CONSTRUCTION SPECIFICATION:
ALLAWUNA FARM LANDFILL

This document describes the standards, materials and engineering requirements for Earthworks, Cell Lining, Leachate Collection System installation and the associated Quality Assurance requirements.

Date: 3rd January 2014

Prepared By

Bowman & Associates Pty Ltd
Environmental Engineering Consultants
Waste Management Specialists
www.bowmanassociates.com.au
DRAFT DOCUMENT

This Construction Specification remains in draft form for submission as a supporting document to the Works Approval application made by SITA Australia Pty Limited (Principal). Upon issuing of a Works Approval this Construction Specification will be amended to comply with any conditions set forth in the Works Approval and updated to reflect any minor improvements to the design or auxiliary features requested by the Principal.

No significant changes that affect the environmental performance of the facility will be made.

All minor amendments will be documented and included in the Construction Quality Assurance (CQA) report, to be supplied to the DER upon completion of the Works, in accordance with an expected general condition of the Works Approval.

Portions of the Construction Specification identified in yellow highlighting are contextual relating to construction phase (Initial Works, Cell 1B or Cell 2), approvals currently being processed or conditional responses to unknown elements of the project.

Drawing numbers are likely to be updated as further detail is incorporated into the design.
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ACRONYMS

AS Australian Standard
ASTM ASTM International (Formerly the American Society for Testing and Materials)
CBR Californian Bearing Ratio
DFES Department of Fire and Emergency Services
EP Act The Environmental Protection Act 1986
DA Development Approval
DER Department of Environment Regulation
GCL Geosynthetic Clay Liner
GRI Geosynthetic Research Institute
HDPE High Density Polyethylene
ISO International Organisation for Standardisation
NATA National Association of Testing Authorities
PE Polyethylene
PPE Personal Protective Equipment
RCBC Reinforced Concrete Box Culvert
uPVC Un-plasticised Polyvinyl Chloride
UTM Universal Transverse Mercator
UV Ultraviolet
WA Western Australia
<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>%</td>
<td>Percent</td>
</tr>
<tr>
<td>cm³/2g</td>
<td>Cubic Centimetre per Two Grams</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td>g/cc</td>
<td>Grams per cubic centimetre</td>
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<td>g/m²</td>
<td>Grams per Square Metre</td>
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<tr>
<td>kg</td>
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<tr>
<td>kPa</td>
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<td>km</td>
<td>Kilometre</td>
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<tr>
<td>kN/m</td>
<td>Kilonewtons per metre</td>
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<td>m</td>
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<td>mm</td>
<td>Millimetre</td>
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<td>m²</td>
<td>Square Metre</td>
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<tr>
<td>m³</td>
<td>Cubic Metre</td>
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<tr>
<td>m/s</td>
<td>Metres per Second</td>
</tr>
<tr>
<td>MPa</td>
<td>Megapascal</td>
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<tr>
<td>Microns</td>
<td>Micron (µm) = 1 x 10⁻⁶ metres</td>
</tr>
<tr>
<td>N</td>
<td>Newton</td>
</tr>
<tr>
<td>N/m</td>
<td>Newtons per Metre</td>
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1 SPECIFICATION PRELIMINARIES

1.1 INTRODUCTION

SITA Australia Pty Limited (Principal) has successfully obtained approval to construct a new landfill facility, to be known as the Allawuna Farm Landfill, in the Shire of York. The site requires establishment of infrastructure including offices, hardstands, water management structures and leachate dams. The landfill will be constructed in a series of lined cells.

1.2 CONSTRUCTION SPECIFICATION

This document provides the technical specifications and the standard of construction to be followed for the construction activities associated with the development of Allawuna Farm Landfill. This document also describes testing procedures to be employed to validate the quality of the constructed Works.

1.3 SUPPORTING DOCUMENTS

This Construction Specification is intended to be read in conjunction with the following documents. Should any of the listed information sources be in contradiction, the document listed first shall take precedence. For technical queries, clarification may be sought from the Superintendent or the Designers Representative.

- Tender response schedules and Special Conditions of Contract,
- AS 4000 General Conditions of Contract,
- Construction Specification (this document),
- Bill of Quantities, and
- Construction Drawings.

1.4 BACKGROUND

1.4.1 PRINCIPAL

The Principal is a leading multinational waste, recycling and resource recovery service provider. The Principal has 100 operations across Australia including composting facilities, resource recovery facilities, materials recycling facilities, depots, transfer stations and nine landfills.

1.4.2 SUPERINTENDENT

The Superintendent will be the Principal, or the Principal’s appropriately skilled and qualified representative, responsible for representing the Principal’s interest during the execution of the Works by the selected Contractor.

1.4.3 DESIGNER

Cell 1, Cell 2 and the supporting infrastructure for Allawuna Farm Landfill has been designed and specified by Bowman & Associates Pty Ltd. Any technical queries regarding the Works shall be referred to the person nominated by the Principal.
A designer’s risk assessment is attached below as Attachment 1. The risk assessment relates to specific safety and performance engineering design features considered during the design phase.

1.4.4 REGULATOR

The Department of Environment Regulation (DER) has issued a Works Approval for the Allawuna Farm Landfill development under Part V of the EP Act. Under the direction of the Principal the Contractor shall carry out the landfill construction in compliance with the terms and conditions of the Works Approval issued by the DER.

1.5 DEFINITIONS

The following terminology shall apply in this Construction Specification:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill of Quantities</td>
<td>A table supplied by the designer describing the estimated volumes, lengths, areas and other quantities of materials and effort required to complete the Works.</td>
</tr>
<tr>
<td>Construction Drawings</td>
<td>Series of drawings setting out the lines and dimensions of the construction Works.</td>
</tr>
<tr>
<td>Construction Specification</td>
<td>Description of the requirements of the construction Works. This Document.</td>
</tr>
<tr>
<td>Contract</td>
<td>Legally binding agreement between the Principal and the Contractor for the provision of the Works.</td>
</tr>
<tr>
<td>Contractor</td>
<td>Organisation or individual commissioned by the Principal to undertake the Works subject to this Construction Specification and associated Contract conditions as provided by the Principal.</td>
</tr>
<tr>
<td>Designer</td>
<td>Bowman &amp; Associates Pty Ltd.</td>
</tr>
<tr>
<td>Landfill Footprint</td>
<td>The area within the site used for waste placement.</td>
</tr>
<tr>
<td>Principal</td>
<td>SITA Australia Pty Limited.</td>
</tr>
<tr>
<td>Regulator</td>
<td>Department of Environment Regulation.</td>
</tr>
<tr>
<td>Schedule of Rates</td>
<td>A table supplied by the Contractor and accepted by the Principal that described the cost per quantity for each item identified in the Bill of Quantities.</td>
</tr>
<tr>
<td>Site</td>
<td>Lots 4869, 5931, 9926 &amp; 26934 Great Southern Highway, Saint Ronans, Shire of York.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>The Principal or the Principals Representative.</td>
</tr>
<tr>
<td>Third Party Quality</td>
<td>An expert Auditor supplied by the Principal who will observe and report on all lining operations.</td>
</tr>
<tr>
<td>Assurance Observer</td>
<td></td>
</tr>
<tr>
<td>Works</td>
<td>All activities undertaken by the Contractor for the execution of the Allawuna Farm Landfill construction Contract.</td>
</tr>
<tr>
<td>Works Approval</td>
<td>Approval issued by the Department of Environment Regulation authorising the Principal to proceed with the Works.</td>
</tr>
</tbody>
</table>
1.6 SITE LOCATION

Allawuna Farm is located on the southern side of Great Southern Highway approximately 80 km by road from Perth and 20 km by road from York. The site is identified as Lots 4869, 5931, 9926 & 26934 Great Southern Highway, Saint Ronans in the Shire of York. The site area totals 1,500 hectares (ha) and is currently used as a broad acre cereal cropping farm.

1.7 WORKS AREA

The Works included in this Construction Specification cover a 3 km long entrance road corridor and approximately 10.5 ha affected by the construction of site infrastructure, Cell 1 and Cell 2.

1.8 DESCRIPTION OF WORKS

The Works includes, but is not limited to, the provision of all equipment, labour, operations, management, supervision, quality control and all other works required for the completion of the construction of [Cell 1A and site infrastructure / Cell 1B / Cell 2] as described in this Construction Specification and in accordance with the Construction Drawings provided. Any additional works or variations from the Construction Specification ordered by the Superintendent is to be included as part of the Contract and subject to additional payment.

1.9 SCOPE OF WORKS

The Works, as defined in the Contract, this Construction Specification and the Construction Drawings includes the following:

- Survey and setting out,
- Mobilisation and demobilisation of plant and equipment,
- Payment of Building and Construction Industry Training Fund Levy,
- Supply of equipment, construction materials, labour and supervision,
- Construction quality control and assurance,
- Construction of the site entrance road, including a creek crossing and all drainage control structures,
- Earthworks excavation and filling to achieve design levels for [infrastructure area and Cell 1A / Cell 1B / Cell 2],
- Detailed design, supply and construction of site office buildings, ablutions and shed(s),
- Obtain a building license for structures to be erected on site,
- Installation of services (power, data, water, leachate transfer, sewerage) as required,
- Construction of the lined leachate dams,
- Construction of [Cell 1A / Cell 1B / Cell 2] of the landfill including all cell liners, leachate collection system and leachate extraction riser pipes,
- Construction of stormwater dam and stormwater drainage structures,
- Installation of fencing as required, and
1.10 CONSTRUCTION PROGRAMME

The stormwater dam is to be constructed prior to other Works on the site and used as a water source during further construction.

1.11 WORKING HOURS

The normal working hours and working days shall be no earlier than 0730 hours and no later than 1630 hours Monday to Saturday, excluding public holidays. Work outside of these hours will be subject to approval by the Principal. The Contractor shall be liable for any additional cost or any claims incurred by the Principal as a result of working outside normal hours.

1.12 DISRUPTION TO FARM ACTIVITIES

As far as practicable, the Contractor shall limit its disturbance of land outside the Works area and accommodate any access requirements of the farm lessee. Contractor vehicles and equipment shall remain on designated roads and tracks and shall not traffic over cropping areas.

1.13 CONTRACT MANAGEMENT

1.13.1 PROJECT SCHEDULING

The Contractor shall submit a detailed Program of Works based on the outlined scope of within two (2) weeks from the date of appointment of Contractor.

The Program of Works shall include a list of subcontractors, resource allocation and time frames for each task. This will be subjected to review by the Superintendent during progress meetings and will be updated on a weekly basis showing the percentage of work completed to form the approved project schedule.

1.13.2 PROGRESS MEETINGS

Progress meetings will be held on site or at other agreed locations throughout the period of construction. The meetings will be held at least weekly and attended by the Principal’s Representative, Contractor or Contractor’s Representative and the Superintendent.

Minutes detailing attendees, discussion topics, resolutions, actions required and responsible parties shall be recorded at all meetings and distributed to all attendees. Previous meeting minutes shall be tabled and confirmed at the following meeting.

1.13.3 PROGRESS REPORTING

The Contractor shall prepare and submit progress reports based on the previous progress meeting to the Superintendent. The format of these reports shall be to the satisfaction of the Superintendent and will include the following as a minimum:

- Progress in Works, percentage of tasks completed, achievement of milestones,
- Delay in achieving expected completion of tasks and valid comments stating the reason,
- Updated and approved project schedule as per the previous project meeting,
- Updated list of tasks and actions considered from the outcome of the previous meeting and the anticipated dates of completion,
- List of upcoming milestone events and the tasks required to complete them, and
- Details of work completed for invoicing.

1.14 HOLD POINTS

The following hold points are minimum requirements only, and additional inspections during the construction phase may be required at the Superintendent’s discretion.

Hold points include but are not limited to the following:

- When soft ground is encountered,
- Prior to placement of any road seal,
- Prior to any concrete pours,
- Following preparation of all subgrade earthworks the Superintendent shall inspect the finished surface for compliance with the requirements of the Construction Specification,
- Survey of the prepared earthworks subgrade in the landfill cell and the internal shoulder up to the excavated anchor trench,
- Survey of the anchor trench prior to installation of geosynthetic clay liner (GCL),
- At hold points to be nominated by the Superintendent based on the Contractor’s proposed construction plan for the installation of the geomembrane liner and cushion geotextile,
- Prior to covering the geomembrane with the cushion geotextile, the Superintendent shall inspect the geomembrane surface and the Superintendent will cross reference the installers Construction Quality Assurance (CQA) documentation to ensure that seams, panels, defects and repairs have been accurately recorded, and
- All other hold points defined in the Construction Specification or as directed by the Superintendent.

The Contractor is to provide the Superintendent with 48 hours written notice of an impending hold point. If a Contractor proceeds to construct beyond the designated hold point without the Superintendents inspection and/or without the Superintendents approval then the Superintendent may direct the Contractor to uncover and remediate the Works to the hold point, at the Contractor’s expense.

The Contractor shall be deemed to have allowed for all time delays and costs associated with the hold points during the Works.
1.15 SETTING OUT AND SURVEY CONTROL

The Contractor shall be responsible for setting out the Works and for ongoing survey control, including alignment of surface water drains and construction of the liners to the grades, levels and locations shown on the Drawings.

The term "survey mark" used in this clause means a survey peg, bench mark, reference mark, signal, alignment, level mark or any other mark used or intended to be used for the purpose of setting out, checking or measuring the work under the Contract.

Unless otherwise required by the Contract, the Contractor shall preserve and maintain in their true positions the survey marks provided by the Principal or by the Superintendent in accordance with the Contract.

Should any survey mark be disturbed or obliterated, the Contractor shall immediately notify the Superintendent and shall, unless the Superintendent otherwise determines, rectify such disturbance or obliteration to the satisfaction of the Superintendent. Unless the disturbance or obliteration has been caused by the Principal, his employees or agents, the cost of rectification shall be borne by the Contractor.

Details of survey control for the Works is available upon request from the Principal’s licensed surveyor.

1.16 ERRORS IN SETTING OUT

If at any time during the progress of the Works, any error is discovered in the position, level, dimensions or alignment of any part of the Works, the Contractor shall immediately notify the Superintendent. The Contractor shall, unless the Superintendent otherwise directs, rectify the error. Unless the error has been caused by incorrect data issued by the Principal, the cost of rectification shall be borne by the Contractor.

The Superintendent may check the setting out of the work under the Contract by the Contractor but the fact that the Superintendent may have carried out such checks shall not relieve the Contractor of any responsibility for the correct setting out of the work.

1.17 SITE SURVEY, AREA AND VOLUME CALCULATIONS

The Contractor shall engage a licensed surveyor to carry out survey control during the execution of the Works. Survey shall allow accurate calculation of all items in the Bill of Quantities.

Survey shall include, but not be limited to:

- Earthworks survey on a maximum 10 m grid over the affected area, at suitable points, including changes in grade, embankment breaklines, changes in material, levels and alignments to define earthworks volumes and areas,
- Limits and alignments of all constructed roads,
- The location and invert levels of all drainage infrastructure,
- Location and alignment of all services,
- Location and volume of all concrete structures,
• Survey of liner anchor trenches,
• Survey of all soil test locations for the geotechnical quality control testing program,
• Geomembrane panel layout and location of any repairs to the geomembrane,
• Survey of the leachate drainage system as installed,
• The top of the aggregate drainage layer, once all liner quality assurance processes are complete, and
• All fences and gates as installed.

The results of the site survey shall be supplied to the Superintendent as Drawings at an appropriately legible scale. Survey shall be provided on paper and in 3D AutoCAD (.dwg or .dxf) format with locations and levels to an accuracy of ± 100 mm horizontally and ± 20 mm vertically. Contours shall be shown at a 0.2 m interval (or as determined by the Superintendent), with the triangulated surface(s) used to determine any contours included in the digital model. Survey shall be supplied to the Superintendent within five (5) working days of the survey being undertaken.

Where claims for payment are based on the Schedule of Rates, quantities shall be calculated from the survey for the items shown in the Schedule of Rates. Claims for payment must be substantiated by relevant survey information and quantity calculations performed by a licensed surveyor.

Should the survey data be deemed to be inaccurate or contain discrepancies, the Principal shall appoint an alternative licensed surveyor to check the survey or quantities. The Contractor will be liable for all costs associated with any survey checks that indicate errors in the Contractor’s original survey data.

1.18 AS CONSTRUCTED DRAWINGS

The Contractor shall supply a set of As Constructed drawings in digital format. The As Constructed drawings will show the true position of the completed Works in Universal Transverse Mercator (UTM) format with AHD datum. Any variations from the ‘Issue For Construction’ drawings will be clearly annotated on the As Constructed drawings.

The Principal shall not issue a Certificate of Practical Completion until As Constructed drawings to an accurate and acceptable standard have been supplied by the Contractor.

1.19 CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

Prior to Practical Completion the Contractor must provide comprehensive Construction Quality Assurance documentation setting out the following information:
• Index,
• List of all materials installed on site giving manufacturers details, agents details and a materials list,
• Earthworks soil test results,
• Maintenance requirements for completed Works,
• All Construction Quality Assurance testing data for the composite liner system,
• All pipe pressure test results,
• Serial numbers for parts and equipment installed on site, and
• All survey data.

The documentation shall be professionally bound and shall be appropriately labelled.
The documentation shall also be supplied in a digital format.

1.20 ENVIRONMENTAL PERFORMANCE

1.20.1 EQUIPMENT
The equipment to be used on site shall have appropriate emission control devices and will be maintained regularly to achieve optimum performance.

1.20.2 CONTAMINATION OF SITE
All refuelling of mobile plant will be undertaken in a designated area of the site nominated by the Contractor and approved by the Superintendent. Any fuel tank(s) stored onsite during construction shall be adequately contained and bunded to avoid spillage and contamination of soil. On occurrence of spillage events, the contaminated soil shall be removed from the site to an appropriate licensed facility at the Contractor’s sole expense.

1.20.3 STORMWATER MANAGEMENT AND WATER DISCHARGE
Water management in the Works area will be the responsibility of the Contractor. Water in the Works area that is generated by rain may be pumped and discharged as stormwater on another part of the site, as directed by the Superintendent. The Contractor shall not discharge any water containing levels of salt, organic matter, hydrocarbons or other contaminants which are incompatible with the receiving water body without prior treatment and approval from the Superintendent. Each discharge request shall contain data on levels of contamination for analysis by the Superintendent at least ten (10) days prior to discharge.

1.20.4 LEACHATE MANAGEMENT
Water that is identified as leachate from existing cell(s), or water that is suspected of contamination with leachate from existing cell(s) must be retained and tested prior to discharge onto another part of the site. Where water is identified as leachate management responsibility shall fall to the Principal.

1.20.5 FIRE PREVENTION
The Contractor shall ensure that no fires are set alight without the written approval of the Superintendent. Flammable or explosive products will be stored on site in accordance with the Dangerous Goods Safety Act 2004 or any other relevant regulation. The Contractor shall obtain all the necessary permits and licences to store and use such materials and pay all relevant fees and charges. The Contractor shall provide and maintain adequate fire fighting equipment on site and observe the WA Bushfires Act, Local Authority regulations, DFES requirements and any regulations in respect to fire prevention. To minimise the risk of fire, smoking shall only be permitted in authorised areas. The Superintendent shall instruct the Contractor on the locations where smoking is and is not permitted.
1.21 ENVIRONMENTAL OBLIGATIONS

1.21.1 DUST CONTROL

The Contractor shall implement all reasonable and practical measures to prevent or minimise the generation of windborne particles during all tasks at all times of the construction phase. The Contractor shall be bound to *A Guideline for the Prevention of Dust and Smoke Pollution from Land Development Sites in Western Australia (November 1996).*

1.21.2 NOISE

The Contractor shall comply with the *Environmental Protection (Noise) Regulation 1997* (EP Noise).

1.21.3 WORKS APPROVAL COMPLIANCE

The Contractor shall, during the period of construction, comply with the terms and conditions specified in the Works Approval issued by the DER. A copy of the Works Approval will be provided to the Contractor upon request.

1.21.4 SOIL EROSION

The Contractor shall take all proper precautions to prevent soil erosion from any land used or occupied by the Contractor in the execution of the Works.

1.21.5 DUST, DIRT, WATER AND FUMES

The Contractor shall prevent any nuisance occurring through the discharge of dust dirt, water, fumes and the like.

1.21.6 REFUSE DISPOSAL

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

1.22 OCCUPATIONAL HEALTH AND SAFETY

Site safety when undertaking the Works shall be the responsibility of the Contractor. The Contractor shall determine appropriate safe working procedures and methodologies to construct the Works as specified.

The Contractor shall provide regular updates on site safety performance to the Superintendent during the Works.

Minimum Personal Protective Equipment (PPE) requirements for all visitors to site are: Protective footwear, high visibility clothing (vest or jacket), long sleeved shirt, and full length trousers.
## 2 STANDARDS

The standards described in Table 1 shall apply to all Works undertaken by the Contractor.

### Table 1: Table of Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Australian Standards</strong></td>
<td></td>
</tr>
<tr>
<td>AS 1289.0</td>
<td>Methods of testing soils for engineering purposes</td>
</tr>
<tr>
<td>AS 1289.6.1.1</td>
<td>Methods of testing soils for engineering purposes – Soils strength and consolidation tests – Determination of the California Bearing Ratio of a soil</td>
</tr>
<tr>
<td>AS 2001.2.3.1</td>
<td>Methods of test for textiles - Physical tests - Determination of maximum force and elongation at maximum force using the strip method</td>
</tr>
<tr>
<td>AS 2033</td>
<td>Installation of polyethylene pipe systems</td>
</tr>
<tr>
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<td>Test Method for Determining Average Bonding Peel Strength between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners</td>
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<tr>
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<td>Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes</td>
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**ISO Standards**

<table>
<thead>
<tr>
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<tr>
<td>ISO 11414</td>
<td>Plastics pipes and fittings -- Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion</td>
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**Geosynthetic Research Institute Standards**

<table>
<thead>
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<td>GRI-GM13</td>
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<td>Drawing 201131-0085</td>
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</tr>
<tr>
<td>Drawing 201131-0086</td>
<td>Standard Drawing - Small Box Culverts - Min Cover 500mm</td>
</tr>
</tbody>
</table>
3 CONTRACTORS SERVICES AND AMENITIES

3.1 CONTRACTORS SITE OFFICE

The Contractor shall provide and maintain suitable site office as it deems necessary for the execution of the Works. The Contractor will obtain any required building licenses at its own expense. The Contractor shall clean and maintain this office during the Works.

Upon completion of the Works the Contractor shall remove the temporary site office and restore the area to the same condition as before the commencement of Works.

3.2 WATER

Water for construction shall be sourced from the stormwater dam on site, which will be constructed and allowed to fill prior to the undertaking of other Works at the site. It is the Contractor's responsibility to determine the available water flow rates from the existing site infrastructure and if deemed not to be adequate the Contractor is responsible for increasing site capacity or providing alternate supply of water at its own expense.

Groundwater extraction and/or extraction of water from 13 Mile Brook will not be permitted during the Works.

3.3 POWER

Supply of electricity during the Works will be the responsibility of the Contractor.

3.4 ABLUTION FACILITIES

The Contractor will be responsible for providing temporary ablution facilities during the Works.

3.5 UNDERGROUND SERVICES

The Contractor must determine the location of any services in the Works area by contacting ‘dial before you dig’ prior to commencing Works.

3.6 TRAFFIC MANAGEMENT

The site is privately owned property and not subject to public through traffic. Where disruption to traffic along Great Southern Highway is necessary to complete the Works or bring large equipment to site, the Contractor shall arrange for appropriate traffic management at its own expense.

3.7 PLANT LAY DOWN AND STORAGE AREA

An area for the lay down of Contractor plant and storage of construction materials is to be designated by the Contractor and approved by the Superintendent.
4 CLEARING AND STRIPPING

The Contractor shall remove vegetation as required to complete the Works. Clearing is required for a strip of bushland near the site entry and various isolated trees in the primary Works area.

Top soil to a depth of 100 mm will be removed from the entire area of Works by the Contractor and stockpiled in a location approved by the Superintendent for future use. The Contractor shall separately stockpile soil from cropping and non-cropping areas. Top soil will be deposited in rows no higher than 3 m and no wider than 15 m to aid the preservation of soil microbes.
5 GRAVEL SCREENING FOR ROAD BASE

Portions of the Works area have significant quantities of laterite gravel in the near-surface soil layers. The Contractor may use in-situ materials located in the Leachate Dam and Cell 2 landfill footprint to produce laterite gravel for use in the Works.

The Contractor shall dig test holes in areas with good gravel reserves and sample and test the material in accordance with AS 1289 *Methods of testing soils for engineering purposes*. Test results for gravel identified as compliant with this Construction Specification shall be submitted to the Superintendent for approval prior to excavating and screening the material to produce laterite gravel road base.
6 EARTHWORKS

6.1 GENERAL REQUIREMENTS

The site is to be graded to the alignments, slopes and gradients as shown on the Drawings. Generally earthworks will be required to shape the Infrastructure Area, Leachate Dams, Stormwater Dam and Landfill Cells.

The internal batters of Cell 1 and Cell 2 bunds will be sloped at 1:3 gradient. External batters will be sloped at 1:4. Landfill base cross sections are shown in Drawing ALLA-WA-20. The base of the cells will have a minimum 2% fall towards the leachate sump as shown in Drawing ALLA-WA-19. The level of excavation/fill to reach the design height and the existing natural surface is also shown on Drawing ALLA-WA-21.

6.2 EXCAVATION

The Contractor shall carry out all earthworks on the site. The Contractor shall perform excavation in every type of material encountered within the limits of the Works to the lines, grades and elevations shown on the Construction Drawings. All suitable excavated material will be used as fill in the Works area. Excavated materials that are unsuitable for placement as fill will be stockpiled separately in areas designated by Superintendent.

It is the responsibility of the Contractor to determine the appropriate equipment to undertake the task after conducting assessment of the soil/rock type on the site. The foundation level cut to the design level shall be brought to the attention of the Superintendent for inspection. Excavations not classified as “Hard Rock” shall be classed as common excavation and the Contractor shall not be entitled to any variation or extension of time due to failure to meet the approved project schedule.

6.2.1 HARD ROCK

Hard Rock refers to the excavation of in-situ material deemed not to be able to be pushed or ripped by a Caterpillar D10N dozer, or equivalent, fitted with a single tine ripper. Hard Rock encountered during excavation shall be removed by a methodology agreed upon by the Contractor and the Superintendent.

6.2.2 SOFT GROUND

Soft ground shall be removed after gaining approval from the Superintendent and disposed of at a location nominated by the Superintendent. The soft ground stockpile shall be protected from erosion using appropriate slope. The subgrade is to be shaped by cutting into natural material or engineered using locally sourced clayey material if soft ground is encountered.

6.2.3 UNDERGROUND SPRINGS AND SEEPAGE

Groundwater seepage and/or springs encountered during excavation shall be brought to the attention of the Superintendent. The Superintendent shall instruct the Contractor should groundwater relief drainage be required.
6.3 GROUNDWATER MANAGEMENT

The Contractor shall be aware of the anticipated groundwater conditions and excavations shall be dewatered as necessary. The dewatered materials shall provide stable foundation for the fill materials in order to permit construction work to take place on a firm subgrade.

Bore installation in the vicinity of Cell 1 and Cell 2 has shown a depth of between 6 and 14 m to the confined groundwater beneath the site. The base earthworks surface for Cell 1 and Cell 2 maintains a minimum 3 m separation from the determined level of groundwater.

6.4 LEACHATE MANAGEMENT

The Principal has a responsibility to manage and contain leachate in the active areas of the landfill. Any leachate encountered within the Works area will firstly be confirmed as leachate by the Superintendent. Leachate disposal will be in the onsite effluent ponds, irrigated onto the active landfill cells or otherwise as advised by the Superintendent. Any costs associated with the disposal of leachate collected in the Works area shall be borne by the Principal.

6.5 FILLING

All suitable excavated materials shall be used as fill material. Unsuitable materials are defined under AS 3798, Guidelines on earthworks for commercial and residential developments. Imported fill material will be sourced from existing stockpiles located within 600 m of the Works area.

6.5.1 FILL PLACEMENT

Areas that have been over excavated, removed as soft ground, removed as spoil or require filling to meet design levels shall be filled using similar materials to those of the subgrade. Fill material is to be placed in layers of not more than 200 mm in depth and compacted using a vibrating pad foot roller (12 tonne or greater) or similar compaction effort.

Prior to subsequent lifts of fill being placed the surface of the preceding lift shall be tined to provide an interlocking bond between layers.

The characteristics of the fill material to be considered are:

- Percentage passing the 0.075 mm sieve not less than 25%,
- Moisture content on placement to be between 3% dry and 1% wet of optimum moisture content (As determined using a standard compactive effort), and
- A minimum standard compaction during placement of 95%.

6.5.2 FILL COMPACTION QUALITY ASSURANCE

The fill shall be compacted to a dry density of not less than 95% of standard dry density as given in AS 1289 Methods for Testing Soils or by alternate method as approved by the Superintendent. The Contractor shall conduct tests on compacted fill as per the testing frequency specified. The criteria that will be assessed to a minimum standard are:

- Standard compaction,
- In-situ density,
The frequency of field density tests will comply with AS 3798, as summarised in Table 2 below.

<table>
<thead>
<tr>
<th>Type of Earthworks</th>
<th>Frequency of Tests</th>
</tr>
</thead>
</table>
| Type 1 Large-scale operations (greater than 1500 m²) | Not less than:  
  - 1 test per layer per material type per 2,500 m², or  
  - 1 test per 500 m³ distributed reasonably evenly throughout full depth and area, or  
  - 3 tests per Lot,  
  whichever requires the most tests |
| Type 2 Small scale operations (500 m² to 1500 m²) | Not less than:  
  - 1 test per layer per 1,000 m², or  
  - 1 test per 200 m³ distributed reasonably evenly throughout full depth and area, or  
  - 1 test per Lot per layer,  
  whichever requires the most tests |
| Type 3 Concentrated operations (less than 500 m²) | Not less than:  
  - 1 test per 100 m³ distributed reasonably evenly throughout full depth and area, or  
  - 1 test per layer per 500 m², or  
  - 3 tests per visit,  
  whichever requires the most tests |
| Type 4 Confined operations (trenches)       | 1 test per 2 layers per 50 m²                                                        |

A Lot is defined as an area of work that is essentially homogeneous in relation to material type, moisture content and compaction effort.

### 6.6 PROOF ROLLING

The subgrade prepared for the installation of the composite lining system will be free of stones greater than 20 mm. There will be no change in grade of greater than 20 mm over a distance of 5.0 m. The surface of the subgrade shall be clear of indentations from tyre tracks and desiccation cracks. The Superintendent shall inspect and approve the prepared subgrade surface prior to the installation of the composite liner. The Contractor will be required to give 48 hours notice for inspection of the prepared subgrade. Proof rolling will be carried out in the presence of the Superintendent and the following methodology will be followed:

- The surface of the subgrade is to be kept moist at all times to prevent cracking, and
- Subgrade is to be proof rolled using a smooth drum roller of 12 tonne capacity or greater using a minimum of six (6) passes over the entire prepared surface.
7 PAVEMENTS

A combination of compacted laterite gravel and bitumen seal will be required for the construction of roads and hardstands at the site.

The Contractor shall install pavements as specified on Drawing ALLA-WA-04.

Pavements shall be generally compliant with Main Roads WA Specification 503 Bituminous Surfacing.

Final design of all seals shall be by the Contractor and approved by the Superintendent.
8 CONCRETE

All concrete Works are to be compliant with the following Australian Standards:

AS 3600 Concrete Structures

AS 3610 Formwork for Concrete

AS 4671 Steel Reinforcing Materials

Formwork shall be constructed to a ± 25 mm tolerance on an appropriately prepared subgrade. Concrete on earthen material shall be underlain by 200 µm polyethylene sheeting with a minimum 200 mm overlap and approved adhesive tape sealing all joints.

For the Cell 1 landfill sump slab, care shall be taken to ensure the HDPE liner is not damaged during the formation of the slab. Any damage to the Cell 1 sump liner is to be reported to the Superintendent and appropriately repaired prior to casting the sump slab.

All mesh and bar reinforcement used in the Works shall have a minimum yield strength of 500 MPa. Concrete cover shall generally be minimum 50 mm. All mesh overlaps shall cover at least 2 transverse bars on each sheet.

All concrete used in the Works, unless otherwise specified on the Drawings shall be N32 grade with 80 mm slump and 20 mm maximum aggregate size. All concrete shall be vibrated when poured. All concrete shall be cured by keeping the exposed surface continuously wetted down for 7 days following pouring. Trafficable concrete surfaces shall be broom finished. All slab perimeter top edges shall be bullnosed with a 25 mm radius chamfer.
9 STRUCTURES

Four structures are proposed for the site, with locations shown on Drawing ALLA-WA-06 and concept designs on Drawing ALLA-WA-29. The structures are:

- Weighbridge office,
- Contractors office,
- Contractors ablutions, and
- Contractors shed.

9.1 DETAILED DESIGN AND BUILDING LICENCE

The Contractor shall develop and supply detailed structural and architectural drawings for the proposed weighbridge office, contractors office, contractors ablutions and contractors shed, to an appropriate standard to acquire a building license. The final design of the structures shall be approved by the Superintendent. The Contractor shall apply for and obtain a Building License for each structure.

9.2 BUILDING INSTALLATION

The Contractor shall supply all materials, labour and equipment to install and/or construct the weighbridge office, contractors office, contractors ablutions and contractors shed in accordance with the approved building plans.
10 STORMWATER CONTROL STRUCTURES

10.1 STORMWATER DAM

A 150,000 m$^3$ capacity stormwater and sedimentation dam is to be installed at the south western boundary of the Works.

The dam is to be constructed prior to other construction activities on site and act as a water source for construction use.

The dam earthworks shall be generally as described in Section 6 above, with the base surface of the dam finished with a 300 mm layer of selected local low permeability clay material to limit the volume of water lost through infiltration.

A trafficable Reinforced Concrete Box Culvert (RCBC) overflow weir shall be installed in the dam bund wall, as shown on Drawing ALLA-WA-19.

A pump with a vehicle filling standpipe is to be installed at the turnaround area to the north of the dam.

10.2 VALLEY DRAINS AND CULVERTS

Drainage around the site shall be managed by a network of drains, culverts and sedimentation control features, as identified in Drawings ALLA-WA-05 to 10 and Drawings ALLA-WA-34 ALLA-WA-35.

10.3 CREEK CROSSING

The contractor shall install a 17 RCBC and link slab culvert structure at the location of an existing ford of 13 Mile Brook. Construction of the crossing shall generally be compliant with the Main Roads WA standard drawings for small box culverts, Drawing 201131-0084, Drawing 201131-0085 and Drawing 201131-0086, with details as shown on Drawing ALLA-WA-27.

Construction of the creek crossing shall be compliant with the Department of Water permit to interfere with bed and banks. A copy of the permit will be supplied to the Contractor upon request [Note Pending].

10.4 SEDIMENT CONTROL

The Contractor shall monitor all Works areas for erosion during construction. The Contractor shall be responsible for maintaining any completed potion of the Works until the Works are complete. Any erosion of finished surfaces must be repaired by the Contractor at the Contractors sole expense.

The Contractor shall appropriately manage erosion on site to prevent any sediment escaping the Works area and entering 13 Mile Brook.
11 SERVICES

11.1 CONDUITS FOR ROAD CROSSINGS

At key points around the site under-road crossing conduits are required to accommodate the various services.

Conduit placed under the road shall be DN180 PVC piping, terminating in a concrete service pit at either side of the road. For number of conduits per crossing refer Drawing ALLA-WA-09.

Pull chamber pits for services shall be installed at 100 m intervals along their route, with appropriately weather and waterproof protective coverings.

11.2 ELECTRICITY

Three phase power from a diesel generator supplied by the Principal will be distributed by a network of underground cables, installed by the Contractor and shown on Drawing ALLA-WA-30. All buildings and fixed equipment shall be appropriately connected to the distribution grid and tested by the Contractors qualified Electrician. Included in the Works will be the provision of a connection box between the distribution grid and the diesel generator.

11.3 POTABLE WATER

Potable water will be stored in two individual 4,500 L polyethylene tanks provided as part of the Works. One tank will be located adjacent to the weighbridge office. The other tank will be located adjacent to the landfill operations contractor office and ablutions.

All water reticulation piping at the site is to be colour coded, with potable and non-potable water clearly distinct.

The Contractor shall install signage in the kitchen and ablutions areas identifying which water sources are acceptable of drinking.

11.4 NON-POTABLE WATER

Non-potable water will be sourced from the stormwater dam and pumped up into the two 100,000 L storage tanks.

Non-potable water is to be reticulated to all areas of the site for general use, as shown on Drawing ALLA-WA-30.

A standpipe for water truck filling is to be installed adjacent to the storage tanks.

11.5 DATA

Data cabling, consisting of multi-core CAT5 network cabling is to be installed across the site. Repeaters and/or junction boxes are to be installed as directed by the Superintendent. [Note exact data requirements are still being determined and will be confirmed prior to construction]
11.6 LEACHATE TRANSFER PIPES

DN90 PN16 PE 100 leachate transfer pipes shall be installed as shown on Drawing ALL-WA-30. All leachate transfer pipes and valves are to be hydrostatically pressure tested in accordance with AS 3500 to their rated limit (16 MPa).

11.7 ALIGNMENT MARKERS

At 100 m intervals along the path of any underground services, at the location of pull chamber pits the Contractor shall install marker posts with signs labelled ‘Caution: Services Below, Contact Site Manager Prior to any Excavation.’

The Contractor shall propose an appropriate size and material(s) for the signs for approval by the Superintendent.
12 COMPOSITE LINING SYSTEM

A composite lining system is to be installed in waste cells and in the leachate dams.

12.1 CONSTRUCTION OVERVIEW

The liner construction is important as it protects the surrounding environment from the impacts of leachate and landfill gas migration. The main engineering components of the proposed liner configuration will include the following (as shown in Drawing ALLA-WA-22):

- Compacted and rolled subgrade,
- GCL will be installed over the base of the landfill cell and on the side slopes. The GCL will have a hydraulic conductivity of less than $1 \times 10^{-9}$ m/s and the GCL will help in limiting contaminant migration and water seepage,
- A second layer of GCL will be installed under the leachate sump, extending 1.0 m beyond the sump footprint in all directions,
- A 2.0 mm thick High Density Polyethylene (HDPE) geomembrane liner will be placed directly above the GCL and will serve as the primary layer to limit contaminant migration and to control landfill gas migration,
- A non-woven geotextile cushion layer will be placed on top of the HDPE liner to serve as a protective layer, minimising the risk of damage or puncture during installation of the drainage layer and operation of the landfill,
- 300 mm aggregate layer will be laid on top of the cushion layer to act as a leachate drainage layer. The hydraulic conductivity of the drainage layer will be greater than $1 \times 10^{-3}$ m/s,
- Leachate collection pipes will be installed in the drainage layer, and
- A non woven geotextile layer will be placed on top of the aggregate to serve as a separation layer from the waste.

All geosynthetic synthetic layers, excluding the separation layer, will be tied into the subgrade in an anchor trench, For liner configurations at the adjacent cell interfaces refer to Drawing ALLA-WA-22.

12.2 QUALITY ASSURANCE DOCUMENTATION

The documents listed below must be supplied to the Superintendent by the Contactor before placement of liner on the prepared subgrade will be authorised.

- Laboratory test result sheets proving the Construction Specification compliance of each roll of geosynthetic clay liner (GCL) to be used in the Works,
- Laboratory test result sheets proving the Construction Specification compliance of each roll of high density polyethylene (HDPE) liner to be used in the Works,
• Certificate from the manufacturer confirming that each roll of HDPE welding rod to be used in the Works is manufactured from the same base resin as the HDPE liner to be used in the Works,
• Proposed panel layouts for both GCL and HDPE liners,
• Work Method Statements for the deployment of GCL and HDPE liners,
• Compaction test results for the prepared cell subgrade, and
• Survey of subgrade and anchor trench.

These items are addressed in more detail in later sections of this Construction Specification. The summary list is included here for convenient reference.

12.3 SUPERVISION

The Contractor shall nominate a Lining Supervisor, who shall be present for all GCL and HDPE liner deployment activities. The Lining Supervisor shall be appropriately qualified to supervise all deployment, seaming, extrusion welding, patching, destructive testing, non-destructive testing and quality assurance documentation.

12.4 THIRD PARTY QUALITY ASSURANCE

An expert Third Party Quality Assurance Observer will be supplied by the Principal for the duration of the GCL and HDPE liner installation activities. The Third Party Quality Assurance Observer may also be the Superintendent. The Third Party Quality Assurance Observer will be responsible for verifying that all GCL and HDPE liner placement occurs in accordance with this Construction Specification.

All installation and Quality Assurance activities will be performed to the satisfaction of the Third Party Quality Assurance Observer.

The Third Party Quality Assurance Observer will independently review all appropriate quality assurance documentation supplied by the Contractor to ensure the liner has been installed as specified.
13 GEOSYNTHETIC CLAY LINER

13.1 LABELLING AND INSTALLATION COMPLIANCE

Every GCL roll delivered to the site will be labelled with the following data:

- Product name, grade and name of manufacturer,
- Date of manufacture, batch number,
- Roll number and unrolling direction, and
- Roll length, width, and weight.

Every GCL roll delivered to the site shall be accompanied by a quality control document from the manufacturer, endorsed by an accredited laboratory. The quality control documentation shall verify the properties of the geotextile and bentonite used in the GCL roll. The GCL shall have a longitudinal edge pre-treatment to ensure sealing between panels is effective. Bentonite shall be used to seal the roll overlaps where there is no edge pre-treatment. The sealing bentonite shall have the same Specification as the bentonite used in the GCL rolls. Hydrated GCL rolls with moisture content above 50%, or otherwise deemed to be unsuitable for use by the Superintendent or Quality Assurance Observer, shall not be used.

The GCL shall be installed in accordance with the manufacturer’s installation guidelines. Where the manufacturer’s installation guidelines and this Construction Specification are in disagreement, the methodology which achieves the best liner performance outcome, as determined by the Superintendent shall be employed.

13.2 GCL MATERIAL PROPERTIES

The GCL shall be a reinforced multi-layer product with two layers of geotextile encapsulating a layer of sodium bentonite. The geotextile shall be nonwoven for the top layer and a composite of woven and non-woven geotextiles for the bottom layer. The top and bottom layers shall be needle punched or mechanically connected across the bentonite layer. The GCL shall have properties complying with GRI-GCL3 standards for reinforced GCLs (column 3 of table 1(a)) and will have the minimum test values as described in Table 3:

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Nonwoven Geotextile Mass</td>
<td>g/m²</td>
<td>≥200</td>
<td>AS 3706.1</td>
</tr>
<tr>
<td>Bentonite Layer Mass at Zero Moisture Content</td>
<td>g/m²</td>
<td>≥3,700</td>
<td>ASTM D5993</td>
</tr>
<tr>
<td>Carrier Geotextile (Total Composite)</td>
<td>g/m²</td>
<td>≥240</td>
<td>AS 3706.1</td>
</tr>
<tr>
<td>Carrier Geotextile (Woven Component)</td>
<td>g/m²</td>
<td>≥100</td>
<td>AS 3706.1</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>N/m</td>
<td>≥360</td>
<td>ASTM D6496</td>
</tr>
<tr>
<td>Permeability</td>
<td>m/s</td>
<td>≤5 x 10⁻¹¹</td>
<td>ASTM D5887</td>
</tr>
<tr>
<td>Free Swell Index</td>
<td>cm³/2g</td>
<td>≥24</td>
<td>ASTM 5890</td>
</tr>
</tbody>
</table>

Note: This table is included quick for reference only. Refer to the complete GRI-GCL3 standard.
13.3 **SUPPLY AND HANDLING**

The GCL shall be delivered to the site, handled and stored in an appropriate manner to avoid any damage to the rolls. The following measures shall be adopted while handling GCL:

- GCL rolls will be wrapped with weather and moisture proof wrapping to avoid any ingress, absorption or contact with moisture prior to installation,
- All GCL rolls shall have a hole in the core for lifting using a spreader bar or carpet pole,
- In the event of contact with water, the Superintendent shall be informed to check the moisture content of the bentonite and use of that roll is at the discretion of the Superintendent,
- The material will be stored in an area designated by the Superintendent and will be close to the Works area,
- The storage area shall be on a level and stable surface free from water, heat, chemicals, traffic, vandalism and animals,
- The stacking height of the GCL rolls shall be kept to a maximum of three (3) rolls to allow for easy handling, safe manoeuvrability and to avoid damage from excessive load,
- Appropriate handling equipment shall be utilised for lifting or moving the GCL using a spreader bar or carpet pole, and
- GCL rolls shall not be dragged, lifted from one end or the middle of the roll, directly lifted by the forks of a fork lift or be pushed along the ground during unloading or stacking.

13.4 **INSTALLATION REQUIREMENTS**

The installation phase will be preceded by a planning phase detailing the GCL panel layout. The GCL plan will be prepared by the Contractor and approved by the Superintendent prior to installation.

13.4.1 **PLANNING**

The planning phase shall address the following as a minimum:

- The arrangement of the GCL panels in the area to be lined,
- Points of overlap and connections,
- Arrangements for panel placements at any specific points to avoid any bends and creases and minimise the stress and overlaps on the GCL,
- Work method statement for deploying the GCL including the equipment to be used shall be prepared by the Contractor and shall be approved by the Superintendent before commencement of installation, and
- The panel placement arrangement shall comply with the installation guidelines provided by the manufacturer. Any deviations from the methodology proposed below shall be brought to the attention of the Superintendent for approval prior to liner placement.
13.4.2 PLACEMENT

The arrangement of GCL panels shall be according to the predetermined layout and the following methodology shall be employed:

- The GCL sheets shall be fixed at the top of the slope in anchor trenches and will be laid in continuous sheets on slopes,
- The leading edge of the anchor trench will be bevelled to minimise stress and prevent damage to the GCL,
- The anchor trench shall be clear of any debris or loose gravel prior to installation of the GCL,
- The GCL shall extend down into and across the base of the anchor trench,
- The overlapping surface between the panels shall be clean and free from any debris prior to sealing,
- Panels shall be overlapped down-slope in a tiled fashion,
- Adjacent panels shall overlap by:
  - 300 mm in both transverse and longitudinal edges on flat areas,
  - 1,500 mm if transverse joins are required on the slopes, and
  - 300 mm for longitudinal joins on slopes,
- Overlaps shall be pre-primed with bentonite powder during manufacture or sealed by bentonite paste or powder granules during installation,
- Overlaps shall be free of any wrinkles or folds,
- The upper surface of the GCL panels shall be clear of any bentonite powder for proper placement of overlaying geomembranes,
- Transverse overlaps along the slopes will require intermediate anchorage of the underlying panels,
- Sand bags, or other method of surcharge approved by the Superintendent, shall be placed on the overlaps to hold the deployed GCL, preventing dislodgement during windy conditions,
- Installation shall not be carried out in wet or windy conditions,
- Only those GCL panels that can be anchored, deployed and covered with the overlaying HDPE panels, with the HDPE panels fully welded in the same day shall be installed,
- Exposed GCL edges shall be covered temporarily by water resistant sheeting until work recommences, and
- Covering or confinement measures shall be available to prevent exposure of GCL to water during an event of rain.
13.4.3 DAMAGE AND REPAIR

- Damaged panels or portions of the damaged panels as identified by the Contractor, Superintendent or Third Party Quality Assurance Observer shall be recorded and removed from the Works,
- Sections of GCL identified as containing needles shall be removed from the Works,
- Surfaces with repairable damages such as rip, tear and shear failure shall be cleared of all foreign objects or soil prior to repair,
- Repair shall be conducted by patching a new piece of GCL of the same material type and thickness extending 500 mm beyond the damaged area in each direction,
- Repair patches shall be completely underlain by a layer of powdered bentonite,
- Any prematurely hydrated GCL panels shall be removed and replaced, and
- If the damages were caused by the agreed deployment technique, it will be reviewed, modified and approved by the Superintendent prior to subsequent laying to avoid further damages.

13.4.4 RECORDING KEEPING

The Contractor shall record the roll number, location and installation date for each roll of GCL to cross reference against the Quality Assurance documentation. These records shall be made available to the Superintendent and the Third Party Quality Assurance Observer.
14 HIGH DENSITY POLYETHYLENE GEOMEMBRANE

The High Density Polyethylene (HDPE) geomembrane liner shall be a new, top quality product designed specifically for use as landfill liner. The geomembrane shall be uniform and free of pin-holes, blisters, undispersed raw materials and contamination by foreign matter. The geomembrane liner shall be manufactured in rolls to a seamless width of not less than 6.8 m.

14.1 LABELLING

Each roll of HDPE liner shipped from the place of manufacture shall be labelled with the following information:

- Product Identification,
- Roll Number,
- Roll Thickness,
- Roll Dimensions, and
- Date of Manufacture.

14.2 HDPE MATERIAL PROPERTIES

One type of HDPE liner shall be used, with all rolls sourced from the same manufacturer and produced from the same base resin formulation. The geomembrane shall be textured on one side and installed with the textured surface facing down.

The HDPE geomembrane shall be 2.0 mm nominal thickness and shall comply with all property requirements prescribed in Table 2(b) of the GRI-GM13 standards. The key parameters of the GRI standards are presented in Table 4 for quick reference.

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Thickness</td>
<td>Mm</td>
<td>&gt; 1.9</td>
<td>ASTM D5994</td>
</tr>
<tr>
<td>Average Density</td>
<td>g/cc</td>
<td>&gt; 0.94</td>
<td>ASTM D1505 / D792</td>
</tr>
<tr>
<td>Tensile Yield Strength</td>
<td>kN/m</td>
<td>&gt; 29</td>
<td>ASTM D6693</td>
</tr>
<tr>
<td>Tensile Yield Elongation</td>
<td>%</td>
<td>&gt; 12</td>
<td>ASTM D6693</td>
</tr>
<tr>
<td>Tensile Break Strength</td>
<td>kN/m</td>
<td>&gt; 21</td>
<td>ASTM D6693</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>%</td>
<td>2.0 - 3.0</td>
<td>ASTM D4218</td>
</tr>
</tbody>
</table>

NOTE: This table is included for convenient reference only. For the complete list of parameters refer to the full table in the GRI standard.

14.3 SUPPLY AND HANDLING

The HDPE liner is to be delivered to site and stored on a hard free draining surface. The HDPE liner rolls are to be handled in accordance with the Manufacturer’s Specification.
14.4 INSTALLATION

14.4.1 PLANNING

The planning phase shall address the following as a minimum:

- The layout of the HDPE geomembrane sheets in the area to be lined shall be approved by the Superintendent,
- Points of overlaps and connections,
- Panel placement to minimise stress on the HDPE,
- Panel placement to minimise wastage and maintain small overlaps,
- A Work Method Statement for deploying the HDPE, including the equipment to be used, shall be prepared by the Contractor and must be approved by the Superintendent before the commencement of liner installation,
- The Work Method Statement shall include a strategy for deploying HDPE over GCL,
- The Contractor shall not allow any vehicles, cranes or other mobile plant to traverse the HDPE liner, and
- The panel placement arrangement shall comply with the installation guidelines provided by the manufacturer. Any contradictions with the methodology proposed below shall be brought to the attention of the Superintendent.

14.4.2 PLACEMENT

The placement methodology will comply with the following:

- The HDPE geomembrane surface shall be inspected during unrolling and installation to ensure no tears, punctures, abrasions, indentations, cracks or other faults are present in the material,
- Any defects identified are to be marked with coloured marker, recorded and repaired,
- The surface of the GCL panels shall be inspected prior to placement of HDPE and approved by the Third Party Quality Assurance Observer,
- The HDPE panels shall be installed in such a way that continuous panels are used on the slopes,
- Placement of HDPE panels shall be consistent with the pre-planned layout designed to minimise the amount of panel welding required,
- No material offcuts, sandbags, waste packaging or other foreign objects are to be left between the GCL and HDPE geomembrane,
- Each panel shall be welded immediately after placement,
- Adjacent panels will have an overlap of minimum 75 mm for fusion welding and minimum 100 mm for extrusion welding,
Panel overlaps shall be oriented down the slope and across the flat base in a tiled fashion to aid drainage,

Connecting seams between the HDPE geomembranes on the slopes and the base shall be located at a minimum distance of 1.5 m from the batter slope toe, on the flat area,

Sand bags shall be placed on the liner during installation to prevent wind uplift,

Sand bags shall also be used during welding in windy conditions to prevent movement of the HDPE panels,

HDPE unrolling and deployment methodology shall not score, scratch or crimp the HDPE geomembrane,

Expansion and contraction of HDPE geomembranes during placement and seaming shall be taken into consideration,

Care shall be taken during installation of the HDPE to limit buckling, wrinkling or tensioning prior to placement of cover material,

HDPE geomembranes installed on the slopes shall be fixed in anchor trenches. Anchor trenches shall be backfilled when the geomembranes are cool,

The anchor trench shall be backfilled with fill material and compacted as soon as the cushion geotextile is laid,

HDPE geomembranes shall not be installed during excessively hot, high wind, dusty or rainy conditions, and

HDPE geomembranes shall not be installed on pre-hydrated GCL.

14.5 WELDING METHODS

Hot-wedge welding shall be used for welding all main joints between adjacent HDPE geomembranes, producing two parallel seams with an air channel in between.

Extrusion welding will be used primarily for detailed work and repair work.

14.6 SEAM PREPARATION

The weld surfaces shall be cleaned prior to welding and shall be free from moisture, debris, and foreign material. Surface grinding for extrusion welds shall not be deeper than 10 percent of the geomembrane thickness. Seams are to be aligned with the smallest possible number of wrinkles.

14.7 WELDING OF GEOMEMBRANE

14.7.1 HOT-WEDGE (FUSION) WELDER

The fusion welding equipment used shall be fully automated with a heated copper wedge, pressure rollers and electronic controls. The copper wedge shall be controlled and constantly monitored by a programmable controller. The equipment shall have an audible temperature alarm to measure the temperature at the point of geomembrane contact and a variable speed drive unit.
14.7.2 EXTRUSION WELDER
The extrusion welder shall be semi-automatic with electronic controls monitoring preheat and extradite temperatures. The unit shall have preheating capabilities to preheat the material ahead of the casting of the extradite.

14.7.3 FUSION WELDS
A minimum 5 mm wide void will be created between two parallel 15 mm wide contact fusion tracks. A consistent squeeze out on the weld edge shall be maintained.

14.7.4 EXTRUSION WELDS
The extrusion process will be applied in approved areas that would be inaccessible to the dual track fusion weld machine and for repair work. The minimum width of the surface extruded bead shall be 30 mm. The material of the extruded granular/rod to be used for surface extrusion welding shall be the same type as used in the manufacture of the HDPE geomembrane. The manufacturer shall provide certified test data for each batch of welding granule/rod and the Contractor shall make it available for verification by the Superintendent. The sheet shall be pre-heated prior to casting of the extradite over the upper and lower section of the weld zone. Patching HDPE geomembranes using transverse extrusion joints on batter slopes is not permitted without prior approval by the Superintendent.

14.8 WELD TESTING
Weld testing will involve both destructive and non-destructive testing. Destructive testing will be used to pre-qualify welding personnel, equipment and procedures. Destructive testing will also be used to carry out spot checks of the welded seam. Non-destructive testing will be used to test the continuity and integrity of the entire seam. Destructive testing will be carried out in compliance with the GRI-GM19 standards.

The Contractor shall record the date, time, technician and results of all testing to verify that every seam and weld has been tested. Any failing tests will be appropriately repaired and recorded.

14.8.1 DESTRUCTIVE TESTING
Destructive testing will be performed to prequalify welders and to verify the integrity of the installed liner.

Trial welds are fusion or extrusion seams on offcut material, used for daily testing.

Production seams are fusion welds on the installed liner.

All tests are to be observed by the Third Party Quality Assurance Observer and recorded by the Contractor and the Third Party Quality Assurance Observer.

The following measures will be followed for destructive testing:

14.8.1.1 General
- A 300 mm long weld sample from each trial weld and each production seam destructive test sample will be labelled with the date, time, welding technician, welder preheat temperature,
welding speed and pass or failure. These samples will be retained and submitted to the Superintendent for future reference.

- In all tested welds the failure shall be in the parent material and not the weld,
- Samples shall be cut from the weld sample using a token cutting device,
- Samples shall not be cut to size using a hand held knife,

**Table 5: Minimum Test Values for a HDPE Weld Sample**

<table>
<thead>
<tr>
<th>Test</th>
<th>Minimum Force (N)</th>
<th>Minimum Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear</td>
<td>690</td>
<td>70.3</td>
</tr>
<tr>
<td>Peel</td>
<td>450</td>
<td>45.9</td>
</tr>
</tbody>
</table>

**NOTE:** These values are applicable only for a 25 mm wide sample of 2 mm thick HDPE.

**14.8.1.2 Trial Welds**

- Trial weld (pre-qualifying test welds) testing will be performed:
  - before the commencement of welding each day,
  - if a stoppage occurs for more than 1 hour,
  - if there is a change in weather conditions, or
  - if a cumulative length of 500 m of seam has been welded since the previous test,
- The trial weld sample shall be a minimum of 1 m long,
- Welds will be allowed to cool naturally, without immersion in water or similar,
- Four 25 mm wide tokens will be cut for trial weld testing,
- Two samples shall be tested for shear strength,
- Two samples shall be tested for peel strength, with both sides of a fusion wedge weld being peel tested,
- All four samples shall pass with the minimum properties as specified in Table 5 to approve the welder and operator combination to commence work,
- If a trial weld fails, the likely reason for the failure will be identified and recorded, the welding technique adjusted and a further trial weld performed, and
- Trial welds qualify only the equipment and operator combination that performed the test weld. Welding may **not** be performed by an alternative operator on the same equipment without a passing trial weld.

**14.8.1.3 Production Seams**

- Destructive seam tests shall be carried out at random locations as identified by the Superintendent or Third Party Quality Assurance Observer, at a minimum frequency of one sample every 150 m of fusion welded seam,
- A 1 m length section of seam shall be removed for testing,
Ten 25 mm wide tokens will be cut for destructive testing,

Five samples shall be tested for shear strength,

Five samples shall be tested for peel strength, with both sides of a fusion weld being tested,

A minimum of 4 out of 5 shear tests and a minimum of 4 out of 5 peel tests must pass for the destructive test to pass,

Should less than 5 out of 5 samples pass, a retest of the seam in the vicinity of the test may be required at the Superintendent's discretion,

Should less than 4 out of 5 samples of either test pass, the integrity of the remainder of the seam shall be determined by the following methodology:
  o Destructive test samples will be taken 3 m either side of the failed test site,
  o If these samples fail, samples will be taken a further 3 m along and so on until the extent of the defective seam section is established, and
  o The entire length of the defective seam section will be capped with an extruded strip.

14.8.2 NON-DESTRUCTIVE TESTING

Non-destructive testing includes air pressure testing for dual track fusion welds and vacuum testing or spark testing for extrusion welds.

The pressurised air test shall comply with ASTM D5820 Standard Practice for Pressurised Air Channel Evaluation of Dual Seamed Geomembranes.

The vacuum box test shall comply with ASTM D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.


The Contractor shall maintain a copy of each of these standards on site during lining Works. All lining personnel shall be familiar with the procedures described in the standards and execute them correctly.

All seams, welds, patches and repairs will be tested and recorded as part of the Contractors Quality Assurance documentation. Where detailed work prohibits the use of a vacuum testing box, the spark test shall be performed. The Contractor shall verify testing is complete by comparing testing records to the As Constructed drawings.

The Contractor shall report the total length of fusion seams in the project to the Superintendent and the Third Party Quality Assurance Observer upon request to ensure the minimum 1 sample per 150 m of seam frequency is achieved. The total length of fusion seams in the project will be calculated by a licensed surveyor.

14.8.3 PATCHING AND EXTRUSION REPAIRS

All repairs to the liner will be performed using a capping strip, overlapping the damaged area by a minimum of 100 mm in all directions,
• Extrusion repairs by placing a bead of extradite along a tear, over a hole or in any other location where a minimum material overlap of 100 mm is not present shall not be permitted,

• It is acceptable to place a bead of extradite on liner material that is scratched, scuffed, creased or otherwise damaged without being perforated for reinforcement, and

• Care shall be taken when grinding the ends of fusion seams to extrude stopper plugs not to grind through the second layer of HDPE geomembrane.

14.9 WARRANTY

The Contractor shall provide a warranty for the life of the HDPE liner system prior to completion of the Works. The Performance Warranty shall incorporate a minimum 5 year Product (Manufacturers) Warranty and a 1 year Installation Warranty.
15 GEOTEXTILE CUSHION LAYER

The geotextile cushion layer will act as the protection layer between the geomembrane and the drainage layer. It shall be installed over the HDPE geomembrane layer.

15.1 LABELLING

Each roll of geotextile cushion layer shall comply with AS 3705 Geotextile Identification, Marking and General Data and shall be labelled to provide the following minimum:

- Product name, grade and name of the manufacturer,
- Date of manufacture, batch number, polymer type,
- Manufacture quality control documentation from the manufacturer/supplier,
- Roll number,
- Roll dimensions, and
- Roll weight.

15.2 MATERIAL SPECIFICATION

The cushion geotextile layer will be a non-woven geotextile manufactured from polyamide, polyolefines, polyester and/or polyvinyl materials. The cushion geotextile shall comply with the GRI-GT12 (a) standards and satisfy the following typical properties:

Table 6: Geotextile Cushion Layer Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezoidal Tear Strength</td>
<td>N</td>
<td>&gt; 1,000</td>
<td>AS 3706.3</td>
</tr>
<tr>
<td>CBR Bust Strength</td>
<td>N</td>
<td>&gt; 6,800</td>
<td>AS 3706.4</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>N</td>
<td>&gt; 2,800</td>
<td>AS 2001.2.3</td>
</tr>
<tr>
<td>UV Resistance</td>
<td>%</td>
<td>&gt; 70</td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>

15.3 QUALITY ASSURANCE

A quality assurance compliance certificate from the geotextile manufacturer is required for each batch of geotextile delivered. The quality assurance certificate shall contain properties in Table 6 as a minimum. Geotextiles will be free from any flaws/needles.

15.4 STORAGE AND HANDLING

All delivered geotextile cushion materials will be stored on level ground, free from any water logging or drain paths and not more than three (3) rolls high. Appropriate lifting methodology shall be used to prevent any damage while handling.
15.5 INSTALLATION

Placement of the geotextile cushion layer shall be carried out in accordance with the manufacturer’s recommendation, details of which shall be provided to the Superintendent for approval.

The following measures will be adopted during placement:

- All testing of the underlying HDPE geomembrane shall be completed to the satisfaction of the Third Party Quality Assurance Observer and approved by the Superintendent prior to placement of the geotextile cushion layer,
- The HDPE geomembrane surface shall be free from any material offcuts, sharp objects, stones, debris, water or other foreign objects,
- Only geotextile cushion rolls inspected and approved by the Superintendent shall be unrolled and used for placement,
- The placement of geotextile shall be in accordance with the approved layout,
- Sheets will be anchored at the crest of the slope and rolled down the slopes,
- Geotextile sheets shall be deployed by hand to minimise the ground contact pressure on the underlying HDPE geomembrane,
- Adjacent geotextile cushioning sheets will have a minimum overlap of 500 mm,
- Joining of sheets shall be conducted by stitching or heat bonding with an approved hot-air device,
- No stapling of adjacent geotextile cushion sheets will be permitted,
- The long joints in the geotextile shall be constructed parallel to the slope gradient,
- Care shall be taken during heat bonding to prevent any damage to the underlying HDPE geomembrane,
- Any damage to the underlying HDPE geomembrane shall be repaired,
- The geotextile cushion materials shall not have transverse joints on slopes steeper than 1:5,
- All deployed geotextile sheets shall be restrained with sand bags as soon as possible to prevent uplift and dislodgement by wind,
- Placing of the aggregate layer over the geotextile cushion layer shall not create stress or tension in the geotextile and underlying layers, and
- The installation of geotextile shall be carried out by experienced and competent installers.

15.6 GEOTEXTILE REPAIRS

Geotextile repairs shall be carried out in compliance with the methodology below:

- Any repair on the damaged geotextile during installation shall be performed by patching with a new piece of geotextile made from the same material,
- Repairs shall overlap the damaged area by a minimum of 200 mm in all directions,
- Repairs shall be conducted only after cleaning of the area subjected to repair, and
- Any repair patches on a slope shall be double seamed into place.
16 LEACHATE COLLECTION SYSTEM

The components of the leachate collection system within Cell 1 and Cell 2 are the aggregate drainage layer, leachate collection pipes, sump and leachate extraction risers. The Contractor shall provide all materials, supervision, labour and equipment for the placement of each component of the leachate collection system in accordance with the Construction Specification and the Construction Drawings.

16.1 LEACHATE COLLECTION PIPES

The Contractor is to carry out the pipework installation as indicated on Drawing ALLA-WA-24 and Drawing ALLA-WA-25. Two types of PE pipes will be used for leachate collection: perforated and non-perforated. Cell 1 and Cell 2 will have two sizes of pipe, the first being DN160 PE100 PN16 black perforated pipes laid at 20 m centres as described in Drawing ALLA-WA-24. The primary collection pipe will be DN250 PE100 PN16 black non-perforated pipe laid in the primary drainage channel and feeding into the leachate sump. There is also a DN250 PE100 PN16 black perforated pipe adjacent to the toe of the southern batter feeding directly to the leachate well.

16.1.1 INSTALLATION

The following measures and placement methodology will be adopted:

- PE pipes shall be stored, handled and transported in accordance with AS 2033 Installation of polyethylene pipe systems,
- Pipes will be handled carefully to avoid distortion, buckling or other damage,
- The joining of pipes shall be by electro-fusion coupling or butt welding,
- All joining procedures will be carried out according to the Manufacturer’s Specification,
- Butt welding or electro-fusion welding will be carried out by a qualified technician,
- Drilling of PE pipes shall not be carried out on the lined cell area,
- All swarf from drilling shall be removed prior to installation of pipes,
- All cut edges and welded joints shall be neat and smooth,
- Pipes shall be clean internally and free from mud, dirt and other debris,
- During placement of the pipe on the landfill liner, each pipe shall be lifted into position to avoid any damage to the liner,
- Each pipe shall be positioned accurately and placed directly on the cell liner,
- Aggregate shall be placed around and on the leachate pipes and carefully spread to avoid any damage to the liner material or the PE pipe itself, and
- Pipe extending into the leachate sump area shall be supported on underlying drainage aggregate so that no bending or deformation of the pipes occurs (Drawing ALLA-WA-23).
16.1.2 PIPE SURVEY

A detailed as constructed survey of the pipe network shall be performed, recording the pipe locations and invert levels to verify compliance with the Construction Drawings. The locations and invert levels of the pipes will be reported to the Superintendent for approval.

16.2 LEACHATE SUMP

The leachate sump will be constructed as a depression within the landfill subgrade as detailed on Drawing ALLA-WA-23 and Drawing ALLA-WA-25. Within the leachate sump and on top on the liner system a reinforced concrete slab will be constructed.

The reinforced concrete slab will be 300 mm thick, N32 concrete with 20 mm aggregate and SL92 mesh at the top and bottom. Minimum cover to reinforcing shall be 50 mm.

The concrete slab will also act as a target pad should a vertical leachate extraction well require installation in the future.

16.3 LEACHATE EXTRACTION RISERS

A pair of DN600 PE100 PN16 HDPE leachate extraction riser pipes (one duty and one spare) will be installed in the sump as shown on Drawing ALLA-WA-23 and Drawing ALLA-WA-25. The lower end of each riser will extend horizontally across the sump floor. The horizontal section of each riser will be perforated with 15 mm holes in a spiral pattern, ensuring each metre of horizontal pipe has 30 holes.

The inside of each riser pipe when installed shall be smooth and continuous, with no burrs remaining from the welding technique employed.

16.4 DRAINAGE AGGREGATE

The drainage layer will be constructed of aggregate free from organic matter and fine material.

16.4.1 AGGREGATE SPECIFICATION

The drainage aggregate will be a hardrock quarry product with a maximum particle size of 63 mm. Materials that are susceptible to degradation by leachate are not acceptable; crushed concrete or limestone are not permitted. The aggregate used in the Works shall comply with the grading described in Table 7.

Table 7: Drainage Aggregate Specification

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Percentage Passing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>100</td>
</tr>
<tr>
<td>53</td>
<td>85 - 100</td>
</tr>
<tr>
<td>37.5</td>
<td>20 - 65</td>
</tr>
<tr>
<td>26.5</td>
<td>10 - 30</td>
</tr>
<tr>
<td>19</td>
<td>0 - 15</td>
</tr>
<tr>
<td>13.2</td>
<td>0 - 5</td>
</tr>
<tr>
<td>4.75</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>
16.4.2 QUALITY ASSURANCE

The drainage aggregate layer shall have permeability greater than $1 \times 10^{-3}$ m/s. The Contractor shall supply a 20 kg sample of the proposed material, accompanied by a copy of particle size distribution test results from a NATA registered laboratory at least 10 days prior to commencement of construction. The particle size distribution test shall be conducted in accordance with AS 1289:3.6. Soil classification tests.

16.4.3 PLACEMENT AND COMPACTION METHODOLOGY

The Contractor shall notify the Superintendent at least 48 hours prior to placement of aggregate. Trafficking will only be permitted over the surface of the aggregate placed to the specified thickness, using plant as approved by the Superintendent. The following measures will be adopted during placement:

- The leachate drainage material shall be placed and spread in a layer of 300 mm minimum thickness,
- Suitable equipment shall be used for spreading the aggregate, with a maximum allowable ground contact pressure of 50 kPa,
- The equipment shall not be allowed to turn or screw on a tight radius over the emplaced drainage aggregate,
- The spread aggregate layer shall be thickened over the leachate collection pipes to maintain 300 mm minimum cover,
- The Contractor shall consider temperature effects, bearing load from haulage and spreading equipment, material placement techniques and propagation of geomembrane waves to minimise the risk of damage to the previous Works,
- Any damage to the HDPE geomembrane caused by aggregate being pushed out shall be repaired by the Contractor at no cost to the Principal,
- The Contractor shall provide a Work Method Statement for approval by the Superintendent prior to commencement of aggregate placement. The Work Method Statement shall outline the measures implemented to prevent geomembrane waves/wrinkling, stress and damage, and
- The Work Method Statement shall also include the type and weight of the equipment to be used, along with the methodology of placing the aggregate.
17 ELECTRONIC LEAK DETECTION SURVEY

Following the installation of the drainage aggregate, prior to the application of the separation geotextile an electronic leak detection survey shall be performed by an appropriately qualified and experienced electronic leak detection contractor.

Electronic leak detection survey is to be supervised and verified by the Third Party Quality Assurance Observer.
18 SEPARATION GEOTEXTILE

A geotextile layer will be placed over the drainage aggregate layer to separate the waste and the leachate drainage system. The separation layer shall be a non-woven polyester or polypropylene geotextile.

18.1 MATERIAL SPECIFICATION

The separation geotextile will have the typical properties described in Table 8.

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezoidal Tear Strength</td>
<td>N</td>
<td>&gt; 390</td>
<td>AS 3706.3</td>
</tr>
<tr>
<td>CBR Burst Strength</td>
<td>N</td>
<td>&gt; 2,650</td>
<td>AS 3706.4</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>N</td>
<td>&gt; 1,000</td>
<td>AS 2001.2.3</td>
</tr>
<tr>
<td>Pore Size</td>
<td>Microns</td>
<td>&gt; 100</td>
<td>AS 3706.7</td>
</tr>
<tr>
<td>Permeability</td>
<td>m/s</td>
<td>&gt; 3.3 x 10⁻³</td>
<td>AS 3706.9</td>
</tr>
<tr>
<td>UV Resistance</td>
<td>%</td>
<td>&gt; 70</td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>

18.2 QUALITY ASSURANCE

The following confirmation documents shall be provided to the Superintendent prior to installation:

- A quality assurance certificate from the geotextile manufacturer for each batch of geotextile delivered,
- The quality assurance certificate shall contain properties in Table 8 as a minimum,
- Geotextiles will be certified needle free and free from other flaws which may have an adverse effect on the physical or mechanical properties of the product, and
- The thread used for stitching shall be polymeric with chemical and UV light resistant properties exceeding those of the geotextile.

18.3 STORAGE AND HANDLING

All delivered separation geotextile materials will be stored on level ground, free from any water logging or drain paths and not more than three (3) rolls high. Appropriate lifting equipment shall be used to prevent any damage while moving the rolls.

Placement of geotextile separation layers shall be carried out in accordance with the manufacturer’s recommendation, details of which shall be provided to the Superintendent for approval. The following measures will be adopted during placement:
• Only geotextile separation rolls inspected and approved by the Superintendent shall be unrolled and used for placement,
• Geotextile sheets will be anchored at the crest of the slope and rolled down the side of walls and slopes,
• The geotextile sheets will overlap by a minimum of 500 mm,
• Joining of sheets shall be performed by stitching or heat bonding with an approved hot-air device, or by stapling to adjacent geotextile sheets,
• The longitudinal joints between panels shall be parallel to the slope gradient,
• The geotextile protection materials shall not have cross joints on slopes steeper than 1:5, and
• Sand bags shall be used to hold the separation layers during and after installation to prevent wind uplift during adverse weather conditions.
19 FENCING

A combination of 1.2 m high farm fencing and 2.3 m high mesh and barbed wire fencing is to be installed around the site, as shown on Drawing ALLA-WA-31.

Emergency access gates are to be installed as shown for access from the surrounding farm.

Each Emergency access gate is to be fitted with two padlocks, each of a matching set to provide access to both the Principal and the Volunteer Bush Fire Brigade. The padlocks are to be provided by the Principal.
# 20 CONSTRUCTION DRAWINGS

## Table 9: Table of Construction Drawings

<table>
<thead>
<tr>
<th>Drawing No</th>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLA-WA-01</td>
<td>B</td>
<td>Cover Sheet</td>
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<tr>
<td>ALLA-WA-02</td>
<td>B</td>
<td>Site Plan</td>
</tr>
<tr>
<td>ALLA-WA-03</td>
<td>B</td>
<td>Overall Layout Plan</td>
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<tr>
<td>ALLA-WA-04</td>
<td>B</td>
<td>Typical Road Cross Sections</td>
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<tr>
<td>ALLA-WA-05</td>
<td>B</td>
<td>Roadworks and Drainage Layout - Plan 1 of 6</td>
</tr>
<tr>
<td>ALLA-WA-06</td>
<td>B</td>
<td>Roadworks and Drainage Layout - Plan 2 of 6</td>
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<tr>
<td>ALLA-WA-07</td>
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<td>Roadworks and Drainage Layout - Plan 3 of 6</td>
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<td>ALLA-WA-08</td>
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<td>Roadworks and Drainage Layout - Plan 4 of 6</td>
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<td>ALLA-WA-09</td>
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<td>Roadworks and Drainage Layout - Plan 5 of 6</td>
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<td>ALLA-WA-10</td>
<td>B</td>
<td>Roadworks and Drainage Layout - Plan 6 of 6</td>
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<tr>
<td>ALLA-WA-11</td>
<td>B</td>
<td>Road No. 1 Longitudinal Section - Sheet 1 of 4</td>
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<tr>
<td>ALLA-WA-12</td>
<td>B</td>
<td>Road No. 1 Longitudinal Section - Sheet 2 of 4</td>
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<td>ALLA-WA-13</td>
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<td>Road No. 1 Longitudinal Section - Sheet 3 of 4</td>
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<td>Road No. 1 Longitudinal Section - Sheet 4 of 4</td>
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<td>ALLA-WA-15</td>
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<td>Road No. 4 Longitudinal Section</td>
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<td>B</td>
<td>Infrastructure Area Layout Plan</td>
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<td>ALLA-WA-17</td>
<td>B</td>
<td>Landfill Cell Layout Plan</td>
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<tr>
<td>ALLA-WA-18</td>
<td>B</td>
<td>Landfill Ultimate Top of Waste Surface</td>
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<tr>
<td>ALLA-WA-19</td>
<td>B</td>
<td>Landfill Cell 1 and 2 Layout Plan</td>
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<td>ALLA-WA-20</td>
<td>B</td>
<td>Landfill Sections - Sheet 1 of 2</td>
</tr>
<tr>
<td>ALLA-WA-21</td>
<td>B</td>
<td>Landfill Sections - Sheet 2 of 2</td>
</tr>
<tr>
<td>ALLA-WA-22</td>
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<td>Landfill Details - Sheet 1 of 2</td>
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<td>ALLA-WA-23</td>
<td>B</td>
<td>Landfill Details - Sheet 2 of 2</td>
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<tr>
<td>ALLA-WA-24</td>
<td>B</td>
<td>Landfill Leachate Layout Plan</td>
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<tr>
<td>ALLA-WA-25</td>
<td>B</td>
<td>Landfill Leachate Riser Pipe Details</td>
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<td>Drawing No</td>
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<td>Description</td>
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<td>------------</td>
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<td>ALLA-WA-26</td>
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<td>Leachate Dam Layout Plan</td>
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<td>B</td>
<td>Miscellaneous Details</td>
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<td>Typical Weighbridge Details</td>
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<td>Site Building Conceptual Plans</td>
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<td>Fence Layout Plan</td>
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<td>Borehole Location Layout Plan</td>
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<td>ALLA-WA-33</td>
<td>B</td>
<td>Stormwater Catchment Plan and Calculations</td>
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<td>ALLA-WA-34</td>
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<td>Sediment and Erosion Control Layout Plan</td>
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<td>B</td>
<td>Sediment and Erosion Control Details</td>
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21 ATTACHMENT 1 - DESIGNERS RISK ASSESSMENT
DESIGNERS RISK ASSESSMENT – CONSTRUCTION ACTIVITIES FOR ALLAWUNA FARM LANDFILL FACILITY

This document describes the Occupational Safety and Health risks associated with the Construction of Cell 1, Cell 2 and Site Infrastructure for Allawuna Farm landfill, as identified during the design and approvals process.

Date: 3rd January 2014

Prepared By

Bowman & Associates Pty Ltd

Environmental Engineering Consultants
Waste Management Specialists
www.bowmanassociates.com.au
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DOCUMENT CONTROL

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<td>1</td>
<td>3.01.14</td>
<td>A Davies</td>
<td>B Bowman</td>
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</table>

FILE NAME

140103 AD Allawuna Designers Risk Assessment.docx
CONSTRUCTION RISK ASSESSMENT AND REVIEW

In accordance with Occupational Safety and Health Regulations 1996, Bowman & Associates has considered the construction practicalities and likely risks to be faced by a contractor executing the construction of the initial Site Infrastructure, Cell 1 and Cell 2 for Allawuna Farm Landfill. **Table 1** describes the risk ranking system used by Bowman & Associates when assessing a particular activity for both personnel and environmental risk.

**Table 1  Risk Ranking**

<table>
<thead>
<tr>
<th>Consequence</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>1</td>
<td>2</td>
<td>4</td>
<td>7</td>
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<td>15</td>
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<td>22</td>
<td>24</td>
<td>25</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability</th>
<th>Consequence (Person / Environment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B: Known to occur or has happened at numerous similar sites</td>
<td>2. Major Injury. Hospitalisation and long term recovery. Soil, water, or air adversely affected in long term, economic and financial loss. Medium term non-hazardous impact on neighbouring properties.</td>
</tr>
<tr>
<td>C: Could occur infrequently</td>
<td>3. Minor Injury. Swift recovery with minimal time off work. Soil, water, or air adversely affected in short term. Short term, non-harmful impact on neighbouring properties.</td>
</tr>
<tr>
<td>E: Practically impossible</td>
<td>5. No impact on health. No environmental impact, no harm, no contamination.</td>
</tr>
</tbody>
</table>

Risks are assessed taking into account the design measures that have been incorporated to mitigate them. **Table 2** describes the risks that were identified during the design phase, the measures that have been taken to limit their likelihood and/or impact and their final risk ranking score.

This list is by no means exhaustive, as many risks are a function of the construction methods and techniques employed by the construction contractor, and cannot be clearly defined during the design phase.
## Table 2  Risk Assessment

<table>
<thead>
<tr>
<th>Construction Element</th>
<th>Description of Risk</th>
<th>Design Control Measures</th>
<th>Probability</th>
<th>Consequence</th>
<th>Risk Rating Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Travel of Personnel to and from the site.</td>
<td>Co-ordination between construction and landfill operations contractors. Awareness of all site users, standard operation procedures and use of appropriate visibility gear.</td>
<td>D</td>
<td>1 – Potential loss of life in vehicle collision.</td>
<td>7 - Medium Risk</td>
</tr>
<tr>
<td>General</td>
<td>Exposure of visiting construction staff to landfill waste or leachate (Cell 1B and Cell 2 Works).</td>
<td>No garbage tipping in Works Area. Landfill operations contractor required to retain waste in licensed landfill areas only. Leachate effectively managed by landfill operations contractor.</td>
<td>D</td>
<td>3 - Skin exposure is unlikely to be harmful. Ingestion even less likely to occur. Health impacts unpredictable, likely minimal.</td>
<td>17 - Low Risk</td>
</tr>
<tr>
<td>General</td>
<td>Contamination of site with hydrocarbons, polluted water or general waste.</td>
<td>Spill response established in Construction Specification. Water discharge procedure described in Construction Specification Waste disposal as directed by Superintendent.</td>
<td>C</td>
<td>4 - Quick response to environmental hazards. No impact off site.</td>
<td>18 - Low Risk</td>
</tr>
<tr>
<td>Clearing and Stripping</td>
<td>Trees falling on bystanders during clearing.</td>
<td>Plant operators to be proficient in the use of their machinery. Bystanders to be clear of machinery when it is operating. Contractor to operate safely when felling trees. High visibility clothing for persons on site.</td>
<td>D</td>
<td>2 - Serious injury to bystander.</td>
<td>12 - Medium Risk</td>
</tr>
<tr>
<td>Construction Element</td>
<td>Description of Risk</td>
<td>Design Control Measures</td>
<td>Probability</td>
<td>Consequence</td>
<td>Risk Rating Number</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Injury due to buried services such as gas and power.</td>
<td>Contractor required to ‘dial before you dig’ and locate services prior to commencement of works. Initial works will be on undeveloped land, underground services will be recorded as installed.</td>
<td>D</td>
<td>2 - Unintentional piercing of gas or power lines may result in severe injury. Unlikely if correct procedures are followed.</td>
<td>12 - Medium Risk</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Rollover of plant equipment.</td>
<td>Design batter slopes at maximum 1:3 grade. Design calls for no deep excavation or steep grades. Contractors are responsible for safe operation of vehicles.</td>
<td>D</td>
<td>1 - Injury or death of Plant operator or bystander.</td>
<td>7 - Medium Risk</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Personnel falling into excavated holes or trenches.</td>
<td>No deep excavations or high ledges in the designed landform. Contractor expected to using bunting or flagging for temporary hazards in line with their own Occupational Health and Safety procedures.</td>
<td>D</td>
<td>3 - Injury from a fall or ledge collapse.</td>
<td>17 - Low Risk</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Damage to plant or personnel due to subsidence.</td>
<td>Maximum fill layer depth and minimum compaction specified to ensure landform geotechnical stability.</td>
<td>D</td>
<td>3 - Minor injuries possible.</td>
<td>17 - Low Risk</td>
</tr>
<tr>
<td>Earthworks</td>
<td>Radiation exposure from Nuclear Density Soil Gauge.</td>
<td>Contractor will employ an appropriately NATA accredited soil laboratory.</td>
<td>E</td>
<td>5 - Low powered instrument, single dose no impact.</td>
<td>25 - Low Risk</td>
</tr>
<tr>
<td>Construction Element</td>
<td>Description of Risk</td>
<td>Design Control Measures</td>
<td>Probability</td>
<td>Consequence</td>
<td>Risk Rating Number</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Liner Installation</td>
<td>Personnel injury when deploying the rolls of geosynthetic clay liner material.</td>
<td>Installer must comply with manufacturers guidelines. Installer must develop a work method statement for safe roll deployment. Smooth subgrade limits opportunity to fall over rocks or loose stones. Design liner orientation (long seam down slope) reduces work required on sloping ground.</td>
<td>C</td>
<td>3 - Slips, trips and falls, or injury due to incorrect lifting technique.</td>
<td>13 - Medium Risk</td>
</tr>
<tr>
<td>Liner Installation</td>
<td>Personnel injury when deploying HDPE liner.</td>
<td>Installer must comply with manufacturers guidelines. Installer must develop a work method statement for safe roll deployment. Liner is not to be deployed in windy conditions.</td>
<td>C</td>
<td>3 - Slips, trips and falls, or injury due to incorrect lifting technique.</td>
<td>13 - Medium Risk</td>
</tr>
<tr>
<td>Liner Installation</td>
<td>Personnel injury when traversing HDPE liner on batters and in sump.</td>
<td>Rope ladders to be used on batters. Access to the sump to be in the corners where gradient is least.</td>
<td>B</td>
<td>3 - Minor sprains.</td>
<td>9 - Medium Risk</td>
</tr>
<tr>
<td>Liner Installation</td>
<td>Personnel injury when welding HDPE liner.</td>
<td>Amount of welding required minimised by panel layout. Main joins performed with automatic wedge welder, limiting extrusion welding requirement. Test welds required to ensure operator proficiency.</td>
<td>B</td>
<td>3 - Minor burns from extrusion equipment or cuts from knife use.</td>
<td>9 - Medium Risk</td>
</tr>
<tr>
<td>Construction Element</td>
<td>Description of Risk</td>
<td>Design Control Measures</td>
<td>Probability</td>
<td>Consequence</td>
<td>Risk Rating Number</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Liner Installation</td>
<td>Personnel injury when deploying the rolls of cushion material.</td>
<td>Design liner orientation (long seam down slope) reduces work required on sloping ground. Preceding liners are maintained free of debris which may cause injury.</td>
<td>B</td>
<td>3 - Slips, trips and falls, or injury due to incorrect lifting technique. Minor burns from heat bonding panels together.</td>
<td>9 - Medium Risk</td>
</tr>
<tr>
<td>Leachate Collection System</td>
<td>Personnel injury when installing Leachate Sump.</td>
<td>Leachate Extraction Riser pipes to be secured with concrete anchor block.</td>
<td>C</td>
<td>2 – Hand or arm trauma from jamming under pipe.</td>
<td>8 – Medium Risk</td>
</tr>
<tr>
<td>Separation Geotextile Installation</td>
<td>Personnel injury when deploying the rolls of separation material.</td>
<td>Design liner orientation (long seam down slope) reduces work required on sloping ground. The aggregate material is placed as a smooth working surface.</td>
<td>B</td>
<td>3 - Slips, trips and falls, or injury due to incorrect lifting technique. Minor burns from heat bonding panels together.</td>
<td>9 - Medium Risk</td>
</tr>
</tbody>
</table>