Technical Specification

Salt Valley Road Landfill – Cells 5 and 6 Lining Works

Prepared for Opalvale Pty Ltd

31 July 2024

Project Number: TW24011

DOCUMENT CONTROL

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Name	Position	File Reference
[redacted]	Waste Infrastructure Lead	TW24011-01_Opalvale Cell 5&6 Tech Spec_1.0
Signature	[redacted]	

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1 Introduction

The work under this Technical Specification consists of all stages of work associated with the Lining System (the Works) for the development of Cell 5 and Cell 6 at the Salt Valley Road Class II Landfill (the Site) for Opalvale Pty Ltd (the Principal). This document forms part of the Contract Documents with the full list described in Section 1.5.

1.1 Site Description

The Site is located approximately 80 kilometres (km) east of Perth and comprises part of Lot 11 Chitty Road on Deposited Plan 34937. The Site occupies an area of approximately 48 hectares (ha) and is located at the Williamsons Clay Pit and is situated on the southeastern portion of Lot 11. The Site can accept up to 150,000 tonnes per annum (tpa), with the Site having the following features:

- A weighbridge for secure site access;
- A site office;
- Putrescible Landfill Cells 1, 2, 3 and 4 surrounded by a 2m high chain-link fence;
- Asbestos Disposal; and
- Three leachate evaporation ponds.

Cells 1, 2, 3 and 4 are approaching the end of their lifespan and the Principal seeks services for the construction of Cells 5 and 6 to extend the lifespan of the Site.

1.2 Location

The Site Boundary is shown in Licence L9089/2017/1 and depicted on Drawing TW24011-W-101.

Access to the site is via Salt Valley Road, with an internal road providing access to the landfill cell.

1.3 Geology

The Department of Mines, Industry Regulation and Safety (DMIRS) Geological Survey of Western Australia (GSWA) 1:500,000 map series describes the underlying bedrock geology as “quartz – mica schist; includes sillimanite, andalusite, kyanite, graphite, and staurolite bearing varieties”. The surface geology has been described as “yellow gravelly loamy sand to depth of approximately 0.5m, underlain by sandy clay” by Stass Environmental.

Based on maximum inferred groundwater levels from the nearest monitoring bores, groundwater within the footprint of the location of proposed cells is at a depth of approximately 276m AHD.

1.4 Scope of Works

The works to be carried out under this Specification include, but are not limited, to the following:

- Removal and stockpiling of temporary fencing along Cell 1,2&4 interface with Cell 5 and 6;
- Preparation of subgrade surface;
- Supply & Installation of the geosynthetic composite lining system;

  - Geosynthetic Clay Liner (GCL);
  - 2mm High Density Polyethylene (HDPE) Double Textured Geomembrane;
  - Protection Geotextile;
  - Leachate Collection Layer – 300mm thick highly permeable low calcareous aggregate; and
  - Separation geotextile.
- Supply and installation of leachate collection pipework comprising:
  - DN225mm HDPE perforated primary pipework; and
  - DN160mm HDPE perforated secondary pipework.
- Construction of leachate extraction and transmission infrastructure comprising:
  - Reinforced concrete slab in sumps;
  - DN355mm HDPE double side riser pipes;
  - DN160mm HDPE leachate monitoring pipes;
  - Side riser concrete headwall and pump control cubicle
  - Supply and installation of ;
  - DN110mm HDPE leachate main and rodding points.
- Installation of a chain-link feral animal fence around the perimeter of Cells 5 & 6 with vehicular access gate.

1.5 Tender Documentation

The following Scope of Works, reports and contracts form the Tender Documentation for this Project:

- This Specification;
- Bill of Quantities;
- Drawings;
- Request for Tender;
- Construction Quality Assurance Plan; and
- Conditions of Contract.

1.6 Drawings

The drawings in Table 1-1 form part of the Tender Documentation.

Table 1-1: List of Drawings

Drawing Number	Drawing Title
TW24011_W-101	Site Layout and Topography
TW24011_W-103	Top of Engineered Fill Levels
TW24011_W-104	Cell 5 Leachate Management Layout
TW24011_W-105	Cell 6 Leachate Management Layout
TW24011_W-301	Basal Lining System Typical Details Sheet 1 of 2

TW24011_W-302	Basal Lining System Typical Details Sheet 2 of 2
TW24011_W-303	Leachate Management Typical Details Sheet 1 of 2
TW24011_W-304	Leachate Management Typical Details Sheet 2 of 2

1.7 Interpretation

Whether or not the words 'provide,' 'install' and/or 'supply' appear in the Tender Document, all equipment for the complete installation shall be provided and installed by the Contractor. Where equipment is to be provided and installed by others, it will be stated.

Terms in use within this Specification are clarified as follows:

- 'Approved', 'directed', 'required', 'rejected', and similar expressions, shall mean approved, directed, required, rejected, and the like, by the Superintendent;
- 'Provide' shall mean the supply and complete installation of the item to the satisfaction of this Specification;
- 'Supply' shall mean supply and delivery without installation;
- 'Install' shall mean complete installation of the item to the satisfaction of this Specification excluding supply;
- Manufacturer's Specifications – applied as directed by the manufacturer by an experienced person with the nominated product;
- 'Give notice', 'submit', 'furnish', and similar expressions, shall mean given notice, submit, furnish, and the like, to the Superintendent;
- 'The Contractor' shall mean the future company contracted by the Principal to execute the works and complete the project;
- 'The Principal' shall be as defined in the Conditions of Contract and for this Project will be Opalvale Pty Ltd (Opalvale); and
- 'The Superintendent' shall be as defined in the Conditions of Contract and for this Project will be Opalvale or their appointed representative.

2 General

2.1 Compliance with the DWER Licence and Licence Amendment

Operations at the Site are governed by Licence L9089/2017/1 under Part V of the *Environmental Protection Act 1986 (WA)*. A copy of the Licence may be viewed on the Department of Water and Environmental Regulation (DWER) website (www.der.wa.gov.au).

The Contractor shall comply with the relevant conditions of the Licence and any subsequent conditions issued by the DWER during the contract.

The rates submitted by the Contractor should allow for compliance with the conditions of the Licence.

2.2 Quality Management

2.2.1 Quality Plan

For all works the Contractor shall plan, develop, document and implement a Quality System based on the principles and practices specified in the AS/NZS ISO 9000 series.

Details of the Contractor's proposed Quality Assurance Plan shall be submitted to the Superintendent for approval within seven (7) days from the Date of Acceptance of Tender. Any delay by the Contractor in obtaining the approval of the Quality Plan by the Superintendent shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent has taken more than seven (7) days to reply to the Contractor's submission.

Works shall not commence until the Superintendent has approved in writing the Contractor's Quality Plan.

2.2.2 Quality Plan Requirements

The Contractor's Quality Assurance Plan shall incorporate:

- Such measures as are necessary to trace each product or service from receipt through to construction;
- Quality assurance and quality control procedures covering all material supply, manufacture and construction carried out by the Contractor and any of its Sub-Contractors;
- Quality control tests and inspections shall include, but not be limited to, the following:
    - The tests and inspections required in accordance with this Specification. The frequency of such tests and inspections shall not be less than the requirements set out in this Specification; and
    - Such tests as are necessary to demonstrate that materials and equipment comply with the requirements of this Specification.

Whenever practicable, the Contractor shall carry out material testing such that the results are available for review by the Superintendent prior to the materials being incorporated into the works. However, should the Contractor proceed in completing any of the works with materials or services which do not comply with the Quality Plan, then the Contractor shall bear the cost of remediating or replacing any non-compliant work.

The Contractor's traceability procedures shall include, but not be limited to, a means of identifying in the works, and the location of all materials represented by a sample which has undergone a quality test.

2.2.3 Quality Plan Contents

The Quality Plan shall include, but not be limited to the following:

- Inspection and test plans for all materials and construction work;
- Items that require approval of the Superintendent before proceeding;
- Non-conformance identification and action procedures;
- Details of quality personnel and relationship to the company; and
- Safety procedures and checklists.

2.2.4 Construction Quality Assurance (CQA) Plan

The supply, storage and placement of Geotextiles and Geomembranes shall be carried out following the below order of precedence:

- The Technical Specification & Construction Quality Assurance (CQA) Plan; and
- Manufacturer's Instructions.

2.3 Programme of Works

The Contractor shall provide a Programme of Works in accordance with the following requirements:

- The Contractor must submit a detailed Construction Programme to the Superintendent for acceptance within seven (7) days of the Date of Acceptance of Tender.
- The Construction Programme must:
  - Be submitted in accordance with (a-e) below; and
  - Comply with the Date of Practical Completion set out in Annexure A to the General Conditions of Contract.

If the Superintendent considers that the Construction Programme submitted does not show sufficient details or does not conform to the requirements of the Contract, then they may direct by written notice, the Contractor to amend the programme. Such amendments shall be provided within seven (7) days of issuing the written notice.

The Construction Programme submitted, and any subsequent amendments thereto submitted by the Contractor shall, when accepted by the Superintendent, be termed the Construction Programme.

Details to be shown on the Construction Programme shall include, but not be limited to:

a. Details of the proposed order of work and the planned dates of completion of the various parts of the works;
b. Placing of orders by both the Contractor and Sub-Contractors;
c. Hold points at listed in Section 2.6;
d. Tests and inspections; and
e. Dates of site testing and commissioning.

The Contractor must provide an updated Programme whenever directed by the Superintendent. At intervals determined by the Superintendent, but not exceeding 28 days, the Contractor and the Superintendent together, shall review the actual progress of the works in comparison with the Construction Programme. If in the opinion of the Superintendent, this review shows that the Contractor will not complete the works by the Date of Practical Completion, the Contractor shall within seven (7) days, amend the Construction Programme so that it complies with the date of Practical Completion stated in Annexure A to General Conditions of Contract and resubmit it to the Superintendent for acceptance.

The Contractor shall not commence works on-site until the Construction Programme has been agreed by the Superintendent. Failure to provide the programme or sufficient detail contained thereon shall not relieve the Contractor of the responsibility for completing the project by the date stated in the Conditions of Contract.

The rates submitted by the Contractor should allow for completing the project in the timeframe set out above.

As much of the work is weather dependent, the Contractor shall make due allowance when resourcing the works to accommodate bad weather by accelerating output if necessary to achieve the deadline.

2.4 Hours of Operations of the Site

The Site is operational by the Principal between the hours of 07:00 and 18:00 Monday to Saturday, excluding public holidays, when the Site is closed.

The normal working hours for this Contract shall be the Site's operational hours as mentioned above, unless specified elsewhere in the contract documents. Exceptionally, the Principal's consent for work outside these hours may be given after any necessary application and consultation with the appropriate authorities. Five working days' notice is required from the Contractor when seeking such consent.

Should the Contractor wish to undertake work outside these hours to perform works that are subject to weather conditions e.g. Installation of Basal Liner/tie-in welds, all night work will require portable lighting. All health and safety controls and costs that are incurred by the Contractor, performing work outside of normal hours shall be deemed to be included in tendered rates.

The Contractor shall employ the best practical means to minimise noise produced by their operations including plant maintenance and shall comply with the recommendations in AS 2436.

2.5 Time for Completion

With the Tender, a realistic time for completion shall be submitted, in accordance with the practical completion date documented in Item 7 Annexure Part A of the Conditions of Contract. This time shall include for all annual holidays, public holidays and weather constraints. This realistic time will be presented in the programme of works as described in Section 2.3.

2.6 Hold Points

The critical hold points for completed works that require the Superintendent and/or the CQA Auditor to check and sign off before the preceding works commence are listed in Table 2-1.

Table 2-1: Project Hold Points

Hold Point Number	Item	Description
1	Pre-commencement Check Survey	Section 2.10.1
2	Approval of Contractor's Management Plans	Section 2.13
3	Approval of Engineered Fill Testing	Section 4.1.3
4	Approval of Engineered Fill Surface	Section 5.1.5
5	Approval of GCL Conformance Testing	Section 5.2.1
6	Approval of GCL Installation	Section 5.2.2
7	Approval of HDPE Conformance Testing	Section 5.3.1
8	Approval of HDPE Non-Destructive Testing	Section 5.3.4.1
19	Approval of HDPE Destructive Testing	Section 5.3.4.3
10	Approval of Geomembrane Ballasting	Section 5.3.5
11	Approval of Protection Geotextile/Leachate Drainage Aggregate Performance testing	Section 5.4
12	Approval of Cushion/Protection Geotextile Conformance Testing	Section 5.4.1
13	Approval of Cushion/Protection Geotextile installation	Section 5.4.2
14	Separation Geotextile Conformance Test	Section 5.5.1
15	Separation Geotextile Installation	Section 5.5.2
16	Anchor Trench Backfilling	Section 5.6
17	Leachate Drainage Aggregate Laboratory Testing	Section 6
18	Approval of Leachate Collection Layer thickness by survey	Section 6.1
19	Approval of the Leachate Drainage Aggregate Laboratory Testing	Section 6.2
20	Approval of Leachate Collection pipework deflection Calculations	Section 7.1.3
21	Approval of Geomembrane Liner Integrity Testing	Section 9

2.7 Site Meetings

The Contractor and any Sub-Contractors that the Contractor deems necessary shall attend a Preliminary Site meeting with the Superintendent and/or the Principal. The meeting will include, but not be limited to, a walk-over of the Site and an opportunity for the meeting attendees to discuss any outstanding issues relating to the works.

The Contractor shall attend Site Meetings when requested by the Superintendent or Client for the proper management and supervision of the contract works. The tendered price shall allow for attendance on-site by the Contractor and/or Sub-Contractors (Domestic or Nominated). Regular meetings shall be called to discuss, but not be limited to:

- Information flow;
- Occupational Health & Safety;

- Co-ordination;
- Resources;
- Progress;
- Quality;
- Procurement; and
- Costs.

The Superintendent shall minute the meetings and distribute the minutes within two working days of the meeting ending. The minutes will include all items discussed and in particular actionable items discussed and the person responsible for closing out that item with the due date.

2.8 Safe Work Method Statements/Procedures

Safe Work Method Statements/Procedures (SWMS or SWP) are required for all major works to include, but not be limited to, the Scope of Works outlined in Section 1.4. The Contractor shall submit relevant SWMS to the Superintendent prior to the works commencing that at a minimum shall address the following:

- Describes how the works are carried out;
- Identifies the work activities assessed as having safety or environmental risks;
- States what the safety and environmental risks are;
- Describes the control measures that will be applied to the work activities to minimise risks to the environment and ensure safety of the workers and end users;
- Describes how measures will be implemented to do the work in a safe and environmentally sound manner;
- Outlines the legislation, standards, and codes to be complied with; and
- Includes a description of the equipment used in the work, the qualifications of the personnel doing the work and the training required to do the work in a safe and environmentally sound manner.

The cost of providing the method statements is to be included in the rates associated with the aspects of the work the method statement relates. If the Superintendent considers that the SWMS submitted does not show sufficient details, is impracticable or does not conform to the requirements set out above, the Superintendent may direct the Contractor to amend and resubmit the SWMS.

The Superintendent's acceptance or non-acceptance of the submitted SWMS does not remove the liability for the works from the Contractor.

2.9 Use of Sub-Contractors

Before commencement of the works, the Contractor shall give full particulars of the Sub-Contractors, if any, it proposes to use for items of work under the Contract. Sub-Contractors shall not be used for any portion of the works without the prior written approval of the Superintendent.

Sub-Contractors shall be skilled in their respective trades and shall provide Certificates of Competency for each employee.

The Sub-Contractors are to provide SWMS for their work a minimum of two weeks prior to commencing on-site as outlined in Section 2.8. The main Contractor is to provide a SWMS pertaining to the Contractor's responsibilities for the Sub-Contractor. The Contractor's SWMS shall also highlight where assistance shall be provided to the Sub-Contractor.

2.10 Drawings and Schedules

The Contractor shall be responsible for checking all Drawings prior to the commencement of the works. If the Contractor discovers any discrepancies between the various Contract Documents or if the Contractor considers that additional Drawings or information are required, then in either case the Contractor shall report such inconsistency to the Superintendent for instruction or apply in writing for such detail drawings or information at least 28 days before the work concerned is to be initiated. This four-week period shall allow the Superintendent to provide any additional information that may be required.

The Contractor shall not be entitled to claim for any additional cost during this four-week period as a result of delays or other increased expenditure which it may incur by not advising the Superintendent in a timely fashion of any discrepancy or query in the information provided.

The Contractor shall be responsible for the preparation of manhole, chamber, ducting, pipeline and finishing schedules, from the contract Drawings, as it deems necessary for the satisfactory completion of the works. These may be requested by the Superintendent for approval.

2.10.1 Setting out the Works

The Contractor shall be responsible for setting out the works. The Contractor shall be supplied with electronic information, in the form of digital terrain model (DTM), with which to establish the lines and levels of the works.

The Contractor will perform a pre-commencement check survey to satisfy itself that the site conditions at the site handover have not changed since the design documentation was produced. This constitutes a Hold Point.

The Map Grid of Australia Zone 50, using GDA94 shall be used for the setting out of the works.

The Contractor shall provide all necessary hardware and software on-site, a drawing package compatible with AutoCAD, electronic surveying equipment and suitably qualified staff, which will enable it to determine setting out co-ordinates at locations deemed necessary.

All control points and reference points shall be clearly marked and where appropriate bedded in concrete. They shall be adequately protected during the construction of the works. Where it is necessary to remove a control point, additional reference points shall be provided to the satisfaction of the Superintendent.

Prior to commencing construction, the Contractor shall check all centre lines, prominent footprints and grid lines in sufficient detail to ensure that the work is fully compatible with existing features.

Where design conflicts are identified or the required levels, grades, alignments, or geometry cannot be achieved for reasons beyond the Contractor's control, the Contractor must bring this to the attention of the Designer prior to commencement of the Works. The Contractor must not modify or adjust the 3D models without prior written consent from the Designer. Check surveys for

comparison against the tolerances described in Section Error! Reference source not found. **must be based on the original DTM unless otherwise approved in writing by the Designer.**

The setting out of the works shall be perfectly co-ordinated with and shall be continuous with that of any adjacent works. The Contractor shall, when instructed by the Superintendent, make any adjustments necessary to satisfy these requirements. Where appropriate, reference points shall be adjusted to take account of the new locations of the master control points.

Subsequently, the Contractor shall be fully responsible for the setting out of the works and the Superintendent accepts no responsibility for replacing any of the master control points or master levels where given. The Superintendent's acceptance or non-acceptance of the setting-out does not remove the liability for the works from the Contractor.

2.10.2 Working and Fabrication Drawings

Whenever required by the Superintendent, the Contractor shall supply calculations, test reports, data sheets, etc., in support of its detailed working and fabrication drawings. Such documents shall remain the property of the Superintendent.

The Contractor shall submit three copies of all relevant documents to the Superintendent at least four weeks in advance of the date on which the Contractor proposes to commence such works.

Drawings shall be to an appropriate scale and in sufficient detail to enable the Superintendent to assess the Contractor’s proposals.

2.10.3 As-Built Drawings

The Contractor shall supply as-built records, Drawings, details, and surveys etc. of all completed work. These records are to be submitted in full to the Superintendent within one month of practical completion of the works in AutoCAD and PDF electronic formats.

Notwithstanding the above timescale, the Contractor shall note that certain as-built drawings are required to accompany the CQA report as specified elsewhere in this document. The Contractor shall note that the main contract works may only be offered for handover to the Principal upon approval of validation report.

The following is a list of minimum criteria to be adhered to when creating the as-built drawings:

- Line types and colours shall be set 'By Layer';
- Layer names should not be abbreviated, and must be self-explanatory;
- All break lines to identify toes and crests of earthwork slopes;
- Units shall be in metres;
- Levels to Australian Height Datum (AHD); and
- Common Site layouts such as surveys, as-built buildings and road layouts shall be externally referenced to all relevant drawings (insert 0, 0, 0 (X, Y, Z) and to Map Grid of Australia Zone 50, using GDA94).

The as-built drawings must detail the following:

- Formation level survey;

- Engineered Attenuation Layer survey;
- Construction details including levels and slope angles for the basal liner system;
- Location of leachate collection and extraction pipework including connections of primary pipework to secondary pipework;
- Top of Leachate Drainage aggregate collection layer levels including mounding of material over pipework (top of bank and bottom of bank each side of mound);
- Location and inverts of leachate extraction pipework and sumps;
- Locations and identification marks of each geosynthetic panel, including anchor trenches;
- Locations of damaged areas and penetrations; and
- Locations of patch repairs.

2.11 Surface Water and Groundwater Management

Where not included in the permanent works, the Contractor shall make allowances in his system of working and pricing for dewatering both surface and subsurface water if required and permitted.

The Contractor shall sequence the works to minimise the build-up of surface water within and outside the Site as a result of its actions and allow for all arrangements for evaporation on-site. Where it is necessary and permitted to discharge water or groundwater, the Contractor shall not cause overtopping and erosion of any part of the downstream surface water network. In any case, measures shall be implemented to prevent silt entering the offsite surface water network.

Where the sequence or method of work is such that there is a build-up of water within or outside the Site Boundary, the Contractor shall be liable for the expense of dewatering, control and, if necessary, remediation to the infrastructure.

Unless permitted, the build-up of any surface water may not be discharged to the groundwater regime.

2.12 Site Boundary

The Site Boundary shall be as identified on the Drawings.

Should other Contractors, Principal Workers, and/or public be operating on-site during this contract, all elements of the works shall be arranged such as to minimise contact. This may require adherence to new haulage routes and variations to the proposed phasing of the works as agreed with the Superintendent.

2.13 Traffic Requirements

2.13.1 General

The Contractor shall submit a Traffic Management Plan (TMP) for the works to the Superintendent for approval at least 5 days prior to commencement of works. This constitutes **Hold Point**. The Contractor shall implement and maintain the endorsed TMP during the works.

The Contractor shall provide traffic signs and undertake any temporary works to comply with the requirements of the Contract. All signs and method of traffic control shall be generally in accordance with AS 1742.

Should circumstances arise which are not adequately covered in this section, the Contractor shall submit alternative proposals to the Superintendent for review and approval prior to works proceeding.

The Contractor shall be liable for any accident, damage or injury to any person and/or any claim or litigation or other matters arising out of the works of this Contract.

2.13.2 Traffic and Safety Management – Internal Road Network

The Contractor shall acknowledge that the Site as a whole is not open to the public but is open to third party companies and the Principal's own staff and vehicles. This flow of traffic has priority over usage of the internal road network. In carrying the works, the Contractor shall not adversely impact the smooth traffic flows for other users. Where the Contractor, its Sub-Contractors and/or suppliers causes congestion or blockages, the Superintendent may require immediate removal of the offending vehicles, plant, equipment and/or supplies regardless of the consequences to the Contractor's operations.

The Superintendent will not entertain any claim for financial compensation or extension of time to the Contract as a result of the removal of the congestion or blockages.

Where the Contractor, Sub-Contractors and/or Suppliers has vehicles which crosses from non-metalled surfaces to asphalt roads, the Contractor shall ensure that no detritus, mud, litter, or other contamination is transferred to the road network. Where the road network surrounding the Site becomes dirty or contaminated, the Superintendent shall require the Contractor to clean the surfacing.

The Contractor shall include cleaning the road surfacing in its pricing structure.

2.13.3 Traffic and Safety Management – External Road Network

All necessary traffic safety precautions shall be taken by the Contractor to ensure the safety of all traffic and pedestrians using the existing roads adjacent to the Site and connecting minor roads during the execution and completion of the works, and all precautions shall be taken to minimise disruption to the local residents.

The Contractor shall ensure that no item of plant, goods, vehicles and/or equipment (including stores or offices) shall be temporarily placed or parked on the public roadway or its verges in a manner which may result in danger to the personnel on the Site or members of the public, or which may restrict sight distances on all accesses to the Site or on public roads.

The Contractor shall ensure that no plant, equipment, goods and/or vehicles shall be parked overnight on the public roads adjacent to the Site.

2.13.4 Cleaning and Damage to Roadways

All roads, accesses, drains, ditches and grips shall be kept clear of all dirt, mud and material arising from the execution and completion of the works and suitable clearing equipment and labour shall be provided by the Contractor for this purpose.

Particular attention shall be paid to the loading of trucks carrying bulk materials into the Site and spoil from the Site to ensure that these shall not be overloaded or loaded in such a way that spillage shall be unavoidable. Any dirt or mud adhering to the tyres or chassis of any vehicles shall be thoroughly cleaned off before the vehicle shall be permitted to leave the Site. In the case of delivery to the Site, vehicles shall be thoroughly cleaned before they leave the point of collection. The Contractor shall be equally responsible for the vehicles of their Sub-Contractors and Suppliers and the like.

Despite any measures and actions undertaken by the Contractor, should it not prove successful in clearing the roads in a timely manner, then the Superintendent will arrange for professional street cleaners to undertake the work. The cost of doing this shall be subtracted from the monthly or final valuations.

The Contractor shall take particular care to avoid damage to roads, footpaths, grass margins and other surfaces outside of the authorised Site and shall be liable for the cost of repairing all such damage caused by the Contractor's operations to the satisfaction of the Superintendent and the Principal. The Contractor shall also take precautions to prevent spillage of diesel fuel or solvents. Should a spillage arise from either the Contractor, its Sub-Contractors or Suppliers then it will promptly clear up the spillage and remediate any damage.

The Contractor shall have regard to the maximum legal permissible loads for public roads and, where requested by the Superintendent, shall provide evidence of compliance with regard to delivery of material to Site. The Contractor shall also prohibit the use of tracked plant on road surfaces outside of the Site unless suitably approved protective measures are taken to safeguard the integrity of the road surfaces. Pumping of water onto a public road or private property shall not be permitted. Heavy discharges to gullies and storm drains shall have silt traps incorporated in the temporary discharge arrangement. Any damage so caused shall be made good by the Contractor at its own expense.

The Contractor must satisfy the requirements of the Chain of Responsibility Legislation with respect to transportation of materials.

https://www.mainroads.wa.gov.au/UsingRoads/HVS/Pages/chainofresponsibility.aspx

2.14 Engineering Control

All verbal instructions given by the Superintendent/CQA Consultant shall be accompanied by a Confirmation of Verbal Instruction (CVI) prior to undertaking in writing or by email. Verbal instructions or verbal requests for information alone shall not be considered binding.

Technical Queries (TQs) from the Contractor to the Superintendent/CQA Consultant are to be issued electronically in a format to be agreed with the Superintendent.

2.15 Variations of Work

Where extra works are ordered, they shall be valued in accordance with the Rates in the Bill of Quantities, where they exist or otherwise in accordance with the Conditions of Contract. Where any additional works are not fully covered by the rates in the Bill of Quantities, the Superintendent will request a separate quotation for the work. Where approved, the Superintendent may commission these works using the Day Rates.

Such works shall not be carried out until a written order has been issued by the Superintendent, and if it is authorised to be carried out on a Time and Materials basis, the Contractor shall submit to the

Superintendent weekly time and material sheets for checking and approval. Payment will not be made for work carried out in this manner unless previously authorised by the Superintendent.

The Superintendent reserves the right on the Principal's behalf to omit any part or parts of the Contract and claims for any loss of profit due to any omissions will not be entertained by the Superintendent unless further specified in the Conditions Contract.

2.16 Dayworks

The Contractor shall provide the following:

- Contractor to submit maximum working hours in a day;
- Dayworks shall be pre-approved by the Superintendent;
- Dayworks shall be signed off by Superintendent at the end of each day; and
- The tendered dayworks rates for all personnel and plant that shall be used during the contract.

The Contractor shall give notice to the Superintendent of the commencement and completion of any work for which the Contractor intends to submit daywork records in accordance with the Conditions of Contract. The Contractor shall submit to the Superintendent at the end of each month an application for payment for all dayworks done in the preceding month.

The dayworks records to support applications for payment will include at a minimum the following:

- Description of work done;
- Operative's name and trade;
- Plant type, make and model;
- Rates and hours worked segregated into normal time; and
- Types and quantities of materials used.

2.17 Control of Environmental Issues

The Contractor shall, within 14 days of the Date of Acceptance of Tender, provide the Superintendent with an Environmental Management Plan (EMP), detailing how the Contractor will implement and maintain environmental management measures to comply with all requirements set out in Sections 2.17.1 to 2.17.9. This plan shall include the name of the relevant manager/supervisor with the primary responsibility for environmental matters and environment related communications.

The Contractor shall address the above commitments in the EMP, as well as the requirements set out in Sections 2.17.1 to 2.17.9 of this Specification.

2.17.1 Noise

The normal working hours within the Site shall be as detailed in Section 2.4 of this Specification. Exceptionally, the Superintendent's consent for work outside these hours may be given after any necessary consultation. Five working days' notice is required from the Contractor when seeking such consent. If complaints are received and justified, during work outside the normal hours the Principal reserves the right to require all construction works to be undertaken during the approved hours.

The Contractor shall employ the best practical means to minimise noise produced by their operations, including plant maintenance, and shall comply with the recommendations in AS 2436.

2.17.2 Mud

The Contractor shall prevent any nuisance occurring through the discharge of dirt, water, fumes, and the like on to persons or property.

The Contractor shall ensure that waste products of whatever description associated with the execution and completion of the works shall not enter watercourses, whether dry or not, which are adjacent to the Site.

2.17.3 Dust

Fine material encountered on the Site is susceptible to erosion by wind under normal wind conditions when the surface material is dry. The Contractor shall provide, use, maintain and keep available plant and equipment necessary to minimise the formation and accumulation of dust arising from the works, normally in dry weather conditions. The Contractor shall implement all measures necessary to minimise wind erosion and prevent material from the Site being blown over or onto property outside the Site or onto others on the Site. The measures shall include, but not be limited to:

- Frequent watering of areas disturbed by the Contractor;
- Not carrying out operations with dust-creating potential at a time of high winds; and
- Control of dust caused by the works.

The Contractor shall allow for any delay and effect on the Contract Programme caused by diverting manpower and equipment to control dust and windborne material.

The Contractor shall be responsible for the cost of controlling dust and windborne material generated by the immediate activities of plant, equipment and/or personnel.

If, during the actual construction of work, the suggested dust suppression measures are found to be insufficient, the responsibility for carrying out additional measures necessary to achieve the desired level of dust suppression rests totally with the Contractor. If this is not carried out in a timely manner, the Superintendent shall arrange for additional dust suppression, the cost of which shall be taken from the monthly or final account.

2.17.4 Contaminated Water and Sewage

The Contractor must, at its own cost, provide toilet and adequate wash facilities for its personnel and that of its Sub-Contractors. These facilities shall be connected to a storage tank, or other facility approved by the Superintendent, which shall have a minimum of 14 days storage capacity and shall be located in a place approved by the Superintendent.

The Contractor shall arrange for the removal of all sewage from the holding tank to be collected at regular intervals and disposed of at approved and lawful locations outside the work site.

2.17.5 Smoking

Smoking is not permitted at the Site unless in authorised areas as agreed by the Superintendent. Smoking is prohibited in Site offices, lunchrooms, or enclosed toilet facilities.

2.17.6 Fire Prevention

No fires shall be set alight by the Contractor under any circumstance. The Contractor shall provide and maintain adequate fire-fighting equipment on-site and must comply with the Bush Fires Act 1954.

2.17.7 Spill Prevention and Response

The Contractor shall plan and execute all works so as to minimise the possibility of pollution of the Site and adjoining areas from chemicals, dangerous goods and other potential contaminants.

The usage, storage and handling of chemicals and dangerous goods shall be in accordance with all relevant legislation, manufacturer's instructions and the relevant Safety Data Sheets (SDS). The Contractor shall employ methods that will prevent chemical, fuel and lubricant spillage on the site and adjoining areas and not permit the pollution of land or waterways by a chemical, fuel or lubricant, or any waste material or imported fill.

Storage areas shall be greater than 50m from natural or built drainage lines, flood prone areas, or on slopes steeper than 1:10.

Spill clean-up equipment and materials, appropriate for the type and quantities of chemicals used on site, must be kept on site in a readily accessible location, at all times during the works. All site personnel must be trained in the use of spill clean-up equipment, and containment of materials and clean up all chemical spills immediately.

All spills shall be reported to the Superintendent and remediated to their satisfaction. If a spill constitutes an environmental incident, the incident must be reported in accordance with reporting procedures and legislative requirements.

2.17.8 Refuse Disposal

All Site refuse (including foodstuffs) shall be handled and disposed of in accordance with the requirements of relevant statutes and to the approval of the Superintendent.

Litter and general rubbish generated by the Contractor in executing the works shall be temporarily stored in appropriate receptacles prior to being conveyed to a licensed disposal facility. Prior approval for the disposal of litter and general rubbish at suitable facilities on-site, should they exist, shall be obtained from the Superintendent. All debris, spoil, rubbish or materials shall be suitably contained and covered in vehicles during transportation to or from the Site to prevent spillage or contamination of adjoining and other areas or property.

2.17.9 Vehicles

The Contractor shall maintain vehicles, wheels, and tracks in a suitable clean condition to prevent transfer of mud onto adjacent roads or other areas. The location of all servicing/maintenance of plant and equipment on-site shall be agreed with the Superintendent. The Contractor shall identify all the key environmental aspects for the storage, use, and safe disposal of hazardous materials/fluids and mitigation of any fuel/oil/diesel etc. spills during the works.

2.18 Occupational Health and Safety

The Contractor shall comply with the Occupational Safety & Health Act 1984 (the OSH Act) and the Occupational Safety & Health Regulations 1996 (the OSH Regulations) and with any amendments that may be made to the OSH Act and OSH Regulations from time to time.

The Contractor shall comply with all relevant safety and security procedures and rules of the Principal. Where there is conflict between the OSH Acts/Regulations and the Principal's safety and security procedures and rules, the more rigorous requirements shall apply.

2.18.1 Contractor's Safety Risk Assessment

Within 14 days of the Date of Acceptance of Tender, the Contractor shall carry out its Safety Risk Assessment and shall supply the Superintendent with a copy of the potential hazards identified and the proposed control measures to be implemented for consideration.

Throughout the Contract period, the Contractor shall report to the Superintendent any potential hazards identified or notified.

2.18.2 Safety Management Plan

The Contractor shall, throughout the Contract, implement and maintain a "Safety Management Plan". The Contractor shall prepare the Safety Management Plan in conjunction with a person suitably experienced and qualified in safety matters.

Two weeks prior to the commencement of Works, the Contractor shall supply to the Superintendent, in writing, its Safety Management Plan.

2.18.3 Induction Training

Employees of the Contractor, its Sub-Contractors and employees of Sub-Contractors shall not commence work on the Site until the Contractor has carried out Site induction training. Prior to this, the Contractor's Representative shall receive the scope of the induction from the Principal in order that it may cascade it to the staff, sub-contractors and suppliers. The Contractor is reminded that the Site induction training is separate to any safety training that it is legally required to impart to its staff. The Contractor's staff, Sub-Contractors and Suppliers will not be allowed to access the Site independently without the Site induction training. To this effect all people engaged in the works will be required to sign an Induction Form confirming that they have received the training.

Upon commencement of work on the Site, the Contractor shall further induct each employee with regard to all significant hazards associated with their particular activity and area of employment on the Site and where relevant, shall include the use of powered plant, tools and equipment. If requested by the Superintendent, the Contractor shall provide appropriate documentation detailing the satisfaction training of its employees on the safe use of all plant, vehicles and equipment to be used on the project. Failure to provide appropriate certification may lead to the relevant employees being removed from the working roster.

2.18.4 Safe Working Procedures

Where legislation or codes of practice identify particularly hazardous activities, including but not limited to, work in confined spaces, asbestos removal, demolition work, excavation work, working near power lines and live conductors and working at heights, the Contractor shall supply to the Superintendent a Safe Work Procedure (SWP) document prior to commencing such activity or type of work on the Site, which complies with the Site Licence.

The Contractor shall induct its employees and its Sub-Contractors with regard to SWP and shall prepare "Training Session Attendance" sheets signed by each attendee verifying that such induction has occurred.

2.18.5 Site and Public Security & Safety

Notwithstanding the Contractor's obligations to the Site and public security as stated elsewhere in this Contract, the Contractor shall monitor and control wherever practical, the access of all persons to the Site.

Where the general safety of the Public is concerned, and time of notification of the Contractor further jeopardises this safety, the Superintendent may order immediate remedial works to be conducted at the Contractor's expense.

2.18.6 Contractor's Safety Agreement

The Contractor shall liaise with the Principal's Occupational Safety & Health (OS&H) Co-ordinator to complete and sign a Contractor's Safety Agreement.

2.18.7 Safety Notifications, Compliance & Standards

The Contractor shall notify the Department of Mines, Industry Regulation, and Safety (formerly the Department of Labour and Industry) of all Notifiable Works and make payment of all inspection and other fees in connection with such works.

The Contractor shall conduct the construction of the works in accordance with all current statutory requirements, Local Government By-laws and the provisions of AS 1470, together with any other Code relating specifically to type of machine, process, handling procedures or materials. The Contractor shall provide employees with all necessary equipment and protective clothing to allow the safe construction of the works and shall ensure maintenance to all plant and machinery to ensure fitness for purpose.

2.18.8 Unsafe Machinery or Structures

On notification from the Superintendent, in respect to any operation, machine or structure being, in the opinion of the Superintendent, unsafe, the Contractor shall cease use immediately of such operation, machine or structure and shall conduct remedial work to the satisfaction of the Superintendent before continuing to use the operation, machine or structure in the works. Where no remedial action can ensure continued safe use of an operation, machine or structure, the Contractor shall, in the case of an operation, cease such operation, and, in the case of a machine or structure, shall dismantle and remove such machine or structure from the Site.

2.18.9 Fire Prevention

The Contractor shall provide and maintain adequate, approved fire-fighting equipment on-site. The Contractor shall observe the provisions of the WA Bushfires Act, Local Authority regulations, WA Fire Brigades Board regulations and any other regulation in respect to fire prevention.

BURNING ON SITE IS PROHIBITED.

The Contractor shall ensure that all flammable materials are used and stored in accordance with the Explosives and Dangerous Goods Act and any other statute or regulation governing storage and use of such materials and shall obtain such permits and licenses and pay all relevant fees and charges..

2.19 Containment of Leachate and/or Surface Water Run-off

Should the Contractor in the course of the works cause a leachate or surface water break out, the Contractor shall immediately inform the Superintendent and remedy the situation at the Contractor's own expense.

Should the Contractor notice a leachate or surface water breakout, the Contractor shall immediately inform the Superintendent and await instruction as to what course of action is required.

2.20 Disposal Areas for Contractor

No waste is expected to be encountered in excavations. The area identified on the contract Drawings is the only area available for the Contractor to dispose of waste where it arises from excavations. The Contractor is to provide reports to the Superintendent on the same day as the tip area is used, detailing the following:

- Location from where the material was extracted;
- Nature of the fill; and
- Number and type of vehicle used for moving the fill.

No material externally sourced from the Site shall be disposed in the landfill unless it is approved by the Superintendent.

Haulage rates internal to the Site are deemed to be included in the appropriate rates.

2.21 Materials Delivered to Site

The Contractor is to provide 24 hours' notice of deliveries to Site and provide written documentation on delivery to Site. Materials shall not be accepted on-site without the appropriate documentation, demonstrating compliance with the specifications. Such documentation should indicate the volume/amount of product delivered.

The Contractor is to maintain a diary of material deliveries, which must be accessible by the Superintendent at all times. Should materials be present on-site for more than 24 hours and not have a corresponding entry in the diary, the materials shall require immediate removal from Site.

2.22 Stability of Ground Conditions

The Contractor is to make all personnel aware (particularly those operating heavy plant and those placing earth) of the hazards associated with working on domestic and industrial waste. The Contractor is to demonstrate to the Superintendent that work practices and sequencing of earth movement shall not increase the risks associated with ground subsidence and slope failure.

The Contractor is to immediately inform the Superintendent should the Contractor become aware of signals indicating subsidence and/or slippage.

2.23 Completion of the Work

The Contractor shall leave the whole of the works in a clean and neat state, perfectly free from all rubbish and superfluous material of any kind. The Contractor shall clear up and cart away all surplus materials and rubbish to an approved waste disposal/recycling facility and shall remove all temporary markings, coverings and protective wrappings unless otherwise instructed.

Surplus excavation material shall be transported at the Contractor's expense to the location shown on the drawings, or alternative location approved by the Superintendent.

Where new works tie-in to existing works and Site boundaries, the existing works shall be reinstated to a standard similar to that which existed prior to the commencement of the works, or as approved by the Superintendent.

2.23.1 Protection of Works

The Contractor shall take all necessary precautions to safeguard all existing structures or infrastructure from ground movement, settlement, and all other activities associated with the execution of the Contract.

The Contractor shall make all necessary records (photographic or otherwise) of existing structures and other properties that could be affected by execution of the works prior to the commencement of construction.

The Contractor shall carefully case and fix boarding, sheeting or devices, to protect, works and materials from damage by weather or any other external element including other contractors, during the contract period until the works have been handed over.

The Contractor shall provide for protection of the works and property, for the protection and convenience of the public, adjacent owners and occupiers including all necessary watching, lighting, barriers, guard rails, warning notices and for all precautions required by the Superintendent.

The Contractor shall take adequate precautions to prevent trespass on adjoining property by Contractor personnel and/or its Sub-Contractors' personnel. The Contractor shall restrict its activities and Site usage to the area of the works as indicated on the Drawings as approved by the Superintendent.

Thorough and appropriate measures shall be taken to prevent damage occurring and hence the necessity to make-good, damaged work. The Contractor shall be responsible for notifying the Superintendent of any damage to the temporary or permanent works as soon as it arises. The Contractor shall identify and understand the possible sources of damage to its works and those of others and take active and positive protection measures to the satisfaction of the Superintendent. The Contractor shall provide protection against damage arising from ground and surface water weather conditions, construction, other contractors, warping, distortion, abrasion, sunlight, humidity or other conditions, which could have an adverse effect on its works and could be reasonably anticipated.

The Contractor must allow for the necessary maintenance, alteration and adaptation of protection during construction to allow for its Subcontractors to progress and to allow the possibility of damage to the contract works by others and allow for removal of protection upon completion. It shall be a requirement of this Contract that a statement on the Contractor's proposals for protecting the works before, during, and upon completion, shall be submitted for approval by the Superintendent. The

Contractor shall provide all necessary scaffolding, barriers and rails and other protective measures to excavations, floor openings and edges during the period of the contract works.

The Contractor shall protect its materials during loading, transportation, unloading and storage on-site, prior to incorporation in the works.

Protection used within the context of this document means that the Contractor is required to protect the contract works until practical completion. The type and extent of protection must be sufficient to protect finished or partly finished work, or any damage, caused by accident or otherwise, likely to occur within the currency of the contract works and with regard to the nature of operations being concurrently executed by others. The Contractor is to allow in its tender for providing such protection as necessary and will be held fully liable for any and all damage resulting from its failure to protect.

2.24 Site Climatic Conditions

The Contractor shall inform itself fully in regard to the climatic conditions likely to be experienced at the Site and shall make its own assessment of the effect that such conditions may have on the execution of the works and make due allowances for it in the Construction Programme. The rainfall and other weather conditions details can be accessed Bureau of Meteorology website (www.bom.gov.au).

2.25 Control of Quantities On-Site

The method adopted to verify volume/mass relationship shall be determined prior to works commencing.

The Contractor is responsible for programming such surveying to limit any delays to the programme and to allow completion of the surveying to the satisfaction of the Superintendent.

The Contractor is required to coordinate with the surveyor to ensure that the surveying is completed in accordance with the Superintendent's requirements without adversely affecting the programme of the works. The independent ground surveyor shall be required at a minimum to survey at the following stages:

- Location of specified Site investigations (trial pits and boreholes) carried out by the Contractor at the direction of the Superintendent;
- The reinstated formation levels at the landfill and all other construction areas;
- The surfaces of the individually completed layers, such as but not limited to, engineered clay, geomembrane, sub-bases, etc.;
- Topographical survey of completed construction including finished earthworks, drainage, all other aspects of the infrastructure and affected areas of the borrow source should it be relevant; and
- Any requirements as stipulated in the CQA Plan as mentioned in the Appendices of this Specification.

2.26 Temporary Accommodation

The Contractor will not be permitted to set-up any residential (donga/demountable) accommodation on-site, for Staff or Sub-Contractors when undertaking the contract works.

2.27 Security

The Contractor shall be responsible for establishing and maintaining a secure Site for the duration of the Contract during and outside of normal working hours. All new structures shall be made secure.

The Contractor shall allow in its tender for security and provision of all necessary accommodation and utilities, including lighting, for the carrying out of these duties.

Security fencing shall be erected where required to delineate working areas/compounds and access to any open excavations at the end of the working day should be cordoned off, with restricted access.

The security measures to be employed by the Contractor must be to the satisfaction of the Superintendent. The Principal is not responsible for any losses due to lapses in security by the Contractor's personnel and/or its Sub-Contractors' personnel.

3 Site Works

3.1 Entry on to the Site

The Contractor shall notify the Superintendent in writing, 14 days in advance, of its intention to start work within each work area.

The Contractor shall allow the Principal unfettered access to all areas of the Site to inspect works and conduct ALL work as required by the Site Licence.

3.2 Site Fencing

Where the type and location of temporary Site fencing are shown in the Contract, the Contractor shall erect such fencing as soon as it is given possession of the relevant portion of the Site. The Contractor shall regularly inspect and maintain all such fencing with any defects being made good without delay. Temporary fencing shall remain in position until either it is replaced by permanent fencing, or the works are sufficiently completed to enable that portion of the Site to be brought into use.

3.3 Contractor's Site Facilities

The Contractor must supply and maintain all facilities on-site as deemed necessary by the Contractor for Contractor's staff, Sub-Contractors and Superintendent. The facilities shall include all necessary offices, stores, toilets, washing facilities and other facilities as required by industrial agreements for facilities, including the cleaning and maintenance of the facilities.

The Contractor must provide facilities satisfactory for the storage of such materials as may be described in the various sections of the Specifications.

Prior to erecting any Site facilities, the Contractor will ensure that the proposed location and positioning of the units have been agreed with the Superintendent.

The compound shall be maintained by the Contractor to the satisfaction of the Superintendent, for the duration of the contract works.

All buildings and facilities established and used by the Contractor must be removed from the Site at no cost to the Principal on completion of the works and the Site must be left in a clean and tidy condition.

3.4 Office Accommodation for the CQA Consultant

The office accommodation for the CQA Consultant personnel shall be provided by the Principal for the duration of the works

3.5 Interference with Land Interests

The Contractor shall confine its constructional operations within the Site, or such other area of land as may be negotiated and shall instruct its employees not to trespass.

Subject to any unavoidable disturbance which may be necessitated by the execution of the Contract, the Contractor shall not interfere with any sporting, fishing or other rights which may be enjoyed on or near the Site.

3.6 Interference with Existing Access

Before interfering with access to any property, the Contractor shall provide alternative arrangements. The Contractor shall notify the Superintendent and the relevant occupiers, in writing, 14 days in advance of any such interference and shall confirm to the Superintendent that alternative arrangements have been agreed.

3.7 Protection against Damage

The Contractor shall take all necessary precautions to avoid causing any unwarranted damage to roads, lands, properties, trees, monitoring boreholes and other features during the currency of the Contract and shall deal promptly with any complaints by owners or occupiers.

Where any portion of the works is close to, across or under any existing apparatus of public utilities or other parties, the Contractor shall temporarily support and work around, under or adjacent to all apparatuses in a manner designed to avoid damage, leakage or danger, and to ensure uninterrupted operation.

If any damage occurs, the Contractor shall, at once, notify the Superintendent and the Statutory Authority or owner concerned. Any damaged or affected apparatus shall be repaired or replaced at the expense of the Contractor.

The Contractor shall take all reasonable and necessary precautions to avoid damage to its own works, by its own employees, domestic and nominated Sub-Contractors, until such time as the works have been handed over and accepted by the Principal.

Where deemed necessary by the Superintendent, stockpiled materials shall be covered with tarpaulin to avoid contamination of adjacent streams.

3.8 Location of Existing Services

The Contractor shall be responsible for the maintenance and protection of existing services which may be affected by the contract works. It is not warranted that the services shown on the Drawings are in the exact position or are to the full extent shown. Prior to commencing any works, the Contractor should make such investigations with all service authorities and Dial Before You Dig (http://www.1100.com.au/)) that are necessary to locate all services on-site or within the work areas adjacent to the Site.

If services are located which are not shown on the Drawings, the Contractor shall give at least three (3) working days' notice to the Superintendent prior to commencement of any construction activity that may affect the service.

The Contractor shall make good any damage resulting from its operations and shall indemnify the Principal against any claim for damage to drains, sewers, mains, cables, water pipes, fittings, boxes, or other property, caused by its operations. The tendered rates are to include for all identification, protection, repair and/or other necessary work to the presence of the services.

Existing private and public statutory services such as water mains, gas mains, cables, house drains, culverts, etc., shall be located insofar as possible before commencement of the works. The Contractor shall proceed with the works in such a manner that the works shall be constructed without interference.

The Contractor shall make its own arrangements for any diversion or removal of services which it may require for its own convenience or because of its proposed method of work and shall, in all cases, inform the Superintendent in advance of its proposals.

Should any service be found to exist which are not indicated, or not as indicated in the Contract, the Contractor shall, at once, give written notice to the Superintendent.

All located services shall be surveyed for size, position and level, by the Contractor and a record of these services given to the Superintendent.

3.9 Advertising and Project Works Signs

Strictly no advertising will be permitted on the Site other than:

- Project signs approved in writing by the Superintendent;
- Names of manufacturers or names of owner on items of construction plant; and
- Contractor's mailbox.

All Project Works signs must be approved by the Superintendent prior to their manufacture.

Project Works signs must be installed by the Contractor no later than one week from the Principal issuing Possession of Site. The Contractor shall be responsible for all costs and charges relating to the manufacture, installation, maintenance, and subsequent removal of all Project Works signs from the Site.

The Contractor must remove all project signs from the Site to an authorised disposal site no earlier than 4 weeks and no later than 6 weeks from the date of Practical Completion unless otherwise directed by the Superintendent.

3.10 Tidiness of Site

The Contractor shall be responsible for the proper upkeep and maintenance of the Site and the works and shall remove, from the Site, rubbish, and other waste as it accumulates. Materials and equipment shall be positioned, stored, and stacked in an orderly manner. Litter is to be contained at all times. Wind-blown litter is be recovered by the end of each working day and contained / disposed of as agreed with the Principal.

3.11 Works Affecting Watercourses

The Contractor shall be responsible for maintaining watercourses within and adjacent to the Site in effective working condition at all times and shall take all practicable measures, which shall be to the prior approval of the Superintendent, to prevent the deposition of silt or other materials in existing watercourses.

4 Engineered Fill

Advance earthworks, completed by under a separate contract will include the placement of Engineered Fill provide the geometry and falls for Cells 5 and 6 as well as the site access roads up the edge of Cell 5. Where the surface of the works within Cells 5 and 6 has deteriorated due to weathering, the affected layers will be ripped, moisture conditioned and compacted in accordance with the requirements in the following sections. All filling required at the Site under the Works shall be Engineered Fill.

4.1.1 Conditioning

Moisture conditioning may be undertaken insitu, or where additional fill is required, prior to placement. Due to the nature of the material to be used as Engineered Fill, conditioning of the material, by thorough mixing and breaking down of clods, and where appropriate water addition, is required prior to placement and compaction. Under no circumstances should clods of greater than 300mm across be placed; if present large clods must be thoroughly broken down prior to placement.

4.1.2 Compaction

A vibratory roller or other suitable compaction plant approved by the Superintendent/CQA Consultant should be used for construction of the EAL. Where more than one layer is required, the surface of the underlying layer shall be scarified/lightly tyned and watered before the next lift of Engineered Fill is placed. The Contractor shall submit with his completed Tender, a method statement detailing the plant, conditioning and compaction techniques they propose to use. Uncompacted lift thickness must not exceed 300mm.

EAL material shall have a moisture content, during and after compaction, within the range of optimum moisture content (OMC) ±3% as determined by the methods of test AS1289, to >95% MMDD.

4.1.3 Testing

The Contractor shall undertake the following compliance tests:

Table 4-1: Engineered Fill Testing Requirements

Test	Frequency
In-situ dry density/moisture	1 per 500m^3 or 1 per 2500m^2 per lift

All laboratory testing shall be undertaken by a NATA accredited laboratory, approved by the CQA Consultant/Superintendent.

The in-situ field dry density shall be measured using either the sand replacement method, core cutter method, or by a nuclear density gauge. If a nuclear gauge is used the readings will be verified by core cutter or sand replacement at a minimum of 1 per 10 nuclear gauge readings. All drill rod penetrations from the nuclear density gauge testing must be backfilled with Engineered Fill material.

The undisturbed samples for laboratory permeability testing shall be taken by the Contractor from the finished mineral liner under the instruction of the Superintendent/CQA Consultant. The samples shall be taken by placing a thin walled sample tube, 150 to 300 mm in length, upright on the completed material and jacking the tube down vertically and steadily. Upon excavation, the samples shall be

immediately sealed, labelled and sent to a NATA accredited laboratory (approved by the Superintendent/CQA Consultant) for determination of permeability.

All perforations made in the Engineered Fill for testing shall be backfilled in a manner approved by the Superintendent/CQA Consultant.

All test results shall be submitted to the Superintendent/CQA Consultant, detailing sample location, level, depth and date taken, for approval, forming **Hold Point**.

4.1.4 Rectification of Works

If the field testing demonstrates that the compaction requirements are not being attained, for the Engineered Fill placed by the Contractor, it must carry out the following at his own expense:

- Undertake additional works on the layer as necessary such that subsequent testing of the layer meets the required compaction requirement. This may include such measures as wetting up or drying of placed materials, additional passes of the compacting plant or other measures as deemed suitable by the Superintendent/CQA Consultant.
- Remove the part of the layer demonstrated to have not met the required compaction requirement and replace it to the satisfaction of the Superintendent/CQA Consultant.

Contractors should allow for reworking the surface of the Engineered Fill in Cells 5 and 6 in its tender.

4.1.5 Tolerances

As part of the Construction Quality Assurance programme the Superintendent/CQA Consultant must verify by survey the final geometry and falls of the remediated surface have been achieved. The Contractor should ensure all survey data is passed to the Superintendent/CQA Consultant within 3 days of undertaking the survey, this comprises a **Hold Point**.

The tolerances for the final surface levels of Engineered Fill lining are: -0mm / +50mm.

4.1.6 Protection of Finished Surface

The site won soils to be used in the Engineered Fill layers are highly susceptible to rapid moisture loss. The Contractor shall protect the surface from desiccation prior to geosynthetic placement. The Contractor shall order its works so the duration of exposure of the prepared subgrade is minimised to prevent deterioration. Additional protection may be in the form of a thin plastic sheet, delaying final trimming prior to liner installation, but shall in all cases require the prior approval of the Superintendent. Surfaces containing desiccation cracks exceeding 12mm deep or exhibiting swelling, heaving or other similar conditions shall be replaced or reworked by the Contractor to remove these defects to the approval of the Superintendent/CQA Consultant.

The requirements for subgrade acceptance are provided in Section 5.1.5.

5 Geosynthetic Liners

5.1.1 General

This section outlines the supply and installation of all geosynthetic materials necessary for the completion of the project. This section should be read in conjunction with the CQA Plan as described in the Appendix C of this Specification.

5.1.2 Codes & Standards

The works shall comply with all current Australian Standards and Statutory regulations where applicable, unless specified otherwise in this Specification. In particular, the following shall apply:

- ASTM D570 Test Method for Water Adsorption of Plastics;
- ASTM D638 Test Method for Tensile Properties of Plastics;
- ASTM D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics;
- ASTM D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact;
- ASTM D751 Method of Testing Coated Fabrics;
- ASTM D792 Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement;
- ASTM D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting;
- ASTM D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer;
- ASTM D1505 Test Method for Density of Plastics by the Density-Gradient Technique;
- ASTM D4218 Test Method for Carbon Black in Olefin Plastics;
- ASTM D1777 Test Method for Thickness of Textile Materials;
- ASTM D1822 Test Method for Tensile-Impact Resistance of Plastics;
- ASTM D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry;
- ASTM D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique;
- ASTM D4437 Non-destructive Testing (NDT) for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes;
- ASTM D4595 Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method;
- ASTM D4716 Test Method Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head;
- ASTM D4833 Test Method for Index Puncture Resistance of Geomembranes and Related Products;
- ASTM D5385 Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes;
- ASTM D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test;
- ASTM D5514 Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics;

- ASTM D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics;
- ASTM D5617 Test Method for Multi- Axial Tension Test for Geosynthetics;
- ASTM D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber;
- ASTM D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes;
- ASTM D5820 Standard Practice for Pressurized Air Channel Evaluation of Duel-Seamed Geomembranes;
- ASTM D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry;
- ASTM D5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter;
- ASTM D5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners;
- ASTM D5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners;
- ASTM D5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners;
- ASTM D5994 Test Method for Measuring Core Thickness of Textured Geomembranes;
- ASTM D6392 Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods;
- ASTM D6496 Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners;
- ASTM D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes;
- ASTM D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus;
- ASTM D7466 Test Method for Measuring Asperity Height of Textured Geomembranes;
- AS 1289.2.1.1 Methods of Testing Soils for Engineering Purposes: Soil Moisture Content Tests – Determination of the Moisture Content of a Soil – Oven Drying Method;
- AS 3706.1 Geotextiles – Methods of Test: General Requirements, Sampling, Conditioning, Basic Physical Properties and Statistical Analysis;
- AS 3706.2 Geotextiles – Methods of Test: Determination of Tensile Properties – Wide Strip and Grab Method;
- AS 3706.3 Geotextiles – Methods of Test: Determination of Tearing Strength - Trapezoidal Method;
- AS 3706.4 Geotextiles – Methods of Test: Determination of Burst Strength - California Bearing Ratio (CBR) - Plunger Method;
- AS 3706.5 Geotextiles – Methods of Test: Determination of Puncture Resistance – Drop Cone Method
- AS 3706.6 Geotextiles – Methods of Test: Determination of Seam Strength;
- AS 3706.9 Geotextiles – Methods of Test: Determination of Permittivity;
- ISO 9001 Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing;
- GRI-GM13 Standard Specification for HDPE Geomembranes;

- GRI-GM19 Seam Strength of Thermally Bonded Geomembranes;
- LFE2 - Cylinder Testing Geomembranes and their Protective Materials;
- EN 13719 Geotextiles and Geotextile-Related Products – Determination of the Long-Term Protection Efficiency of Geotextiles in Contact with Geosynthetic Barriers;
- EN 14574 Geosynthetics – Determination of the pyramid puncture resistance of supported geosynthetics

5.1.3 Environmental Conditions

The Contractor is to take whatever measures are necessary to ensure the timely and effective execution of the works without compromising workmanship, safety or seaming quality. The Contractor shall be responsible for provision of all temporary protection and anchorage for the geosynthetic materials.

5.1.4 Supply, Handling and Storage

All materials supplied shall be manufactured and provided in accordance with a quality system approved by the Superintendent/CQA Consultant.

The Contractor shall be responsible for all freight, transportation to Site, handling and storage, including security. It is the Contractor's responsibility to prevent any damage of the material due to weather. If the materials are damaged due to any of these activities, including the weather, and subsequently rejected for use by the Superintendent/CQA Consultant, then no claims against the Principal can be made.

Lining materials are generally delivered in rolls weighing up to 1,500kg. For handling and deployment, it is considered by the Principal to be necessary to support this weight using an appropriate core pipe which must not deflect more than 50mm as measured from end to midpoint when a full roll is lifted.

Lifting chains or straps rated for at least twice the load of the roll should be used in combination with a spreader bar. The spreader bar must be wide enough to ensure that the lifting chains or straps do not chafe against the ends of the roll, which must be able to rotate freely during installation.

All lining components must be handled with care to avoid damage to the material. Any damaged geosynthetic liner material shall be replaced at the Contractor's expense. Delays in shipping geosynthetic materials shall not qualify for claims for Extension of Time.

Each roll of geosynthetics shall bear a label which identifies the following:

- Manufacturer;
- Product identification;
- Roll number;
- Raw material;
- Batch number;
- Roll width; and
- Roll length.

Lining geosynthetics shall be stacked in accordance with the manufacturer's recommendations. The Superintendent may direct the Contractor to adjust the stored materials if evidence of damage is observed. Any defects or damage detected shall be repaired to acceptable standards or totally replaced. The rolls shall not be stored on ground conditions which are likely to impose damage or affect the integrity of its long-term performance.

5.1.5 Subgrade Acceptance

The geosynthetics shall, except where stated, be deployed on prepared subgrade. The subgrade preparation shall be such that damage will not be caused to the geomembrane either during installation or during operation. The subgrade material shall be placed and compacted such that the geomembrane will be in continuous contact with the layer and the geomembrane shall not be stretched or bridged over any hollows or humps.

The installer shall certify in writing that the surface on which the geosynthetic will be installed is acceptable. The acceptance of the engineered attenuation surface constitutes a **Hold Point**.

After the supporting subgrade has been accepted by the Contractor it will be the Contractor's responsibility to maintain its condition and to indicate to the Superintendent/CQA Consultant any change in the supporting soil condition that may require repair work. The Contractor will ensure that the supporting soil is repaired prior to placement of the relevant panels of geosynthetics.

5.2 Geosynthetic Clay Liner

The Geosynthetic Clay Liner (GCL) shall be a needle punched multi-layered system comprising at least two layers of geotextile encapsulating a layer of dry bentonite. **The geotextile shall be certified needle free.**

The bentonite shall be powdered or granulated meeting the requirements in Table 5-1.

Table 5-1: Bentonite Minimum Requirements

Property	Range or Value
Montmorillonite Content	> 70% wt
Carbonate Content	<1 - 2% wt
Bentonite Form	Natural Na bentonite or >80% wt sodium as activated bentonite
Particle Size	Powdered (e.g. 80% passing 75 micron sieve) or Granulated (e.g. <1% passing 75 micron sieve)
Cation Exchange Capacity	≥ 70 meg/100g (or cmol/kg)
Free Swell Index	≥ 24 ml/2g

No additives to the bentonite shall be allowed unless the supplier can demonstrate the nature, suitability and long-term durability of the additive. In all cases the final decision regarding acceptability shall be made by the Superintendent.

The GCL shall meet the requirements of Table 5-2.

Table 5-2: Geosynthetic Clay Liner Minimum Requirements

Property	Unit	Range or Value	
		Landfill Base	Side slope
Geotextile Component			
Cover Layer	g/m² (MARV)	≥ 200	≥ 200
Carrier Layer	g/m² (MARV)	≥ 100	≥ 100
Bentonite Component			
Mass per unit area	g/m² (MARV) / (Typical)	≥ 3,700 / ≥ 4,250 @ 0% MC	≥ 3,700 / ≥ 4,250 @ 0% MC
Swell Index	ml/2g	≥ 24	≥ 24
Fluid Loss	ml	≤ 18	≤ 18
Geosynthetic Clay Liner			
Mass per unit area	g/m² (MARV)	≥ 4,000 0% MC	≥ 4,000 0% MC
Thickness	mm	≥ 5	≥ 5
Maximum Tensile Strength (Machine Direction)	kN/m (MARV) / (Typical)	≥ 8 / ≥ 10	≥ 8/ ≥ 10
Peel Strength	N/m	360	360
CBR/Puncture Resistance	N (MARV) / (Typical)	≥ 1,600 / ≥ 2,000	≥ 1,600 / ≥ 2,000
Hydraulic Conductivity/Permeability	m/s (MaxARV) / (Typical)	≤ 3.0×10^{-11} / ≤ 2.4×10^{-11}	≤ 3.0×10^{-11} / ≤ 2.4×10^{-11}

No transverse jointing/overlapping of geosynthetic panels will be allowed on side slopes. The Contractors shall ensure that ***bespoke roll lengths*** are manufactured to ensure that rolls are installed within the anchor trenches and extend down the slopes to a minimum of 2m onto the cell base.

The use of additional reinforcing geotextiles above or below the GCL to provide sufficient angle of internal friction on the side slopes shall be allowed subject to calculations provided and subject to the final decision of the Superintendent.

Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternative material meets all requirements of this Specification and must obtain prior approval of the alternative GCL by the Superintendent.

5.2.1 GCL Acceptance

GCL conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent/CQA Consultant has assessed the laboratory results. This constitutes **Hold Point**.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any retesting required

to meet the Specification shall be at the Contractor's cost. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at a NATA accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant. In addition, the CQA Consultant will undertake on-site visual inspection of the GCL roll delivered to the Site. All Conformance Testing and Visual Inspections are detailed within Table 5-3.

Table 5-3: Minimum CQA Testing for GCL

Property	Frequency	Standards
Conformance Testing		
Thickness (dry)	1 sample per 2,500m^2	ASTM D1777
Mass per unit area of bentonite component of GCL	1 sample per 2,500m^2	ASTM D5993
Mass per unit area of GCL	1 sample per 2,500m^2	ASTM D5993
Montmorillonite content (X-ray diffraction method)	1 sample per 10,000m^2	
Cation exchange capacity of bentonite (methylene blue method)	1 sample per 20,000m^2	
Mass/unit length of bentonite in overlaps (visual inspection and weighting)	1 per 2,500m^2 Daily visual inspections	ASTM D5993
Moisture content of bentonite	1 sample per 2,500m^2	AS 1289.2.1.1
Swell index/free swell of clay	1 sample per 5,000m^2	ASTM D5890
Fluid Loss	1 sample per 5,000m^2	ASTM D5891
Peel strength (for needle-punched products only)	1 sample per 4,000 m^2	ASTM D6496
Permeability	1 sample per 25,000m^2	ASTM D5887
Tensile strength	1 sample per 10,000m^2	ASTM D4595
CBR of geotextile	1 sample per 25,000m^2	AS 3706.4
Puncture resistance of geotextile	1 sample per 25,000m^2	AS 3706.5
Index Flux	1 sample per 25,000 m^2	ASTM D5887
Visual Inspection of GCL (on arrival and during placement at the Site)		
Colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material	Every roll	
Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution		

Thickness of GCL (i.e. uniformity of bentonite distribution) and apparent variations in the as placed moisture distribution	Each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area should be conducted	

All conformance tests must be reviewed, accepted, and reported by the CQA Consultant before deployment of the geosynthetic clay liner. All sampling taken from the GCL at the Manufacturer' premises or Site shall be under the CQA Consultant's instruction. This is a **Hold Point.**

The NATA laboratory shall issue all results to the Superintendent/CQA Consultant at the same time as they are issued to the Contractor. The Contractor and the NATA laboratory shall provide a signed disclosure confirming this procedure has been followed.

5.2.2 GCL Installation

The laying and installation of all GCL shall follow the Manufacturer's details as well as the requirements as specified. There shall be ***no trafficking directly on the GCL*** once installed.

The method of installation of the GCL shall ensure that the following are complied with:

- On slopes, the GCL shall be securely anchored and the GCL material then deployed down the slope in such a manner as to keep the GCL panel in tension. The dimensions of the anchor trenches are as shown on the Drawings;
- Seams shall be placed perpendicular to the line of slope. Horizontal seams shall only be permitted on the face of the slope, where directed by the contract drawings;
- The Contractors shall ensure that bespoke roll lengths are manufactured to ensure that rolls are installed within the anchor trenches and extend down the slopes to a minimum of 2m onto the cell base. However, where slope lengths are longer than manufactured roll lengths, the GCL is to be secured in intermediate anchor trenches. Upslope panels will rainlap (roof-tile) downslope panels with a minimum overlap of 1.5m;
- The Contractor shall take all necessary precautions to prevent damage to the underlying layers during placement of the GCL;
- During placement of the GCL, care shall be taken not to entrap beneath the GCL, any stones, excessive dust or moisture that could damage the GCL;
- After installation, a visual examination of the GCL shall be carried out to ensure that no potentially harmful foreign objects, contaminated soil or damaged areas are present; and
- Excess loss of bentonite on edges during deployment should be minimised.

The seams shall have a minimum overlap of 300mm and shall be joined by the addition of bentonite paste, applied to a minimum width of 200mm and a nominal thickness of 10mm as per Manufacturer's installation guidelines, or equivalent application of powdered bentonite to a minimum of 0.4kg/m length of seam, unless the GCL has impregnated surfaces along sheet edges and is installed under the Manufacturer's guidelines. The CQA Consultant will visually inspect all seams and shall reserve the right to remove samples for weighing.

No more GCL material will be deployed during one working day than can be covered by the end of that day. GCL deployment shall not be undertaken during precipitation. The Contractor shall ensure full protection is afforded to the GCL so that premature hydration does not occur.

Approval of the final GCL Installation by the CQA Consultant constitutes **Hold Point**.

5.2.3 GCL Repair Procedures

Any portion of the GCL exhibiting flaws shall be repaired. Prior to the acceptance of the installed GCL, the contractor shall locate and repair all damaged areas of the liner. Defects or damage can be identified by rips, tears, premature hydration of the GCL or delamination of the geotextiles.

Rips or tears in the GCL shall be covered by another piece of material meeting the project specifications. The material shall extend over the entire damaged area with a minimum 300mm overlap in all directions. Addition of bentonite shall be in accordance with Manufacturer's recommendations.

Where the GCL has been exposed to moisture and has prematurely hydrated prior to placement of overlying material, the material shall be removed and replaced with material meeting the specification.

5.2.4 GCL Materials Placement

Construction vehicles shall not be allowed to operate directly on top of the GCL. The Contractor is to submit method statements and Plant details for the placement of GCL to the Superintendent for approval prior to placement.

5.3 Geomembrane (HDPE)

The raw material used for the 2.0mm High Density Polyethylene (HDPE) geomembrane manufacture shall be first quality virgin resin, of the type nominated with no more than 10% factory re-work material and no post-consumer resin. The quality of the HDPE geomembrane shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) - GM13 as indicated on Table 5-4 and Table 5-5.

The geomembrane liner shall be a new, first-quality product designed specifically for the purpose of hydraulic containment and a thickness of not less than that specified. The membrane shall be uniform and free of pinholes, blisters, undispersed raw materials and contamination by foreign matter. The membrane liner shall be shop manufactured in rolls to a seamless width of not less than 5 metres, each roll identifiable in thickness, length and manufacturer’s roll number.

Any defects such as holes, tears, blisters, ‘fisheyes’, delamination, undispersed raw materials or visible non-uniformity or contamination by foreign matter which in the opinion of the Superintendent is detrimental to the long service life required of the membrane liner, shall be grounds for rejection of the membrane liner material.

Defects which are considered as minor by the Superintendent shall be repaired in the presence of the Superintendent. Such repair shall be carried out using the extrusion fusion welding technique in accordance with the Manufacturer’s recommendation and tested in a manner agreeable to the Superintendent.

A material warranty of 20 years is required from the geomembrane manufacturer. The Contractor shall provide the warranty in writing prior to the commencement of geomembrane installation.

Table 5-4: Raw Material (polymer Resin) – Minimum Test Values Required

Property		Test Method	Standard HDPE
Density		ASTM D1505 or D792	0.935g/cm^3
Melt Flow Index (minimum)	At 190°C/21.6kg	ASTM D1238	< 10g/10min
	At 190°C/5kg		< 1g/10min
Standard Oxidative Induction Time (OIT)		ASTM D3895	100 mins

The required minimum test values for geomembrane are set out below:

	Test Method	0.75mm		1.00mm		1.25mm		1.50mm		2.00mm		2.50mm		3.00mm	
individual for 8 out of 10 values	D5199	nom.	-10%	nom.	-10%	nom.	-10%	nom.	-10%	**nom.**	**-10%**	nom.	-10%	nom.	-10%
individual for any of the 10 values		-5%	-15%	-5%	-15%	-5%	-15%	-5%	-15%	**-5%**	**-15%**	-5%	-15%	-5%	-15%
min. ave.)[1]	GM 12	0.40mm		0.40mm		0.40mm		0.40mm		**0.40mm**		0.40mm		0.40mm	
	D1505/D792	0.940 g/cc		0.940 g/cc		0.940 g/cc		0.940 g/cc		**0.940 g/cc**		0.940 g/cc		0.940 g/cc	
rength	D6693 Type IV	11 kN/m		15 kN/m		18 kN/m		22 kN/m		**29 kN/m**		37 kN/m		44 kN/m	
trength		8 kN/m		10 kN/m		13 kN/m		16 kN/m		**21 kN/m**		26 kN/m		32 kN/m	
ongation		12%		12%		12%		12%		**12%**		12%		12%	
longation		100%		100%		100%		100%		**100%**		100%		100%	
ave.)	D1004	93 N		125 N		156 N		187 N		**249 N**		311 N		374 N	
min. ave.)	D4833	200 N		267 N		333 N		400 N		**534 N**		667 N		800 N	
ce[3]	D5397 (app.)	500 hr.		500 hr.		500 hr.		500 hr.		**500 hr.**		500 hr.		500 hr.	
(range)	D1603[4]	2.0% - 3.0%		2.0% - 3.0%		2.0% - 3.0%		2.0% - 3.0%		**2.0% - 3.0%**		2.0% - 3.0%		2.0% - 3.0%	
on	D5596	Note 5		Note 5		Note 5		Note 5		**Note 5**		Note 5		Note 5	
d OIT, or	D8117	100 min.		100 min.		100 min.		100 min.		**100 min.**		100 min.		100 min.	
essure OIT	D5885	400 min.		400 min.		400 min.		400 min.		**400 min.**		400 min.		400 min.	
d OIT (min. ave.) - % retained after , or	D5721	D3895	55%	55%		55%		55%		**55%**		55%		55%	
essure OIT (min. ave.) - % retained days		D5885	80%	80%		80%		80%		**80%**		80%		80%	
d OIT (min. ave.), or	D8117	Note 9		Note 9		Note 9		Note 9		**Note 9**		Note 9		Note 9	
essure OIT (min. ave.) - % retained 600 hrs[10]	D5885	50%		50%		50%		50%		**50%**		50%		50%	

surement side for double sided textured sheet.
(MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
tion is calculated using a gauge length of 33mm.
ation is calculated using a gauge length of 50mm.
s not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets the same formulation as being used for the textured sheet mate
ess used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value Via MQC testing.
ch as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
ersion (only near spherical agglomerates) 10 different views:
es 1 or 2 and 1 in category 3

5.3.1 Geomembrane Conformance Testing Requirements

As a minimum, the tests outlined in Table 5-6 should be completed.

Geomembrane conformance testing shall be undertaken by the Contractor. Materials shall not be incorporated into the works until the Superintendent/CQA Consultant has assessed the laboratory results, which comprises **Hold Point**.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any retesting required to meet the Specification shall be at the Contractor's cost. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

Testing will be undertaken at a NATA accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant.

Table 5-6: Minimum CQA Testing for Geomembranes

Item	Property	Standards	Frequency
Conformance Testing (upon shipment of geomembrane to the Site)	Thickness	ASTM D5994	Each Roll
	Asperity Height (textured only)	ASTM D7466	One Sample per 5,000m^2, or every five rolls delivered to Site, whichever is the greatest number of tests
	Density	ASTM D1505, ASTM D792	
	Tensile Properties (yield and break stress, yield and break elongation)	ASTM D6693 Type IV	
	Puncture Resistance	ASTM D4883	
	Tear Resistance	ASTM D1004	
	Carbon Black Content	ASTM D1603	
	Carbon Black Dispersion	ASTM D5596	
	Stress Crack Resistance	ASTM D5397	One sample every 10,000m^2, or resin type or manufacturing run (LLDPE only)
	Oxidative Induction Timing	ASTM D8117, ASTM D5885	
	Axi-Symmetric Break Resistance Strain	ASTM D5617	Per formulation (LLDPE only)
	Oxidative Induction Timing	ASTM D8117, ASTM D5885	One sample every 10,000m^2, or resin type or manufacturing run (LLDPE only)
	Oven Ageing and Oxidative Induction Timing	ASTM D5721, ASTM D8117, ASTM D5885	
Start-up test weld	Welding Equipment		Checked daily at start of works, whenever the

			welding equipment is shut-off for more than one hour, and after significant changes in weather conditions
	Weld Conditions		Test weld strips will be required whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced. Minimum 1.5m continuous seam
Destructive weld testing	Onsite, hand tensiometer in peel mode		1 tab from start and finish of each weld for fusion welds
	Offsite – weld seam strength in peel and shear	ASTM D6392	Every 300m (if fusion weld, every 150m)
Non-destructive weld testing		Air pressure test, ASTM D5820	All seams over full length
		Vacuum box test, ASTM D5641	
Visual inspection of geomembrane	Tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material		Every roll

Note:

1. *All conformance tests must be reviewed, accepted and reported by a CQA Consultant before deployment of the geomembrane.*
2. *All testing must be performed on samples taken from the geomembrane delivered to Site under the CQA Consultant instruction*
3. *All laboratory tests must be performed in a third-party independent accredited geosynthetics laboratory.*
4. *The required testing frequencies may be revised by the CQA Consultant to conform to improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application (i.e. to account for the importance of the geomembrane for the safety of works). Revisions must be approved by the relevant authorities before application.*

The NATA laboratory shall issue all results to the Superintendent/CQA Consultant at the same time as they are issued to the Contractor. The Contractor and the NATA laboratory shall provide a signed disclosure confirming this procedure has been followed.

5.3.2 Geomembrane Deployment

The Contractor shall submit a detailed Geomembrane Panel Layout Plan showing the proposed layout and sequence of geomembrane placement not less than one week prior to commencing installation. Geomembrane panels shall be installed in accordance with the Layout Plan as approved by the Superintendent/CQA Consultant.

The Contractor shall arrange the panels so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), whenever practicable in accordance with accepted good practice.

There shall be no cross tie-in seams between batter and base panels within 2m of the toe of the batter.

The free edges of each panel shall be adequately weighed down with sandbags, tyres or other means approved by the Superintendent/CQA Consultant in readiness for seaming.

5.3.3 Seaming

All seaming shall conform to the methods detailed in the EPA Technical Guidance Document, "The Fabrication of Polyethylene FML Field Seams" (no. EPA/530/SW-09/069, September 1989).

The Contractor shall submit method statements not less than one week prior to commencing installation, detailing the following as a minimum:

- Proposed seaming technique or techniques and their proposed applications;
- Proposed seaming machinery;
- Overlap widths and overlap preparation prior to seaming;
- Proposed acceptable temperature ranges for extrudate and/or hot wedge; and
- Proposed acceptable maximum seaming speed if automated machinery to be used.

The Contractor should be aware of the possible temperature differential at the Site during the installation works. Typical Bureau of Meteorology (BOM) weather statistics from Northam, the closest weather station to the Site at approximately 18.2km, are presented in Table 5-7.

Table 5-7: BOM Monthly Weather Statistics

Northam (1902-2024)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Max. Temperature (°C)	34.3	33.7	30.8	26.1	21.3	18.0	17.0	18.0	20.5	24.2	28.6	32.2
Highest Temperature (°C)	46.3	48.1	43.9	39.5	35.2	27.2	25.2	29.7	34.7	40.0	44.1	45.6
Mean Min. Temperature (°C)	17.2	17.2	15.5	12.0	8.4	6.4	5.4	5.6	6.9	9.0	12.5	15.3

To minimise the propagation of wrinkles and tensions during installation due the expansion/contraction of the geomembrane, the Contractor shall be deemed to have allowed for all precautions as deemed necessary by the specialist lining Contractor including welding at night (if required) for all general seaming and tie-in welds.

All night work will require portable lighting. All health and safety controls and costs that are incurred by the Contractor, performing work outside of normal hours shall be deemed to be included in tendered rates.

5.3.3.1 *Trial Seams*

The Contractor shall perform trial seams with each seaming machine and operator at least at the start of each shift, after every four hours of operation and following any period of machine shutdown or change of operator.

The trial seams shall be at least 1.5m long in the case of extrusion and fusion seams. On completion of the trial seam, the Contractor shall cut six 25mm wide field tabs normal to the seam spaced along the seam length. The tabs shall be subjected to field qualitative destructive testing using a tensiometer. Four of the six tabs shall be tested in peel mode with the other samples tested in shear mode.

The trial seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the parent material and does not enter the seam. The seam will be deemed to have failed qualitative destructive testing if any of the failure enters the seam.

If a trial seam fails field destructive testing as specified above, then the seaming machine and the operator shall not be allowed to perform field seaming until the deficiencies are corrected and both machine and operator have achieved a passing trial seam. Trial seaming and destructive testing will be observed by the Superintendent/CQA Consultant.

5.3.3.2 *Field Seams*

The Contractor shall perform field seams only after satisfying trial seam conditions as specified in Section 5.3.3.1 of this Specification. The Contractor shall ensure that all pre-treatment measures (e.g. grinding and cleaning), as specified in EPA/530/SW-89/069 are carried out and that extrudate and/or wedge temperatures are maintained within a range approved by the Superintendent.

The Contractor's attention is drawn to the stipulations in EPA/530/SW-89/069 that:

Seaming is not allowed during rain, hail, or snow unless proper precautions, are made to allow the seam to be made on dry geomembrane materials:

- Seaming above saturated soil is not acceptable;
- Ponded water on the soil surface beneath the geomembrane is not acceptable;
- Seaming above frozen ground is not acceptable; and
- Ambient temperature for seaming should be above 5°C.

All field seams shall be completed to the back edge of the anchor trench, i.e. the edge furthest away from the slope or toe bund. Any seam defects falling within the anchor trench shall be repaired in accordance with Section 5.3.4.4 of this Specification.

During construction the specified overlap shall be clearly marked on the edge of the underlying sheet seam prior to seaming. Failure to maintain the minimum overlap may be cause for rejection of the seam.

Extrusion Welding

The Contractor shall verify that extrusion-seaming apparatuses are equipped with gauges giving the relevant temperatures of the extrudate, nozzle, and preheat. In addition, the Contractor shall certify in writing to the Superintendent that the extrudate is compatible with the specifications.

A log of apparatus temperatures, extrudate temperatures, and ambient temperatures at appropriate intervals will be made by the Contractor, during the installation works. Ambient temperatures will be measured approximately 50mm above the geomembrane surface.

Fusion Welding

The Contractor shall ensure that fusion-seaming apparatus comply with the requirements of the Specification. Temperature and pressure settings shall be verified by the Contractor prior to each seaming period, and will be logged (ambient temperatures, seaming apparatus temperatures, speeds). Ambient temperatures will be measured approximately 50mm above the geomembrane surface.

Prior to seaming the Contractor shall confirm that:

- the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- if seam overlap grinding is required, the process is completed within one hour of the seaming operation, and in a way that does not damage the geomembrane;
- if seam overlap grinding is required, less than 10% of the nominal thickness shall be removed;
- the grinding does not extend more than 10mm on either side of the extrusion seam; and
- seams are aligned with the fewest possible number of wrinkles and “fish-mouths”.

5.3.4 Sampling and Testing

5.3.4.1 *Non-Destructive Testing*

The Contractor shall perform non-destructive testing along the entire lengths of all field seams including patches and repairs. The Contractor shall submit not less than one week prior to commencing installation a method statement detailing the proposed non-destructive test technique or techniques and the proposed applications.

For air pressure testing of fusion seams the test length should be sealed at both ends and an approved pressure feed divide inserted into the air channel. The channel should then be pumped to a pressure of between 25 and 30 psi (~2bar) and allowed to stabilise for 1 minute. The test will have deemed to have failed if the loss of pressure exceeds 10% over a 5 minute period following stabilisation.

Air pressure tests shall be released from the opposite end of the seam to the gauge to verify that the entire seam has been tested and there is no blockage part way along the seam. All pressure test perforations shall be repaired by grinding and welding over the perforation (this also includes needle holes).

For vacuum box testing each section of the seam should be tested and observed for a period of not less than 10 seconds. Apply a generous amount of a strong soapy solution and water to the area to be tested to help create a vacuum. Turn on the vacuum pump and set it to produce approximately

0.35bar of vacuum. It is important that an overlap of a minimum of 75mm is maintained every time the vacuum box is moved along the seam.

For spark testing, a length of copper wire shall be placed along the edge of the repair or extrusion welded seam prior to welding. Following welding, a high tension electrode is passed over the seam, and any faults in the seam are highlighted by a characteristic increased sparking sound and electrical discharge. Any faults shall then be ground to remove any dirt and a further layer of extrudate applied to ensure a seal is formed. The defect shall then be tested again to ensure that the area has been remediated to a suitable manner.

In the event of a field seam failing non-destructive testing the Contractor shall identify and repair the failed area in accordance with Section 5.3.4.4 of this Specification. The Contractor shall then subject the repair to further non-destructive testing until the repair shall pass the test.

The Contractor shall advise the Superintendent/CQA Consultant when he is ready to commence non-destructive testing and shall not perform non-destructive testing unless the Superintendent/CQA Consultant is in attendance, constituting **Hold Point**.

5.3.4.2 *Qualitative Destructive Testing*

The Contractor shall cut a 25mm wide field tab from the beginning and end of each completed field seam and shall subject it to qualitative destructive testing in peel mode using a tensiometer.

The Contractor **shall not** tear overlaps/rip into the seams to check weld quality. Any such damage shall be deemed a defect and repaired.

The seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the parent material and does not enter the seam. The seam will be deemed to have failed qualitative destructive testing if any of the failure enters the seam.

If a field tab fails qualitative destructive testing, the Contractor shall either:

- reconstruct the seam between two tabs shown to have passed qualitative destructive testing; or
- cut further tabs from 3m to each side of the failed tab and subject these to qualitative destructive testing. If these tabs pass qualitative destructive testing the Contractor shall reconstruct the seam between the passed locations in accordance with Section 5.3.4.4 of this Specification. If either sample fails, the Contractor shall cut and test further field tabs until an area bounded by two passed locations can be identified. The Contractor shall then reconstruct the failed seam in accordance with Section 5.3.4.4 of this Specification.

The Superintendent/CQA Consultant reserves the right to request the cutting and destructive testing of further field tabs at any locations along the length of a seam. Acceptance of the qualitative HDPE destructive testing constitutes a **Hold Point**.

5.3.4.3 *Quantitative Destructive Testing*

The Contractor shall cut laboratory samples from the field seams when instructed by the CQA Consultant and in any case at a frequency not exceeding 1 sample per 300m (if fusion weld), 1 sample per 150m (if extrusion weld) or one per day of welding of seam performed by an individual machine whichever is greater.

The Contractor shall divide the sample and release sub-sample A to the Superintendent for archiving.

The Contractor shall without delay dispatch sub-sample B to an approved geosynthetic laboratory for destructive testing in accordance with Table 5-8, or testing on-site utilising a calibrated tensiometer. The Contractor should note that five tabs should be cut for peel tests and five tabs for shear tests. The laboratory shall report quantitative results and the mode of failure for the tests carried out. The Contractor shall issue copies of the test results certificates to the Superintendent/CQA Consultant immediately upon receipt, within 48 hours of cutting the sample from the installation.

If the samples are tested on-site the Contractor shall provide the calibration certificate to the Superintendent for the field tensiometer prior to undertaking any testing. The CQA Consultant may corroborate the results from the calibrated tensiometer by undertaking duplicate quantitative destructive tests in a NATA accredited laboratory, one at commencement of lining works, and another at the end.

The seam will be deemed to have passed quantitative destructive testing if in four out of five of the tabs:

- The failure occurs solely in the parent material and does not enter the seam;
- The peel strength exceeds that indicated in Table 5-8; and
- The shear strength exceeds that indicated in Table 5-8.

The seam will be deemed to have failed quantitative destructive testing if in more than one out of the five tabs:

- Any of the failure enters the seam;
- The peel strength is less than that indicated in Table 5-8; and
- The shear strength is less than that indicated in Table 5-8.

If a seam fails quantitative destructive testing the Contractor shall investigate the seam to each side of the failed sample as specified in Section 5.3.4.2 of this Specification. The Contractor shall cut further laboratory samples from each side of the failed section and perform laboratory tests, at its own cost, until the failed seam is bounded by two passed locations.

The Contractor shall then reconstruct the failed seam in accordance with Section 5.3.4.4 of this Specification. The Superintendent/CQA Consultant may at his discretion observe laboratory destructive testing in which event the Contractor shall arrange permission for access to the approved laboratory.

The Contractor shall furnish the CQA Consultant/ Superintendent with a copy of the formal report from the destructive testing detailing the procedures used for testing and including a summary of all results, prior to covering of the geosynthetics. This constitutes **Hold Point**.

Table 5-8: Geomembrane Field Seam Destructive Testing Criteria

Test	Method	2.0mm HDPE Minimum Requirement
Fusion Welds		
Fusion Shear	ASTM D4437	28.0 N/mm or 701 N/25mm
Fusion Peel	ASTM D4437	21.2 N/mm or 530 N/25mm

Extrusion Welds		
Extrusion Shear	ASTM D4437	28.0 N/mm or 701 N/25mm
Extrusion Peel	ASTM D4437	18.2 N/mm or 455 N/25mm

Note:

1. *Peel Test on double fusion welds to be carried out on both welds.*
2. *Peel Separation <25% of seam width.*
3. *Shear Elongation at failure: Smooth >100% x L, Textured >50% x L.*
4. *Both sides of Fusion weld need to pass strength requirements and Film Tear Bond to constitute a pass.*
5. *Seam strengths are in accordance with GRI GM 19.*

5.3.4.4 *Repairs, Patches and Cap Strips*

All discontinuities in the geomembrane (whether caused by damage, or failure of geomembrane or seams to conform with Specification, or of sampling or testing or other factors), shall be repaired by the Contractor in the following manner, all holes (including pinholes) in the liner will be patched:

Superficial Defects (Dents and Creases)

- The area shall be prepared in accordance with EPA/530/SW-89/069 and an extra layer of extrudate applied as approved by the Superintendent.

Holes, Pinholes, Cuts & Large Faults

- Large faults, and any holes in the faulted area shall be cut back to remove all imperfections and shall be overlain with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions. The area shall then be prepared in accordance with EPA/530/SW-89/069 and seamed in accordance with Section 5.3.3 of this Specification.

Seam Faults

- Faulted extrusion seams shall be overlain with a single piece of compatible geomembrane with a minimum overlap of 100mm in all directions to form a cap strip. The repair may then be completed as for large faults.
- Faulted fusion seams shall be cut back to remove the upper flap, prepared in accordance with EPA/530/SW-89/069, and extruded in accordance with Section 5.3.3 of this Specification.

The Contractor shall test all repairs in accordance with Section 5.3.4.1 of this Specification.

5.3.5 Geomembrane Ballasting

Unless specified otherwise, the Contractor shall design, supply and install the geomembrane ballasting system to ensure that the liner will not be adversely affected by wind and/or thermal movement during installation of the lining system. The ballasting system shall be submitted to the Superintendent/CQA Consultant in writing for approval prior to its use.

The Contractor is to place permanent sandbag surcharge on permanently exposed HDPE geomembrane/protection geotextile on the side slopes that will not be covered by another layer at a minimum of 2m spacing along the seams, change of grade between the basal and side slopes and external perimeter of the geomembrane. The Contractor is to satisfy themself of surcharging adequacy to prevent uplift and damage of the geomembrane/geotextile. This constitutes a **Hold Point**.

5.4 Cushion/Protection Geotextile

A cushion/protection geotextile is required between the HDPE geomembrane layer and the leachate collection aggregate. The cushion/protection geotextile shall be a non-woven, needle punched product, constructed from virgin fibres of polypropylene or polyester, incorporating a minimum 1% by weight active carbon black, or another Superintendent approved UV stabiliser. **The geotextile shall be certified needle free.**

No transverse jointing/overlapping of geosynthetic panels will be allowed on side slopes. The Contractor shall ensure that ***bespoke roll lengths*** are manufactured so that rolls can be installed within the anchor trenches and extend down the slopes to a minimum of 2m onto the cell base without the need for mid-slope seams.

The Contractor should confirm the grade of geotextile proposed to be of sufficient mass, strength and thickness, to protect the underlying geomembrane from damage from the overlying leachate drainage aggregate, with regards to stresses, strains and indentations. **Maximum allowable global strain of 4% for HDPE textured geomembrane.**

International methods for examining performance of a protection geotextile and geomembrane include:

- LFE 2 – Cylinder Testing Geomembranes and their Protective Materials: A Methodology for testing protective materials: A methodology for testing protector geotextiles for their performance in specific Site conditions (UK Environment Agency, 2014);

The sample shall be subjected to a loading of the height of waste at an assumed density 1.0 tonnes/m^3 load plus the thickness of restoration soils at a density of 2.0 tonnes/m^3, the total load being factored accordingly to the test duration and temperature. The specific pass and failure criteria for the test should be agreed with the Superintendent/CQA Consultant following agreement on the specific test method. As guidance a specific strain value may be used for acceptance, with the allowable local strain criteria ≤0.25%.

- ASTM D5514 / D5514M-14, Standard Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics (ASTM International, 2014);
- EN 13719:2016 – Geotextiles and Geotextile-Related Products – Determination of the Long-Term Protection Efficiency of Geotextiles in Contact with Geosynthetic Barriers; and
- EN 14574:2015 Geosynthetics – Determination of the pyramid puncture resistance of supported geosynthetics.

Maximum allowable global strains should be in accordance with Victoria EPA BPEM and NSW EPA Solid Waste Landfills maximum allowable strains, who have adopted values from Peggs, 2003.

Table 5-9: Summary of Maximum Allowable Strains for Varying Geomembranes (from Peggs, 2003)

Geomembrane Type	Maximum Allowable Global Strain
HDPE Smooth	6%
HDPE randomly textured	4%
HDPE structured profile	6%

Tests should be undertaken with a loading of the height of waste at an assumed density 1.0 tonnes/m3 load plus 1.0m of restoration soils at a density of 2.0 tonnes/m3, the total load being

factored accordingly to the test duration and temperature (typically 2.5 times loading to account for geotextile performance reduction factors and temperature).

The Contractor shall inform the CQA Consultant/Superintendent of the proposed test method, including material parameters/stone gradings/loadings/methodology etc., for approval prior to undertaking the test. The Contractor shall supply the CQA Consultant/Superintendent with a copy of the formal report from the performance testing detailing the procedures used for testing and including a summary of all results, for acceptance prior to incorporation of materials in the works.

The required material properties, test methods, values and units are presented in Table 5-10, as a general guide only. These values are subject to change following completion of the aforementioned strain analysis. This constitutes **Hold Point**.

Table 5-10: Physical Properties for Cushion Protection Geotextile

Properties	Test Method	Guide value
CBR Puncture Resistance	AS 3706.4	9,000 N
Strip Tensile Strength MD/CD	AS 3706.2	50/50 kN/m
Tear Strength CD	AS 3706.2	1,200 N
Thickness @ 2kPa	AS 3706.1	5 mm *
Mass per unit area	AS 3706.1	TBC g/m² *

**Dependent on MARV of proposed protection geotextile.*
MD = machine direction
CD = cross direction

5.4.1 Cushion/Protection Geotextile Conformance Testing Requirements

All conformance test results must be reviewed, accepted and reported by the CQA Consultant before deployment of the cushion/protection geotextile, comprising **Hold Point**. All sampling taken from the cushion/protection geotextile at the Manufacturer's premises or Site shall be under the CQA Consultant's instruction/oversight.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant for the properties detailed in Table 5-11.

Table 5-11: Conformance Testing for Cushion/Protection Geotextile

Item	Property	Standards	Frequency
Conformance Testing	Thickness	AS 3706.1	One sample per 2,500m²
	Mass per unit area	AS 3706.1	
	Tensile Strength	AS 3706.2	One sample per 5,000m²
	Tear Strength	ASTM D4833, AS 3706.3	
	Burst Strength	ASTM D6241, AS3706.4	

The accredited, independent third-party laboratory shall issue all results to the Superintendent/CQA Consultant at the same time as they are issued to the Contractor for approval of the use of the materials in the works, at the earliest opportunity. This constitutes **Hold Point**. The Contractor and

the third-party laboratory shall provide a signed disclosure confirming this procedure has been followed.

Any retesting required to meet the Specification shall be at the Contractor's cost. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission.

5.4.2 Cushion/Protection Geotextile Installation

The Manufacturer's recommended installation procedures will be submitted by the Contractor for the sewing/thermally bonding of the geotextile, including procedures for repair. All seaming shall be performed by trained, experienced and competent personnel. The Contractor may also be requested to submit training, competency or experience records of the installers to the Superintendent for approval.

Non-woven needle-punched geotextile shall be installed to the requirements of the construction specifications. The geotextile shall be placed by the lining contractor at the locations shown on the contract Drawings. All geotextile seams placed on slopes shall be overlapped a minimum of 300mm and thermally bonded using a "Leister" gun. Seams on side slopes will be oriented with the slope. End-of-roll seams will be offset a minimum of 1m between adjacent roll ends. Cross-slope seams shall be avoided. Installed bedding geotextile shall be covered with the interfacing material as soon as practical, but in no case longer than 14 calendar days. During periods of high winds, sandbags or other methods approved by the Manufacturer shall be used to secure any exposed geotextile in place. Surcharge will be placed at minimum 1m spacing along joints.

Construction vehicles shall not be allowed to operate directly on top of the geotextile and will only be permitted to travel over the geosynthetics on haul roads that are a minimum of 1m in depth constructed out of soils/drainage materials. Any geotextile that has granular material placed upon it shall have 300mm (minimum) of the material placed onto the geotextile and spread in advance of construction equipment with high floatation/low ground pressure equipment. The material will be spread in the same direction as the geotextile is seamed. Extreme care is required by the Contractor so that the equipment operator only pushes the materials ahead without damage to the geotextile. At no time will construction equipment be permitted to track directly on the geotextile.

Any holes or tears in the geotextile will be repaired by placing a patch with at least 300mm of overlap of the same material over the defective area. All patches will be thermally bonded as per normal seaming practices. Any damage to the geotextile or lining system will be repaired by the Contractor (using approved methods) at no expense to the Principal. Completed cushion/protection geotextile installation and surcharging shall be approved by the Superintendent/CQA Consultant, making **Hold Point**.

5.5 Separation Geotextile

Following placement of the leachate collection layer, a separation geotextile is to be placed directly over the leachate drainage and collection system on the base of the landfill cell. The separation geotextile shall be a non-woven needle punched product, constructed from virgin fibres of polypropylene or polyester, incorporating a minimum 1% by weight active carbon black, or another approved UV stabiliser. **The geotextile shall be certified needle free.**

Non-woven needle-punched geotextile shall be installed to the requirements of the construction specifications. The geotextile shall extend 1m beyond the leachate collection layer, as shown on the construction Drawings.

A general guide to the required material properties, test methods, values and units are presented in Table 5-12.

Table 5-12: Physical Properties for Separation Geotextile

Properties	Test Method	Requirement
CBR Puncture Resistance	AS 3706.4	2,500 N
Strip Tensile Strength MD/CD	AS 3706.2	14 kN/m
Elongation at MD	AS 3706.2	50 %
Thickness @ 2kPa	AS 3706.1	TBC mm *
Mass per unit area	AS 3706.1	TBC g/m² *

**Dependent on MARV of proposed protection geotextile.*
MD = machine direction
CD = cross direction

5.5.1 Separation Geotextile Conformance Testing Requirements

All conformance tests must be, reviewed, accepted and reported by the CQA Consultant before deployment of the separation geotextile, constituting **Hold Point**. All sampling taken from the separation geotextile at the Manufacturer' premises or Site shall be under the CQA Consultant's instruction/oversight.

Testing will be undertaken at an accredited, independent third-party laboratory as approved by the Superintendent/CQA Consultant for the properties detailed in Table 5-13.

Table 5-13: Conformance Testing for Separation Geotextile

Item	Property	Standards	Frequency
Conformance Testing	Thickness	AS 3706.1	One sample per 2,500m²
	Mass per unit area	AS 1001-2.13	
	Tensile Strength	AS 3706.2	One sample per 5,000m²
	Tear Strength	ASTM D4833, AS 3706.3	
	Burst Strength	ASTM D6241, AS3706.4	

The accredited, independent third-party laboratory shall issue all results to the Superintendent/CQA Consultant at the same time as they are issued to the Contractor for approval of the use of the materials in the works, at the earliest opportunity. This constitutes **Hold Point**. The Contractor and the third-party laboratory shall provide a signed disclosure confirming this procedure has been followed.

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall

not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission. Any retesting required to meet the Specification shall be at the Contractor's cost.

5.5.2 Separation Geotextile Installation

The Manufacturer's recommended installation procedures will be submitted by the Contractor for the sewing/thermally bonding of the geotextiles, including procedures for repair. All seaming shall be performed by trained personnel. The Contractor may also be requested to submit training or experience records of the installers to the Superintendent for approval.

Non-woven needle-punched geotextiles shall be installed to the requirements of the construction specifications. The geotextiles shall extend 1m beyond the leachate collection layer, as shown on the construction Drawings.

The separation geotextiles shall be placed by the lining contractor at the locations shown on the contract Drawings. All geotextile seams placed on slopes shall be overlapped a minimum of 300mm and thermally bonded using a "Leister" gun. Seams on side slopes will be oriented with the slope. End-of-roll seams will be offset a minimum of 1m between adjacent roll ends. Cross-slope seams shall be avoided. Installed bedding geotextile shall be covered with the interfacing material as soon as practical, but in no case longer than 14 calendar days. During periods of high winds, sandbags or other methods approved by the Manufacturer shall be used to secure any exposed geotextile in place. Surcharge will be placed at minimum 1m spacing along joints.

The separator geotextile will be thermally bonded using a "Leister" gun onto the protection geotextile at the extents of installation on the side slopes and bunds. The Contractor is to place permanent sandbag surcharge on the separator geotextile at a minimum of 5m spacing along the seams and either side of each primary and secondary leachate collection pipe run aggregate mound, change of grade between the basal and side slopes and external perimeter of the separation geotextile. The Contractor is to satisfy themselves of surcharging adequacy to prevent uplift and damage of the geotextile.

Construction vehicles shall not be allowed to operate directly on top of the geotextile and will only be permitted to travel over the geosynthetics on haul roads that are a minimum of 1m in depth constructed out of soils/drainage materials. Any geotextile that has granular material placed upon it shall have 300mm (minimum) of the material placed onto the geotextile and spread in advance of construction equipment with high floatation/low ground pressure equipment. The material will be spread in the same direction as the geotextile is seamed. Extreme care is required by the Contractor so that the equipment operator only pushes the materials ahead without damage to the geotextile. At no time will construction equipment be permitted to track directly on the geotextile.

Any holes or tears in the geotextile will be repaired by placing a patch with at least 300mm of overlap of the same material over the defective area. All patches will be thermally bonded as per normal seaming practices.

Any damage to the geotextile or lining system will be repaired by the Contractor (using approved methods) at no expense to the Principal. Completed separation geotextile installation and surcharging shall be approved by the Superintendent/CQA Consultant, comprising **Hold Point**.

5.6 Anchor Trenches

Excavation

Anchor trenches for the geosynthetic liner components shall be constructed at the locations shown on the Drawings. The anchor trench shape and dimensions shall be as shown on the Drawings.

Where the Contractor considers that there is insufficient room to handle the geosynthetics alongside the anchor trenches, the Contractor may construct a wider working area than shown in the Drawings. This working area shall be removed prior to Practical Completion. The construction of this working area shall be at the discretion of the Contractor, and its construction, maintenance and removal shall not constitute a variation under the Contract or a cause for Extension of Time.

Backfilling

Generally, the excavated material from the anchor trench will be used as backfill over the geosynthetics in the trench. Where this material is unsuitable, it shall be removed and replaced by suitable Engineered Fill material or other material approved by the Superintendent.

The fill shall be placed and suitably compacted in horizontal layers not exceeding 150mm in thickness to an approved density. This constitutes a **Hold Point**.

Prior to backfilling, the geosynthetic liners shall be checked to ensure that there are no folds or other irregularities. The geosynthetic liners shall be in a stress free, 'layflat' state over the entire area.

5.7 Maintenance

The geosynthetic materials shall not be exposed for longer than is specified on the manufacturer's installation guidelines. Each layer of geosynthetic liner shall be kept clean, free from dust, sticks and rocks during its temporary exposure.

The Superintendent will not entertain any claim for financial compensation or extension of time to the Contract as a result of delays in the provision of laboratory or on-site testing of geosynthetic materials.

6 Leachate Drainage Aggregate

The leachate collection layer aggregate shall be a low calcareous aggregate with a hydraulic conductivity of >1 x 10^{-3} m/s and the properties in Table 6-1**.**

Table 6-1: Properties of Leachate Collection Layer (Aggregate)

Property	Requirement
Maximum Particle Size	40mm (TBC following testing in Section 5.4)
Percent Passing 37.5mm sieve	TBC following testing in Section 5.4
Percent Passing a 20mm sieve	TBC following testing in Section 5.4
Percent fines value	<1%
Calcium Carbonate Content	<8.5% wt.
Soaked Ten percent fines value	100kN

The leachate drainage aggregate grading will be confirmed following the aggregate and cushion/ protection geotextile performance testing to determine actual passing material combinations, comprising **Hold Point**.

6.1 Installation

The leachate collection layer will be constructed across the base of the cell and extended up the side slopes to a vertical height of 4.5m.

Construction vehicles shall not be allowed to operate directly on top of the geotextiles and will only be permitted to travel over the geosynthetics on haul roads that are a minimum of 1m in depth constructed out of soils/drainage materials. Any geotextile that has granular material placed upon it shall have 300mm (minimum) of the material placed onto the geotextile and spread in advance of construction equipment with high floatation/low ground pressure equipment. The material will be spread in the same direction as the geotextile is seamed. Extreme care is required by the Contractor so that the equipment operator only pushes the materials ahead without damage to the geotextile. At no time will construction equipment be permitted to track directly on the geotextile.

The leachate collection layer shall be placed in a single layer. Placement of this layer shall be carried out without any deforming of the underlying materials. The final surface shall be smooth and free from surface aberrations. The Contractor shall provide an as-built survey (and isopachyte) of the installed leachate drainage thickness to the Superintendent/CQA Consultant for approval, constituting **Hold Point**.

It is a requirement that the proposed material for the leachate collection layer be approved by the Superintendent prior to its intended placement. The Superintendent reserves the right to reject the use of any material that they deem unsuitable for use in the leachate collection layer, whether or not it conforms to this Specification. All expenses for the transport, testing, placing of material that the Superintendent has not approved will be borne by the Contractor.

6.2 Testing

The Contractor will undertake two grading analyses from the leachate drainage aggregate materials delivered to Site, for acceptance by the Superintendent/CQA Consultant prior to incorporation into the works, comprising **Hold Point**.

7 Pipework

Leachate collection pipework shall be installed across the basal area of the landfill cell to transmit leachate to the sump area. Two (No. 2) leachate side slope riser pipes shall be installed to extract leachate from the landfill cell.

7.1 Products and Materials

7.1.1 Select Bedding Material

Select bedding material shall be as indicated on the Drawings. Select bedding material shall be sand material supplied by the Principal, or other suitable material approved by the Superintendent.

7.1.2 Backfill Material

Backfill material shall consist of the same leachate drainage aggregate used in the basal area of the cell.

7.1.3 High Density Polyethylene Pipes

High Density Polyethylene (HDPE) pipes shall be supplied in accordance with this Specification and Drawings and shall be installed and tested in accordance with **Section 7.2.5** of this Specification. All HDPE pipework shall be to the nominal diameter and standard dimension ratio as shown on the Drawings. The Contractor shall provide all necessary fittings and accessories including junctions, branches, and other fitments. The Contractor may elect to use prefabricated pipework for complex or bespoke sections.

All HDPE pipework shall be to the nominal diameter and standard dimension ratio as shown on the Drawings. All HDPE pipes shall be butt weld jointed by proprietary welding equipment unless specified elsewhere. Welding shall take place in locations which are protected from unfavourable weather conditions. All butt welds shall be reamed internally in order to remove excess beading. Plain pipes shall be tested to 1.5 times the working pressure. All pipe fitting and specials has be fabricated from the same material with equal or better performance.

All leachate collection pipework shall be laid upon 100mm of drainage layer material, shall have twice the pipe diameter of cover. For leachate collection pipes, the Contractor shall submit calculations from the pipework Manufacturer using ATV 127 Method (or similar approved) to demonstrate the following requirements:

- Pipe deflection < 6%;
- D85/hole diameter >1.0 (Circular perforations -5% open area);
- D85/hole diameter >1.2 (Slot perforations - 5% open area);
- Where D85 refers to the pipe granular surround. The following assumptions can be made:
  - waste Density 1000 kg/m3;
  - maximum waste depth = 27m;
  - soil stiffness of an uncompacted unconfined gravel surround on the base of the landfill (Bank installation under ATV); and
  - pipe is perforated.

For perforated pipes, the pipe Manufacturer shall submit calculation to confirm the integrity of the pipes as not being compromised by the installation of slots/perforations. Unless agreed otherwise by the Superintendent, slots shall be as indicated on the Drawings.

Approval of the pipe deflection calculations forms **Hold Point**.

7.2 Installation

7.2.1 Inspection of Pipe Materials

All materials to be used in the pipe laying operations shall be carefully inspected before use to ensure that damaged material is not used in the works. The interior of pipes, specials and fittings shall be carefully cleaned before being laid in the trench.

Pipe laying shall not commence until the bottom of the trench and the pipe bed has been approved by the Superintendent. Pipes shall be brought to the correct alignment and inclination, concentric with the pipes already laid.

7.2.2 Pipe Laying

The installation and butt fusion/electrofusion welding of Polyethylene (PE) pipes shall only be undertaken by skilled, competent and experienced personnel. The Principal reserves the right to request documentation for proof of competency, training and experience.

All pipes shall be laid in accordance with the manufacturer's recommendations to uniform gradients and to levels shown. All materials to be used in the pipe laying operations shall be carefully inspected before use to ensure that damaged material is not used in the works. The interior of pipes, specials and fittings shall be carefully cleaned before being installed.

Pipe laying shall not commence until the underlying geosynthetics and the pipe bed has been approved by the CQA Consultant. Pipes shall be brought to the correct alignment and inclination, concentric with the pipes already laid.

Pipes shall be set in an upstream direction unless otherwise approved by the Superintendent. All HDPE pipes shall be butt weld jointed by proprietary welding equipment unless specified elsewhere. Welding shall take place in locations which are protected from unfavourable weather conditions. All butt welds shall be reamed internally in order to remove excess beading.

The Contractor shall prevent any damage from occurring to the underlying geotextile and geomembrane during pipe installation. Should the geotextile or geomembrane be damaged in any way the Contractor shall repair the damage at the Contractor's cost according to Sections 5.2.3, 5.3.4.4, 5.4.2 and 5.5.2.

PE pipes should be backfilled/covered as soon as practicable to minimise thermal movements.

7.2.3 Continuity of Laying

All pipelines shall be laid in a continuous operation. It will not be permissible to leave gaps where fittings, etc., occur and return later to infill the gaps. The Contractor shall ensure that all bends and specials are available for each section of the work before work commences on that particular section. Immediately after laying, the open end of a pipe will have to be sealed with a wooden plug or approved stopper of appropriate size to prevent the entry of material which contaminates the pipeline, damages

linings or impacts its functionality. Adequate precautions shall be taken to prevent floatation of the pipeline in the event of the trench being flooded.

7.2.4 Tolerances

The tolerances shown in Table 7-1 shall apply to all installed pipes, unless specified otherwise.

Table 7-1: Tolerances of Pipes and their Components

Component	Alignment	Level
Pipes	±25mm	±5mm
Manholes and drainage structures	±20mm	±10mm

7.2.5 Sub-surface Pipes

7.2.5.1 *Trench Excavation*

Trench excavation for pipelines shall be in accordance with **Section** Error! Reference source not found. and conform to the longitudinal sections shown on the Contract Drawings. Sharp changes in gradient shall be avoided. Horizontally, smooth curves may be used to avoid bends provided that the maximum deflection of any pipe joint does not exceed the manufacturer's recommendations.

The length of trench to be opened at any one time shall be at the Superintendent's discretion and cognisant of the potential inconvenience to the public and disruption to traffic.

7.2.5.2 *Protection of Foundation Surfaces*

The exposed surface at the bottom of the excavation shall be adequately protected from disturbance by the Contractor's operations or by the action of storm water or ground water. Where required, dewatering shall be undertaken in accordance with the requirements of Section **Error! Reference source not found.** this Specification. Any disturbance shall be reinstated to original conditions by the Contractor at no cost to the Principal.

7.2.5.3 *Pipe Bedding*

Bedding shall be well compacted, provide sound, uniform support, and not be disturbed by groundwater or other similar conditions. Bedding material shall be free from organic matter. Where conditions are dry, the Superintendent may authorise the use of excavated sand as bedding material. In the event of wet conditions, bedding material shall be granular material as approved by the Superintendent.

Pipe bedding material shall be shaped to suit the barrel of the pipe to give full support to the length of the pipe. Bedding shall be tamped into position up the sides of the pipe to give full support to the diameter of the pipe. At collars, the bedding material shall be scooped out to allow jointing to be carried out and the pipe shall not rest on the pipe collars.

7.2.5.4 *Pipe Laying*

All pipes shall be laid in accordance with the manufacturer’s recommendations to uniform gradients and to levels shown. Pipes shall be set in an upstream direction unless otherwise approved by the Superintendent.

PE pipes should be 'snaked' during installation and backfilled immediately as to minimise thermal movements.

The Contractor shall provide all necessary fittings and accessories including junctions, branches, and other fitments.

7.2.5.5 *Backfilling*

Following satisfactory inspection, testing and recording of as-constructed information, the trench shall be backfilled and compacted by hand with selected materials as shown on the Drawings. Backfill will be carefully placed and compacted under, around and over the pipe taking precautions to ensure the pipe is not disturbed in line or level, or damaged. Backfill levels on each side of any conduit shall not differ by more than 150mm. The Contractor shall ensure that the backfill placement does not damage the end treatments.

The dimensional requirements relating to backfill shall be as shown on the Drawings. All sheeting, struts, braces, and similar temporary supports shall be entirely removed from the trench prior to backfilling. Removal shall be affected in such a way so as not to disturb or displace the conduit.

Backfill will be placed in continuous horizontal layers not exceeding 150mm loose thickness using light compaction equipment above the pipe until a minimum depth of 150mm has been placed and compacted over the pipe.

Once the backfill is over 150mm above the crown of the pipe, backfill shall proceed in 300mm loose layers.

Heavy compaction equipment will not be permitted unless 600mm of fill has been properly compacted over the pipe.

7.3 Acceptance

7.3.1 Field Testing of Mains

All solid pipelines shall be subjected to hydrostatic test before being brought into service. The required field test on pipes shall be 1.5 times the maximum working pressure. The test pressure shall be applied and maintained for at least 24 hours.

If a drop in pressure occurs, the quantity of water to be added in order to re-establish the test pressure shall be measured. The test shall be considered satisfactory when the amount of water added does not exceed 0.1 litres/mm of diameter/km of length/30m of head/24hr (i.e. 1 gallon/inch diameter/mile/100ft head/24hr).

If the pipeline fails to meet the above criteria, the fault shall be found and rectified. To this purpose, it is advisable to leave as many joints exposed as possible during the test by partially backfilling only between joints.

7.3.2 Overall Pressure Test

When all pipe laying has been completed, and all sections of main are interconnected in the system, an overall hydrostatic test shall be applied to the system at 1.5 times the working pressure.

7.3.3 Water for Testing

The Contractor shall make his own arrangements for obtaining test water from the on Site 'Turkey's Nest' dam. Where a public water supply is not available, the Contractor shall locate suitable sources

of water for testing purposes on Site and shall obtain the Superintendent's approval to the use of such sources.

A contractor quality sign-off form shall be issued by the Contractor, for the witnessing of testing of all pipework, to the Superintendent 24 hours in advance of the test being carried out, for approval.

8 Mechanical

8.1 Parts in contact with Leachate

Parts in contact with leachate shall not include unsuitable materials such as zinc, or galvanised surfaces (as these impart metals to the leachate, and are not long lasting in such an environment).

Aluminium is not considered suitable in most instances.

8.2 Leachate Pump

The Contractor is to confirm the suitability of the pump, which should:

- Generally meet the requirements of Water Industry Standards
- Be of the fully submersible, non-clog, progressive cavity type. They must be constructed from materials resistant to corrosion and capable of working while immersed in leachate.
- Be selected with a stable pump head-flow curve with the tangent at any point directed downward in the direction of increasing flow rate. The pump shall avoid run out conditions with the wet well at maximum water level.
- Be capable of continuous operation over its full operating range, either partially or fully submerged. Cooling of the motor shall be an integral part of the pump design and shall not rely on a separately supplied or driven cooling supply.
- Be designed for both continuous and intermittent operation capable of a minimum of 15 starts per hour.
- Be capable of withstanding the effects of short-term reverse rotation following pump stop.
- Be capable of operating at zero flow rate (closed valve) for a period not less than 2 minutes.
- Be capable of running dry for short periods during maintenance, inspection or rotation checks.
- The design of the pump must include every precaution to eliminate choking of the pumps and other mechanical breakdowns.
- Have the direction of rotation clearly and permanently marked on the pump housing, the direction of rotation shall be clockwise when viewed from above the motor.
- Be fitted with motor enclosures rated to IP68 with a continuous submergence depth rating of 20m.
- Be designed, manufactured and erected in accordance with the latest valid issues of codes, standards, IEC recommendations, accident prevention regulations and legal regulations.

8.2.1 Pump Casing

- The material for the pump casing must be a high quality SAE 316L (marine grade) stainless steel, or similar approved.
- The pump casing must be designed for easy access to all parts.
- The pump casing must be able to withstand a hydrostatic test head of twice the maximum possible delivery head.
- Any detachable fittings must be held in place with countersunk screws or locking devices.

8.2.2 Pump Mounting

- Pumps will be freestanding to allow easy removal without the need to remove bolts or drain or enter the well/borehole.
- Pump-sets installed in wells shall be coupled to the outlet pipework at the headworks by means of 32mm PE100 SDR11 pipework.

8.2.3 Bearings

- Ball or roller bearings must be able to absorb axial and/or radial thrust where appropriate. They must be adequately housed and continuously rated.
- Bearings shall be lubricated for life and not require routine lubrication.

8.2.4 Seals

- Shaft seals must be the mechanical type, rated to ensure exclusion of the pumped media from the bearings and motor.
- Shaft seal cooling shall be an integrated part of the pump and not require additional facilities.

8.2.5 Pump Identification Plates

- The pump identification plate shall be made from non-corrosive material and shall contain, as a minimum, the following information:
  - Manufacturer
  - Serial Number
  - Rated head (metres)
  - Rated flow (l/s)
  - Motor Power (kW)
  - Weight (kg)
  - Pump set IP rating
  - Voltage/Phases/Frequency/Amps
- The identification plates shall be permanently fixed on each pump set starter with self-tapping screws.

8.2.6 Noise Levels

- Under all operational conditions the noise level of pumps and equipment shall not exceed the following figures, unless otherwise specified:
  - The overall noise level shall not exceed 85 dB (A) measured at a distance of 1 m from the pump well.
  - The noise level from any one individual item of equipment shall not exceed 80 dB (A) measured at a distance of 1m in any direction from the noise source.
  - Special effort shall be made to eliminate noise with tonal characteristics such as whistles, screeches and hums.
- ISO R 532 shall be the basis for assessment of the noise levels.

8.2.7 Pump Lifting

- The pump-set shall be provided with a lifting point located to provide safe and balanced lifting for the design load of the pump, cables and pipework.
- Borehole pumps shall have a suitable lifting point about the centre of gravity of the pump.
- Each Pump shall be supplied with lifting chains permanently connected to the pump lifting point. Each chain shall be fitted with a locking device or padlock to allow it to be secured at the top of the well.

8.2.8 Lifting Equipment

Due to the lightweight nature of the pumps lifting equipment is not likely to be necessary, however if lifting equipment is necessary for the safe removal and reinstatement of any plant the following will apply:

- All Lifting Appliances inclusive of gantries, portable/fixed lifting systems and associated equipment shall be protected against corrosion as defined.
- The finished colour shall be a full gloss yellow colour no. 356 to BS 381C:1996 or equivalent reference.
- All lifting appliances shall include identification of the Safe Working Load (SWL).
- All lifting appliances shall be tested and supplied with:
    - Individual Test Certificate (Certificate of Conformity), for each item of lifting equipment, which shall include the name of the "Owner or Occupier".
    - All individual items of Lifting Equipment shall be clearly marked with their respective serial number and safe working loads.
    - Where lifting equipment is provided with the purpose of forming an assembly, then one test certificate shall be provided for the complete assembly. The test certificate shall clearly and unambiguously identify the complete assembly.
    - Site load testing of all lifting equipment include the hoist and lifting assembly shall be undertaken using calibrated weights, certification shall be provided.
- All lifting equipment shall be suitable for intermittent operation. The service life of the equipment shall not be less than 25 years.

Lifting equipment shall conform, where applicable to the Australian standards.

8.2.9 Chains

All lifting equipment shall be operated by chain.

Each lifting chain shall be fitted with 50mm internal diameter rings at maximum of 1m intervals. Chains shall be shackled to the pump and secured at the top of the wet well within safe reach.

The lifting chains, and any eye bolts or shackles used to lift the pumps shall be supplied with individual load test certificates. The lifting chains shall extend a minimum of 1m above the top of the well when the pump is in position and shall be secured to a stainless steel hook that can be accessed without leaning over the wet well.

Chains supplied and/or included in the Contract that are submersed totally or partially below top of liquid shall exhibit corrosion resistance properties equivalent to that of a 'grade 316' stainless steel.

Lifting chains and associated components shall be stainless steel and shall conform to Australian standards.

8.2.10 Valves and Penstocks

Valves and penstocks shall comply with the relevant provisions of the appropriate Australian Standards.

All valves shall be individually tested by the manufacturer for both strength and leakage.

Unless indicated otherwise, direction of closure shall be clockwise. The direction of closing shall be indicated by an arrow cast on the upper face of the gland or stem seal housing.

Hand wheels, valve caps and spindle couplings shall be positively located and secured on spindles, friction location is not acceptable.

Operating hand wheels shall have the direction of open/close operation permanently cast or stamped into the hand wheel rim. Hand wheels shall be sized so the valve can be operated against the design differential pressure referred to in the data sheet or 1 bar, whichever is the greater, with an operating effort at the rim (push/pull) not exceeding 250 N.

8.2.10.1 *Ball Valves*

Ball Valves shall be installed in the valve coffin at each pumping well and shall comprise:

- 316 Stainless Steel body
- PTFE Seals
- Screwed BSP Fitting
- Lever Operation

8.2.10.2 *Non-return/Check Valves*

Non-Return Valves shall be installed in the valve coffin at each pumping well and shall comprise:

- 316 Stainless Steel body
- Swing Type
- Metal seat

8.2.10.3 *Valve Pits*

The rising main from each pump well shall pass through a valve pit to the Contractor's design. The valve pit design should be supplied at time of tender, for approval by the Principal and Superintendent.

The pipework entering the valve pit from the pump well shall be 50mm OD and the pipework exiting the coffin shall be 50mm OD.

The valve pit will house a vortex flow meter, non-return valve, and lever operated ball valve. The valve pit will be lockable.

8.3 Syphoning

Any syphoning potential should be considered within the design and installation process. Where pipework is installed at a lower elevation to leachate storage an air valve and/or non-return-valve (NRV) should be considered.

As a minimum, air valves are to be installed at the leachate ring main discharge (high points) at the evaporation pond. The Contractor is to recommend any further air valves as part of their detailed design of the pumping system.

8.4 Well Heads

Typical Wellhead details are provided on the Drawings. Should the Contractor specify an alternative design, this should be supplied at time of tender, for approval by the Principal and Superintendent.

8.5 Take-Over Procedures, Testing and Commissioning

The Contractor shall carry out comprehensive documented Factory Acceptance and Site Acceptance test as necessary, whether particularly described in this Contract or not, to prove the operability, functionality and safety of the leachate extraction system.

9 Liner Integrity Survey

The Contractor is advised that geomembrane leak location surveys are to be undertaken following installation of the leachate drainage aggregate and before the separation geotextile installation.

The Contractor is to undertake a dipole survey over the surface area of the completed leachate drainage stone, in accordance with ASTM D7007. An electrical voltage is passed between two electrodes, a fixed electrode placed in the ground outside the lined area and a moveable set of electrodes within the cell area. The Contractor is required to measure the electrical potential and detect any defects within the geomembrane. To ensure no electrical leakage occurs, a strip of geomembrane should be left exposed around the perimeter of the test area to ensure complete electrical isolation.

The Contractor should ensure a 0.5m (minimum) wide strip of geomembrane/geotextile is to be left exposed around the perimeter of the area to be tested, enabling the geomembrane to be electrically isolated from the surrounding ground during testing. The Contractor will be required to place drainage aggregate/reinstate the access ramp on the isolation strip upon successful completion of the leak detection test.

The Contractor is to undertake an artificial leak detection sensitivity test prior to the commencement of each day of surveying. The cell area shall be surveyed on a grid system, data shall be recorded, plotted and analysed for leak signals. The Contractor shall also ensure that the drainage blanket is wet enough to conduct electricity and shall be required to wet the drainage stone throughout the survey period.

All anomalies shall be investigated, and where defects are identified the geomembrane shall be repaired. Following repair procedures and reinstatement of geosynthetics and drainage stone, the area shall be locally resurveyed to ensure the defect was not masking further defects in the vicinity.

On completion of the leak detection survey the Contractor is to provide a report as a minimum as described in ASTM D7007 outlining the electrical potential across the landfill cell area, including the location of the internal and external electrodes for each day of surveying, and the location of any detected leaks/defects. All resurveying shall also be recorded and provided within the final report.

The geomembrane above the leachate drainage stone shall also be surveyed with a dipole survey to detect any potential leaks/defects.

The Contractor will investigate all anomalies and, where required by the CQA Consultant/Superintendent, repair the underlying geomembrane. All repair works to the geomembrane, and overlying materials which require removal and reinstatement, will be at the cost of the Contractor.

Approval of the Liner Integrity Survey by the CQA Consultant comprises **Hold Point**.

APPENDIX A
Drawings

APPENDIX B
Bill of Quantities

APPENDIX C
Construction Quality Assurance Plan

Assets | Engineering | Environment | Noise | Spatial | Waste

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