Technical Specification

Red Hill Waste Management Facility – GO Hardstand, Leachate Pond & Road Network Construction

Prepared for Eastern Metropolitan Regional Council

17 April 2025

Project Number: TC24042

Assets | Engineering | Environment | Noise | Spatial | Waste

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Signature	[redacted]	

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1 General

The works under this Technical Specification consists of the civil works associated with the proposed EMRC GO Hardstand.

This Technical Specification provides minimum requirements for materials and workmanship for the project. Any discrepancies between this Specification and other contract documents must be referred to the Superintendent for clarification.

This Technical Specification shall be read in conjunction with the Drawings, Other Specifications, and Bill of Quantities.

1.1 Scope of Works

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

- Construction of a 6m wide access road and tie-in to the Site's existing internal network;
- Placement and compaction of additional Ferricrete base material to design levels at varying thicknesses (material supplied by Principal);
- General earthwork excavation to formation levels for the leachate pond;
- Supply & installation of the geosynthetic lining system for the leachate pond:
    - 2mm High Density Polyethylene (HDPE) Double Textured Geomembrane;
- Construction of a leachate management system comprising:
    - Open channel drains; and
    - Pipework.
- Construction of a surface water management system comprising:
    - Open channel drains;
    - Culverts; and
    - Grouted/mortared rock pitching outlet to existing surface water detention basin.
- Supply & installation of 1.8m high chain-link fence around the perimeter of the leachate pond with a 4m wide gate.

1.2 Setting Out the Works

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

The Map Grid of Australia Zone 50, using GDA20 shall be used for the setting out of the works.

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

All control points and reference points shall be clearly marked and where appropriate bedded in concrete. They shall be adequately protected during the construction of the works. Where it is

necessary to remove a control point, additional reference points shall be provided to the satisfaction of the Superintendent.

Prior to commencing construction, the Contractor shall locate and mark all existing services, check all centrelines, prominent footprints and grid lines in sufficient detail to ensure that the work is fully compatible with existing features. **This is a Hold Point.**

Where design conflicts are identified or the required levels, grades, alignments, or geometry cannot be achieved for reasons beyond the Contractor's control, the Contractor must bring this to the attention of the Designer prior to commencement of the Works. The Contractor must not modify or adjust the 3D models without prior written consent from the Designer. Check surveys for comparison against the tolerances described in Section 2.7 must be based on the original DTM unless otherwise approved in writing by the Designer.

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

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

1.3 Document Management

In the performance of the Services, the Contractor shall prepare a wide variety of documentation and information ("Records").

- The Contractor shall ensure proper storage, management and maintenance of the information and store these Records;
- The Contractor will maintain a record keeping system that meets the minimum compliance requirements of State Records Commission Standard 1 "Government Record Keeping", to the satisfaction of the Principal; and
- The Contractor must not dispose of any records created or collected by the Contractor in the performance of the Services/works without authorisation of the Principal.

2 General Requirements

2.1 Occupational Health, Safety and Environment

The Contractor shall comply with the Work Health and Safety Act 2020 ('WHS Act') and the Work Health and Safety (General) Regulations 2022 (the WHS Regulations) and with any amendments that may be made to the WHS Act and WHS Regulations from time to time.

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

2.1.1 Contract Safety Risk Assessment

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

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

2.1.2 Safety Management Plan

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

Prior to the commencement of the Contract, the Contractor shall supply to the Superintendent, in writing, its Safety Management Plan.

2.1.3 Safe Working Procedures

Where legislation or codes of practice identify particularly hazardous activities, including but not limited to, work in confined spaces, asbestos removal, demolition work, excavation work, working near power lines and live conductors and working at heights, the Contractor shall supply to the Superintendent a Safe Work Procedure (SWP) document prior to commencing such activity or type of work on the Site, which complies with the Site Licence L8889/2015/2.

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

2.1.4 Site and Public Security & Safety

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

Should the general safety of the public be compromised, the Superintendent may order an immediate stoppage of the works and may order remedial works at the Contractor's expense.

2.1.5 Contractor's Safety Agreement

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

2.1.6 Safety Notifications, Compliance & Standards

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

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

2.1.7 Unsafe Machinery or Structures

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

2.1.8 Fire Prevention

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

BURNING ON SITE IS PROHIBITED.

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

2.1.9 Containment of Leachate and/or Surface Water Run-Off

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

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

2.1.10 Disposal Areas for Contractor

The area identified on the contract Drawings is the only area available for the Contractor to dispose of waste arising from excavations. The Contractor is to provide reports to the Superintendent on the same day as the tip area is used, detailing the following:

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

No material externally sourced from the Site shall be tipped in the tip area unless it is approved by the Superintendent.

Haulage rates internal to the Site must be included in the appropriate rates.

2.1.11 Materials Delivered to Site

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

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

2.1.12 Stability of Ground Conditions

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

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

2.1.13 Completion of the Work

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

Surplus excavation material shall be transported at the Contractor's expense to a location approved by Superintendent.

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

2.1.14 Protection of Works

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

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

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

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

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

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

The Contractor must allow for the necessary maintenance, alteration and adaptation of protection during construction to allow for its Subcontractors to progress and to allow the possibility of damage to the contract works by others and allow for removal of protection upon completion. It shall be a requirement of this Contract that a statement on the Contractor's proposals for protecting the works before, during, and upon completion, shall be submitted for approval by the Superintendent. The Contractor shall provide all necessary scaffolding, barriers and rails and other protective measures to excavations, floor openings and edges during the period of the contract works.

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

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

2.1.15 Site Climatic Conditions

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

2.1.16 Control of Quantities On-Site

The method adopted to verify volume/mass relationship shall be determined between the Contractor and the Superintendent prior to works commencing.

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

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

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

2.1.17 Security

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

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

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

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

2.2 Traffic Management

The Contractor shall submit a project specific Traffic Management Plan (TMP) to be implemented at all work locations. This is a **Hold Point.**

The TMP shall comply with the requirements of:

- AS 1742.3: 2019 Manual of uniform traffic control devices Traffic control for works on roads; and
- Main Roads Western Australia Code of Practice – Traffic Management for Works on Roads (2023).

2.3 Traffic Requirements

2.3.1 General

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

The Contractor shall provide traffic signs and undertake any temporary works to comply with the requirements of the Contract. All signs and method of traffic control shall be generally in accordance with AS 1742 and to the express approval of The Local Authority or Main Roads Western Australia (MRWA) as appropriate. A copy of the relevant standard method of signing will need to be obtained by the successful Contractor.

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

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

2.3.2 Traffic Safety and Management – Internal Road Network

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

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

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

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

2.3.3 Traffic Safety and Management – External Road Network

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

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

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

2.3.4 Cleaning and Damage to Roadways

All roads, accesses, drains, ditches and grips shall be kept clear of all dirt, mud and material arising from the execution and completion of the works and suitable clearing equipment and labour shall be provided by the Contractor for this purpose. Where this is likely, the Contractor shall install temporary wheelwash facilities and/or provide road cleaning equipment.

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

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

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

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

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

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

2.4 Compliance with the DWER Licence and Works Approval

Operations at the Site are governed by Licence L8889/2015/2 under the Environmental Protection Act 1986, Part V. A copy of the Licence may be viewed on the Department of Water and Environmental Regulation (DWER) website (www.der.wa.gov.au).

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

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

2.5 Water Supply

2.5.1 General

The Contractor must make all necessary arrangements for the supply and servicing of the required quantities of suitable water for the Works both for construction purposes and for potable water for concrete manufacture, pavement construction and site facilities.

The responsibility for investigating the feasibility and availability of suitable water for the Works from all sources and obtaining the necessary approvals will rest entirely with the Contractor.

2.5.2 Construction Water

Water used by the Contractor for material compaction and dust suppression must be obtained from sources other than Water Corporation water supply services, existing wetlands or the River, unless it can be demonstrated to the satisfaction of Superintendent that alternatives are not viable, and all required approvals have been obtained.

2.5.3 Water Bores

Where the Principal has established water bores in the vicinity of the Works, these will be made available for use by the Contractor as possible water sources. All risks associated with the use of such water bores will remain with the Contractor, as the performance of the bores may be affected by seasonal fluctuations and cannot be guaranteed.

The selection of the appropriate pumping equipment to utilise the bores is dependent on the nominal size and class of bore casing used in the development of the bores.

If drawdown at any water source during the Works is considered excessive, the Superintendent may then direct the Contractor to discontinue the use of the bore or limit the amount of water drawn from the bore. The Contractor must use replacement water from alternative sources at no additional cost to the Principal.

2.6 Utilities and Services

2.6.1 Location

The location of all existing utilities and services shown on the Drawings will be regarded as indicative only. The Contractor must ascertain the exact location of the utilities prior to commencing works in the area.

2.6.2 Liaison

The Contractor must make the appropriate allowances in the Contractor's Works Program for all necessary liaison and programming with service authorities as required for the provision of installation by service authorities during the Works. The Contractor must reinstate, make good, and backfill service trenches to the relevant service authority requirements.

2.6.3 Protection of Services

The Contractor must locate and take all necessary precautions when working in the vicinity of all utilities and services with in the construction site. The Superintendent may arrange for the repair of damage not made good by the Contractor and the cost of such repair will be deducted from payments due to the Contractor.

2.7 Survey

2.7.1 Supplied Survey Setting Out Information

Prior to commencing work under the Contract, the Contractor shall certify to the Superintendent that the Contractor has checked the digital design model provided by the Principal to ensure that there is no discrepancy between the digital design model and the Drawings.

2.7.2 Minimum Setting Out

The Contractor must as a minimum provide the following horizontal and longitudinal alignment control requirements for the use of the Superintendent prior to the commencement of subgrade preparation or any pavement construction:

- Offset pegs must be established on at least one side of the road formation;
- The pegs must be placed at 500mm offset to the surface design edge of Subgrade;
- Chainages must be clearly marked on the pegs;
- The spacing between pegs must not be greater than 50m on straights and 20m on curves and include all curve Tangent Points;
- The pegs must be placed vertical and within ±25mm tolerance to their exact horizontal location;
- Any pegs that are disturbed must be re-established by the Contractor at no cost to the Principal;
- Construction levels are not required to be marked on the pegs; and
- The pegs must be removed by the Contractor at the completion of the works.

2.7.3 As-Constructed Survey

The Contractor shall undertake as-constructed survey during and after completion of the Works. As-constructed survey shall include:

- Spot-heights of subgrade and pavement layers sufficient to accurately determine the dimensions and thickness of each layer;
- All stormwater infrastructure, including invert levels, pit locations and headwall locations;
- Alignment of any safety barriers;
- Location and heights of any encountered or new service, utility or conduit;
- All kerbing, footpaths and pram ramps; and
- All traffic facilities including medians, signs and pavement markings.

2.8 Hours of Operation of the Site

The Site is operational by the Principal between the hours of 7.00am and 4.00pm Monday to Friday, 8.00am and 4.00pm on Saturday, and 10.00am and 4.00pm on Sunday, excluding Good Friday, Christmas Day and New Year's Day when the Site is closed.

The normal working hours for this Contract shall be 7:00am to 5:00pm, unless specified elsewhere in the contract documents. Exceptionally, the Principal's consent for work outside these hours may be given after any necessary application and consultation with the appropriate authorities. Five working days' notice is required from the Contractor when seeking such consent.

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

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

3 Quality

3.1 General

The Contractor shall manage its Contract obligations through the implementation of a third party certified Quality Management System compliant with AS/NZS ISO 9001. Third party certification shall be maintained for the duration of the Contract.

3.2 Quality Plan

The Quality Plan shall be the document specifying the processes of the Contractor's quality management system (including the product realisation processes) and the resources to be applied to achieve the specific requirements of the Contract.

The Quality Plan shall address the Contractor's management responsibility, authority and communication requirements and clearly detail the Contractor's "Quality Management Representative (QMR)" role with respect to the Contract.

The Quality Plan shall include the scope of works detailed in the Contract. The Quality Plan must also address the requirements detailed in the General and any Special Conditions of Contract.

The Quality Plan shall clearly detail how the Contractor's Quality Management System procedures and instructions shall be applied to meet the requirements of the Contract and shall clearly detail the cross referencing to all documents of the Contract.

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

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

The Contractor shall submit a suitable fully documented Quality Plan to the Superintendent for approval prior to commencement of work under the Contract. **This is a Hold Point.**

3.2.1 Construction Quality Assurance (CQA) Plan

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

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

3.3 Inspection and Testing

The Contractor shall develop and document Inspection and Test Plans (ITPs) to undertake the monitoring and measurement of the works. **This is a Hold Point.**

The ITPs shall clearly describe the monitoring, verification and validation activities specific to the product and criteria for product acceptance.

All quality control testing shall be conducted by a laboratory holding current National Association of Testing Authorities (NATA) accreditation for all test methods referred to in the Specifications. Sampling methods shall be unbiased and either random or systematic in concept or as specified.

3.4 Identification and Traceability

A Lot is defined as a portion of material or a section of works that has been constructed and/or supplied under uniform conditions, contains material of uniform quality and presents uniformly without distinguishable sub-segments.

The principles used to define the limits of any Lot for the Contract shall be:

- The maximum size of a Lot is limited to the quantity of work that is the subject of a single conformance decision;
- The whole of the works included in the Lot shall be continuous;
- The Lot has been produced by the same works process;
- The Lot has been brought to the completion at the same time; and
- The Lot shall appear to be of a constant quality without obvious changes in attribute values, whether or not those attribute values form part of the acceptance criteria.

The Contractor shall provide traceability for all manufactured products incorporated into the Works in accordance with AS/NZS ISO 9001. The trace shall start at the supplier and finish at the location where product is incorporated into the Works.

3.5 Control of Documented Information

The control of records shall be in accordance with the requirements of the Contract and AS/NZS ISO 9001. The Contractor shall ensure as a minimum, but not limited to that the following records are kept and forwarded to the Superintendent:

- Audit reports;
- Conformance reports;
- Test results
- As Constructed Drawings and information;
- Commissioning records; and
- Operation manuals relevant to the completed Works.

3.6 Hold Points

A Hold Point is defined as that stage in the process of delivering the work under the Contract, beyond which the Contractor must not proceed to the next activity without the written approval of the Superintendent.

Table 3-1: Hold Points

Hold Point	Stage	Criteria	Reference Section
Setting out the works	Prior to commencement of works under the Contract	Locate and mark all existing services and check centrelines, prominent footprints and grid lines	Section 1.2
Quality Plan	Prior to commencement of works under the Contract	Submit a fully documented Quality Plan for Superintendent's approval	Section 3.2
Inspection and Test Plans	Prior to commencement of works under the Contract	Submit document Inspection and Test Plans (ITPs) for Superintendent approval.	Section 3.3
Traffic Management Plan	Prior to commencement of works under the Contract	Submit an endorsed Traffic Management Plan for Superintendent's approval	Section 2.2 Section 2.3
Road subgrade compaction	After the completion of clearing, topsoil removal and excavations for road widening	Compaction of the top 150mm of the subgrade to specifications	Section 4.5.2
Road subgrade Preparation	Prior to the construction of road widening	Provide evidence to the Superintendent that the underlying layer has been constructed to specifications	Section 4.5
Pavement spreading	Prior to the construction of any pavement layer	Provide evidence to the Superintendent that the underlying layer has been constructed to specifications	Section 5.2.2 Section 5.3
Culvert backfilling	Prior to backfilling culvert trenches	Provide evidence to the Superintendent that compliance has been achieved with all specified requirements for pipe laying	Section 11.2.3.2
Rock pitching geotextile	Prior to geotextile lining installation	Submit proposed geotextile lining material for the Principal approval	Section 11.2.5
Leachate Pond Construction			
Approval of formation excavation levels survey**	Prior to geomembrane installation	Provide a survey in line with conditions outlined in Section 2.7	Section 2.7
Approval of formation surface	Prior to geomembrane installation	Superintendent and Contractor to walk the full pond area confirming the condition is	Section 8.4.1

Hold Point	Stage	Criteria	Reference Section
		suitable for geomembrane installation as outlined in Section 8.4.1	
Approval of HDPE conformance testing	Prior to geomembrane installation	Provide NATA certified laboratory certificates and manufacturer's MQA documentation	Section 8.5.1
Approval of HDPE non-destructive testing	During geomembrane installation	CQA Consultant to observe all testing and record results as outlined in the CQA Plan in Appendix B	Section 8.5.4.1
Approval of HDPE destructive testing	During geomembrane installation	CQA Consultant to observe all testing and record results as outlined in the CQA Plan in Appendix B	Sections 8.5.4.2 & 8.5.4.3
Approval of leak detection testing	Following completion of geomembrane installation	Contractor to provide a report outlining the works to confirm no defects detected	Section 8.5.7

Note: ** Files to be provided in AutoCAD and PDF electronic formats with relevant isopachyte as outlined in Section 2.7.3 and Section 11.3

4 Earthworks

4.1 Products and Materials

4.1.1 General

Unless specified otherwise, earthworks material for embankments shall be suitable material extracted from cuttings in the Works or, should such material be totally exhausted or not available, be imported onto the Site by the Contractor from other sources. Other sources shall include borrow pits nominated by the Principal, or from the Contractor's own sources.

Material for embankments shall be free from boulders and shall be free from clods, stumps, roots, sticks, vegetable matter or other deleterious materials.

4.1.2 Use of Materials

The Contractor shall be responsible for any assumptions made by the Contractor in relation to the nature and types of materials encountered in excavations and the bulking and compaction characteristics of materials incorporated in embankments.

The summary of the estimated quantity for general earthworks provided includes all types of materials that may be encountered in the cuttings.

Where material from excavations is suitable for use in embankments, but the Contractor elects to:

- Spoil it; or
- Use it for the Contractor's own purposes; or
- Use it as a source of pavement materials; or
- Construct embankments with dimensions other than those shown on the Drawings, or to dimensions as otherwise authorised by the Superintendent,

and a deficiency of material for embankment construction is thereby created, the Contractor shall make good that deficiency from sources of suitable material. The making good of such deficiency of material shall be affected at no cost to the Principal.

4.1.3 Imported Material for Fill

Imported material for embankments, inclusive of Subgrade, shall be certified as "Dieback-free" (free from the plant disease phytophthera cinnamomi), and shall conform to the requirements for Particle Size Distribution in Table 4-1.

The portion of the material passing the 0.425mm sieve for imported material shall have a linear shrinkage not exceeding 1.0% and the material shall have a CBR value of greater than 10%.

The material shall contain no more than 1% organic matter.

Table 4-1: Particle Size Distribution (Imported Material)

Australian Standard Sieve Size (mm)	% Passing by mass (Minimum and Maximum Limits)
37.5	80 – 100
2.36	30 – 100
0.075	1 - 10

4.2 Topsoil Removal

4.2.1 General

During the removal of topsoil the Contractor shall take all precautions necessary to prevent damage to any retained vegetation within or adjoining the limits of clearing. Retained vegetation shall not be covered or buried with topsoil.

The pruning of tree roots greater than 50 millimetre diameter from retained vegetation shall be promptly carried out by a qualified tree surgeon engaged by the Contractor to prevent tree damage.

4.2.2 Topsoil Removal within Limits of Clearing

Topsoil shall be removed to the depth as specified in the Drawings. If not specified a nominal depth of 75mm of topsoil shall be removed unless otherwise approved by the Superintendent.

The Contractor shall ensure that appropriate plant and equipment are utilised by competent operators to ensure that the subsoil and topsoil layers are not mixed and the subgrade integrity is not affected during the stripping and stockpiling process.

4.3 Excavations

4.3.1 General

Excavations in cut sections including benching shall be carried out to the shapes shown in the Drawings and to the specified tolerances. General requirements for benching of stepped cut batters are given in the Drawings.

All suitable materials from excavations may be used in embankment construction. No material resulting from cutting operations of the existing pavement shall be incorporated into the road pavement, but may be utilised as oversize material.

Any over-excavation below the Subgrade surface and table drains shall be backfilled with embankment quality material. Any backfilled material more than 150mm below the Subgrade surface shall be compacted as specified for embankment construction.

4.4 Unsuitable Material

Material which the Superintendent deems to be unsuitable for use shall be excavated and then disposed of in accordance with the Superintendent's direction.

A void created from the excavation of unsuitable material during shall be backfilled with suitable embankment quality material or as directed by the Superintendent and compacted in accordance with Section 4.5.2.

4.4.1 Disposal

Oversize material shall be disposed to the spoil sites. Where no such sites are listed, oversize material shall be disposed to an authorised waste disposal site in accordance with the Superintendent's requirements.

4.5 Subgrade Preparation

4.5.1 General

Subgrade preparation shall be completed in all areas where a Pavement is to be constructed.

The Subgrade surface shall be constructed to the shape and levels as shown in the Drawings and to specified requirements and tolerances of this Clause.

During the whole of the compaction process the moisture content, at any point in the Lot, of the subgrade material shall be within 90% - 110% of the optimum moisture content for that material as determined by WA 133.1 or 133.2.

The completed Subgrade layer shall be in a homogeneous uniformly bonded condition with no evidence of layering or disintegration.

The completed subgrade surface shall be maintained in its conforming condition until pavement construction commences and shall be watered as necessary to prevent shrinkage cracking, dusting or loosening of its surface.

Subgrade shall be worked in compacted layers not greater than 250mm nor less than 100mm. Where less than 100mm is required to be worked the underlying material shall be scarified to such a depth that the resulting compacted thickness of the layer to be worked is not less than 100mm.

4.5.2 Compaction: End Product Specification

Where material for a depth of 150mm below the subgrade surface contains 20% or less by mass of material retained on a 37.5mm sieve then that material shall be compacted to the Dry Density Ratio of 92% or greater.

4.5.3 Surface Width

The outer top edge of the Subgrade shall be no closer to the road centreline and no more than 100mm further from the road centreline than the position shown in the Drawings.

4.5.4 Surface Shape

The shape of the Subgrade surface shall be deemed to be conforming when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 15mm.

Additionally, for widening of the existing roadway the crossfall measured at right angles to the road centreline shall be within 0.5% of the existing crossfall, or within 0.5% of any crossfall detailed on the Drawings.

4.5.5 Surface Levels

4.5.5.1 *Access Road Subgrade*

The level of the completed Subgrade surface shall be deemed to be conforming when the level measured at any point on the surface is within -35mm, + 5mm of the subgrade level at that point as determined from the Drawings.

4.6 Spoil

Spoil is defined as surplus material from excavations under the Contract which is not required to complete the Works, or material from excavations under the Contract whose quality renders it unacceptable for incorporation in the Works.

The Contractor shall dispose spoil to an authorised waste disposal site in accordance with the Superintendent's requirements.

4.7 Acceptance

The Contractor shall undertake the below tests with the minimum testing frequency shown in Table 4-2.

Table 4-2: Minimum Testing Frequency

Construction Element	Test	Test Method	Minimum Frequency	Acceptance Criteria
Imported Material	Particle Size Distribution	WA 115.1	1 per 2,500m^3	Per Table 4-1
	Linear Shrinkage	WA 123.1	1 per 2,500m^3	1.0% Maximum
	California Bearing Ratio	WA 141.1	1 per 10,000m^3	10% Minimum
	Organics	AS 1289.4.1.1	5 per Source	1.0% Maximum
Subgrade Construction	Dry Density Ratio	WA 134.1	6 per Lot	92% Minimum
	Construction Moisture Content	WA 110.1 or 110.2	6 per Lot	90 – 100% of OMC
	Optimum Moisture Content	WA 133.1 or WA 133.2	2 per Lot	

5 Pavement

5.1 Products and Materials

5.1.1 Water

Water used in any pavement construction shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances.

5.1.2 Sub-Base Gravel

Gravel Sub-Base material shall consist of durable pebble in soil mortar. The material shall be free from cobbles greater than 75.0mm and free from clods, stumps, roots, sticks, vegetable matter or other deleterious materials.

The Sub-Base material shall meet the grading requirements shown in Table 5-1 when tested in accordance with Test Method WA 115.1. The grading of material passing the 75.0mm sieve shall vary from coarse to fine in a uniform and consistent manner. The material shall not be gap graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another sieve size.

Table 5-1: Particle Size Distribution (Gravel Sub-Base)

Australian Standard Sieve Size (mm)	% Passing by mass (Minimum and Maximum Limits)
75.0	100
37.5	80 – 100
19.0	50 – 100
9.5	36 – 81
4.75	25 – 66
2.36	18 – 53
1.18	13 – 43
0.425	8 – 32
0.075	3 - 19

The Sub-Base material shall also meet the acceptance limits shown in Table 5-2.

Table 5-2: Acceptance Limits (Gravel Sub-Base)

Test	Limits	Test Method
Liquid Limit	30.0% Maximum	WA 120.2
Plasticity Index	10.0% Maximum	WA 122.2
Linear Shrinkage	4.0% Maximum	WA 123.1
California Bearing Ratio (Soaked 4 days with 6.75kg Surcharge) at 94% of MDD and 100% of OMC	30 % Minimum	WA 141.1

Test	Limits	Test Method
Secondary Mineral Content in Basic Igneous Rocks	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29

5.1.3 Basecourse Gravel

Gravel Basecourse material shall consist of durable pebble in soil mortar. The material shall be free from particles having any dimension greater than 50mm and free from clods, stumps, roots, sticks, vegetable matter or other deleterious materials.

When the stockpiled material contains oversized material, the Contractor shall screen the stockpiles to ensure that the pavement material does not contain more than 20% by mass of material retained on a 37.5mm sieve. The screen aperture shall be selected so that only the minimum quantity of material is removed from the existing stockpile to satisfy this requirement.

Basecourse material having any dimension greater than 50mm shall be deemed oversize and shall not be delivered to the pavement construction area.

The Particle Size Distribution shall be determined in accordance with Test Method WA 115.1. The particle size distribution of the portion passing a 37.5mm Australian Standard sieve shall conform to the grading limits shown in Table 5-3. The grading of material passing the 37.5mm sieve shall vary from coarse to fine in a uniform and consistent manner. The material shall not be gap graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another sieve size, and shall conform as closely as possible to the specified target grading.

Table 5-3: Particle Size Distribution (Gravel Basecourse)

Australian Standard Sieve Size (mm)	% Passing by mass (Minimum and Maximum Limits)
37.5	100
19.0	72 – 100
9.5	50 – 78
4.75	36 – 58
2.36	25 – 44
1.18	18 – 35
0.600	13 – 28
0.425	11 – 25
0.300	9 – 22
0.150	6 – 17
0.075	4 – 13
0.0135	2 - 9

The material shall also comply with the limits shown in Table 5-4. The Secondary Mineral Content in Basic Igneous Rock test is only applicable to basic igneous rock. The Accelerated Soundness Index test is only applicable to basic igneous rock.

Table 5-4: Acceptance Limits (Gravel Basecourse)

Test	Limits	Test Method
Liquid Limit	25.0% Maximum	WA 120.2
Linear Shrinkage	2.0% Maximum	WA 123.1
Maximum Dry Compressive Strength	2.3MPa Minimum	WA 140.1
California Bearing Ratio (Soaked 4 days with 4.5kg Surcharge) at 96% MDD and 100% OMC	80% Minimum	WA 141.1
Secondary Mineral Content in Basic Igneous Rock	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29

5.2 Construction

5.2.1 General

Pavement construction includes the supply, placing, compacting and finishing of pavement materials in accordance with the Specifications and Drawings to the prepared Subgrade surface. Pavement construction shall include construction of stabilised pavements.

Prior to the construction of any Pavement Layer, the Contractor shall certify to the Superintendent that the underlying layer has been constructed as specified. **This is a Hold Point.**

Transverse joints shall be offset from one layer to the next by not less than 5 metres. Longitudinal joints shall be located within 300mm of the planned position of traffic lane lines or within 300mm of the centre of a traffic lane.

5.2.2 Spreading

Each Pavement Layer worked shall be generally parallel to the finished pavement surface and shall extend the full width of the layer.

Pavement layers shall be worked in compacted layers not greater than 250mm nor less than 100mm. Where less than 100mm is required to be worked the underlying Sub-Base shall be scarified to such a depth that the resulting compacted thickness of the layer to be worked is not less than 100mm.

5.2.3 Compaction

Pavement material shall be spread, mixed and compacted to achieve uniformity free from any evidence of segregation.

Compaction shall be carried out at a Construction Moisture Content, at any point in the Lot within the range of 90% - 110% of the Optimum Moisture Content and with a uniform compactive effort applied longitudinally and transversely to the road alignment.

5.3 Acceptance

5.3.1 General

Each Pavement Layer shall be constructed to the dimensions and details shown on the Drawings and shall be constructed in accordance with this Specification.

Prior to the construction of any Pavement Layer, the Contractor shall certify to the Superintendent that the pavement material supplied by the Contractor complies in all respects with the specified requirements. **This is a Hold Point.**

5.3.2 Compaction

Each Pavement Layer shall be compacted to the Dry Density Ratio shown in Table 5-5.

Where the pavement material contains more than 20% by mass of material retained on a 37.5mm sieve, the Maximum Dry Density shall be determined on that portion of the material that passes a 37.5mm sieve.

Table 5-5: Compaction Requirements

Pavement Layer	Minimum Characteristic Dry Density Ratio (%)	Test Method	Minimum Testing Frequency
Subgrade	96%	WA 134.1	6 per Lot
Sub-Base	96%	WA 134.1	9 per Lot
Basecourse	98%	WA 134.1	9 per Lot

5.3.3 Dryback

Each Pavement Layer and the layer 150mm below the Subgrade shall be dried back such that the Dryback Moisture Content (DMc) is equal to or less than the proportion of the Optimum Moisture Content as shown in Table 5-6, as determined by Test Method WA 133.1 or WA 133.2 as appropriate.

Where the pavement material or the material in the layer 150mm below the Subgrade contains more than 20% by mass of material retained on a 37.5mm sieve, the Optimum Moisture Content and the Maximum Dry Density shall be determined on that portion of the material that passes a 37.5mm sieve.

Table 5-6: Dryback Requirements

Subgrade or Pavement Layers	Dryback Moisture Content (DMc) as a proportion of Optimum Moisture Content (OMC)	Minimum Testing Frequency
Layer 150mm below Subgrade surface	85%	6 per Lot
Sub-Base	85%	9 per Lot
Basecourse	70%	9 per Lot

5.3.4 Layer Width

The outer top edge of any layer of the Pavement shall be no closer to the road centreline and no more than 100mm further away from the road centreline than the positions shown in the Drawings.

5.3.5 Surface Shape

5.3.5.1 *Sub-Base*

The shape of the Sub-Base in granular Pavement shall be judged to be acceptable when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 10mm.

5.3.5.2 *Basecourse*

The shape of the Basecourse shall be judged to be acceptable when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 6mm.

5.3.6 Surface Levels

The level of the completed Sub-Base surface shall be deemed to be conforming when the level measured at any point on the surface is within +5mm, -25mm of the Sub-Base level at that point as determined from the Drawings.

The level of the completed Basecourse surface shall be judged to be acceptable when the level measured at any point on the surface is within -5mm, +20mm of the Basecourse level at that point as determined from the Drawings.

5.3.7 Surface Finish

Completed Pavement Layers shall be in a homogeneous, uniformly bonded condition with no evidence of layering, cracking, disintegration or surface tearing. The finished surface should appear as a stone mosaic interlocked with fine material and shall be dense, even textured and tightly bonded. Basecourse must retain those characteristics after rotary brooming and be suitable to receive bituminous surfacing. Prior to the application of a bituminous surfacing the surface of the Basecourse shall be uniformly dry.

5.4 Maintenance

5.4.1 Maintenance of Compacted Layers

The surface of any compacted Pavement Layer or prepared Subgrade shall be maintained in such a way as to minimise dust, prevent ravelling, erosion, deformation or any other damage to the layer resulting from environment conditions, traffic or construction activities. The layer shall be kept free from contamination until any subsequent pavement work under the Contract is commenced.

Completed Subgrade and Pavement Layers shall be maintained to the specified standards of surface shape, level, dryback and compaction up to the time of construction of the subsequent Pavement Layer or application of the bituminous surfacing.

Watering shall be continued as necessary to prevent, dusting or loosening of the surface.

6 Pavement Marking and Signage

All regulatory signs, warning signs, guide signs and hazard markers shall be undertaken in accordance with Main Roads Western Australia Specification 601 and Australian Standard 1742.

6.1 Products and Materials

6.1.1 Road Marking Paint

Water borne road marking paint shall be used and shall be an APAS approved product which complies with APAS Specification AP-S0041/5.

6.2 Application

Road marking materials shall not be applied during wet weather, or when the road pavement is wet or when adverse weather conditions may prevail during the work.

The road surface shall be dry and air blasted prior to application of road marking material.

6.2.1 Spotting

The Contractor shall undertake the spotting for longitudinal lines in accordance with the following:

- Spotting to be done in white paint;
- Spots to be no further apart than 4 metres;
- Spots installed using GPS or stringline only (not measured off kerbs);
- Spots to be 40mm to 50mm in size; and
- Start and finish points for each line type to be marked with a 100mm transverse marking.

7 Kerbing

7.1 Products and Materials

The kerbing shall be constructed using pre-mixed concrete complying with AS 1379: Specification and Supply of Concrete and the following requirements:

Table 7-1: Concrete for Kerb Constructions

Item	Value
Compressive Strength	> 32MPa at 28 days
Aggregate Size	< 19mm
Slump	< 100mm at delivery

High early strength additive in accordance with AS 1478: Chemical Admixtures for Concrete may be used. No other additives or admixtures of any kind shall be used without written approval from the Superintendent.

7.2 Construction

7.2.1 Preparation and Placement

The road surface shall be thoroughly swept clean of all loose material prior to the kerb being extruded to ensure the maximum bond between the kerb and pavement material.

Road kerbing shall be constructed of extruded concrete kerbing using an approved extrusion machine equipped with an automatic levelling device. Kerbing to small radii that cannot be placed with the extrusion machine shall be cast in situ to the same cross-section as the extruded kerbing.

The finished alignment shall conform to requirements of the drawings.

The first 150 millimetres of any new pour shall be cut away and removed. Any gap between the old and new work shall be filled by hand-placing, rodding and shaping of the concrete until a uniform shape and finish has been obtained.

7.2.2 Contraction Joints

Contraction joints shall be constructed at 4.0-metre intervals along the new kerbline.

Contraction joints shall be five millimetres wide and shall be cut through the kerb above the road surface level with an approved tool immediately after extrusion. Care shall be taken to avoid disturbing joint edges, with any disturbance made good immediately.

Where the kerb adjoins a footpath the contraction joints are to coincide with the footpath joints where possible.

7.2.3 Expansion Joints

Not less than 24 hours after kerb placement, expansion joints shall be formed by completely cutting through the kerb with a suitable cutting wheel at mid-points between contraction joints along the new kerbline, at sides of drainage gullies, at tangent points of all small radius horizontal curves and at junctions with existing kerbing. Expansion joints shall be a minimum of 10 millimetres wide.

Each expansion joint shall be filled with an approved butyl mastic compound filler and foam or polyurethane backing.

Where the kerb adjoins a footpath, the expansion joints are to coincide with the footpath joints where possible.

7.2.4 Curing

Within two hours of surface finishing, all exposed faces of the completed kerb shall be protected from moisture loss for a period of not less than four days by covering with plastic sheeting or spraying with an approved curing compound.

The kerb shall be maintained by the Contractor until Practical Completion.

7.2.5 Backfilling

Backfilling to the kerbing shall be placed after curing the concrete and acceptance of the kerbing. Backfill material shall be free draining sand or a similar material to the local topsoil, free from debris and compacted to a thickness not less than that of the surrounding natural surface.

7.3 Acceptance

7.3.1 Tolerances

The finished product shall be true to the dimensions specified and shall be to a smooth finish.

Tolerances for kerbing shall be in accordance with the following requirements:

- The top surface of the kerb shall be parallel to the ruling grade of the pavement;
- Free from depressions exceeding five millimetres when measured with a three metre straight edge;
- Level ±5 millimetres;
- Line ±10 millimetres to face of kerb or gutter line; and
- Cross-section dimensions ±5 millimetres.

8 Geosynthetic Layers

8.1 General

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

8.2 Codes & Standards

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

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

- ASTM D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test;
- ASTM D5514 Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics;
- ASTM D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics;
- ASTM D5617 Test Method for Multi- Axial Tension Test for Geosynthetics;
- ASTM D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber;
- ASTM D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes;
- ASTM D5820 Standard Practice for Pressurized Air Channel Evaluation of Duel-Seamed Geomembranes;
- ASTM D5885 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry;
- ASTM D5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter;
- ASTM D5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners;
- ASTM D5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners;
- ASTM D5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners;
- ASTM D5994 Test Method for Measuring Core Thickness of Textured Geomembranes;
- ASTM D6392 Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods;
- ASTM D6496 Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners;
- ASTM D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes;
- ASTM D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus;
- ASTM D7466 Test Method for Measuring Asperity Height of Textured Geomembranes;
- AS 1289.2.1.1 Methods of Testing Soils for Engineering Purposes: Soil Moisture Content Tests – Determination of the Moisture Content of a Soil – Oven Drying Method;
- AS 3706.1 Geotextiles – Methods of Test: General Requirements, Sampling, Conditioning, Basic Physical Properties and Statistical Analysis;
- AS 3706.2 Geotextiles – Methods of Test: Determination of Tensile Properties – Wide Strip and Grab Method;
- AS 3706.3 Geotextiles – Methods of Test: Determination of Tearing Strength - Trapezoidal Method;
- AS 3706.4 Geotextiles – Methods of Test: Determination of Burst Strength - California Bearing Ratio (CBR) - Plunger Method;

- AS 3706.5 Geotextiles – Methods of Test: Determination of Puncture Resistance – Drop Cone Method
- AS 3706.6 Geotextiles – Methods of Test: Determination of Seam Strength;
- AS 3706.9 Geotextiles – Methods of Test: Determination of Permittivity;
- ISO 9001 Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing;
- GRI-GM13 Standard Specification for HDPE Geomembranes;
- GRI-GM19 Seam Strength of Thermally Bonded Geomembranes;
- LFE2 Cylinder Testing Geomembranes and their Protective Materials;
- EN 13719 Geotextiles and Geotextile-Related Products – Determination of the Long-Term Protection Efficiency of Geotextiles in Contact with Geosynthetic Barriers;
- EN 14574 Geosynthetics – Determination of the pyramid puncture resistance of supported geosynthetics

8.3 Environmental Conditions

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

8.4 Supply, Handling and Storage

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

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

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

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

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

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

- Manufacturer;

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

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

8.4.1 Subgrade Acceptance

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

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

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

8.5 Geomembrane (HDPE)

The raw material used for High Density Polyethylene (HDPE) geomembrane manufacture shall be first quality virgin resin of the type nominated with no more than 10% factory re-work material and no post-consumer resin. The quality of the HDPE geomembrane shall be in accordance with the requirements of the Geosynthetic Research Institute (GRI) - GM13 as indicated on Table 8-1 and Table 8-2.

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

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

Defects which are considered as minor by the Superintendent shall be repaired in the presence of the Superintendent. Such repair shall be carried out using the extrusion fusion welding technique in

accordance with the Manufacturer's recommendation and tested in a manner agreeable to the Superintendent.

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

Table 8-1: Raw Material (Polymer Resin) – Minimum Test Value Required

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

The required minimum test values for geomembrane are set out in Table 8-2.

Table 8-2: High Density Polyethylene (HDPE) Geomembrane - Textured

Properties		Test Method	0.75mm	1.00mm	1.25mm	1.50mm	2.00mm	2.50mm	3.00mm	Minimum Testing Frequency
Thickness – mils (min. ave.)	Lowest individual for 8 out of 10 values	D5199	nom. -5% / -10%	nom. -5% / -10%	nom. -5% / -10%	nom. -5% / -10%	nom. -5% / -10%	nom. -5% / -10%	nom. -5% / -10%	Per Roll
	Lowest individual for any of the 10 values		-15%	-15%	-15%	-15%	-15%	-15%	-15%	
Asperity Height mils (min. ave.)[1]		GM 12	0.40mm	0.40mm	0.40mm	0.40mm	0.40mm	0.40mm	0.40mm	Every Second Roll[2]
Density (min. ave.)		D1505/D792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.)[2]	Yield Strength	D6693 Type IV	11 kN/m	15 kN/m	18 kN/m	22 kN/m	29 kN/m	37 kN/m	44 kN/m	9,000 kg
	Break Strength		8 kN/m	10 kN/m	13 kN/m	16 kN/m	21 kN/m	26 kN/m	32 kN/m	
	Yield Elongation		12%	12%	12%	12%	12%	12%	12%	
	Break Elongation		100%	100%	100%	100%	100%	100%	100%	
Tear Resistance (min. ave.)		D1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)		D4833	200 N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance[3]		D5397 (app.)	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	500 hr.	Per GRI GM 10
Carbon Black Content (range)		D4218[4]	2.0% - 3.0%	2.0% - 3.0%	2.0% - 3.0%	2.0% - 3.0%	2.0% - 3.0%	2.0% - 3.0%	2.0% - 3.0%	9,000 kg
Carbon Black Dispersion		D5596	Note 5	Note 5	Note 5	Note 5	Note 5	Note 5	Note 5	20,000 kg
Oxidative Induction Time (min. ave)[6]	Standard OIT, or	D8117	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	90,000 kg
	High Pressure OIT	D5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C [6,7]	Standard OIT (min. ave.) - % retained after 90 days, or	D5721 D8117	55%	55%	55%	55%	55%	55%	55%	Per each formulation
	High Pressure OIT (min. ave.) - % retained after 90 days	D5721 D5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance[8]	Standard OIT (min. ave.), or	D8117	Note 9	Note 9	Note 9	Note 9	Note 9	Note 9	Note 9	Per each formulation
	High Pressure OIT (min. ave.) - % retained after 1,600 hrs[10]	D5885	50%	50%	50%	50%	50%	50%	50%	

1. *Alternate the measurement side for double sided textured sheet.*
2. *Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 33mm. Break elongation is calculated using a gauge length of 50mm.*
3. *The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value Via MQC testing.*
4. *Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.*
5. *Carbon black dispersion (only near spherical agglomerates) 10 different views: 9 in categories 1 or 2 and 1 in category 3.*
6. *The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.*
7. *It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.*
8. *The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr condensation at 60°C.*
9. *Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.*
10. *UV resistance is based on percent retained value regardless of the original HP-OIT value.*

8.5.1 Geomembrane Conformance Testing Requirements

As a minimum, the tests outlined in Table 8-3 should be completed.

Geomembrane conformance testing shall be undertaken by the Contractor. All conformance sampling shall be under the CQA Consultant's supervision, whether at the Manufacturer' premises or onsite. Materials shall not be incorporated into the works until the Superintendent/CQA Consultant has assessed the laboratory results, which comprises a **Hold Point.**

The Contractor shall submit the laboratory test results to the Superintendent/CQA Consultant for approval of the use of the materials in the works, at the earliest opportunity. Any delay by the Contractor in obtaining the test results shall be at the Contractor's expense and the Contractor shall not be entitled to any extension of time for the Contract due to such delay unless the Superintendent/CQA Consultant has taken more than seven (7) days to reply to the Contractor's submission. Acceptance of the HDPE conformance testing constitutes a **Hold Point**.

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

Table 8-3: Minimum CQA Testing for Geomembranes

Item	Property	Standards	Frequency per Geomembrane Type
Conformance Testing	Thickness	ASTM D5994	One sample per 5,000m², or every five rolls delivered to Site, whichever is the greatest number of tests
	Asperity Height (textured only)	ASTM D7466	
	Density	ASTM D1505, ASTM D792	
	Tensile properties (yield and break stress, yield and break elongation)	ASTM D6693 type IV	
	Puncture resistance	ASTM D4833	
	Tear resistance	ASTM D1004	
	Carbon black content	ASTM D1603	
	Carbon black dispersion	ASTM D5596	
	Stress crack resistance	ASTM D5397	One sample every 10,000m², or resin type or manufacturing run (HDPE only)
	Oxidative induction time	ASTM D8117, ASTM D5885	
	Axi-Symmetric break resistance strain	ASTM D5617	Per formulation (LLDPE only)
	Oxidative induction time	ASTM D8117, ASTM D5885	

Item	Property	Standards	Frequency per Geomembrane Type
	Oven ageing and oxidative induction Time	ASTM D5721, ASTM D8117, ASTM D5885	One sample every 10,000m², or resin type or manufacturing run (LLDPE only MQC)
Start-up test weld	Welding equipment		Checked daily at start of works, and whenever the welding equipment is shut-off for more than one hour. Also after significant changes in weather conditions
	Weld conditions		Test weld strips will be required whenever personnel or equipment are changed and/or wide temperature fluctuations are experienced. Minimum 1.5m continuous seam
Destructive weld testing	Onsite, hand tensiometer in peel mode		1 tab from start and finish of each weld for fusion welds
	Offsite - weld seam strength in peel and shear	ASTM D6392	Every 300m (if fusion weld) Every 150m (if extrusion weld)
Non-destructive weld testing		Air pressure test, ASTM D5820 Vacuum box test, ASTM D5641	All seams over full length
Visual inspection of geomembrane	Tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material		Every roll

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

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

8.5.2 Geomembrane Deployment

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

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

There shall be no cross tie-in seams between batter and base panels within 2.5m of toe of batter.

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

8.5.3 Seaming

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

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

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

The Contractor should be aware of the possible temperature differential at the Site during the installation works. Typical Bureau of Meteorology (BOM) weather statistics from Perth Airport, the closest weather station to the Site at approximately 12.3km, are presented in Table 8-4.

Table 8-4: BOM Perth Airport Monthly Weather Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Rainfall (mm)	10.5	15.0	16.2	39.9	97.5	153	155	119	72.6	43.2	26.0	10.8
Mean Max Temp (°C)	31.8	32.0	29.8	25.7	21.8	19.0	18.0	18.6	20.3	22.8	26.1	29.2
Mean Min Temp (°C)	17.1	17.6	16.0	13.0	10.4	9.0	8.1	8.1	8.9	10.3	12.8	15.0

To minimise the propagation of wrinkles and tensions during installation due the expansion/contraction of the geomembrane, the Contractor shall be deemed to have allowed for all

precautions as deemed necessary by the specialist lining Contractor including welding at night (if required) for all general seaming and tie-in welds.

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

8.5.3.1 *Trial Seams*

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

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

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

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

8.5.3.2 *Field Seams*

The Contractor shall perform field seams only after satisfying trial seam conditions as specified in Section 8.5.3.1 of this Specification. The Contractor shall ensure that all pre-treatment measures (e.g. grinding and cleaning), as specified in EPA/530/SW-89/069 are carried out and that extrudate and/or wedge temperatures are maintained within a range approved by the Superintendent.

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

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

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

All field seams shall be completed to the back edge of the anchor trench, i.e. the edge furthest away from the slope or toe bund. Any seam defects falling within the anchor trench shall be repaired in accordance with Section 8.5.4.4 of this Specification.

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

Extrusion Welding

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

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

Fusion Welding

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

Prior to seaming the Contractor shall confirm that:

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

8.5.4 Sampling and Testing

8.5.4.1 *Non-Destructive Testing*

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

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

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

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

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

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

In the event of a field seam failing non-destructive testing the Contractor shall identify and repair the failed area in accordance with Section 8.5.4.4 of this Specification. The Contractor shall then subject the repair to further non-destructive testing until the repair shall pass the test.

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

8.5.4.2 *Qualitative Destructive Testing*

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

The Contractor shall not tear overlaps/rip into the seams to check weld quality. Any such damage shall be deemed a defect and repaired in accordance with Section 8.5.4.4.

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

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

- reconstruct the seam between two tabs shown to have passed qualitative destructive testing; or
- cut further tabs from 3m to each side of the failed tab and subject these to qualitative destructive testing.

If these tabs pass qualitative destructive testing the Contractor shall reconstruct the seam between the passed locations in accordance with Section 8.5.4.4 of this Specification. If either sample fails, the Contractor shall cut and test further field tabs until an area bounded by two passed locations can be identified. The Contractor shall then reconstruct the failed seam in accordance with Section 8.5.4.4 of this Specification.

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

8.5.4.3 *Quantitative Destructive Testing*

The Contractor shall cut laboratory samples from the field seams when instructed by the CQA Consultant and in any case at a frequency not exceeding 1 sample per 300m (if fusion weld), 1 sample

per 150m (if extrusion weld) or one per day of welding of seam performed by an individual machine whichever is greater.

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

If the samples are tested on-site the Contractor shall provide the calibration certificate to the Superintendent for the field tensiometer prior to undertaking any testing.

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

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

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

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

If a seam fails quantitative destructive testing the Contractor shall investigate the seam to each side of the failed sample as specified in Section 8.5.4.2 of this Specification. The Contractor shall cut further laboratory samples from each side of the failed section and perform laboratory tests upon them at the expense of the Contractor until the failed seam is bounded by two passed locations.

The Contractor shall then reconstruct the failed seam in accordance with Section 8.5.4.4 of this Specification. The Superintendent/CQA Consultant may at the Superintendent/CQA Consultant's discretion observe laboratory destructive testing in which event the Contractor shall arrange permission for access to the approved laboratory.

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

Table 8-5: Geomembrane Field Seam Destructive Testing Criteria

Test	Method	2.0 mm HDPE Requirement (minimum)
Fusion Welds		
Fusion Shear	ASTM D4437	28.0 N/mm (~701N/25mm)
Fusion Peel	ASTM D4437	21.2 N/mm (~530N/25mm)
Extrusion Welds		
Extrusion Shear	ASTM D4437	28.0 N/mm (~701N/25mm)
Extrusion Peel	ASTM D4437	18.2 N/mm (~455N/25mm)

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

8.5.4.4 *Repairs, Patches and Cap-Strips*

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

Superficial Defects (Dents and Creases)

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

Holes, Pinholes, Cuts & Large Faults

- Large faults, and any holes in the faulted area shall be cut back to remove all imperfections and shall be overlain with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions. The area shall then be prepared in accordance with EPA/530/SW-89/069 and seamed in accordance with Section 8.5.3 of this Specification.

Seam Faults

- Faulted extrusion seams shall be overlain with a single piece of compatible geomembrane with a minimum overlap of 100mm in all directions to form a cap strip. The repair may then be completed as for large faults.
- Faulted fusion seams shall be cut back to remove the upper flap, prepared in accordance with EPA/530/SW-89/069, and extruded in accordance with Section 8.5.3 of this Specification.

The Contractor shall test all repairs in accordance with Section 8.5.4.1 of this Specification.

8.5.5 Geomembrane Ballasting

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

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

8.5.6 Anchor Trenches

8.5.6.1 *Excavation*

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

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

8.5.6.2 *Backfilling*

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

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

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

Marker posts are to be installed once the backfilling has been completed to locate the centreline of the anchor trenches.

8.5.7 Liner Integrity Survey

The Contractor is advised that a geomembrane leak location survey is to be undertaken before the commissioning of the leachate evaporation pond. The exposed bare geomembrane for the leachate evaporation pond shall be surveyed with a water lance or arc testing method to detect any potential leaks/defects.

8.5.7.1 *Water Lance or Arc Test Survey*

The Contractor is to undertake an artificial leak detection sensitivity test prior to the commencement of each day of surveying. The pond area shall be surveyed on a grid system, data shall be recorded, plotted and analysed for leak signals.

All anomalies shall be investigated, and where defects are identified the geomembrane shall be repaired. Following repair procedures and reinstatement of geosynthetics, the area shall be locally resurveyed to ensure the defect was not masking further defects in the vicinity. All repair works to the geomembrane, and overlying materials which require removal and reinstatement, will be at the cost of the Contractor.

On completion of the leak detection survey the Contractor is to provide a report that includes the location of the internal and external electrodes for each day of surveying, and the location of any detected leaks/defects. All resurveying shall also be recorded and provided within the final report.

Completed leak detection survey results and reporting shall be submitted to the Superintendent/CQA Consultant for approval and constitute a **Hold Point**.

9 Fencing

The work under this Section consists of all operations involved in the supply and installation of fencing and gates including concrete footings, and fence materials. Locations and types of fencings are shown on the Drawings.

9.1 Products and Materials

9.1.1 Concrete Footings

Concrete used in the construction of footings and any other concrete elements of fencing shall be in accordance with this Specification. Concrete shall be Class N20 unless otherwise specified in the Drawings.

Where concrete is mixed on Site:

- Cement shall be fresh and in sealed bags;
- Contractor to provide slump testing records and provide certified aggregate and cement for the mix;
- Aggregate shall be well graded, clean, sharp and free from clay and organic impurities.
- Water shall be clean and of potable standard;
- Sand shall be of uniform grading and free from all deleterious substances, roots, clay, or any organic matter;
- Admixtures shall comply with AS 1478;
- Concrete shall be mixed in an approved mechanical batch mixer. All concrete works shall comply with the following Standards listed in Section 3.

Reinforcing steel used in the construction of reinforced concrete footings, columns, coping and any other reinforced concrete elements of fencing shall be in accordance with AS/NZS 4671.

9.1.2 Steelwork

All steelwork used in the construction of steel sheet fencing including panels, posts, tracks and connection fittings shall be in accordance with the manufacturer's published specifications. Sheets shall have uniform colour, shape and size, free from defects.

9.2 Construction

All fencing materials shall be stored in a manner that will not damage the material. Any damaged materials shall not be incorporated into the Works and be replaced as directed by the Superintendent at no cost to the Principal.

The fence alignment shall be set out in accordance with the Drawings. The provision of any additional markers and sight pegs shall be the responsibility of the Contractor. Survey marks shall not be removed or disturbed. Disturbed survey marks shall be re-established at no cost to the Principal.

Existing fence shall not be cut without first being tied back to a strainer post. Footing, post and strainer holes shall be backfilled using suitable fill material to ground level.

9.2.1 Chain Link Mesh Fencing

1800mm high galvanised chain link fencing shall be installed in accordance with the Drawings and the manufacturer's published specifications.

9.2.2 Gates

All new gates, or gates to be relocated from existing fences, shall be installed at locations in accordance with the Drawings. The Contractor shall supply all hinges, bolts and the like as required in accordance with the Drawings or the manufacturer's published specifications. Gates shall be consistent with the existing fences on either side of the gate unless otherwise directed by the Superintendent. Strainers, posts, columns or piers used to support gates shall be positioned in the ground so that gate panels are able to swing freely in both directions and when brought into line, do not overlap nor have a gap wider than 50mm unless otherwise specified in the Drawings or manufacturer's published specifications.

10 Leachate Pipework

Leachate collection pipework shall be installed to convey leachate from perimeter swale discharging to the Leachate Pond.

10.1 Products and Materials

10.1.1 Select Bedding Material

Select bedding material shall be as indicated on the Drawings.

10.1.2 Backfill Material

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

10.1.3 High Density Polyethylene Pipes

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

All pipes shall be formed from solid walled HDPE pipe. Plain pipes shall be tested to 1.5 times the working pressure. For perforated pipes, the pipe Manufacturer shall submit calculation to confirm the integrity of the pipes as not being compromised by the installation of slots/perforations. Unless agreed otherwise by the Superintendent, slots shall be as indicated on the Drawings.

10.2 Installation

10.2.1 Pipe Laying

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

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

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

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

The Contractor shall prevent any damage from occurring to the underlying geotextile and geomembrane during pipe installation. Should the geotextile or geomembrane be damaged in any way the Contractor shall repair the damage at the Contractor's cost according to Section 8.

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

10.2.2 Continuity of Laying

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

10.2.3 Tolerances

The tolerances shown in Table 10-1 shall apply to all installed pipes, unless specified otherwise.

Table 10-1: Tolerances of Pipes and Components

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

11 Stormwater Drainage

11.1 Products and Materials

11.1.1 Reinforced Concrete Pipes

Concrete pipes for culverts shall be pre-cast reinforced concrete pipes (RCPs) to the Classes shown on the Drawings. Concrete pipes shall be manufactured, tested and inspected in accordance with the requirements of AS / NZS 4058.

Rubber ring joints shall be provided for all spigot and socket pipes, unless otherwise shown on the Drawings.

11.1.2 Reinforced Concrete Boxes

Reinforced concrete box culvert units with spans up to and equal to 1200mm shall be manufactured, tested and inspected in accordance with AS 1597.1.

Joint sealant for masking external joints shall be a 150mm wide joint sealant.

11.1.3 Cement Stabilised Backfill

Select bedding material shall conform to the grading requirements of AS/NZS 3725 Table 6 and have a maximum linear shrinkage of 10%.

11.1.4 Select Bedding Material

Select bedding material shall be basecourse material, or other suitable material approved by the Superintendent, containing less than 20% by mass of material retained on the 37.5mm sieve as determined by MRWA Test Method WA 115.2.

11.1.5 Joint Sealant

Acceptable joint sealant for masking external joints are Flash Tac Scotch Wrap No.50 and Rock Wrap 3000 or a suitable equivalent approved by the Superintendent.

11.1.6 Geotextile Lining

The geotextile for rock protection shall be Bidim A44 or similar approved.

11.2 Installation

11.2.1 General

The installation of pipes and drainage structures shall include all trench excavations, construction and backfill to the details shown on the Drawings and as described in this Specification.

11.2.2 Bedding

Pipes and drainage structures shall be bedded as detailed in the Drawings.

Select bedding material shall be constructed to the dimensions shown in the Drawings. Select bedding material shall be compacted to a minimum Characteristic Dry Density Ratio of 96%.

Provisions shall be made to accommodate pipe socket/connections to ensure pipes are fully supported along the barrels.

11.2.3 Backfill and Compaction

11.2.3.1 *General*

Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements. **This is a Hold Point.**

The backfill requirements for all culverts shall be as detailed in the Drawings. Unless otherwise shown on the Drawings backfill material, other than cement stabilised backfill shall be embankment material placed and compacted. Backfill levels on each side of any conduit shall not differ by more than 150mm. The Contractor shall ensure that the backfill placement does not damage the end treatments.

The dimensional requirements relating to backfill shall be as shown on the Drawings.

The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with AS/NZS 3725 for reinforced concrete pipes or AS 1597 for reinforced box culverts.

No backfill shall be placed behind in-situ wingwalls or headwalls within seven days of concrete being placed in the wingwalls or headwalls.

11.2.3.2 *Cement Stabilised Backfill*

Cement stabilised backfill shall be placed to the limits and dimensions as shown on the Drawings.

Only sufficient water shall be mixed with the stabilised material to facilitate compaction.

Cement stabilised backfill material shall be placed within 90 minutes of mixing the cement with water. The stabilised backfill shall be compacted during placement using pneumatic or mechanical rotary type immersion vibrators. The cement stabilised material shall be vibrated until all excess water and air are expelled.

During placing of cement stabilised backfill the backfill levels on each side of any conduit shall not differ by more than 150mm. Backfill placement shall not damage the culverts or end treatments.

Immersion vibrators shall be of the rotary out of balance type with a frequency of not less than 10,000 cycles per minute. Before the commencement of each backfill, sufficient vibrators and spares shall be available and tested.

11.2.4 Pipes

11.2.4.1 *General*

Batter slopes at pipes shall be evenly transitioned over a length of 10m from the edge of the wingwall to match culvert wingwall slopes.

All culverts shall be constructed to the correct alignment and cross sectional shape and shall conform to dimensions, levels and other details specified or shown in the Drawings.

Inlet and outlet invert levels shall be as shown in the Drawings plus or minus 10mm. Inverts shall be smooth and of uniform gradient throughout each culvert length.

Any pipe which is not true to line, level or grade, or shows settlement after laying, or which is damaged during backfilling, compaction or subsequent operations, shall be removed by the Contractor and replaced at no cost to the Principal.

All pipes shall be flushed clean from end to end on completion of the installation and maintained in proper working order for the duration of the Contract.

Pipes shall be laid with the connections kept clean and shall be laid with the inverts true to the lines and levels shown on the Drawings and to the following tolerances:

- Horizontal alignment: ± 25mm
- Vertical level: ± 10mm

The Contractor shall seal the ends of the culverts with a temporary plug to exclude water, sand or other deleterious materials caused from work under the Contract unless otherwise approved by the Superintendent.

11.2.4.2 *Reinforced Concrete Pipes*

Pipe laying shall proceed up-grade with the pipe sockets at the higher end of the pipes.

Rubber ring joints shall be lubricated in accordance with the manufacturer's recommendations. Pipe handling shall be carefully controlled to avoid disturbing the rubber ring and to ensure that it is free from dirt and other foreign materials. Any rubber ring so disturbed shall be removed, cleaned and re-lubricated before refitting.

Care shall be taken to properly align the pipe before the joint is forced home. During the jointing operation the pipe shall be partially supported in a suitable manner to minimise unequal lateral pressure on the rubber ring and to maintain concentricity until the rubber ring is properly seated.

Flush jointed concrete pipes shall be installed in accordance with the manufacturer's recommendations, with the rubber jointing bands and pipe joints being kept free from dirt and foreign materials.

The installation and jointing recommendations provided by the pipe manufacturer shall be followed at all times. Sufficient pressure shall be applied in making the joint to ensure proper seating and sufficient restraint shall be applied to ensure that the line does not creep until backfill material can be placed and thoroughly compacted around the pipe. At the end of the work day the last pipe shall be blocked in an effective manner to prevent creep.

11.2.4.3 *Concrete Box Culverts*

Unless otherwise detailed in the Specification or Drawings, installation of all pre-cast reinforced concrete boxes shall comply with the requirements of AS 1597 Section 6 - Installation.

Reinforced concrete box culvert units, including link slab units, shall be placed in position on a mortar bed in accordance with the Drawings. Unless specified otherwise on the Drawings, cement mortar is to be 0.4 : 1, water : cement ratio by mass and 3 : 1, sand : cement ratio by mass.

Cement stabilised backfill shall not be placed until the cement mortar used to seal culvert crown units and link slabs has cured for 48 hours.

If the base slabs are in-situ, then they shall comply with the following requirements:

- Dimensions shall be within 10mm of those shown on the Drawings. Surface irregularities shall be less than 5mm abrupt and 8mm over a 3 metre straight edge.
- No construction equipment or public traffic is permitted to travel or work on or over the concrete base slab within seven days of the placement of concrete in the base slabs.

- The Contractor shall not operate any plant directly on the concrete base slabs without prior approval from the Superintendent.
- Reinforced concrete box culvert units shall not be placed on concrete base slabs within 24 hours of completing the concrete base slabs.

11.2.5 Existing Pipes

11.2.5.1 *Removal & Backfill*

Where detailed on the Drawings, existing pipes shall be removed and, if deemed suitable for re-use by the Superintendent, can be used for sidetracks. When the sidetrack is no longer in use, or if there is no sidetrack, removed pipes shall be stored or disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority.

Where damage to the concrete that exposes the reinforcement or any cracking which exceeds 0.1mm wide occurs then those damaged culvert units shall be disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority. Minor chipping of the concrete may be repaired by the Contractor using an approved epoxy mortar and the culverts will be considered to be undamaged.

11.2.5.2 *Pipe Extensions*

Construction of extensions to existing pipes shall be in accordance with the relevant construction requirements for new pipes, except that extension of a pipe shall normally be completed before associated earthworks at the same location.

Trench excavation for the pipe extension shall be carried out as required. Where the invert level of the pipe extension is lower than the existing ground level, the in-situ material shall be excavated to the width shown on the Drawings for new pipes.

Existing pipe endwalls shall be broken out as required and the old endwall material removed to spoil areas. Care shall be taken not to damage retained pipe conduit.

Unless shown otherwise on the Drawings, the existing pipe barrel shall be excavated back to a minimum of 500mm from the end of the pipe. Prior to backfilling, the joint between the existing and the new conduit shall be masked with a suitable joint sealant in accordance with Section 11.1.5.

The gradient of the pipe extension shall match the gradient of the retained portion of the existing pipe, or where required the extension shall be laid to a specified invert level. Pipe extensions shall be thoroughly jointed with the existing pipe so as to provide a continuous structure with no internal projections to impede the flow of water.

End treatments to extensions shall be constructed as for new pipes.

11.2.6 Damage to Existing Structures

Any damage to any pipe, end treatment or any other structure during the Contract shall be repaired by the Contractor at no cost to the Principal.

11.2.7 Pegging of Pipes

Prior to any clearing at pipe locations, the Contractor shall peg the centreline of the pipe at the inlet and outlet inverts and peg the extent of the clearing required for associated works for the Superintendent's verification and adjustment as required. **This is a Hold Point.**

11.2.8 End Treatments

11.2.8.1 *In-Situ Construction*

The dimensions of the end treatments shall be within 10mm of those shown on the Drawings when measured in accordance with AS 3610.

Surface irregularities of the concrete end walls, wing walls, cut off walls and aprons shall be less than 5mm abrupt and 8mm over a 3 metre straight edge.

Unless otherwise shown on the Drawings, mortar for mortared rock pitching shall comprise a 6 to 1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source.

11.2.8.2 *Pre-Cast Concrete End Treatments*

Where specified in the Drawings, the contractor shall use pre-cast concrete end treatments. The pre-cast concrete end treatments shall comply with the following minimum treatments:

- The end treatments shall be placed on a concrete bed consisting of Class N40 concrete, not less than 50mm thick and be restrained against movement, including overturning; and
- Where not incorporated into the pre-cast unit, the concrete bed shall be constructed with a 150mm wide by 450mm deep cut off wall unless otherwise specified in the Drawings.
- Pre-cast concrete end treatments shall be supplied, delivered and installed in accordance with the manufacturer's recommendations.

11.2.9 Removal of Existing Drainage Structures

Where detailed on the Drawings, redundant drainage structures located under roadways shall be removed and disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the relevant Local Government Authority.

Voids left from the removal of a drainage structure, not intended to be replaced shall be backfilled and compacted with embankment quality material or pavement material in accordance with the Drawings and this Specification.

11.3 As-Built and Handover Requirements

As-Built Drawings shall include the following information for pipes and drainage structures:

- Material type;
- Length;
- Culvert Skew Angle;
- Inlet and Outlet Invert Levels;
- Nominal diameter for pipes or span and height for RCBs; and
- Number of barrels. In the case of box culverts, in addition to the number of barrels, number of link slabs shall also be noted (where applicable).

APPENDIX A
Drawings

APPENDIX B
CQA Plan

Assets | Engineering | Environment | Noise | Spatial | Waste

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