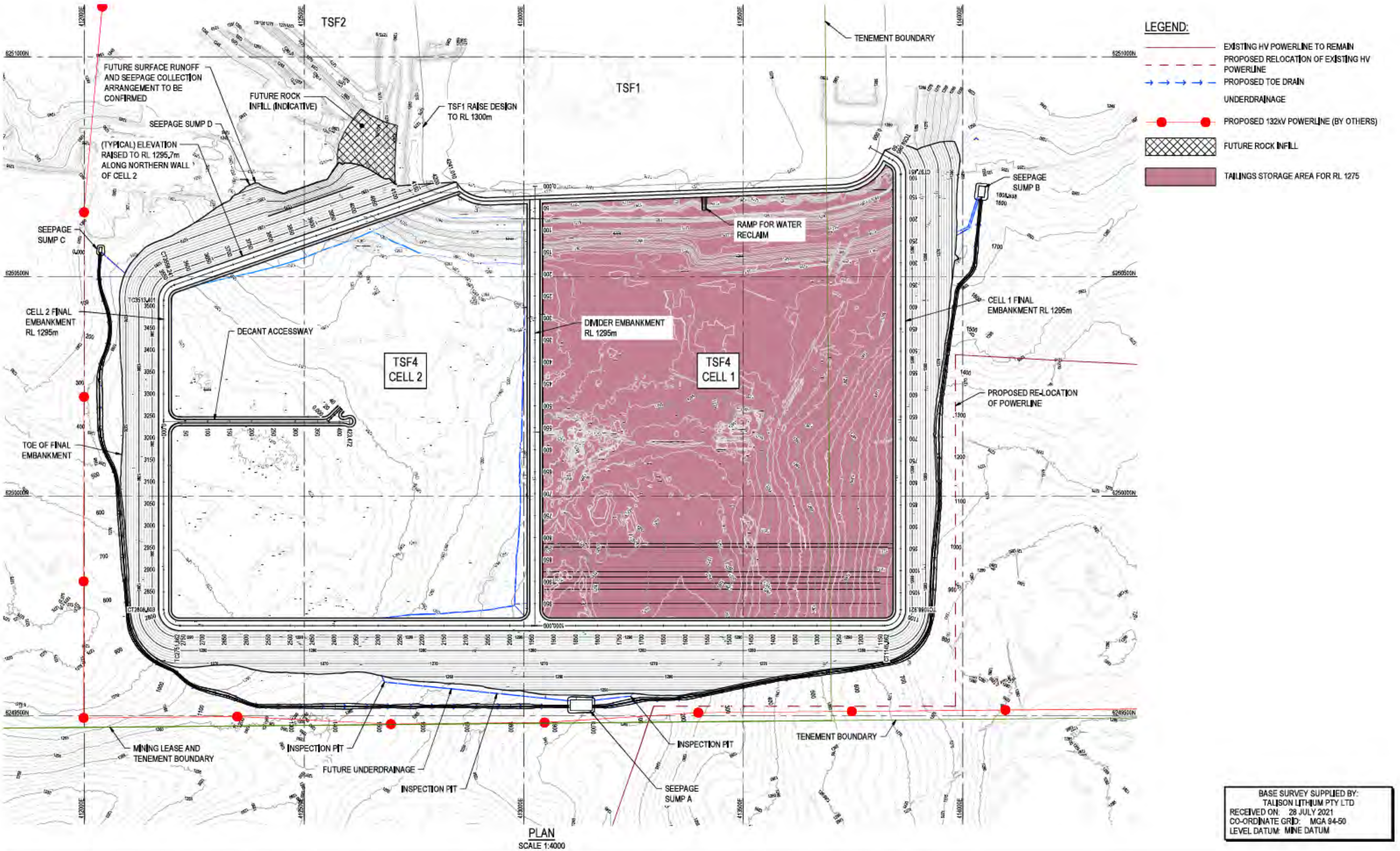

Talison Lithium Pty Ltd
Talison TSF4 Expansion Project
Commissioning TSF4 Cell 1 at RL1261

Embankment Staging Raises 2 to 6

Job Number	12574082
Revision	A
Date	Jul 2023

Figure 03

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Appendix B

BGM Manufacturer Data Sheets

COLETANCHE® by AXTER
Rue Joseph Coste
59552 Courchelettes
France
www.coletanche.com

Certified to NSF/ANSI/CAN 61

Update 08/09/2021
Cancel and replace 24/02/2020
Code 1876M01
Origin Courchelettes (FR)
Technical Ref. FT COLETANCHE ASTM

Product data sheet

COLETANCHE ES2

Description

Coletanche ES2 is an elastomeric modified bituminous geomembrane.

Use

Moderate level of mechanical constraints, exposed or covered (allow hot asphalt mixes). For example:
- Landfill and waste capping, biogas barriers,
- Methanisation units, industrial platforms,
- Hydraulic, mining and industrial ponds,
- Canals.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	250 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	4300 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Silicone coated film	15 g/m²

Characteristics

		Standards	Units	Average	*Minimum*
Dimensions	Length	-	m	80	*79*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	4.00	*3.60*
Surface mass		ASTM D5261	kg/m²	4.85	*4.30*
Tear resistance	Longitudinal direction	ASTM D4073	N	825	*619*
	Cross direction			700	*525*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	27	*20.3*
	Cross direction			24	*15*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	530	*477*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

The manufacturer reserves the right to modify, at any time, the characteristics of its products.

COLETANCHE by AXTER
Rue Joseph Coste
59552 Courchelettes
France
www.coletanche.com

Update 08/09/2021
Cancel and replace 24/02/2020
Code 1877M01
Origin Courchelettes (FR)
Technical Ref. FT COLETANCHE ASTM

NSF Certified to NSF/ANSI/CAN 61

Product data sheet

COLETANCHE ES3

Description

Coletanche ES3 is an elastomeric modified bituminous geomembrane.

Use

Extreme level of mechanical constraints, exposed or covered (puncturing materials, thick cover layer, high pressures). For example:
- Mining and industrial waste storage facilities,
- Bottom of landfill cells,
- Deep hydraulic ponds,
- Dams.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	300 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	4800 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Silicone coated film	15 g/m²

Characteristics

		Standards	Units	**Average**	***Minimum***
Dimensions	Length	-	m	65	*64*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	4.80	*4.20*
Surface mass		ASTM D5261	kg/m²	5.80	*5.00*
Tear resistance	Longitudinal direction	ASTM D4073	N	950	*713*
	Cross direction			850	*638*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	33	*24.8*
	Cross direction			29	*21.8*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	570	*513*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

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Update	08/09/2021
Cancel and replace	24/02/2020
Code	1878M01
Origin	Courchelettes (FR)
Technical Ref.	FT COLETANCHE ASTM

Product data sheet

COLETANCHE ES4

Description

Coletanche ES4 is an elastomeric modified bituminous geomembrane.

Use

Extreme level of mechanical constraints, exposed or covered (aggressive materials, reinforced precautions). For example:
- Storage of harmful waste,
- Large dams,
- Railways (use directly under ballast),
- Railway bridges.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	400 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	5400 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Silicone coated film	15 g/m²

Characteristics

		Standards	Units	**Average**	***Minimum***
Dimensions	Length	-	m	55	*54*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	5.60	*4.80*
Surface mass		ASTM D5261	kg/m²	6.40	*5.90*
Tear resistance	Longitudinal direction	ASTM D4073	N	1225	*919*
	Cross direction			1025	*769*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	35	*29.2*
	Cross direction			30	*23.2*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	650	*585*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

COLETANCHE® by AXTER
Rue Joseph Coste
59552 Courchelettes
France
www.coletanche.com

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Update	08/09/2021
Cancel and replace	24/02/2020
Code	187640M
Origin	Courchelettes (FR)
Technical Ref.	FT COLETANCHE ASTM

Product data sheet

COLETANCHE ES2 HFA

Description

Coletanche ES2 HFA is an elastomeric modified bituminous geomembrane.

Use

Moderate level of mechanical constraints, exposed or covered (allow hot asphalt mixes). For example:
- Landfill and waste capping, biogas barriers,
- Methanisation units, industrial platforms,
- Hydraulic, mining and industrial ponds,
- Canals.

The membrane has the same friction angle on both sides.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	250 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	4300 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Peel-off silicone coated film	40 g/m²

Characteristics

		Standards	Units	Average	*Minimum*
Dimensions	Length	-	m	80	*79*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	4.00	*3.60*
Surface mass		ASTM D5261	kg/m²	4.85	*4.30*
Tear resistance	Longitudinal direction	ASTM D4073	N	825	*619*
	Cross direction			700	*525*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	27	*20.3*
	Cross direction			24	*15*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	530	*477*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

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Rue Joseph Coste
59552 Courchelettes
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Update 08/09/2021
Cancel and replace 24/02/2020
Code 187710M
Origin Courchelettes (FR)
Technical Ref. FT COLETANCHE ASTM

Product data sheet

COLETANCHE ES3 HFA

Description

Coletanche ES3 HFA is an elastomeric modified bituminous geomembrane.

Use

Extreme level of mechanical constraints, exposed or covered (puncturing materials, thick cover layer, high pressures). For example:
- Mining and industrial waste storage facilities,
- Bottom of landfill cells,
- Deep hydraulic ponds,
- Dams.

The membrane has the same friction angle on both sides.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	300 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	4800 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Peel-off silicone coated film	40 g/m²

Characteristics

		Standards	Units	Average	*Minimum*
Dimensions	Length	-	m	65	*64*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	4.80	*4.20*
Surface mass		ASTM D5261	kg/m²	5.80	*5.00*
Tear resistance	Longitudinal direction	ASTM D4073	N	950	*713*
	Cross direction			850	*638*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	33	*24.8*
	Cross direction			29	*21.8*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	570	*513*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

The manufacturer reserves the right to modify, at any time, the characteristics of its products.

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59552 Courchelettes
France
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Update 08/09/2021
Cancel and replace 24/02/2020
Code 187840M
Origin Courchelettes (FR)
Technical Ref. FT COLETANCHE ASTM

Product data sheet

COLETANCHE ES4 HFA

Description

Coletanche ES4 HFA is an elastomeric modified bituminous geomembrane.

Use

Extreme level of mechanical constraints, exposed or covered (aggressive materials, reinforced precautions). For example:
- Storage of harmful waste,
- Large dams,
- Railways (use directly under ballast),
- Railway bridges.

The membrane has the same friction angle on both sides.

The product use must be validated by consultation.

Application method

By torch welding or other similar process.

Storage

Rolls must not be stored directly on the ground. Provide suitable supports (blocks, slides, wooden planks) with a minimum height of 35 cm to be placed under the ends of the mandrel.

Composition (indicative)

Reinforcement:	Geotextile	400 g/m²
Reinforcement:	Glass fleece	50 g/m²
Binder:	Elastomeric bitumen	5400 g/m²
Surface finish:	Sand	250 g/m²
Underside finish:	Peel-off silicone coated film	40 g/m²

Characteristics

		Standards	Units	Average	*Minimum*
Dimensions	Length	-	m	55	*54*
	Width		m	5.10	*5.01*
Thickness (on finished product)		ASTM D5199	mm	5.60	*4.80*
Surface mass		ASTM D5261	kg/m²	6.40	*5.90*
Tear resistance	Longitudinal direction	ASTM D4073	N	1225	*919*
	Cross direction			1025	*769*
Tensile properties: Strength	Longitudinal direction	ASTM D7275	kN/m	35	*29.2*
	Cross direction			30	*23.2*
Tensile properties: Elongation	Longitudinal direction		%	60	*45*
	Cross direction			60	*45*
Static puncture		ASTM D4833	N	650	*585*
Flexibility at low temperature	Longitudinal direction	ASTM D5147	°C	-20	*-15*
	Cross direction			-20	*-15*
Water permeability		ASTM E96	m/s	6.10^{-14}	<
Gas permeability		ASTM D1434-82	m³/(m².d.atm)	2.10^{-4}	<

The manufacturer reserves the right to modify, at any time, the characteristics of its products.