



# Talison Lithium Pty Ltd

## TSF4 Cell 1 and Cell 2 1270 mRL Raise

### Technical Specification

December 2023



<b>Project name</b>	Talisson TSF4 Cell1 Raise Design to 1270 mRL						
<b>Document title</b>	Technical Specification   TSF4 Cell 1 and Cell 2 1270 mRL						
<b>Project number</b>	12621963						
<b>File name</b>	12621963-SPC_Technical Specification for Talisson TSF4 Cell 1 and Cell 2 Raise Design to 1270 mRL						
<b>Status Code</b>	<b>Revision</b>	<b>Author</b>	<b>Reviewer</b>		<b>Approved for issue</b>		
			<b>Name</b>	<b>Signature</b>	<b>Name</b>	<b>Signature</b>	<b>Date</b>

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# 1. General

## 1.1 Introduction

The project is operated by Talison Lithium Pty Ltd (Talison). This Technical Specification (Specification) covers the construction works of Tailings Storage Facility 4 (TSF4) Cell 1 and Cell 2 embankment raise to 1270 mRL at the Talison Lithium Project as detailed in the design report. The embankment raise has been designed with a Bituminous Geomembrane (BGM) liner. The specification shall be read in conjunction with the Construction Drawings (Drawings).

The Contractor(s) shall supply all construction plant, construction equipment, labour, supervision, tools, services, warehousing, if required, testing equipment, and all other items required to complete the Works described on the Drawings and Specifications. The BGM material will be provided by the Principal.

## 1.2 Purpose of this document

The purpose of this document is to provide for consistency and technical requirements concerning materials, components and systems specified on the construction drawings (refer Table 3 for list of construction drawings) regarding standards, workmanship quality and methods of quality assurance for the construction.

## 1.3 Scope and 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 Clause 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 (refer Clause(s) 1 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

## 1.4 Assumptions

The construction of the Cell 1 starter embankment to 1265 mRL is complete, while that of Cell 2 is ongoing and is estimated to be complete by May 2024. It is noted that the 1270 mRL raise design is required ahead of construction completion and deposition commissioning without as-built surveys. These specifications are therefore based on design models completed for the 1265 mRL work package (GHD Project Numbers 6137226, 12574082 and 12613531).

## 1.5 Definitions

For the purpose of this Specification, the following terms are defined:

'AS'	Australian Standard
'ASTM'	American Society for Testing and Materials
'BGM'	Bituminous geomembrane

‘The Works’	all construction works required to deliver the project as defined by this Specification and as shown on the Drawings.
‘Principal’	Talison Lithium Pty Ltd
‘Contractor’	Party awarded the Contract to complete the Works (mainly earthworks excluding Geosynthetics (BGM liner) installation contract, to be undertaken by a specialised Liner Installation Contractor).
‘Liner Installation Contractor’	a highly specialised Party awarded the Contract to undertake the Geosynthetics (BGM liner) installation works.
‘Superintendent’	has the meaning given to it in the amended AS4000-1997 General Conditions of Contract (including the Annexures) and, so far as concerns the functions exercisable by Superintendent’s Representative, includes a Superintendent’s Representative
‘CQA’	Construction Quality Assurance (CQA) is defined as a planned system of activities that provides assurance that construction (installation of the BGM liner) proceeds in accordance with the project design drawings and specifications. Done by the CQA Inspector, in general, these activities include continuous inspection of the installation, testing of materials and procedures, and overall documentation.
‘CQC’	Construction Quality Control (CQC) is defined as a planned system of activities that provides assurance that the properties of the construction materials (BGM) meet the requirements of the project specifications. Done by the Liner Installation Contractor, these activities primarily include materials testing and documentation.
‘MQA’	Manufacturing Quality Assurance
‘MQC’	Manufacturing Quality Control
‘Master Seamer’	Liner Installation Contractor’s Site Supervisor with BGM liner installation experience of no less than 250,000 m <sup>2</sup> installed. All personnel performing installation and seaming operations shall be qualified by a representative of the manufacturer.
‘CQA Inspector’	The CQA Inspector is a person or corporation hired by the Principal, who is responsible for monitoring, and documenting activities related to the CQA of the BGM from manufacturing through installation.
‘CQA Laboratory’	A Geosynthetic Accreditation Institute’s Laboratory Accreditation Program (GAI-LAP) accredited laboratory responsible for providing CQA testing of BGM and BGM seams on site.

## 1.6 Scope of this Specification

The Works detailed in this Specification include but are not limited to the following components:

- Set out and survey control.
- Clearing and grubbing of vegetation in Cell 2.
- Clearing and grubbing of TSF1 embankment to RL 1270 m including existing bench
- Stripping of topsoil and subsoil to subgrade level.
- Foundation preparation for embankments and associated infrastructure.
- Construction of embankments to 1270 mRL.
- Tying in Cell 1 and Cell 2 embankments into existing TSF1 south embankment.
- Preparation and reshaping of basin subgrade for BGM liner installation on Cell 2.
- Subgrade preparation for BGM liner installation on embankments (Cell 1, Cell 2 and TSF 1 southern embankments).
- BGM liner installation on basin and embankments as indicated on the Drawings.

- Tying in BGM liner onto existing liner (liner at 1265 mRL).
- Tying in BGM liner into TSF1 south embankment.
- Construction of seepage collection systems (above liner drainage) and connecting to the existing system.
- **Construction of underdrainage systems (subsoil drainage below BGM liner) including sumps.**
- Formation of crossfall and construction of safety windrows on embankment crests.
- Construction of decant ramps.
- Extension of toe drains.
- Installation of embankment monitoring instrumentation.
- Conduct ongoing quality assurance, testing and reporting.

## 1.7 Project Location

The project is located within the Shire of Bridgetown – Greenbushes, approximately 250 km south of Perth, Western Australia. It is approximately 90 km south-east of the Port of Bunbury, a major bulk handling port in the south-west of Western Australia as shown on Figure 1.



Figure 1 Site location

## 1.8 TSF location

TSF4 is located south of existing TSF1 and TSF2 and will occupy a final embankment footprint area of approximately 250 ha. The centre of TSF4 in MGA94 (Zone 50) coordinates is approximately 6,250,250 North and 413,000 East.



## 1.9 Project scope of work staging

TSF4 is designed with two cells separated by the Divider Embankment. Ongoing construction is staged as follows:

- Stage 1 works associated with Cell 1 to 1265 mRL are complete as of November 2023.
- Stage 2 works associated with Cell 2 to 1265 mRL are ongoing and are scheduled for completion in the second quarter of 2024. Project is staged as follows:

This technical specification covers Cell 1 and Cell 2 embankment raise to 1270 mRL only and includes the BGM lining of embankment raises together with the remainder of Cell 2 basin.

Staging of the scope of work is detailed in Table 1.

Table 1 Scope of work (to be read with Drawings)

Scope element	Cell 1 and Cell 2 scope
Clearing and grubbing of vegetation	Inside the remaining Cell 2 extent
Clearing and grubbing of TSF1 embankment to 1270 mRL including existing bench	Along Cell 2 Northern embankment
Set out and survey control	Cell 1 and Cell 2 embankments. Below liner and above liner drainage system
Stripping of topsoil and subsoil as directed in works area	Along Cell 1 eastern embankment Inside the remaining Cell 2 extent
Prepare foundation for embankments	Under Cell 1 eastern embankment Under Cell 2 embankment along the southern, and western embankment.
Embankment construction with BGM liner subgrade, waste rock and any other materials specified on the drawings	Cell 1 and Cell 2 embankment raise to 1270 mRL including the divider embankment
Prepare foundation subgrade for BGM liner on basin floors	Whole remaining extent of Cell 2 basin including TSF1 southern slope embankment
Prepare TSF1 slope embankment tie-in detail with Cell 1 and Cell 2	Along Cell 1 and Cell 2 interface with TSF1 southern slope embankment
Prepare TSF 1 embankment for BGM liner	Cell 2 interface with TSF1 southern slope embankment
Key trenching to embankments	Cell 1 eastern embankments and Cell 2 southern and western embankments
Underdrainage system (under liner) and outlets	Remaining extent of Cell 2 footprint and connecting to existing system
Underdrainage system (above liner) and outlets	Remaining extent of Cell 2 footprint and connecting to existing system
BGM liner installation	Remaining extent of Cell 2 footprint and all Cell 1 and Cell 2 embankments
Tying in new BGM liner onto existing liner at 1265 mRL	Along Cell 1 northern interface with TSF1, and inside Cell 2 basin
BGM liner anchorage	Along all Cell 1 and Cell 2 embankments, and in anchor trenches on TSF1 slope embankment at the 1270 mRL bench
Ramp to TSF1	Between Cell 2 northern embankment and TSF1
Decant ramps for Cell 1 and Cell 2	In Cell 1 and Cell 2
Formation of crossfall and construction of safety windrows on embankment crests	Along all Cell 1 and Cell 2 embankments
Installation of embankment monitoring instrumentation (survey markers)	On Cell 1 and Cell 2 embankments
Conduct ongoing quality assurance, and documenting / reporting	Cell 1 and Cell 2 embankment raise to 1270 mRL

## 1.10 Referenced specifications and statutory regulations

All work performed and all materials specified in this Specification shall comply with the applicable statutory requirements of the Australian Federal, Western Australian State and Local Authorities, the requirements of this Specification, Talison Works Agreement, Talison Standard Specifications, Drawings, and the latest revision of Codes, Standards and Regulations referenced herein. The Contractor shall raise any discrepancies between standards in writing as part of the final tender submission.

The statutory authorities having jurisdiction over the plant site are the Department of Mines, Industry Regulation and Safety (DMIRS) Western Australia and the Department of Water and Environmental Regulation (DWER) Western Australia.

The design and manufacture of all equipment shall comply with all relevant government acts, by-laws, and regulations, both state and federal, including but not limited to:

- Work Health and Safety Act, 2020
- Work Health and Safety Regulations, 2022
- Mines Safety and Inspection Act, 1994 and
- Mines Safety and Inspection Regulations, 1995.

The Australian Standards (AS) referenced in this Specification include but are not necessarily limited to the following:

- AS 1141 Methods for Sampling and Testing Aggregates
- AS/NZS 4801:2001 Occupational health and safety management systems
- AS 1289 Methods of Testing Soils for Engineering Purpose
- AS 1726-2017 Geotechnical Site Investigations
- AS/NZS ISO 9001:2016 Quality Management Systems – Requirements
- HB 90.3-2000 (R2016) The Construction Industry – Guide to ISO 9001:2000
- AS 1379-2007 Specification and supply of Concrete
- AS 3600-2018 Concrete Structures
- AS 3610.1-2018 Formwork for Concrete
- AS/NZS 2033-2008 Installation of Polyethylene Pipe Systems
- AS/NZS 4130-2018 Polyethylene (PE) Pipes for Pressure Applications
- AS 4131-2010 Polyethylene (PE) Compounds for Pressure and Fittings

Talison Standard Specifications applicable to the Works include but are not necessarily limited to the following:

- ES 01 – Earthworks
- ES 02 – Excavation and Filling for Structures
- ES 03 – Drainage
- ES 07 – Embedded Items for Concrete Work
- ES 09 – Erection of Fabricated Steelwork
- ES 15 – Surface Treatment

## 1.11 Drawings

The Contractor shall familiarise itself with the Drawings listed below prior to commencement of the Works. The Contractor shall express any concerns and discrepancies identified on the Drawings in writing as part of the final tender submission.

Drawings listed on Table 2 and Table 3 form part of the Contract.

Table 2 Cell 1 Drawings

<b>Drawing Number</b>	<b>Drawing Title</b>
1262-1963-GHD-00-01-DRG-CI-10000	SITE PLAN
1262-1963-GHD-00-01-DRG-CI-10001	GEOTECHNICAL INVESTIGATION PLAN
1262-1963-GHD-00-01-DRG-CI-10002	CLEARING PLAN
1262-1963-GHD-00-01-DRG-CI-10003	FOUNDATION PREPARATION
1262-1963-GHD-00-01-DRG-CI-10004	GENERAL ARRANGEMENT
1262-1963-GHD-00-01-DRG-CI-10005	GENERAL ARRANGEMENT – FINAL EMBANKMENT
1262-1963-GHD-00-01-DRG-CI-10006	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 1
1262-1963-GHD-00-01-DRG-CI-10007	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 2
1262-1963-GHD-00-01-DRG-CI-10008	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 3
1262-1963-GHD-00-01-DRG-CI-10009	DIVIDER EMBANKMENT – STAGING PLAN
1262-1963-GHD-00-01-DRG-CI-10010	DECANT PLAN AND DETAILS
1262-1963-GHD-00-01-DRG-CI-10011	INSTRUMENTATION PLAN – PIEZOMETERS
1262-1963-GHD-00-01-DRG-CI-10012	INSTRUMENTATION PLAN – SURVEY MARKERS AND INCLINOMETERS
1262-1963-GHD-00-01-DRG-CI-10013	INSTRUMENTATION DETAILS
1262-1963-GHD-00-01-DRG-CI-10014	BGM LINER – GENERAL ARRANGEMENT
1262-1963-GHD-00-01-DRG-CI-10015	BGM – SECTION AND DETAILS
1262-1963-GHD-00-01-DRG-CI-10016	FOUNDATION UNDERDRAINAGE PLAN
1262-1963-GHD-00-01-DRG-CI-10017	FOUNDATION UNDERDRAINAGE LONGITUDINAL SECTIONS
1262-1963-GHD-00-01-DRG-CI-10018	EMBANKMENT UNDERDRAINAGE PLAN
1262-1963-GHD-00-01-DRG-CI-10019	EMBANKMENT UNDERDRAINAGE LONGITUDINAL SECTIONS

Table 3 Cell 2 Drawings

Drawing Number	Drawing Title
1262-1963-GHD-00-02-DRG-CI-20000	SITE PLAN
1262-1963-GHD-00-02-DRG-CI-20001	GEOTECHNICAL INVESTIGATION PLAN
1262-1963-GHD-00-02-DRG-CI-20002	CLEARING PLAN
1262-1963-GHD-00-02-DRG-CI-20003	FOUNDATION PREPARATION
1262-1963-GHD-00-02-DRG-CI-20004	GENERAL ARRANGEMENT
1262-1963-GHD-00-02-DRG-CI-20005	GENERAL ARRANGEMENT – FINAL EMBANKMENT
1262-1963-GHD-00-02-DRG-CI-20006	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 1
1262-1963-GHD-00-02-DRG-CI-20007	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 2
1262-1963-GHD-00-02-DRG-CI-20008	TYPICAL EMBANKMENT SECTIONS AND DETAILS – SHEET 3
1262-1963-GHD-00-02-DRG-CI-20009	DIVIDER EMBANKMENT STAGING PLAN
1262-1963-GHD-00-02-DRG-CI-20010	TSF1 ACCESS RAMP – PLAN DETAILS
1262-1963-GHD-00-02-DRG-CI-20011	DECANT PLAN DETAILS
1262-1963-GHD-00-02-DRG-CI-20012	INSTRUMENTATION PLAN – PIEZOMETERS
1262-1963-GHD-00-02-DRG-CI-20013	INSTRUMENTATION PLAN – SURVEY MARKERS AND INCLINOMETERS
1262-1963-GHD-00-02-DRG-CI-20014	INSTRUMENTATION DETAILS
1262-1963-GHD-00-02-DRG-CI-20015	BGM LINER GENERAL ARRANGEMENT
1262-1963-GHD-00-02-DRG-CI-20016	BGM SECTION DETAILS
1262-1963-GHD-00-02-DRG-CI-20017	FOUNDATION UNDERDRAINAGE – LAYOUT
1262-1963-GHD-00-02-DRG-CI-20018	FOUNDATION UNDERDRAINAGE – LONGITUDINAL SECTIONS – SHEET 1
1262-1963-GHD-00-02-DRG-CI-20019	FOUNDATION UNDERDRAINAGE – LONGITUDINAL SECTIONS – SHEET 2
1262-1963-GHD-00-02-DRG-CI-20020	FOUNDATION UNDERDRAINAGE – LONGITUDINAL SECTIONS – SHEET 3
1262-1963-GHD-00-02-DRG-CI-20021	TAILINGS UNDERDRAINAGE LAYOUT
1262-1963-GHD-00-02-DRG-CI-20022	TAILINGS UNDERDRAINAGE LONGITUDINAL SECTIONS – SHEET 1
1262-1963-GHD-00-02-DRG-CI-20023	TAILINGS UNDERDRAINAGE LONGITUDINAL SECTIONS – SHEET 2
1262-1963-GHD-00-02-DRG-CI-20024	UNDERDRAINAGE SECTIONS AND DETAILS – SHEET 1
1262-1963-GHD-00-02-DRG-CI-20025	UNDERDRAINAGE SECTIONS AND DETAILS – SHEET 2

## 1.12 Contractor’s method statement

The Contractor shall prepare a written method statement detailing the construction methodology to be used for the Works. The Contractor shall submit the method statement as part of the final tender submission (**Hold Point**).

The method statement shall be further detailed prior to the construction commencement and the detailed method statement shall be submitted to the Superintendent for approval no later than 10 days prior to mobilisation.

As a minimum the method statement shall include sequencing of works, including methods of selecting and processing construction materials, placement and compaction quality assurance plan, Traffic Management Plan and Construction Safety Management Plan.

## 1.13 Construction programme

The Contractor shall prepare a construction programme including resource planning that shall identify the work to be undertaken, sequencing of the work and the **Hold Points** as nominated in this Specification. The construction programme shall identify and clearly state any milestones, **Hold Points**, critical paths, and dates by which the Superintendent is required to provide any information or approvals required for the execution of the Contract.



## **1.14 Site conditions**

The Contractor shall inform itself of the existing site conditions.

The Superintendent does not warrant that the available information shows completely the existing conditions; and does not warrant the correctness of the information shown on the Drawings (see Table 3 or in reports, maps, additional drawings or other information made available by the Superintendent; and does not warrant the correctness of any interpretation, deduction or conclusion shown in the aforementioned documents or drawings.

The Contractor shall confirm any dimensions and details of the layout and position of the Works prior to commencement of the construction Works and shall accept responsibility for these items.

The Contractor shall adhere to all the Principal's processes, procedures, approvals, and permits. Any loss of income due to delays as a result of not following the Principal's processes and procedures, or not obtaining approvals and permits shall be borne by the Contractor.

The Contractor shall consider the operational activities and requirements of the process plant(s) and existing TSFs when planning and executing the Works.

## **1.15 Technical queries**

The Contractor shall raise any questions, queries and suggestions related to the Works in writing and issue the technical queries (TQs) to the Superintendent. All TQs shall state the impact on schedule and cost. The Contractor shall not implement any modifications to the design or to the approved construction methods without written approval from the Superintendent.

## **1.16 Bill of Quantities**

The quantities provided in the Bill of Quantities (BoQ) are indicative only.

The Contractor shall make an independent assessment of the quantities based on the Drawings and tender site inspection and express any concerns or discrepancies identified in the BoQ in writing as part of the final Tender submission.

## **1.17 Site establishment and disestablishment**

All work and costs associated with the establishment of the Contractor's site management systems, offices and plant on the site, and removal thereof, and reinstatement of the area after completion of the Works shall be to the satisfaction of the Superintendent.

The Contractor shall provide a construction work plan which includes proposed work rosters per week, maximum number of personnel on site during the rostered week, roster system to be used and nominated working hours to the Superintendent no later than 10 days prior to mobilisation.

The Contractor shall establish its construction facilities within the stripped areas or in locations within the mine site approved by the Superintendent. The facilities shall include all workshops, maintenance areas, stores, hydrocarbon storage areas, material laydown areas and protection, vehicle parking area, toilet / washroom facilities, communication control facilities and the support equipment for the Works. The Contractor shall provide a layout and management plan of the construction facilities as part of the tender submission.

The Contractor shall mobilise all necessary plant and personnel to the site prior to commencing the Works and shall demobilise all necessary plant and personnel from the site after completion of the Works, leaving the site clean, tidy, and free from obstructions to the satisfaction of the Superintendent.

The Contractor shall provide suitable offices and amenities for personnel including a three-person office area for the Principal / Superintendent, including furnishings, power, and broadband internet connections.

The Contractor shall establish, clean, and maintain site services such as waste management bins, waste collection and ablution pump out during construction. All rubbish shall be disposed of off Site except as noted in the Contract, or as directed by the Superintendent.

Access track(s) and any additional roads approved by the Principal shall be constructed by the Contractor as required for construction of the Works. The Contractor is responsible for maintaining the access tracks and roads.

Construction water will be made available free of charge by the Principal at a point within the works perimeter. The water supply will be available on an 'as-is, where-is basis'. The Contractor shall be responsible for the connection to the pipe, storage, distribution, and any other measures required to manage water.

## 1.18 Survey

### 1.18.1 Benchmarks

The Contractor shall provide all surveying services required to establish and to maintain sufficient local benchmarks to set out the Works, maintain survey control during the execution of the Works and to carry out as-constructed surveys of the Works.

The Superintendent will provide four (4) benchmarks in close proximity to the Works for ground control. The Contractor shall check, verify, and accept these benchmarks for use. The Contractor shall be responsible for replacement of the benchmarks should they be damaged during the Works.

The Contractor may establish additional points to adequately and efficiently set out and monitor the Works. The establishment of additional benchmarks shall be completed to a standard consistent with the rest of the mine site and general accepted surveying best practice.

During, or at the completion of, the Works, the Superintendent may request the additional benchmark information from the Contractor. At the end of the Works, the temporary survey benchmarks shall be removed, excluding those as required by the Superintendent to remain.

It shall be the Contractor's responsibility to carry out all necessary survey and to determine quantities for approval by the Superintendent prior to payment of any claims. The Superintendent may, at their own expense, take levels and calculate cut and fill quantities if he should wish to check the Contractor's quantities and confirm their accuracy.

### 1.18.2 Setting out and survey control

The Superintendent will issue an electronic digital terrain model (DTM) of the design to the Contractor for setting out purposes and to verify the quantities forming the Contract. The DTM will include embankment centreline, crest and toe lines, underdrainage centreline and invert elevations, seepage sumps and the toe drain centreline. The DTM will not include construction material zoning. The toe lines provided will be approximate only and shall be confirmed by the Contractor after stripping.

The DTM as issued shall be reviewed and agreed by the Contractor, after which the agreed DTM shall form the basis of the verification of the progress payments and the final payment. Any discrepancies found in the DTM by the Contractor shall be reported to the Principal in the final tender submission and as soon as they are identified during the course of the Works.

All survey shall be carried out in the Map Grid of Australia (MGA) ZONE 50 system. All elevations shall be provided and carried out in Mine Datum (defined to be 1,000 m above the Australian Height Datum).

The Contractor shall be responsible for setting out all of the Works, including baselines and levels. Survey measurement of the completed Works shall be required to support progress payment claims and shall be submitted to the Superintendent for verification.

The Contractor shall present the set-out points to be used for construction of the Works, or any part of it, to the Superintendent (**Hold Point**). No works shall be carried out in areas where set out points have not approved by the Superintendent.

At the completion of the Works, the Contractor shall submit to the Superintendent as-constructed survey including embankment crest, zones, access ramps, windrow, upstream and downstream toe lines, pipelines and instrumentation and other features of the Works (**Hold Point**).

The Contractor shall submit Manufacturing Data Records (MDR) to the Superintendent. The MDR shall include all information as required by the Superintendent to document the Works.

### 1.18.3 Pre-works survey

The Contractor shall carry out pre-works survey after clearing, grubbing, and stripping has been undertaken and provide the pre-works survey to the Superintendent in digital format (**Hold Point**). Any Works, except for clearing, grubbing, and stripping, shall not commence until the pre-works survey has been accepted by the Superintendent.

### 1.18.4 Roller passes

For the purpose of this specification a 'pass' of compaction equipment is considered to consist of a travel in two directions i.e., forwards and reverse.

## 2. Materials

### 2.1 General requirements

The Contractor shall source construction materials from areas located within the site as agreed with the Superintendent except where stated otherwise in this Specification. The Contractor shall ensure that the materials meet the requirements of this Specification and shall demonstrate the Compliance as outlined in Clause 0 of this Specification.

The Contractor shall adhere to all Talison processes, procedures, approvals and permits in the sourcing of materials as described in this Clause.

Unless otherwise specified, the geotechnical properties outlined in this Specification shall be determined as follows:

- All gradations shall be determined in accordance with AS 1289.3.6.1
- All plasticity indexes shall be determined in accordance with AS 1289.3.3.2
- All liquid limits shall be determined in accordance with AS 1289.3.1.1
- All specific gravities shall be determined in accordance with AS 1289.3.5.1
- All optimum moisture content shall be determined in accordance with AS 1289.5.5.1

### 2.2 Material definitions

Material definitions are listed in Table 4.

Table 4 *Material definitions*

Material	Description	Material Source
Selected fill	Imported (borrow material), non-topsoil	Source to be supplied by the Principal within 800 m of the Works perimeter. Contractor shall process.
General fill	Borrow material, non-topsoil	Source to be supplied by the Principal within 800 m of the Works perimeter. Contractor shall process.
Internal fill	General fill, non-topsoil	Within storage area
Mine waste rock	Mine waste rock fill, centreline embankment raise of TSF4 (Cell 1 and Cell 2)	Mine waste rock stockpiles as directed by the Principal within the Works Perimeter. Contractor shall process.
Select mine waste rock	Select mine waste rock, to form a layer beneath the mine waste rock embankment zone as specified	Source – mine waste rock stockpile. Contractor shall process.
Wearing course	Wearing course, to form trafficable access on the crest of embankments	Will be supplied in stockpiles by the Principal within 1400 m of the Works perimeter.
Drainage material (Zone 2B)	Drainage aggregates, backfill underdrainage trenches	Will be supplied in stockpiles by the Principal within the Works perimeter.
Tailings sand	Tailings sand, sand blanket under embankment	TSF2 tailings beach as directed by the Superintendent
Soil bentonite mix	Underdrainage outlet pipe trench cut-offs	To be supplied by the Contractor
Geotextile	Lining underdrainage trenches prior to backfilling with Drainage Material	To be supplied by the Contractor
Bituminous Geomembrane (BGM)	A composite material consisting mainly of non-woven geotextile and glass fleece layers impregnated with and encapsulated in elastomeric bitumen, with a sanded surface on one side for enhanced friction and an anti-root layer on the other. BGM	To be supplied by the Principal



Material	Description	Material Source
	will be installed on portions of Cell 1 indicated on the Drawings.	
Underdrainage pipework and associated items	Perforated drainage pipe (Draincoil), Megaflo drain and HDPE outlet pipe	To be supplied by the Contractor
HDPE Geonet Geocomposite (double sided) strip drain	Extruded three dimensional bi-planar HDPE core with heat laminated nonwoven polypropylene geotextile on both sides	To be supplied by the Principal
Monitoring instrumentation	Survey Markers	To be supplied by the Contractor

## 2.3 Subgrade material for BGM placement

The subgrade material for BGM placement shall comply with the following requirements:

- It shall consist of selected / imported fill material placed as specified on the drawings:
  - 200 mm layer thickness on the basin floor,
  - 300 mm layer thickness on embankments.
- It shall be free from vegetation, tree roots and stumps.
- It shall have less than three percent (3%) organic material as tested in accordance with AS 1289 4.1.1.
- The particle size distribution as tested in accordance with AS 1289.3.6.1 shall be as per Table 5.
- If intercepted subgrade material in cut areas does not comply with specifications, the same shall be removed and replaced with competent selected fill / imported fill material as specified, that is minimum 200 mm layer thickness of subgrade material.
- Areas in fill where depths of fill exceed 1 m shall first be pioneered with mine waste rock and then capped with selected / imported fill of 200 mm thickness.

Table 5 Particle size distribution of subgrade material for BGM placement as tested in accordance with AS 1289.3.6.1

Sieve Size	Percentage (%) Passing
37.5	100
19.0	80-100
9.5	60-100
4.75	45-100
2.36	30-100
1.18	20-100
0.425	5-100 (with a Plasticity Index greater than 6% as tested in in accordance with AS 1289.3.3.2.)
0.150	3-30
0.075	>15

## 2.4 General fill

General fill shall be uncontaminated non-topsoil borrow material complying with the following requirements:

- It shall be free from vegetation, tree roots and stumps.
- It shall have less than three percent (3%) organic material as tested in accordance with AS 1289 4.1.1.
- The fraction passing the 0.075 mm sieve shall not be greater than 10% as tested in accordance with AS 1289.3.6.1.

- The fraction passing the 0.425 mm sieve shall have a Plasticity Index (PI) as tested in accordance with AS 1289.3.3.2 in the range  $6\% < PI < 18\%$ .
- Any rocks in the fill shall not exceed 75% the thickness of the layer being compacted.

Where internal fill underlies the BGM liner it shall have properties equal to Subgrade material.

## 2.5 Internal fill

Internal fill can be uncontaminated excavated material from drains, stripping of borrow pits or other non-topsoil materials from within the site. It shall comply with the following requirements:

- It shall be free from vegetation, tree roots and stumps.
- It shall have less than three percent (3%) organic material as tested in accordance with AS 1289 4.1.1.
- Any rocks in the fill shall not exceed 300 mm (second dimension).

Where internal fill underlies the BGM liner it shall have properties equal to Subgrade material.

## 2.6 Mine waste rock

Mine waste rock material shall be sourced from the mine waste rock stockpile provided by the Principal and processed by the Contractor to comply with the following requirements:

- It shall be non-acid forming (NAF) waste rock.
- It shall be free of visible organic and deleterious material.
- It shall comprise sound, hard, well-graded and durable rockfill, with visually inspected nominal maximum size of 300 mm.
- Any rock greater than 800 mm shall be selectively removed from the stockpile or placed on the outer edge of the embankment.
- Material shall be visually assessed to confirm compliance, subject to testing as per clause 6.2.3.

The Contractor shall confirm the material compliance before transporting the material to the area of placement.

## 2.7 Select mine waste rock

Select rock fill material shall a free draining material be sourced from the mine waste rock stockpile provided by the Principal and processed by the Contractor to comply with the following requirements:

- It shall be non-acid forming (NAF) waste rock.
- It shall be free of visible organic and deleterious material.
- It shall comprise sound, hard, well-graded and durable rockfill.
- It shall have maximum particle size of 500 mm with no fines (visually inspected).
- Material shall be visually assessed to confirm compliance, subject to testing as per clause 6.2.3.

The Contractor shall confirm the material compliance before transporting the material to the area of placement.

## 2.8 Wearing course

Wearing course shall be sourced from mine waste rock or natural gravels provided by the Principal within 1,400 m of the Works perimeter and approved by the Superintendent.

Wearing course material shall comply with the following requirements:

- The material shall be free of visible organic and deleterious material.
- The material shall comprise non-plastic aggregates of sound, hard and durable material and shall be well graded.

The Contractor shall confirm the material compliance before transporting the material to the area of placement.

## 2.9 Drainage material (Zone 2B)

Drainage material will be supplied in stockpiles by the Principal within 800 m of the Works perimeter.

Drainage material shall consist of washed, non-plastic aggregates of sound, hard and durable material. It consists of blended mix of -75 site screened material and imported 14/10/7.5 mm in ratio of 1:2.

## 2.10 Tailings sand

Tailings sand material shall be borrowed from nominated areas of the tailings beach of TSF2 as approved by the Superintendent.

Tailings sand materials shall be free of visible organic and deleterious material. Material shall be visually assessed to confirm compliance, subject to testing as per clause 6.2.3.

The suitability and accessibility of tailings from TSF2 shall be agreed with the Superintendent prior to borrowing (**Hold Point**). Testing results shall be presented to Designer.

## 2.11 Geotextile

The geotextile shall be heavy duty, non-woven BIDUM type A44, supplied by Geofabrics Australasia Pty Ltd or approved equivalent.

## 2.12 Cushion geotextile

The cushion geotextile shall be heavy duty, non-woven BIDUM type A64, supplied by Geofabrics Australasia Pty Ltd or approved equivalent.

## 2.13 Bituminous geomembrane

BGM material specification, installation, construction quality control (CQC) activities and construction quality assurance (CQA) plan are addressed in detail in Clause 0. The BGM liner tests, inspection and verification are detailed in Clause 6.1.4.

## 2.14 Underdrainage pipework

The Contractor shall supply all underdrainage pipework materials and all required fittings, including but not limited to bends, junctions and end caps as listed below and as shown on the Drawings:

- Draincoil DN 160 SN20 with filter socks.
- DN160 end caps.
- DN200 HDPE outlet pipes.
- Megaflo 450 mm drains.
- Megaflo 450 mm outlet connectors.

The Contractor shall supply DN200 PE 100 PN 16 HDPE underdrainage outlet pipes and all required fittings, including but not limited to bends, junctions and end caps as shown on the Drawings.

## 2.15 HDPE Geonet Geocomposite (double sided) strip drain

The Principal shall supply a double-sided HDPE Geonet Geocomposite for the construction of the strip drain. The composite drain shall consist of the following:

- Extruded three dimensional bi-planar core made from virgin HDPE resin
- Quality nonwoven polypropylene geotextile fabric heat bonded on both sides of the HDPE core

- Geotextiles used in the manufacture must be resistant to ultraviolet degradation, rotting, biological degradation, and naturally encountered acids and alkalis within the range of pH 2 – 13.

The properties of the Geonet Geocomposite shall comply with the following properties:

Table 6 Properties of HDPE Geonet Geocomposite

Property	Test Method	Unit	Value	
<b>Geonet</b>				
Thickness	ASTM D 5199	mm	5.84	
Carbon Black	ASTM D 4218	%	2.0	
Tensile Strength	ASTM D 7179	kN/m	8.74	
Compressive Strength	ASTM D 6364	kPa	830	
Melt Flow	ASTM D 1238	g/10 min	1.0	
Density	ASTM D 1505	g/cm <sup>3</sup>	0.94	
Transmissivity <sup>(1)</sup>	ASTM D 4716	m <sup>2</sup> /sec	2.5 x 10 <sup>-3</sup>	
<b>Composite</b>			200 g/m <sup>2</sup>	270 g/m <sup>2</sup>
Ply Adhesion	ASTM D 7005	g/m <sup>2</sup>		
Transmissivity <sup>(1)</sup>	ASTM D 4716	m <sup>2</sup> /sec		
<b>Geotextile</b>				
Fabric Weight	ASTM D 5261	g/m <sup>2</sup>		
Grab Tensile	ASTM D 4632	N		
Grab Elongation	ASTM D 4632	%		
Trapezoid Tear	ASTM D 4533	N		
CBR Puncture	ASTM D 6241	N		
Water Flow <sup>(5)</sup>	ASTM D 4491	l/min/m <sup>2</sup>		
Permittivity <sup>(5)</sup>	ASTM D 4491	sec <sup>-1</sup>		
Permeability <sup>(5)</sup>	ASTM D 4491	cm/sec		
AOS	ASTM D 4751	mm		
UV Resistance	ASTM D 4355	Strength Retained %		
<b>Production Details</b>			Net/Geotextile DS <sup>(6)</sup>	Net/Geotextile DS <sup>(6)</sup>
Roll Dimensions	Manufacturer	m	3.81 x 64.01	3.81 x 60.96

Notes:

- (1) Transmissivity measured using water at 21 ± 2 °C with a gradient of 0.1 and a confining pressure of 480 kPa between steel plates after 15 minutes. Values may vary with individual labs.
- (2) Condition 190/2.16
- (3) Minimum average value.
- (4) MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.
- (5) At the time of manufacturing. Handling may change these properties.
- (6) SS = Net with one side of geotextile DS = Net both sides with geotextile.

## 2.16 Monitoring instrumentation

The Contractor shall supply Standard Borehole Vibrating Wire Piezometers from Durham Geo Slope Indicator (DGSI) or approved equivalent. The Vibrating Wire Piezometers shall have minimum pressure rating of 350 kPa. The Contractor shall supply conduits, read out boxes and mounting poles, sufficient length of cabling, bentonite-cement grout and all other items required for installation of the piezometers as shown on the Drawings and in accordance with the manufacturer's specifications.



The Contractor shall supply survey markers and all associated items as shown on the Drawings.

The Contractor shall supply the Serial HD In-Place Inclometers and inclinometer casing supplied by DGSI or approved equivalent. The Contractor shall supply and install data loggers and cabling.

## **2.17 Concrete**

Concrete blinding layer installed in the foundation of seepage sumps D and inspection pits shall comprise a lean mix to provide workable and level base whilst working on rest of pit. Slump to suit working conditions. No testing required; however, foundation should be approved by Superintendent.

Precast bases and/ or concrete infill shall be minimum grade class NS40 concrete.

## 3. Construction

### 3.1 Site preparation

#### 3.1.1 General

All stripping and excavations shall be to the lines, levels and grades shown on the Drawings. The Contractor shall not excavate beyond the lines and grades shown on the Drawings without prior written approval of the Superintendent.

The Contractor shall not damage any trees and flora adjacent to the area of the Works or as nominated by the Superintendent.

The Contractor shall construct, maintain, and rehabilitate, at its own expense any temporary access tracks, ramps or the like required for construction purposes.

#### 3.1.2 Dust suppression

The Contractor shall provide adequate dust suppression systems to minimize any hazards arising from dust on the site of the Works and/ or any associated temporary haul roads or other areas being blown off the site of the Works to the satisfaction of the Superintendent.

Use of water for dust suppression shall be kept to the minimum required, and care shall be taken to ensure that there is no spillage of excess water to other areas. The extent and frequency of water applications shall be determined according to site conditions; however, it shall be not less than that required to ensure compliance with the *Mines Safety & Inspection Act and the Environmental Protection Act*.

### 3.2 Clearing and grubbing

Clearing and grubbing is the removal within specified limits of vegetation such as trees, tree stumps, tree roots, logs, brush, and noxious weeds.

### 3.3 Stripping

#### 3.3.1 General

The Contractor shall strip topsoil and subsoil within the specified limits of vegetation to remove existing topsoil and visible organic materials and roots in particular. Methods employed for stripping shall not increase the extent of unstable areas.

The Contractor shall strip topsoil to a nominal depth of 100 mm - 300 mm below the cleared level.

The Contractor shall strip subsoil to an average nominal depth of 500 mm below the topsoil level. Depths will be provided by the Superintendent.

The Contractor shall mark the completed stripped areas, or their parts, and notify the Superintendent who shall inspect and approve the marked areas (**Hold Point**). The Superintendent may instruct the Contractor to further strip the areas with visible roots and other organic materials. The Contractor shall mark the areas selected by the Superintendent, undertake the further stripping, and notify the Superintendent who shall inspect and approve the selected areas (**Hold Point**).

Stripped material shall be placed in stockpiles within 800 m of the Works perimeter for later use as directed by the Superintendent. Stripped material stockpiles shall be constructed to a measurable shape. Compaction of stripped material during stockpiling shall be minimised.

Stripped surfaces for the embankment foundation shall be graded to an even self-draining surface.

## 3.3.2 Limits

The limits of stripping shall include:

- The area beneath the embankment foundations.
- The area downstream of the embankment extending to the clearing limits as shown on the Drawings.
- Area along TSF4 Cell 1 eastern embankment
- The area inside the TSF4 Cell 2 storage.
- TSF1 southern embankment interface area with TSF4 Cell 1 and Cell 2 as indicated on drawings
- Other areas within the site boundary as approved by the Superintendent subject to the need for appropriate approvals.

The Contractor shall not clear, remove or damage areas of vegetation or ground cover, which are not required to be cleared to enable construction Works to proceed. Where the Contractor removes or damages areas of vegetation and ground cover outside of these zones these shall be re-instated by the Contractor and all costs of such re-instatement shall be borne by the Contractor.

Trees marked by the Superintendent for preservation shall not be cut down or otherwise harmed and any damage caused by the Contractor shall be made good at the Contractor's expense.

## 3.4 Excavation

### 3.4.1 General

All excavation shall be to the lines, levels and grades shown on the Drawings or as directed by the Superintendent.

Excavation works shall not commence in any area prior to inspection and approval of the Contractor's survey markers in that area by the Superintendent (**Hold Point**).

After an excavation has been completed to the lines, levels and grades as specified, the Contractor shall notify the Superintendent giving a minimum 1-day notice period, who shall inspect the Works. No excavation shall be backfilled or covered in any way until the Contractor has obtained the written approval of the Superintendent (**Hold Point**). The Contractor shall, at their own expense uncover any excavations that have covered without the prior inspection and approval of the Superintendent.

During the progress of the Works, the Superintendent may find it necessary or desirable to revise the lines, levels, and grades of any part of the excavations due to unfavourable soil conditions exposed by the excavations, or for any other reason. If such revision requires additional excavation to be made after the excavation of such part has already been completed to the lines, levels and grades shown on the Drawings, then the additional excavation shall be carried out as specified herein.

All necessary precautions shall be taken to preserve the material below and beyond the lines of all excavations in the soundest possible condition. Any damage by the Contractor including the loosening of material or excavation beyond the required lines and grades shall be repaired by the Contractor at their expense. If such excavation should, in the opinion of the Superintendent, require backfilling, such backfilling shall be completed to the satisfaction of Superintendent with material similar to the fill to be placed against the excavated surface in accordance with this Specification, at the Contractor's expense.

Excavation shall, irrespective of type and subsurface conditions, include the selection of material for re-use as specified, the disposal of all surplus excavated materials not required for embankment construction, and shaping of the formation and batters, all as specified herein or as otherwise to the satisfaction of the Superintendent.

### 3.4.2 Soft ground

Potential soft ground areas (material with Soft and/or Very Soft consistency in accordance with AS 1726) within the foundation areas and footprint areas of the embankment shall be brought to the attention of Superintendent for

confirmation. Potential soft ground shall not be removed without written approval from the Superintendent (**Hold Point**).

Approved soft ground shall be removed within the limits specified by the Superintendent using appropriate equipment and as agreed with the Superintendent before removal. Approved soft ground shall be disposed of at a location nominated by Superintendent.

The soft ground stockpile area shall be protected from erosion by suitable sloping and windrowing during construction, to the dimensions designated by the Superintendent.

Material approved as soft ground shall be replaced with material similar to the fill to be placed against the excavated surface, which shall be moisture conditioned and compacted in accordance with the requirements of the material to be placed above the soft ground, unless otherwise directed in writing by Superintendent.

The removal of soft ground shall be paid for as a Day Works item using the schedule of rates provided in the Tender Submission or as agreed by Superintendent. The applicable Day Work items shall be agreed with Superintendent prior to the Contractor carrying out the work.

Filling the areas from which soft ground was removed will be measured using the same rate as for filling with the material to be placed above the soft ground.

Sand to be removed from the entire embankment footprint. For the remainder of the floor area sand removal to be as follows:

- All sand to be removed within 75 m of the upstream toe of the dam.
- Past 75 m within the cell, sand to be removed from over 90% of area provided that there are no continuous seams of sand across the area. Remaining sand to be tined and mixed with adjoining material.

### 3.4.3 Stability of excavation

The sides of all excavations steeper than the angle of repose of the material shall be benched, battered, or adequately supported, as necessary, to ensure against slides, cave-ins or danger to persons or structures. All slips of unstable masses of materials outside the limits of excavations and specified cut batters shall be rectified by the Contractor at their expense.

Where required or directed by the Superintendent, the Contractor shall use benching techniques to ensure the stability of bulk excavations. Benches shall be sloped away from the deepest part of the excavation and the lowest edge of the bench shall be adequately drained.

### 3.4.4 Treatment and disposal of excavated material

All suitable material from excavations to be used in the Works shall be separated from unsuitable material and placed in the final position where it shall be used, or else stockpiled separately in a place and manner that is acceptable to the Superintendent, until required.

The Contractor shall dispose all material which has to be excavated from the site but is unsuitable for construction purposes at a location nominated by the Superintendent within 500 m of the perimeter of the Works. All such disposal areas shall be kept neat and tidy to the satisfaction of the Superintendent.

Waste stockpiles shall be levelled, trimmed, and shaped to regular lines and grades to prevent ponding or concentrations of surface water runoff.

### 3.4.5 Dewatering

The Contractor shall construct and maintain such intercepting works as may be necessary to prevent surface water from entering foundations, excavations or drainage works.

The Contractor shall also provide, install, maintain, and operate all necessary pumping and other equipment required for dewatering excavations and for maintaining the foundations and other parts of the Works free from water. The Contractor shall only pump water to locations approved by the Superintendent.

### 3.4.6 Classification of excavated material

For payment purposes, material excavated, will be classified as follows:

"**Common excavation**" shall include all overburden, shattered rock and other material which can be removed by any of the following methods:

- By hand
- By scraper
- By excavator, with competent operator, with an operating weight not less than 30 tonne and a rock bucket not less than 1 m<sup>3</sup> in capacity, at a rate of more than 40 BCM (Bank Cubic Metres) per hour and
- By track-type tractor, with competent operator, equivalent to a Caterpillar D9N in mass and power, ripping and bulldozing at a rate of more than 100 BCM per hour.

"**Hard rock excavation**" shall include all materials which cannot be removed by the methods described above for "**Common excavation**" and which normally would require drilling and blasting.

If the Contractor considers that rock has been encountered during excavation, the Contractor shall notify the Superintendent and await instructions before proceeding further with the excavation. In the event of a dispute as to the classification of a material, the decision of the Superintendent shall be final.

If rock excavation is required, the Contractor shall bring onsite additional machinery and personnel as necessary to finish the excavation as necessary, at a rate agreed with the Superintendent before the commencement of work.

### 3.4.7 Excavation for bentonite mix cut-off trench

The Contractor shall excavate the cut-off trench in the location shown on the Drawings. The cut-off trench shall be excavated to a depth of nominally 2 m from the stripped surface level as shown on the Drawings. The centreline of the cut-off trench will be confirmed by the Superintendent following review of the post stripping survey (**Hold Point**).

The cut-off trench shall be inspected by the Superintendent to ensure that there are no unsuitable materials, such as high permeability materials including sands and gravels, and open cracks at the base of the trench and at the excavated faces of the trench between the trench floor and 300 mm (vertical) above the trench floor.

If highly permeable, otherwise unsuitable foundation materials and/or open cracks are found at the trench base or in the excavation batters within 300 mm from the trench floor, the Contractor shall either:

- Excavate test pits from the base of the 2 m deep trench to 3 m depth (measured from the stripped surface) to determine the depth to suitable foundation materials and/or cracks; or
- Excavate the trapezoidal trench deeper such that the base is at least 300 mm below the bottom of any unsuitable layer or to a maximum depth of 5 m below the stripped surface.

If the test pits indicate suitable foundation materials between 2 m and 3 m measured from the stripped surface, the Contractor shall deepen the trapezoidal trench so that the base is at least 300 mm into the suitable foundation materials as approved by the Superintendent.

If the test pits indicate that suitable foundation materials are not found within 3 m measured from the stripped surface, the Contractor shall either:

- Deepen the trapezoidal trench to a target depth of 5 m below the stripped surface, or
- Excavate a secondary trench from the base of the 2 m deep trapezoidal trench base to a depth of 3 m. The Contractor may excavate the secondary trench below the trapezoidal trench vertically. The width of the secondary trench shall allow for compaction using a pad foot drum or similar attached to the excavator arm. The pad foot drum or similar shall have a minimum width of 400 mm.

The Contractor shall incorporate safe working practices for trench excavation and backfilling as approved prior to works commencing.

The Contractor shall mark the completed section(s) of the cut-off trench and notify the Superintendent, giving a reasonable notice period, who will inspect the completed cut-off trench section(s). The Superintendent may

instruct the Contractor to further excavate area(s) failing the compliance criteria specified in this Clause. The Contractor shall mark the areas selected for further stripping and ask the Superintendent for approval after the further stripping is completed. No excavation shall be backfilled or covered in any way until the Contractor has obtained the written approval of the Superintendent (**Hold Point**).

The Contractor shall, at their own expense, uncover any excavation which has been covered without the prior inspection and approval of the Superintendent.

## 3.5 Stockpile operations

Material stockpiles will be provided by the Principal for some construction materials as stated in Table 4. The Contractor may also need to temporarily stockpile construction materials as required to suit programming of construction.

The following activities shall be undertaken by the Contractor in relation to material stockpiles:

- The Contractor shall be responsible for all mixing, blending, conditioning, curing and any other measures required for all construction materials in stockpiles.
- Materials in stockpiles shall be tested at the stockpile in accordance with this Specification.
- Stockpiles shall be developed to prevent segregation or degradation of material or intermixing of any separate type or types of material by cross cutting of stockpiled material. If stockpiling is required, then stockpiles of different types of material shall be separated in distance by not less than 10 m.
- Stockpiles shall be developed to have slopes that are stable and minimise effects of erosion from runoff. Berms and catch drains shall be provided as appropriate. Stockpiles of moisture-conditioned material shall be maintained in an acceptable condition through the use of seal rolling or other techniques as required. Material that has dried out or has become saturated because of water runoff or ponding shall be removed from the stockpile and separately stockpiled.
- Where unsuitable material is encountered, as determined by compliance testing or by the Superintendent, such material shall not be used. This material shall be discarded or stockpiled separately for possible use in other areas of the Works as directed by the Superintendent. The Contractor shall, where practicable and with the approval of the Superintendent, blend materials that do not comply with the acceptance criteria to ensure maximum usage of the stockpile materials.

## 3.6 Foundation preparation

### 3.6.1 General

The foundations to be prepared by the Contractor shall include the footprints to all embankments, the TSF1 downstream slope, embankment tie-ins, underdrainage, and other drainage structures, as shown on the Drawings (see Table 3).

The preparation of all foundations shall be in accordance with this Specification. Prepared areas shall be presented to the Superintendent for inspection and approval prior to any further placement of material (**Hold Point**).

### 3.6.2 Foundation preparation for embankment footprint

The Contractor shall prepare all areas under the embankment including the base of the cut-off trench areas in accordance with this Clause.

The Contractor shall remove all loose, soft material to the depth of stiff residual soils and/or extremely weathered materials of minimum undrained shear strength of 100 kPa. The foundation surface shall be cleaned for inspection by the Superintendent. The foundation preparation will be subject to approval by the Superintendent following inspection and survey (**Hold Point**).

If required, the Superintendent will direct the Contractor to excavate further materials from the designated areas to a specific depth and inspect, survey, and approve the reworked areas.



### 3.6.3 Subgrade preparation

The contractor shall determine working areas that can be prepared, and the BGM liner placed in time frames that minimise damage to prepared surfaces. The preparation shall be identical to that for embankment footprint as per Clause 3.6.2. Internal fill material used to fill up areas to required levels shall have properties equal to Subgrade material.

Further details of the required subgrade properties in accordance with specifications for BGM liner installation are outlined in Clause 4.12.

## 3.7 Embankments

### 3.7.1 General

The embankments and the decant accessways shall be constructed to the lines, levels and grades as shown on the Drawings (see Table 3).

Materials as detailed in Clause 0 and as shown in Drawings shall be used for the construction.

Where necessary or as instructed by the Superintendent, the Contractor shall be responsible for constructing and maintaining edge windrows or safety bunds on the embankment working area during construction.

The final surface of the perimeter embankments shall be graded with a cross fall as shown in the Drawings.

The upstream and downstream slopes of the embankment and batter slopes of decant accessways shall not be steeper than as shown on the Drawings

A detailed construction method shall be developed by the Contractor for the project as a part of the final tender submission (Hold Point).

### 3.7.2 Mine waste rock placement

Mine waste rock shall be placed loose in layers with the thickness not exceeding 1 m. Each layer shall be trimmed, and track rolled using D9 dozers or approved equivalent. Access routes for loaded trucks shall be regularly varied to maximise compaction by loaded trucks.

Moisture shall be added to the rock surfaces with at least two passes of a water truck per day.

There is no moisture control or testing requirement for mine waste rock materials.

### 3.7.3 Select mine waste rock placement

Select mine waste rock shall be placed in accordance with Clause 3.7.2.

### 3.7.4 Selection and placement of tailings sand material

The Contractor shall borrow tailings sand material from the nominated areas in such a manner that a uniform material is produced, which is free from lenses, pockets, streaks, or material differing substantially in texture or gradation from the surrounding material.

The Contractor's handling and spreading tailings sand material at the areas of placement shall result in an even distribution and gradation of the materials throughout the zone. The Contractor shall place tailings sand to form the sand blanket and underdrainage cover as shown on the Drawings (see Table 3).

Compaction shall be carried out using Method Specification with layers 400 mm thick at a moisture content between 6% and 10% and six passes of non-vibrating smooth drum roller. Testing as noted in Clause 6.2.3 is to confirm that sand material was compacted whilst in the 6% to 10% moisture range.

In the event that unsuitable material has been placed, the Contractor shall remove the material identified by the Superintendent as unsuitable and replace it with suitable material at the Contractor's expense. The Contractor shall stockpile the noncompliant material at a location nominated by the Superintendent.

### 3.7.5 Placement and grading of wearing course material

The Contractor shall place wearing course to form a minimum 150 mm thick layer as shown on the Drawings (see Table 3).

### 3.7.6 Windrows

The Contractor shall construct minimum 500 mm high windrows along both edges of the embankment as shown on the Drawings or as directed by the Superintendent. The windrows shall be constructed from general rockfill material. The windrows shall be compacted by tamping with the excavator bucket as approved by the Superintendent.

Gaps of 1.0 m width shall be constructed in the down slope windrows at 40 m intervals to provide surface drainage as indicated on the Drawings (see Table 3).

## 3.8 Underdrainage system

### 3.8.1 General

The Contractor shall prepare the foundation surface for the geotextile and the Megaflo/Draincoil pipes as specified in Clause 3.6.2 to the lines and levels shown on the Drawings (see Table 3).

The Contractor shall install all Megaflo/Draincoil pipes to the sections, lines, levels, and dimensions shown on the Drawings and DTM. The final alignment and levels of the underdrainage will be confirmed by the Superintendent prior to construction based on the actual surface levels provided by the Contractor (**Hold Point**).

The prepared foundation surfaces shall be surveyed, inspected, and approved by the Superintendent prior to the placement of geotextile around the pipes (**Hold Point**).

The Contractor shall install the Megaflo/Draincoil pipes in accordance with the manufacturer's recommendations.

### 3.8.2 Excavation of trenches

The Contractor shall excavate the trenches for the Megaflo/Draincoil pipes and underdrainage outlets in accordance with Clause 3.4.7.

The Contractor shall take measures to ensure the integrity of the final excavated surface is maintained and shall limit erosion of the surfaces after the acceptance of the Superintendent. Any areas of the final excavated surface which, in the opinion of the Superintendent, are damaged, loose, or cracked shall be rectified at the Contractor's expense.

### 3.8.3 Placement of geotextile

The Contractor shall place the geotextile for the pipes and outlets installed in fill locations as shown on the Drawings. The geotextile shall be installed as per the manufacturer's instructions including overlap requirements.

Following pipe installation and backfilling of trenches, the geotextile shall be wrapped back over the gravel with a minimum 500 mm lap.

### 3.8.4 Pipe installation

Slotted drainage pipes shall be placed on the prepared Drainage material bedding surface with an even fall towards the outlet points as shown on the Drawings. The bedding surface materials shall be placed and compacted to the final thickness as shown on the Drawings (see Table 3).

All pipes shall be placed on the prepared bedding surface with an even fall towards the outlet point as shown on the Drawings. Pipes shall be placed and installed in accordance with the manufacturer's specifications.

All pipes shall be surveyed by the Contractor and inspected by the Superintendent prior to the placement of backfill. (**Hold Point**).

Any pipes which are not laid to lines, levels, or grades, or are damaged or displaced during backfilling or other operations by the Contractor in the course of the Works, shall be removed and replaced, if necessary, at the Contractor's expense. The Contractor shall be responsible for any excavation or backfilling necessary for the removal and replacement of any pipes.

The Contractor shall shape and trim the final surface to receive the geotextile around the Draincoil to form a smooth, dense uniform surface, free of abrupt changes, water, or cracks.

### 3.8.5 Underdrainage outlet pipes

Draincoil shall be connected to seepage sumps with DN200 PE 100 PN 16 HDPE underdrainage outlet pipes as specified on Drawings and as approved by the Superintendent.

Prior to backfilling, all underdrainage outlet pipes (as shown on the Drawings – see Table 3) shall be filled with water and pressure tested to 50 % of the pipes pressure rating by the Contractor. The pressure testing shall be in accordance with this Specification and AS 4037 – 1999. Any leakage occurring shall be repaired and then the pipe shall be re-tested at the Contractor's expense.

The Contractor shall submit all pressure tests to the Superintendent prior to the trench backfilling (**Hold Point**).

All pipes shall be surveyed by the Contractor and inspected by the Superintendent prior to the placement of backfill (**Hold Point**).

Any pipes which are not laid to lines, levels, or grades, or are damaged or displaced during backfilling or other operations by the Contractor in the course of the Works, shall be removed and replaced, if necessary, at the Contractor's expense. The Contractor shall be responsible for any excavation or backfilling necessary for the removal and replacement of any pipes.

All pipes shall be placed on the prepared bedding surface as shown on the Drawings. Pipes shall be installed and connected in accordance with the manufacturer's specifications.

### 3.8.6 Backfilling of trenches

The Contractor shall only commence backfilling of the trenches after the pipe(s), in the section of the trench to be backfilled, have been installed in accordance with Clause 3.8.4 and any outlets in this section have passed the pressure tests Clause 3.8.5.

All Drainage backfill materials shall be placed uniformly on each side and over the pipe in layers not exceeding 150 mm loose thickness before compaction. The backfill materials shall be placed such that the distribution and gradation of the materials is consistent throughout the layer, free from lenses, pockets, streaks, or layers of material differing substantially in texture from the surrounding material within the layer. The backfill material shall be nominally compacted as directed by the Superintendent.

Extreme care shall be taken to avoid any damage to the installed pipework when backfilling and compacting around and above the pipes.

### 3.8.7 HDPE Geonet Geocomposite (double sided) strip drain

The strip drain shall be constructed in accordance with the Manufacturer's specifications and as specified on the following drawings:

- 1262-1963-GHD-00-02-DRG-CI-20021
- 1262-1963-GHD-00-02-DRG-CI-20025

The following shall be noted during installation:

- The HDPE Geonet Geocomposite shall be laid on top of BGM liner at locations and to lengths indicated on the Drawings.
- A cushion geotextile shall be placed to separate BGM liner and strip drain.
- The HDPE Geonet Geocomposite drain shall be joined onto the existing 1265 mRL raise or tied into the tailings underdrainage as per drawing 1262-1963-GHD-00-02-DRG-CI-20021, as applicable.

- Extreme care shall be taken to avoid any damage to the installed BGM liner.
- All works undertaken on top of the BGM liner shall be in accordance with Clause 4.13.

### **3.9 Installation of monitoring instrumentation**

Settlement survey points and all associated infrastructure shall be installed as shown on the Drawings and in accordance with manufacturer's specifications.

Wherever possible common cable conduits shall be used to house cables through the embankment to the instrumentation read out boxes as shown on the Drawings.

### **3.10 Final proof rolling**

Following stripping, any required excavations and backfilling, the Contractor shall regrade the floor such that no slopes are steeper than 1V:10H. The Contractor shall survey the floor to demonstrate compliance (**Hold Point**).

Upon receiving the Superintendent's approval, the Contractor shall proof roll the final TSF floor surface with two passes of a vibratory smooth drum roller of minimum weight of 15 t.

# 4. Bituminous Geomembrane Installation

## 4.1 Description of work

The Liner Installation Contractor shall provide all labour, materials, tools, supervision, transportation, equipment, and incidentals necessary for the installation of BGM as shown on the Drawings (see Table 3). The BGM liner shall be provided by the Principal.

The Works shall include, but not be limited to, delivery, unloading containers with specific equipment to assure the integrity of the BGM storage, placement, anchorage, and seaming of the BGM.

## 4.2 References

The publications listed in Table 7 form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Table 7 ASTM references

Number	Title
ASTM D696	Standard Test Method for Coefficient of Linear Expansion of Plastics between -30°C and +30°C with a Vitreous Silica Dilatometer
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1204	Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D3746	Standard Test Method for Impact Resistance of Bituminous Roofing Systems
ASTM D3776	Standard Test Methods for Mass per Unit Area (Weight) of Fabric
ASTM D4073	Standard Test Method for Tensile-Tear Strength of Bituminous Roofing Geomembranes ASTM D4354 Standard Practice for Sampling of Geomembranes for Testing
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method
ASTM D4833	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Measuring Nominal Thickness of Geosynthetics
ASTM D5321	Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D7056	Standard Test Method for Determining the Tensile Shear Strength of Prefabricated Bituminous Geomembrane Seams
ASTM D7954	Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method
ASTM D4437	Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes (Air Lance Test)
ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

## 4.3 Measurement

Measurement shall be made of the total surface area in square meters covered by BGM. Final quantities shall be based on as-built conditions. Allowance shall be made for BGM in anchor trenches, drainage trenches, and overlaps; however, no allowance shall be made for waste or materials used for the convenience of the Liner Installation Contractor.

## 4.4 Submittals

### 4.4.1 Prior to installation of BGM

The Liner Installation Contractor shall submit the following to the Principal for review and approval prior to installation of the bituminous geomembrane (**Hold Point**):

- Delivery, storage, and handling log for all BGM rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling.
- Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of **panel installation**.
- **Certification from the CQA Inspector and Liner Installation Contractor of the acceptability of the surface on which the BGM is to be placed, immediately prior to BGM placement.**

### 4.4.2 Following installation of BGM

The Contractor shall submit the following to the Principal for review and approval following installation of the BGM:

- Panel placement log, providing details on panel number and associated roll number, date and time placed, condition of receiving surface, weather conditions and precipitation events, CQA checks performed, and all other relevant information.
- Trial weld log, recording all trial welds and testing undertaken.
- Field welding log providing details of all field welding undertaken, including:
  - Weld type
  - Weld ID number
  - ID numbers of panels to be joined
  - Name of welder
  - Details of equipment used
  - Ambient air temperature
  - Geomembrane surface temperature
  - Weld temperature
  - Any problems or issues arising during welding.
- Field sampling and testing results, including non-destructive and destructive tests.
- Finalised panel placement drawing showing the as-built location of all panels, seams, connections, and penetrations.
- Defects and repairs log, showing details of all defects identified and repairs completed.

## 4.5 Manufacturer's Quality Assurance (QA) / Quality Control (QC)

### 4.5.1 Manufacturer's Quality Control (MQC)

The manufacturer shall follow an approved quality control program throughout the manufacturing of all BGM for the Works.

Manufacturer's quality control submissions shall include:

- Date of manufacture.
- Lot number, roll number, length, and width.
- Quality control program laboratory-certified reports.
- The manufacturer's approved quality assurance stamp and the technician's signature.



The frequency of sampling and testing shall be in accordance with Table 9.

## **4.5.2 Manufacturer's Quality Assurance (MQA)**

The manufacturer shall follow an approved quality assurance program throughout the manufacturing of all BGM for the Works.

The frequency of sampling and testing shall be in accordance with ASTM D4354.

## **4.6 Qualifications**

### **4.6.1 Manufacturer**

The Manufacturer shall be responsible for the production of BGM rolls and shall have sufficient production capacity and qualified personnel to provide material meeting the requirements of this Clause and the construction schedule for this project.

### **4.6.2 Liner Installation Contractor**

The Liner Installation Contractor shall be responsible and shall provide sufficient resources for all CQC, field handling, deploying, seaming, temporarily restraining (against wind), and other aspects of the deployment and installation of the BGM. All personnel performing installation and seaming operations shall be qualified by a representative of the manufacturer. No seaming shall be performed unless a "master seamer" is present on-site. The Liner Installation Contractor shall make adequate provision for all required labour and site supervision at all times. All requirements relating to document, reporting and records are outlined in Clause 6.1.9.3.

### **4.6.3 Liner CQA Inspector**

The Liner CQA Inspector is the person or corporation hired by the Principal, who shall be responsible for monitoring and documenting activities related to the CQA of the BGM installation.

### **4.6.4 Liner CQA laboratory**

The CQA laboratory shall have provided CQA testing of BGM seams and shall demonstrate at least five completed projects having a minimum area of 200,000 m<sup>2</sup>. The CQA laboratory shall be accredited by the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the CQA laboratory will be required to perform.

## **4.7 Delivery, storage, and handling**

### **4.7.1 Delivery**

The CQA Inspector shall be present during delivery and unloading of the bituminous geomembrane. Each BGM roll/panel shall be labelled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions. All rolls shall be verified by CQC with conforming MQA records.

### **4.7.2 Storage**

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The BGM shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll or flattening of the rolls. Rolls shall not be stored more than two high. Damaged BGM shall be removed from the site and replaced with BGM that meets the specified requirements.

### 4.7.3 Handling

BGM rolls shall not be dragged, lifted by one end, or dropped. A mandrel of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the mandrel shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the mandrel to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and capable of supporting the full weight of the roll without significant bending.

If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

## 4.8 Equipment

Equipment used in performance of the Work shall be in accordance with the BGM manufacturer's recommendations and shall be maintained in satisfactory working condition.

## 4.9 Weather limitations

BGM shall not be deployed or field-seamed in the presence of significant rain, in areas of ponded water, or in the presence of wind in excess of 55 km/hour. Unless authorized by the Principal, no placement or seaming shall be attempted at ambient temperatures below -25°C or above 40°C. Ambient temperature shall be measured at a height no greater than 150 mm above the ground or BGM surface. In marginal conditions, seaming shall cease unless destructive field seam tests, conducted by the CQA laboratory, confirm that seam properties meet the design requirements.

## 4.10 Traffic

Equipment used shall not damage the BGM by handling, trafficking, leakage of hydrocarbons, or by other means.

No vehicle shall be allowed to travel directly on the BGM unless approved by the CQA Inspector. Prior to approval, the Contractor shall provide the CQA Inspector the following information:

- Guidance from the manufacturer on suitable plant for trafficking for the BGM and confirmation that the Contractor shall only use this plant
- Certification from the manufacturer that the above trafficking method and plant shall not void the warranty for the BGM.

## 4.11 Materials

### 4.11.1 BGM specification and supply

The BGM shall be supplied from Axter Australia Pty Ltd and shall consist of the follow material:

- Coletanche ES1 installed on the floor basin of Cell 1 and Cell 2
- Coletanche ES3 installed on the embankment slopes of Cell 1 and Cell 2.

Through CQC, the Liner Installation Contractor shall confirm that the supplied materials MQA data comply with the requirements of Table 8 and advise the Principal of any variations noted prior to use (**Hold Point**).

### 4.11.2 BGM rolls

BGM rolls shall be manufactured 5.1 m wide where possible and shall be uniform in thickness and surface texture. The BGM shall be free of and / or resistant to fungal or bacterial attack, abrasions, holes, blisters, contaminants, and other imperfections. BGM shall conform to the manufacturer specifications for the selected BGM properties listed in Table 8 for Manufacturing Quality Control (MQC).

Table 8 Bituminous Geomembrane properties

Property	Value	Standard
Nominal thickness	3.5 - 5.6 mm	ASTM D5199
Mass per unit area	4.2 - 5.8 kg/m <sup>2</sup>	ASTM D5261
Unit weight of incorporated non-woven geotextile	200 g/m <sup>2</sup> - 400 g/m <sup>2</sup>	n/a
Roll width	5.10 m	n/a
Roll length	100 m - 65 m	n/a
Tensile strength (maximum) – MD	35 kN/m	ASTM D7275
Tensile strength (maximum) – XD	30 kN/m	ASTM D7275
Elongation at break – MD	50 %	ASTM D7275
Elongation at break – XD	50 %	ASTM D7275
Tensile tear resistance – XD (maximum)	1225 N	ASTM D4073
Tensile tear resistance – MD (maximum)	1025 N	ASTM D4073
Static puncture	650	ASTM 4833
Permeability	6 X 10 <sup>-14</sup> m/s	ASTM E 96
Coefficient of thermal expansion	-0.1% (MD) 0.3% (XD)	ASTM D 696
Interface friction angle	~35 degrees	-

### 4.11.3 Welding primer material for bonding BGM with concrete

Where required, the BGM welding primer material shall be Elastocol 500 as manufactured by Soprema or approved equivalent and shall be supplied by the Liner Installation Contractor.

The BGM welding primer material shall be a blend of SBS (Styrene Butadiene Styrene) - modified bitumen, fast-evaporating solvents, and adhesive-enhancing additives. The welding primer material is required to prime surfaces such as concrete and metal in order to improve the adhesion of torch applied BGM.

## 4.12 Foundation preparation for BGM liner

### 4.12.1 Familiarisation

Prior to implementing any of the work described in this Clause, the Contractor shall become thoroughly familiar with all portions of the work falling within this Clause of the Specification.

The Liner Installation Contractor shall carefully inspect the installed work of all other Clauses and verify that all work is complete to the point where the work of this Clause may properly commence without adverse effect.

If the Liner Installation Contractor has any concerns regarding the installed work of other sections, he shall notify the Principal in writing prior to the start of the work of this Clause. Failure to inform the CQA Inspector in writing or commencing installation of the BGM will be construed as the Contractor's acceptance of the related work of all other Clauses.

A pre-installation meeting shall be held to coordinate the installation of the BGM with the installation of other components of the work.

Representatives of the Contractor, the Liner Installation Contractor, the Principal and the CQA Inspector shall be present in the meeting.

## 4.12.2 Surface preparation

### 4.12.2.1 General

Surface preparation shall be performed in accordance with the Drawings.

Surfaces to be covered with BGM shall be trimmed and rolled with a flat drum and maintained in preparation for the installation of BGM.

CQA Lot boundaries shall be staked and flagged to ensure the accuracy of the deployment of the BGM.

The trimmed surface shall be brushed and rolled with a smooth drum roller and shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm, and unyielding to the satisfaction of the CQA Inspector.
- Rocks larger than 20 mm in diameter and any other material which could damage the BGM shall be removed from the surface to be covered with the BGM.
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability. Construction equipment tyre or track deformations beneath the BGM shall not be greater than 25 mm in depth.
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials.
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface.
- The surface shall promote drainage no water allowed to pond on the surface.
- All construction stakes, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material.

BGM shall be installed as soon as practicable after surface preparation has been accepted.

Prior to the placement of BGM, the CQA Inspector and Contractor shall inspect the surface on which BGM is to be placed and certify in writing that the surface is acceptable (**Hold Point**).

### 4.12.2.2 Subgrade preparation on natural ground

Natural ground shall be prepared in accordance with Clause 3.6.3 Cell 2 subgrade preparation. Prepared foundations shall be trimmed and rolled with a flat drum in preparation for the installation of BGM.

### 4.12.2.3 Subgrade on general fill (meeting BGM subgrade requirements)

General fill shall be constructed using material as specified in Clause 2.4 in accordance with the Drawings. Once placed, the fill will be trimmed and rolled with a flat drum in preparation for the installation of BGM.

### 4.12.2.4 Subgrade on general fill (not meeting BGM subgrade requirements)

General fill not meeting BGM liner subgrade material shall be capped with a 200 mm layer of subgrade material as specified in Clause 2.3 in accordance with the Drawings.

### 4.12.2.5 Subgrade on fill areas filled up with mine waste rock

Areas requiring fill depths of more than 1 m shall be pioneered with mine waste rock and capped with BGM liner subgrade material as specified in Clause 2.3.

## 4.12.3 Anchor trenches

Where an anchor trench is required, it shall be constructed as per the Drawings (see Table 3). If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of BGM in a single day shall be excavated. Ponded water shall be removed from the anchor trench while the

trench is open. Trench corners shall be chamfered to avoid sharp bends in the BGM. Loose soil, rocks larger than 20 mm in diameter, and any other material which could damage the BGM shall be removed from the surfaces of the trench. The BGM shall extend down the front wall and across the bottom of the anchor trench. The anchor trench shall be backfilled with the excavated soil and compacted to 95% MMDD at 2% to +2% OMC with approved rollers until the field density, as determined by Nuclear Density Gauge in accordance with AS 1289.5.8.1 is achieved.

#### 4.12.4 Foundation preparation for TSF1 downstream slope

The Contractor shall cut back, remove any vegetation and loose and/or soft material, and reshape (1V:3H slope) the downstream face of the TSF1 to which the new TSF4 will tie-in to as shown on the Drawings (see Table 3). Following clearing of loose material, the Contractor shall strip minimum of 300 mm of topsoil.

The TSF1 embankment shall be prepared in accordance with Clause 3.6.3. Prepared foundations shall be trimmed and rolled with a flat drum in preparation for the installation of BGM.

#### 4.12.5 Foundation preparation for TSF1 embankment key-ins

The foundation for the embankment key ins shall be stepped into the TSF1 embankment as shown on the Drawings or as directed by the Superintendent.

### 4.13 BGM deployment

#### 4.13.1 General

The BGM shall be deployed in accordance with manufacturer's guidelines. Care must be taken to ensure deployment is done from the top of the embankment (highest elevation) to the floor (lowest elevation).

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the BGM, other geosynthetic layers, or the underlying subgrade. BGM damaged during installation shall be replaced or repaired, at the CQA Inspector's discretion.

Adequate ballast (i.e., sandbags) shall be placed on the BGM, without damaging the BGM, to prevent uplift by wind. Particular care shall be taken to ensure adequate ballasting of strips at the end of the day if all the welds are not completed.

No equipment shall be operated on the top surface of the BGM without permission from the Principal.

Seams shall be oriented parallel to the line of maximum slope. Transverse joints on the slopes are prohibited unless approved beforehand by the Principal. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel.

Quadruple overlaps due to the alignment of 4 strips are prohibited. Special attention must be given to triple overlaps and must be offset by 300 mm and patched (refer Figure 2).



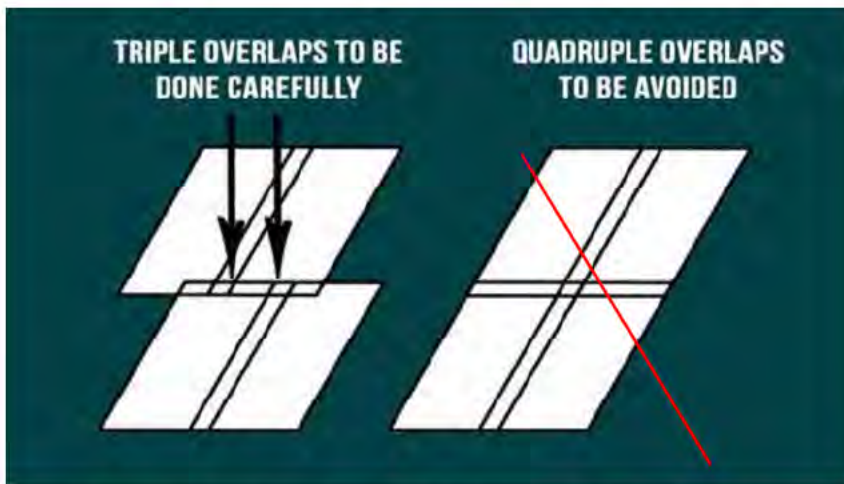


Figure 2 Orientation of overlaps (Axter 2022, Installation Specifications Coletanche Geomembranes (ES, XP, Axter TP), May 2022)

The methods used to deploy and backfill over the BGM shall minimize wrinkles and tensile stresses in the BGM. The BGM shall have adequate slack to prevent the creation of tensile stress.

### 4.13.2 Layout drawings

The Contractor shall deploy the BGM panels in general accordance with the layout drawing specified. The layout drawings must be approved by the Principal prior to installation of any geomembrane (**Hold Point**).

### 4.13.3 Field panel identification

A BGM field panel is a roll, or a portion of roll cut in the field.

Each field panel shall be given a unique identification code (number or letter-number). This identification code shall be agreed upon by the CQA Inspector and the Liner Installation Contractor.

Field panels shall be installed, as approved, or modified, at the location and positions indicated on the layout drawings.

## 4.14 Field seaming

### 4.14.1 Trial seams

Trial seams shall be made under field conditions on strips of excess BGM. Trial seams shall be made each day prior to production seaming (**Hold Point**), whenever there is a change in seaming personnel, by each seamer. Seams must match the grade of product being welded (ES1 or ES3).

### 4.14.2 Field seams

Panels shall be seamed in accordance with the BGM manufacturer's recommendations. In sumps, corners and odd-shaped geometric locations, the number of field seams shall be minimized. Seaming shall extend to the outside edge of panels. Soft subgrades shall be compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. The panels shall overlap 20 cm (minimum) for seaming. Ends and overlaps must be welded on a homogeneous and continuous basis, leaving 10 - 30 mm bitumen bead along the seam.

Seams shall be welded using propane torches. The torch-welds must be approved at the preparation meeting and performed according to the Manufacturer's recommendations.

Where a cushion geotextile between the subgrade layer and the BGM liner has been used, an insulation mat must be included between the geotextile and the liner to ensure the geotextile underneath is not damaged / burnt.



## 4.15 Attachment to concrete

Attachments to concrete shall be performed by welding the BGM directly on the surface previously primed with welding primer material described in Clause 4.11.3 (**Hold Point**).

## 4.16 Installation tests, inspection, and verification

### 4.16.1 Destructive testing (HOLD POINT)

#### 4.16.1.1 Sampling

One CQA sample, 600 mm in length and 500 mm in width, shall be obtained for every 150 m of seam. The samples shall be identified by manufacturer's name, product identification and lot and roll/panel number. The date and a unique sample number shall also be noted.

#### 4.16.1.2 Testing

The Contractor shall provide all destructive CQA samples to the CQA laboratory for tensile shear strength testing according to ASTM D7056. Tensile shear strengths shall exceed a strength of 18 kN/m. Samples not meeting the specified requirements shall result in the rejection of the seam.

Where destructive test fails to meet the requirements, additional samples shall be collected 1 m prior to and 1 m immediately after the failed test and retested. If the retest fails to meet the requirement, further samples shall be collected 3 m prior to and 3 m immediately after the failed test and retested. If retest fail to meet the requirements the process will be repeated (sampling 3 m prior to and 3 m immediately after the retest) until samples meet the requirements in both directions. If no passing samples are found on the seam testing shall continue on the welds seamed by the same technician prior to and immediately after failed seam until samples that meet the requirements of the Technical Specifications are encountered.

All seams that do not meet the requirements shall be capped in accordance with the Technical Specifications and with a minimum of 200 mm overlap (see Clause 4.17.1).

### 4.16.2 Non-destructive field seam continuity testing

#### 4.16.2.1 Field seam continuity testing

Field seams shall be non-destructively tested for continuity over their full length in accordance with the Liner Installation Contractor's approved CQC manual. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming (**Hold Point**). Any seams which fail shall be documented and repaired in accordance with the Liner Installation Contractor's approved CQC manual.

The following procedures shall apply:

- Visual control and closure of the weld by a welder equipped with a trowel, a torch, and a marker.
- Air Lance Test in accordance with ASTM D4437 on all welds.
- Vacuum testing in accordance with ASTM D5641 as requested by CQA Inspector.

The Liner Installation Contractor shall perform CQC testing of the type and frequency indicated in the Table 9.

#### 4.16.2.2 Confirmation testing

Non-destructive confirmation testing shall comprise:

- Electrical leak survey in accordance with ASTM D7953: Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method (**Hold Point**).

## 4.17 Defects and repairs

### 4.17.1 Destructive seam test repairs

Seams that fail destructive seam testing (in accordance with procedure outlined in Clause 4.16.1.2) may be overlaid with a strip of new material and seamed (cap stripped). Strip shall have rounded corners and extend a minimum of 200 mm beyond the edge of the repair. After repairs are completed, the repaired seam shall be non-destructively tested in accordance with Clause 4.17.4.

### 4.17.2 Patches

Tears, holes, blisters, and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same BGM, and extend a minimum of 200 mm beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the CQA inspector. Repairs shall be non-destructively tested. The CQA Inspector may also elect to perform destructive seam tests on suspect areas.

Quadruple overlaps due to the alignment of 4 strips are prohibited. Special attention must be given to triple overlaps and must be offset by 300 mm and patched.

### 4.17.3 Visual inspection and evaluation

Immediately prior to covering, the BGM, seams, and non-seam areas shall be visually inspected by the CQA Inspector and Principal for defects, holes, or damage due to weather conditions or construction activities. At the Principal or the CQA Inspector's discretion, the surface of the BGM shall be brushed, blown, or washed by the Liner Installation Contractor if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material. Each suspect location shall be non-destructively tested in accordance with Clause 4.16.2. Each location that fails non-destructive testing shall be repaired in accordance with Clause 4.17.2.

### 4.17.4 Penetrations

BGM penetration details shall be in accordance with ASTM D 6497 or as recommended by the BGM manufacturer. Field seams for penetrations shall be non-destructively tested in accordance with the Liner Installation Contractor's approved CQC manual. Seams that fail non-destructive testing shall be repaired in accordance with the Liner Installation Contractor's approved CQC manual and non-destructively tested prior to acceptance.

### 4.17.5 Protection and backfilling (trafficked areas)

For areas requiring trafficking, the deployed and seamed BGM shall be covered with tailings sand within 5 calendar days of acceptance. Wrinkles in the BGM shall be prevented from folding over during placement of cover materials. The tailings sand shall not be dropped onto the BGM or overlying geosynthetics from a height greater than 1 m. The tailings sand shall be pushed out over the BGM in a careful manner to avoid creasing of the geomembrane. The initial loose tailings lift thickness shall be 300 mm. Equipment with ground pressures less than 50 kPa shall be used to place the first lift over the BGM. A minimum of 300 mm of soil shall be maintained between construction equipment with ground pressures greater than 50 kPa and the BGM.

Equipment placing tailings sand shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 8 km/h.

## 4.18 As-built drawings

Final as-built drawings of the BGM installation shall be prepared by the Liner Installation Contractor. These drawings shall include panel numbers, seam numbers, location of repairs, destructive seam samples, and penetrations. The as-built drawings shall be provided as follows:

- Survey files (DWG, DXF, ASCII files)
- 12D / DEM models

## 5. Tolerances

Embankment dimensions shall not be less, nor the slopes steeper, than those specified on the Drawings. Dimensional tolerances shall be the following unless specifically otherwise noted:

- Vertical tolerance -50 mm to +50 mm.
- Horizontal tolerance -0 mm to +150 mm from the set-out centreline and all minimum widths shall be maintained.

Tolerances for the clay liner shall be as for embankment tolerances except that the tolerance for thickness of any one layer of the liner shall be -30 mm to +50 mm and the tolerance of the combined thickness of 600 mm shall be -30 mm to + 100 mm.

Tolerances for drains shall be the following unless specifically otherwise noted:

- Depth tolerances – minimum 1 m depth.
- Gradient tolerance – minimum 0.5% fall.

The Contractor shall provide and have available at all times during the contract working hours, the necessary staff and equipment to ensure that the correct setting out of the Works is maintained continuously throughout construction. Should any errors in setting out of the Works occur, such errors shall be corrected, and any necessary adjustments shall be carried out to the satisfaction of the Superintendent, at the Contractor's expense.

All pipeline tolerances shall be the following unless specifically otherwise noted:

- Vertical tolerance -50 mm to +50 mm.
- Horizontal tolerance -200 mm to +200 mm from the set-out centreline.
- Gradient tolerance for underdrain systems – minimum 0.2% fall.
- Gradient tolerance for underdrainage outlets – minimum 0.5% fall.

# 6. Quality control

## 6.1 Quality control procedures and documentation

### 6.1.1 General

The Contractor shall maintain an effective and adequately documented system of Quality Management, planned, and developed, in conjunction with other supplier's functions, necessary to satisfy the Contract requirements. This requirement shall be met by the establishment and implementation of procedures that ensure that all technical standards are entirely achieved in the construction of the permanent work under the Contract.

The Contractor shall, as a minimum, meet the requirements of:

- Standards Australia AS/NZS ISO 9001:2008 Quality Systems –Requirements; and
- Standards Australia AS/ANZ ISO 9000.2:1998 Quality System Guidelines – Guide to AS/NZS ISO 9001, AS/NZS ISO 9002 and AS/NZS ISO 9003 for Construction.

Unless otherwise specified, the Contractor shall follow the Quality Guidelines for Construction (AS/NZS 3905.2-1997) and the Health and Safety at Work, Principles and Practices (AS 1470-1986).

Notwithstanding any statements to the contrary in the Contractor's Quality System, no part of the Quality System shall be used to pre-empt, preclude or otherwise negate the requirements of any part of the Contract Documents. Quality System elements shall be used as an aid to achieve compliance with the Contract Documents and documenting such compliance, and in no way shall they relieve the Contractor of responsibility to comply with the Contract Documents.

### 6.1.2 Quality plan

#### 6.1.2.1 Contractor

The Contractor shall produce a Quality Plan, based upon the guidelines detailed in Standards Australia AS/NZS ISO 9004:2011, and should as a minimum address the following:

- The quality objectives to be attained for the Contract
- The specific allocation of responsibilities and authority during the different phases of the Contract
- The specific procedures, methods, and work instructions to be applied during the course of the Contract
- Suitable testing, including testing by NATA approved authorities where appropriate, inspection, examination, and audit programs at appropriate stages of the Contract
- Control and distribution of Quality Records
- A method for managing changes, exceptions, and modifications in the Quality Plan as the Contract proceeds
- Production of record documents at the completion of the Contract and
- Other measures necessary to meet the objectives of the Contract.

The detailed Quality Plan shall be submitted to the Superintendent within two (2) weeks of award of the Contract. If the whole, or part, of the Quality Plan is not completed within four weeks of award of Contract, the Contractor shall hold up and not proceed with any work covered under the whole or parts of the Quality Plan which are not completed. No extension of time claims shall be made or considered for the work so held-up.

The Contractor shall appoint a representative, who shall have responsibility for implementing the Quality Plan (Contractor's Quality Control Representative).

#### 6.1.2.2 Liner Installation Contractor

The Liner Installation Contractor shall prepare and submit to the Principal a BGM Liner Installation Quality Plan. As a minimum, the Quality Plan shall contain the following information:

- A Project Organisation Chart or list of nominated Project Personnel showing their positions, lines of communication and details of the responsibilities of the positions.
- A Lot Plan, or the methods by which lots will be identified.
- Inspection and Test Plans for the various phases during construction and commissioning, as applicable to the project.
- Project specific operating procedures or descriptions outlining details of activities, who is responsible for implementation/verification, identification of relevant Quality Records and distribution of such records.
- A Register of all intended Quality Records to be used on the project, together with any proformas.

### 6.1.3 Inspection and test plans

Inspection and Test Plans (ITPs) shall be submitted by the Contractor to the Superintendent on an on-going basis during the course of the Work but at least ten (10) days prior to the commencement of the item of work to which the ITP applies (**Hold Point**).

An ITP shall apply to, and be initiated for, each Lot of the Work. For the purposes of this Clause, a Lot is defined as a section, element, or complete component of the work commensurate with a required conformance decision and shall be designated by the Contractor's Quality Control Representative unless otherwise modified by the Superintendent.

A detailed lot structure plan shall be submitted to the Superintendent minimum 10 days prior to commencement of the Works (Hold Point).

ITPs shall as a minimum, include:

- The work process sequences and their associated inspection and test points
- The allocation of responsibilities for carrying out the inspection and testing
- The required frequency of inspection and testing and the criteria for acceptance
- The methods of testing to be used
- Provision for identification of the work Lot to which the ITP applies
- Verification of completion of various inspections/tests by the Contractor
- Inspection approval (Hold Points) by the Superintendent at specified construction phases
- Product identification and traceability of materials for which test certificates are required

Where the content of an ITP is in conflict with the requirements of the Specification, the requirements of the Specification shall prevail, unless the Superintendent specifically varies the requirements of the Specification in writing.

Work shall not commence on any Lot to which an ITP applies until the specific provisions and procedures of the ITP are approved and signed by the Superintendent.

The inspections identified in this Specification shall be carried out jointly by the Superintendent and the Contractor, in addition to other random inspections by the Superintendent from time to time as is deemed necessary. These specific inspections should be included in the Contractor's ITPs.

If the Contractor discovers material or work that is not in accordance with the Specification, the Contractor shall promptly initiate the defect procedure required by the Quality System.

### 6.1.4 BGM tests, inspection, verification, manufacturing, sampling, and testing

BGM sheets shall be tested in accordance with the approved MQC manual. As a minimum, MQC testing shall be conducted at the frequencies shown in Table 9. Sheets not meeting the minimum requirements specified in Table 9 shall not be sent to the site.

Table 9 BGM Conformance Testing requirements

Test Name	Test Method	Frequency
Specific Gravity	ASTM D 792 Method A	As per manufactures quality requirements
Thickness	ASTM D 5199	
Tensile Strength	ASTM D 4595	
Tensile Tear Resistance	ASTM D 4073	
Elongation at Break	ASTM D 4595	
Static Puncture	ASTM D 4833	

## 6.1.5 Hold Points

Throughout the Works, Hold Points shall apply whereby the Contractor shall submit relevant information to the Superintendent for approval prior to commencing with the next stage of the Works. The Contractor shall provide the Superintendent a minimum of 48 hours' notice prior to request for approval. The Contractor shall not proceed beyond the Hold Points prior to receiving written approval from the Superintendent.

The Contractor may subdivide the area into Lots such that approval of a Hold Point can allow work to continue in the specific area of the Lot.

If the Contractor proceeds to construct beyond the designated Hold Point without the Superintendent's inspection and or without the Superintendent's approval then the Superintendent may direct the Contractor to uncover and remediate the Works to the Hold Point, at the Contractor's expense.

The Contractor shall be deemed to have allowed for all time delays and costs associated with the Hold Points during the Works.

The Hold Points include but are not limited to the items listed in Table 10.

Table 10 Summary of Hold Points

Clause no.	Requirement	Superintendent's Role
1.12	The Contractor shall prepare a written method statement detailing the construction methodology to be used for the Works. The Contractor shall submit the method statement as part of the final tender submission	Review, modify, reject, or approve
1.18.1	The Contractor shall present the set-out points to be used for construction of the Works, or any part of it, to the Superintendent	Review, modify, reject, or approve
1.18.2	At the completion of the Works, the Contractor shall submit to the Superintendent as-constructed survey including embankment crest, zones, access ramps, windrow, upstream and downstream toe lines, pipelines and instrumentation and other features of the Works	Review, reject or approve
1.18.3	The Contractor shall carry out pre-works survey after clearing, grubbing, and stripping has been undertaken and provide this to the Superintendent	Review, reject or approve
2.10	Suitability and accessibility of tailings from TSF2 shall be agreed with the Superintendent prior to borrowing	Inspect, reject, or approve
3.3	The Contractor shall mark the completed stripped areas, or their parts, and notify the Superintendent who shall inspect and approve the marked areas	Inspect, reject, or approve
3.3	The Superintendent may instruct the Contractor to further strip the areas with visible roots and other organic materials. The Contractor shall mark the areas selected by the Superintendent, undertake the further stripping, and notify the Superintendent who shall inspect and approve the selected areas	Inspect, reject, or approve
3.4.1	Excavation works shall not commence in any area prior to inspection and approval of the Contractor's survey markers in that area by the Superintendent	Inspect, reject, or approve
3.4.1	After an excavation has been completed to the lines, levels and grades as specified, the Contractor shall notify the Superintendent giving a minimum 1-day notice period, who shall inspect the Works.	Inspect, reject, or approve



Clause no.	Requirement	Superintendent's Role
3.4.2	Potential soft ground areas within the foundation areas and footprint areas of the embankment shall be brought to the attention of Superintendent for confirmation. Potential soft ground shall not be removed without written approval from the Superintendent	Inspect, reject, or approve
3.4.7	The centreline of the cut-off trench is to be confirmed following review of the post stripping survey	Review, modify, reject, or approve
3.4.7	The Contractor shall mark the completed section(s) of the cut-off trench and notify the Superintendent, giving a reasonable notice period, who will inspect the completed cut-off trench section(s).	Review, modify, reject, or approve
3.6.1	The preparation of all foundations shall be in accordance with this Specification. Prepared areas shall be presented to the Superintendent for inspection and approval prior to any further placement of material	Inspect, reject, or approve
3.6.2	The Contractor shall remove all loose, soft material to the depth of stiff residual soils and/or extremely weathered materials. The foundation preparation will be subject to approval by the Superintendent following inspection and survey	Inspect, reject, or approve
3.7.1	A detailed construction method to construct embankments and decant ramps shall be developed by the Contractor for the project as a part of the final tender submission	Review, modify, reject, or approve
3.8.1	The final alignment and levels of the underdrainage will be confirmed by the Superintendent prior to construction based on the actual surface levels provided by the Contractor	Confirm alignments and levels
3.8.1	The prepared foundation surfaces shall be surveyed, inspected, and approved by the Superintendent prior to the placement of geotextile around the Draincoil pipes	Inspect, reject, or approve
3.8.4	All pipes shall be surveyed by the Contractor and inspected by the Superintendent prior to the placement of backfill	Inspect, reject, or approve
3.8.5	The Contractor shall submit all pressure tests to the Superintendent prior to the trench backfilling	Review, reject or approve
3.8.5	All pipes shall be surveyed by the Contractor and inspected by the Superintendent prior to the placement of backfill	Inspect, reject, or approve
3.8.6	The details of the cross connection will be confirmed by the Superintendent prior to installation	Confirm details
3.10	Following stripping, any required excavations and backfilling, the Contractor shall regrade the floor such that no slopes exceed 1V: 10H. The Contractor shall survey the floor to demonstrate compliance	Inspect, reject, or approve
4.4.1	The Liner Installation Contractor shall submit the following to the Principal for review and approval prior to installation of the bituminous geomembrane Delivery, storage, and handling log for all BGM rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling. Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation. Certification from the CQA Inspector and Liner Installation Contractor of the acceptability of the surface on which the BGM is to be placed, immediately prior to BGM placement.	Inspect, reject, or approve
4.11.1	The Liner Installation Contractor shall confirm that the supplied BGM properties comply with the requirements of Table 10 and advise the Principal of any variations noted prior to use	Confirm properties
4.12.2.1	Prior to the placement of BGM, the CQA Inspector and Liner Installation Contractor shall inspect the surface on which BGM is to be placed and certify in writing that the surface is acceptable	Inspect, reject, or approve
4.12.3	BGM shall be anchored on embankments as indicated on the drawings	Confirm alignments and levels

Clause no.	Requirement	Superintendent's Role
4.13.2	The Contractor shall deploy the BGM panels in general accordance with the layout drawings specified approved by the Principal prior to installation of any geomembrane.	Inspect, reject, or approve
4.14.1	Trial seams shall be made each day prior to production seaming	Inspect, reject, or approve
4.15	Attachments to concrete shall be performed by welding the BGM directly on the surface previously primed with welding primer material described in Clause 4.11.1	Inspect, reject, or approve
4.16.1	The Liner Installation Contractor shall undertake destructive testing on BGM liner as specified	Inspect, reject, or approve
4.16.2.1	The Liner Installation Contractor shall undertake Field Seam Continuity tests as the work progress and if failure, remediate accordingly	Inspect, reject, or approve
4.16.2.2	The Liner Installation Contractor shall undertake leak detection tests on all BGM lined surfaces, and if failure then remediate accordingly before the liner can be accepted	Inspect, reject, or approve
6.1.3	Inspection and Test Plans (ITPs) shall be submitted by the Contractor to the Superintendent on an on-going basis during the course of the Work but at least ten (10) days prior to the commencement of the item of work to which the ITP applies	Review, reject or approve
6.1.3	A detailed lot structure plan shall be submitted to the Superintendent minimum 10 days prior to commencement of the Works	Review, modify, reject, or approve

The Contractor shall present a list of Suppliers and Sub-Contractors undertaking any parts of the Works as part of the final tender submission. The Contractor shall not use any other suppliers and/or subcontractors for the Works without prior written permission from the Superintendent.

Hold points in relation to BGM liner installation shall, as a minimum include, but not be limited to:

- Pre-Construction Meeting prior to start of liner installation.
- Approval of Contractors Quality Control Methods and Procedures.
- Approval of BGM supplier and installation contractor.
- Approval of BGM Delivery, Installation and Welding Methodology.
- Approval of BGM Procedures.
- BGM Trial seams.
- BGM Surface preparation approval.
- Approval of installed BGM.
- Practical completion after cleaning up.
- Additional as instructed by the Principal.

## 6.1.6 Non-conforming works

In the event that a Lot, or any part thereof, does not conform to the requirements of the Quality Plan, the Contractor shall promptly initiate a Non-Conformance Report (NCR) in accordance with the Quality Plan. In addition, the Superintendent may initiate a Non-Conformance Report for non-conforming work.

The Contractor shall notify the Superintendent of all non-conformances within 24 hours of the non-conformance being detected. If the Contractor proposes a disposition, with respect to any non-conforming work under the Contract or with regard to materials, which differs from the requirements of the Specification, such a disposition shall be submitted in writing to the Superintendent. Work shall not proceed on the Lot to which the non-conformance refers until such time that the Superintendent has approved the disposition or an amended disposition, as the case may be, in writing.

If appropriate for the particular non-conformance in question, the Contractor shall issue a Corrective Action Report (CAR) or similar in accordance with the Quality Plan.

## 6.1.7 Quality assurance audits

The Superintendent reserves the right to reasonable access to the Contractor's facilities and Quality Assurance records for the purposes of Quality Assurance Audit and inspection throughout the Contract period.

The Superintendent requires that the Contractor's Quality Control System shall be subjected to formal audits by the Superintendent during the Contract. Such audits shall be scheduled at the beginning of the Contract, during the Contract period and at the end of the Contract.

The Contractor's Quality Plan shall define the method for performing audits, responsibility for performing the audits, and an audit program. The documentation required for the audit shall also be defined along with the procedures for correcting discrepancies discussed during such audits.

## 6.1.8 Quality records

The Contractor shall establish, file, and maintain at the Site Office, or other location approved by the Superintendent, up to date records which demonstrate that the Contractor's Quality Management System is being effectively implemented. All test results shall be verbally communicated to the Superintendent as soon as the results become available; and within 24 hours of completing testing on any Lot the Contractor shall deliver to the Superintendent copies of summary sheets and/or test results applicable to that Lot.

Throughout the Contract, the Contractor shall maintain a record of data specified within this Specification. Prior to the issue of the Certificate of Practical Completion, the Contractor shall deliver to the Superintendent a report with a copy of all the construction procedures, ITPs and a copy of all test records and summary sheets.

## 6.1.9 Construction quality assurance and quality control for BGM installation

### 6.1.9.1 Construction Quality Assurance / Quality Control

The Manufacturer and the Liner Installation Contractor shall conform to the minimum Quality Assurance/Control Program detailed in this section.

### 6.1.9.2 General requirements

The Liner Installation Contractor shall perform CQC testing of the type and frequency indicated below.

Table 11 CQC testing type and frequency

Test	Frequency
Visual Inspection using trowel methods	All Seams
Air Lance Test	All Seams
Vacuum Box test	Every 1,000 m <sup>2</sup>
Electrical leak survey in accordance with ASTM D7953: Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method.	All surfaces lined with BGM.

### 6.1.9.3 Documentation and reporting

Prepare and submit the following:

Daily report:

- BGM delivery records with MQA verification
- Summary of work completed
- List of equipment working on project



- Number of personnel in each trade
- Results of CQC field and laboratory testing and test data sheets
- Repair records (including documenting the location of all repairs on layout plan.)
- Description of incidents and problems, and steps to solve them and prevent re-occurrence

#### Weekly field summary report

- Summary of work completed
- Summary of CQC field-testing with diagrams showing locations of tests
- Summary of CQC laboratory testing with diagrams showing locations of acquired samples

### 6.1.9.4 Field inspection of liner and testing of seams

#### 6.1.9.4.1 By Liner Installation Contractor

Carry out inspection of membrane after installation and perform destructive and non-destructive testing of seams in accordance with Clause 4.14 and Clause 6.1.9.2.

#### 6.1.9.4.2 By CQA Inspector

The CQA Inspector will perform CQA inspection of the liner and will periodically audit the Liner Installation Contractor's CQC procedures and documentation. The Liner Installation Contractor shall correct any deficiencies identified by the CQA Inspector promptly.

The Liner Installation Contractor shall cooperate with the CQA Inspector and provide access by CQA Inspector to liner for inspections. The liner shall not be covered before the CQA Inspector has given written approval of material and seams.

### 6.1.9.5 Flaws in membrane

Flaws, which shall be repaired, shall not exceed one per 500 m<sup>2</sup>. Edge flaws will only be accepted if they do not interfere with the seaming process. Defects such as holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, shall result in rejection of the roll.

## 6.2 Compliance testing and procedures

### 6.2.1 Methods of testing

Unless otherwise specified, the Contractor shall demonstrate the compliance with this Specification using as minimum the tests listed in Table 13.

Table 12 Compliance method testing summary

Type of test or methods	Tests or methods reference
Concrete Slump Test	AS 1012.3.1
Concrete Compressive Strength Test	AS 1012.9
Liquid Limits Test	AS 1289.3.1.1
Plasticity Index Test	AS 1289.3.3.2
Soil Particle Density Test	AS 1289.3.5.1
Particle Size Distribution Test	AS 1289.3.6.1
Organic content in soil	AS 1289 4.1.1
Standard Compaction Test	AS 1289.5.1.1
Modified Compaction Test	AS 1289.5.2.1
Sand Replacement Test	AS 1289.5.3.1

Type of test or methods	Tests or methods reference
Compaction Control Test (Dry Density Ratio)	AS 1289.5.4.1
Compaction Control Test (Hilf Density Ratio and Hilf Moisture Variation)	AS 1289.5.7.1
Nuclear Densometer Test	AS 1289.5.8.1
Permeability Tests	AS 1289.6.7.1
Shrinkage Index Tests	AS 1289.7.1
Specification and Supply of Concrete	AS 1379
Concrete Structures	AS 3600
Formwork for Concrete	AS 3610
Geotextiles - Methods of Test	AS 3706
Pipe Pressure Testing	AS 4037
Polyethylene (PE) Pipes for Pressure Applications	AS 4130
Polyethylene (PE) Compounds for Pressure Pipes and Fittings	AS 4131

## 6.2.2 Approved laboratories

All compliance testing shall be performed by an onsite NATA registered laboratory subcontracted to the Contractor as approved by the Superintendent. The Contractor / Liner Installation Contractor shall provide details of their proposed laboratory as a part of the final tender submission.

All test reports shall be NATA endorsed by a current NATA signatory for the laboratory conducting the testing.

At the commencement of the Contract and at any other time as required by the Superintendent, the soil tester and NATA registered laboratory shall provide the Superintendent with copies of the calibration certificates for all testing equipment in use on the Works.

## 6.2.3 Compliance testing of construction materials

To demonstrate compliance with this Specification, the Contractor shall conduct the compliance testing included herein. Compliance Testing shall include but not be limited to the tests / procedures summarised in Table 13.

Table 13 Compliance testing summary

Material type	Type of test	Minimum testing frequency	Clause reference
Foundation preparation for embankment	Modified compaction. Can be substituted by sand replacement if gravelly foundation is observed	2 tests per Lot. Testing to apply to upper 150 mm of existing material	Clause 3.6.2 and 3.6.3
Internal fill / General fill	Atterberg limits (index testing), modified compaction	One test per 2,500 m <sup>3</sup>	Clause 2.5
Subgrade material for BGM placement	Atterberg limits (index testing)	One test per 2,500 m <sup>3</sup>	Clause 2.3
Internal fill / General fill	Modified Compaction Test	One test per 2,500 m <sup>3</sup>	Clause 2.5
Internal Fill / General fill	Organic content	As required	Clause 2.5
Tailings sand	Particle Size Distribution and Moisture Content	One test per 5,000 m <sup>3</sup>	Clause 2.10 and 3.7.4



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