RUM JUNGLE REHABILITATION - STAGE 2A
DETAILED ENGINEERING DESIGN

General Site Civil and Earthworks Work Package
Technical Specification

Prepared for:

NT DPIR - Mines Division
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with NT DPIR - Mines Division (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
680.10421-R01-v1.0 Issued for Implementation	18 June 2020	Sam Butler	Dominic Trani	Danielle O'Toole
680.10421-R01-v0.1 Issued for Industry Engagement	1 April 2020	Sam Butler	Danielle O'Toole	Danielle O'Toole

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GLOSSARY

Refer **Section 1.5**.

1 Preliminaries

1.1 General

The Northern Territory Government (NTG), represented by the Department of Primary Industry and Resources (DPIR), proposes the rehabilitation of the former Rum Jungle Mine site (the Project), located 6km north of Batchelor, Northern Territory (NT).

SLR Consulting Australia Pty Ltd (SLR) was engaged by DPIR to undertake the detailed design to meet the engineering requriements for construction of the rehabiliation strategy. The full design is detailed in SLR Report *Rum Jungle Rehabiliation – Stage 2A Detailed Engineering Report: Summary of Detailed Engineering Design*, dated June 2020 (SLR Consulting, 2020b).

As part of the rehabilitation design, a General Site Civil and Earthworks (Earthworks) Works Package is to be undertaken, covering:

- Site Establishment, including:
    - Construction of haul roads and access road;
    - Construction of the East Branch Finnis River (EBFR) diversion drain culvert crossing;
    - Civil earthworks for site establishment for all Works areas (i.e. Head Contractor, Water Treatment Plant compound, Main Pit Backfill compound); and
    - Surface water and erosion and sediment control measures for the Works.
- Construction of a cultural centre.
- Demolition of existing structures.
- Construction of two new Waste Storage Facilities (East WSF and West WSF) to encapsulate potentially acid forming (PAF) waste rock, radiological soils and other impacted soil materials from across the Project site. The WSFs will be capped to avoid excess infiltration to halt or minimise acid metalliferous drainage (AMD) and therefore downstream water contamination.
- Haulage of site waste rock and impacted material to the new WSFs as well as to the Main Pit stockpile area (for treatment by others).
- Haulage of Mt Burton waste rock to new WSFs and Mt Fitch waste rock to Mt Fitch open pit.
- Remediation of excavated waste rock and contaminated soils footprints.
- Main Pit rim works, including ramp construction and demolition and pit rim reprofiling.
- Realignment of the East Branch Finniss River (EBFR) and removal of site infrastructure.
- Final site remediation.
- As-constructed surveys.

SLR has prepared detailed design drawings and this Specification for the **Earthwork Works Package**.

The purpose of this Specification is to describe the scope of the works and to outline the standard of construction to be achieved. This Specification is to be read in conjunction with the associated design drawings and design and construction methodology statements as follows:

- Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design: Waste Storage Facility and General Site Civil Works, Detailed Design and Construction Methodology Report, June 2020 (SLR Consulting, 2020d), including appendices.
- Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design: Geotechnical Investigation Waste Storage Facilities and Borrow Areas, June 2020 (SLR Consulting, 2020a)
- Rum Jungle Rehabilitation – Stage 2A Detailed Engineering Design: Borrow Area Development, April 2020 (SLR Consulting, 2020e)
- Detailed Design Drawing Sets:
    - GEN Design Drawings – Site Layout and Preliminaries
    - WSF Design Drawings - Waste Storage Facilities Construction and Excavated Footprint Treatment
    - BEW Design Drawings – Bulk Earthworks
    - SUW Design Drawings – Surface Water
    - MPS Design Drawings – Main Pit
    - RFR Design Drawings - Reinstatement of East Branch Finniss River
    - REH Design Drawings – Site Rehabilitation
    - BOR Design Drawings - Borrow Area Development
    - WTP Design Drawings – Water Treatment Plant
    - HR Design Drawings – Haul Roads
    - Diversion Drain Crossing Drawings

Where a difference of information occurs, the Specification shall take preference. Figured dimensions shall be taken in preference to scale. The Contractor shall verify all dimensions on site prior to commencing any work and be responsible for their accuracy.

The Contractor will be responsible for coordinating and receiving approval from the Principal for any activities which require assistance by site staff or activities that may impact Site operations. The Contractor shall supply all plant, materials (other than those earthworks materials made available by the Principal within the site) and incidentals required to carry out and complete the Work.

1.2 Rehabilitation Strategy Overview

The scope of works for the Rehabilitation Project was developed from an understanding of current site conditions, contamination processes and a Land Use Plan goal.

1.2.1 Environmental Rehabilitation

The actions planned to address contamination processes are:

- Slow down or halt the AMD production reactions from waste rock onsite by consolidating waste rock into one of three new facilities based on PAF characteristics. These facilities are:
    - Main Pit backfill zone;
    - East WSF; and

  - West WSF.
- Treat existing groundwater sources (i.e. the Main and Intermediate WRDs) that contaminate the EBFR by pumping and treating these impacted waters.
- Treat other AMD-impacted groundwater that does not contribute to the EBFR copper load (i.e. old ore stockpile area) by pumping and treating these impacted waters.
- Isolate radiological, salt, metal and other impacted soils at the Rum Jungle site, Mt Burton and Mt Fitch from environmental and human receptors by relocating these soils to the Main Pit, Mt Fitch open pit and/or the new WSFs.
- Slow down or halt the future generation and transportation mechanisms for copper and other metals in the new WSF by adopting leading practice methodology for storage of PAF waste rock.

1.2.2 Reestablishment of Cultural Values

The actions that are planned to address the compromised environmental and cultural values that are not related to contamination processes are:

- Return the EBFR to its original course as far as possible.
- Restore land parcels that are poorly vegetated such as the Old Tailings Dam area and vine thicket stand.
- Revegetate new landforms to stabilise the surface and restore ecological function as far as practicable.

1.2.3 Overall Scope of Works

To meet the above requirements, three (3) Works packages have been developed. These works will be concurrent, and all packages must take into consideration parallel works:

1. General Site Civil and Earthworks Work Package ***(this scope of works)***, including:
    a. Construction of New Waste Storage Facilities;
    b. Access and haul roads and river crossing;
    c. Demolition of existing buildings, concrete footings, etc;
    d. Borrow pit operations;
    e. Remediation of excavated footprints;
    f. Main Pit backfill operations enabling works;
    g. Material haulage to the WSFs for placement, treatment and compaction;
    h. Material haulage to the Main Pit backfill operations (for treatment by others);
    i. Reprofiling of the Main Pit rim;
    j. Realignment of the EBFR; and
    k. Design and construction of a Cultural Centre.
2. Main Pit Backfilling Works Package;
3. Water Treatment Plant Works Package, including:
    a. Design, construction and operation of a water treatment plant;

b. Main Pit Water Management; and

c. Groundwater Interception System.

It is important to note that multiple Contractors may be on site at one time**. A Head Contractor will be appointed who will have overall responsibility for the Project Site**. It is envisaged that the Head Contractor will be responsible for this **Earthworks Works Package**, hence all earthworks related activities, such as site set up, material haulage, haul road maintenance, etc. will be the Head Contractor responsibility.

1.3 Objectives

The primary objective of this project is to restore the environmental condition onsite and downstream by addressing the AMD contaminant loads discharged from the Rum Jungle site. All proposed actions are driven by removing (or reducing) the above contamination causing processes and restoring ecological function at the Site.

1.4 Nomenclature

For the purpose of this Technical Specification, the following terminology shall apply:

Drawings – The designated drawings, standard plans, profiles, typical cross-sections, working drawings and supplemental drawings, or reproductions thereof, approved by the Design Consultant, which shows the location, character, dimensions and details of the Work(s) (see below) performed.

Construction Quality Assurance (CQA) – A planned and systematic pattern of all means and actions designed to provide confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the CQA Consultant or Superintendent on behalf of the Principal, to assure conformity of the Works to the Design documentation.

Construction Quality Control (CQC) – Those actions which provide a means to measure and regulate the characteristics of an item or service to contractual requirements. Construction Quality Control refers to those actions taken by the Contractor to ensure the materials and the workmanship meet the requirements of the Design documentation.

Contract – The written agreement between the Contractor and the Principal covering the performance of the Work(s). The Contract shall include all tender documents, the Contractor's tender, drawings, specifications, contract bonds (if applicable), and all supplemental agreements amending or extending the Work(s) contemplated and which may be required to complete the Work(s) in a substantial and acceptable manner.

Contractor – The individual, partnership, corporation, joint venture, alliance, or other legal entity having a Contract with the Principal to perform the Work and includes the Contractor's representatives or other parties such as sub-contractors, manufacturers, suppliers, etc. The Contractor will undertake the execution of the Works under the terms of the Contract.

CQA Consultant – The Company responsible for undertaking quality assurance associated with the Works.

Design Consultant – The Company responsible for design and preparation of the Design documentation. All design changes must be approved by the Design Consultant (SLR Consulting).

Design Documentation – All drawings and documents presenting the Design for the Rum Jungle Rehabilitation and approved for use by the Principal.

Geosynthetics Installer – The Company responsible for the installation of the geosynthetics, including all field construction quality control activities, including field seam testing and preparing as-built documentation.

GITA – Geotechnical Inspection and Testing Authority undertaking Level 1 inspection and testing of earthworks in accordance with AS 3798-2007.

Head Contractor – The Contractor who is to carry out construction work or supply related goods and services for the Principal under a construction contract (the "Main Contract") and for whom construction work is to be carried out or related goods and services supplied under a construction contract as part of or incidental to the work or goods and services carried out or supplied under the main contract.

The Head Contractor will take account of the health and safety risks to everyone affected by the work (including members of the public), in planning and managing the measures needed to control them.

Independent Testing Laboratory – The NATA-accredited firm(s) responsible for conducting all required laboratory tests.

NT DPIR – Northern Territory Department for Primary Industry and Resources.

Principal – The person or persons, firm or company or other body who owns and has responsibility for the site and has entered into the Contract with the Contractor.

Site – Rum Jungle Rehabilitation Project located approximately 6km north of Batchelor, Northern Territory (NT).

Superintendent – Person(s) authorised by the Principal to manage and oversee the construction and CQA works.

Work(s) – All actions, tools, equipment, supervision, labour and materials or supplies necessary to complete construction of the Rum Jungle Rehabilitation Works in accordance with the Design documentation.

Work(s) Area – The portion within the Site associated with the Works.

1.5 Glossary

Table 1 Glossary of Terms

Term	Definition
AHD	Australian Height Datum
ALS	Australian Laboratory Services
AMD	Acid Mine Drainage
APHA	American Public Health Association
ARI	Average Recurrence Interval
AS	Australian Standard
ASTM	American Society for Testing and Materials
AUL	Auxiliary Left Turn Treatment
$CaCO_3$	Calcium Carbonate
CCL	Compacted Clay Liner

Term	Definition
CQC	Construction Quality Control
CQA	Construction Quality Assurance
EBFR	Eastern Branch Finniss River
EIS	Environmental Impact Statement
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
EWSF	East Waste Storage Facility
FRALT	Finniss River Aboriginal Land Trust
GITA	Geotechnical Inspection and Testing Authority
H_2SO_4	Sulfuric Acid
LLDPE	Linear Low Density Polyethylene
LR	Light Rigid
MDD	Maximum Dry Density
NATA Laboratory	National Association of Testing Authorities Laboratory
NAF	Non-Acid Forming
NCST	National Committee for Soil and Terrain
NT	Northern Territory
NT-DPIR	Northern Territory Department of Primary Industry and Resources
NTEPA	Northern Territory Environmental Protection Agency
NTG	Northern Territory Government
OMC	Optimum Moisture Content
PAF	Potentially Acid Forming
pH	A measure of the acidity or alkalinity of a solution.
SDDR	Standard Dry Density Ratio
SLR	SLR Consulting Australia Pty Ltd
SRA	Slope Risk Assessment
TSS	Total Suspended Solids
WR	Waste Rock
WRD	Waste Rock Dump
WSF	Waste Storage Facility
WTP	Water Treatment Plant
WWSF	West Waste Storage Facility
XRF	X-Ray Fluorescence

1.6 Drawing List

The full list of Construction Drawings as summarised in **Table 2** shall be read in conjunction with this Specification (though some fall outside this specification).

Table 2 List of Construction Drawings

Drawing Number	Drawing Description
General	
680.10421.GEN.D00	Locality Plan and Schedule of Drawings
680.10421.GEN.D01	Existing Site Conditions
680.10421.GEN.D02	Site Construction Works Layout
680.10421.GEN.D03	Rehabilitation General Arrangement Plan
680.10421.GEN.D04	Site Exclusion Zones
Waste Storage Facilities	
680.10421.WSF.D01	WSF General Arrangement Plan
680.10421.WSF.D02	EWSF Foundation Plan
680.10421.WSF.D03	EWSF Layout Plan
680.10421.WSF.D04	EWSF Fill Elevation Plan
680.10421.WSF.D05	EWSF Sections
680.10421.WSF.D06	WWSF Foundation Plan Radiological Soil Treatment
680.10421.WSF.D07	WWSF Foundation Plan
680.10421.WSF.D08	WWSF Layout Plan
680.10421.WSF.D09	WWSF Fill Elevation Plan
680.10421.WSF.D10	WWSF Sections
680.10421.WSF.D11	Typical Details
680.10421.WSF.D12	WSF Lysimeter Layout Plan
680.10421.WSF.D13	Lysimeter Details
680.10421.WSF.D14	Soil Monitoring Stations Details
Bulk Earthworks	
680.10421.BEW.D01	Material Excavation Summary
680.10421.BEW.D02	Rip-Rap Scavenging Plan Summary
680.10421.BEW.D03	Detailed Excavation Plan – Sheet 1 of 4
680.10421.BEW.D04	Detailed Excavation Plan – Sheet 2 of 4
680.10421.BEW.D05	Detailed Excavation Plan – Sheet 3 of 4
680.10421.BEW.D06	Detailed Excavation Plan – Sheet 4 of 4
680.10421.BEW.D07	Detailed Excavation Sections – Sheet 1 of 4
680.10421.BEW.D08	Detailed Excavation Sections – Sheet 2 of 4

Drawing Number	Drawing Description
680.10421.BEW.D09	Detailed Excavation Sections – Sheet 3 of 4
680.10421.BEW.D10	Detailed Excavation Sections – Sheet 4 of 4
Surface Water	
680.10421.SUW.D01	Construction Notes
680.10421.SUW.D02	Surface Water and Erosion Control General Arrangement
680.10421.SUW.D03	Surface Water and Erosion Control Overview Plan 1 of 3
680.10421.SUW.D04	Surface Water and Erosion Control Overview Plan 2 of 3
680.10421.SUW.D05	Surface Water and Erosion Control Overview Plan 3 of 3
680.10421.SUW.D06	Sediment Dam Detailed Plans Sheet 1 of 4
680.10421.SUW.D07	Sediment Dam Detailed Plans Sheet 2 of 4
680.10421.SUW.D08	Sediment Dam Detailed Plans Sheet 3 of 4
680.10421.SUW.D09	Sediment Dam Detailed Plans Sheet 4 of 4
680.10421.SUW.D10	Sediment Dam Typical Sections
680.10421.SUW.D11	Conveyance Channel Typical Sections
680.10421.SUW.D11	Surface Water and Erosion Control Proposed EBFR Realignment
Main Pit	
680.10421.MPS.D01	Existing Main Pit Site Conditions
680.10421.MPS.D02	Main Pit Rehabilitation Plan
680.10421.MPS.D03	Main Pit Access and Laydown Area
680.10421.MPS.D04	Main Pit Entry Ramp Detail
680.10421.MPS.D05	Main Pit Rehabilitation Sections
680.10421.MPS.D06	Typical Main Pit Backfill Section – Sheet 1 of 8
680.10421.MPS.D07	Typical Main Pit Backfill Section – Sheet 2 of 8
680.10421.MPS.D08	Typical Main Pit Backfill Section – Sheet 3 of 8
680.10421.MPS.D09	Typical Main Pit Backfill Section – Sheet 4 of 8
680.10421.MPS.D10	Typical Main Pit Backfill Section – Sheet 5 of 8
680.10421.MPS.D11	Typical Main Pit Backfill Section – Sheet 6 of 8
680.10421.MPS.D12	Typical Main Pit Backfill Section – Sheet 7 of 8
680.10421.MPS.D13	Typical Main Pit Backfill Section – Sheet 8 of 8
680.10421.MPS.D14	Main Pit Backfill Methodology Details
680.10421.MPS.D15	Re-Profiling Infill Layout Plan
680.10421.MPS.D16	Re-Profiling Infill – Typical Sections
Reinstatement of East Branch Finniss River (EBFR)	
680.10421.RFR.D01	General Arrangement
680.10421.RFR.D02	Existing and Final Contours Planning
680.10421.RFR.D03	Sections – Sheet 1 of 2

Drawing Number	Drawing Description
680.10421.RFR.D04	Sections – Sheet 2 of 2
680.10421.RFR.D05	Details – Sheet 1 of 3
680.10421.RFR.D06	Details – Sheet 2 of 3
680.10421.RFR.D07	Details – Sheet 3 of 3
680.10421.RFR.D08	Existing EBFR Division Channel GA
Site Rehabilitation	
680.10421.REH.D01	Detailed Rehabilitation Plan – Sheet 1 of 4
680.10421.REH.D02	Detailed Rehabilitation Plan – Sheet 2 of 4
680.10421.REH.D03	Detailed Rehabilitation Plan – Sheet 3 of 4
680.10421.REH.D04	Detailed Rehabilitation Plan – Sheet 4 of 4
680.10421.REH.D05	Detailed Rehabilitation Sections – Sheet 1 of 4
680.10421.REH.D06	Detailed Rehabilitation Sections – Sheet 2 of 4
680.10421.REH.D07	Detailed Rehabilitation Sections – Sheet 3 of 4
680.10421.REH.D08	Detailed Rehabilitation Sections – Sheet 4 of 4
Borrow Areas	
680.10421.BOR.D01	Material Types Plan - Borrow Area A – Coomalie Council Free Hold
680.10421.BOR.D02	Typical Sections - Borrow Area A – Coomalie Council Free Hold
680.10421.BOR.D03	Material Types Plan – Borrow Area B - FRLT
680.10421.BOR.D04	Typical Sections – Borrow Area B - FRLT
Water Treatment Plant	
680.10421.WTP.D01	Water Treatment Plant Layout
680.10421.WTP.D02	Water Treatment Plant Schematic
680.10421.WTP.D03	Water Treatment Plant Schedule
680.10421.PIP.D01	Site Wide Pipelines – Ground & Surface Water Extraction & Treated Water Discharge
Haul Roads	
680.10421.HR.D00	Haul Roads – Cover Sheet
680.10421.HR.D01	Haul Roads – Drawing List
680.10421.HR.D02	Haul Roads – Overview
680.10421.HR.D03	Haul Roads – Section A1 – Long Section
680.10421.HR.D04	Haul Roads – Section A1 – Cross Sections
680.10421.HR.D05	Haul Roads – Section A2 – Long Section
680.10421.HR.D06	Haul Roads – Section A2 – Cross Sections
680.10421.HR.D07 and D08	Haul Roads – Section A3 – Long Section
680.10421.HR.D09 and D10	Haul Roads – Section A3 – Cross Sections
680.10421.HR.D11	Haul Roads – Section A4 – Long Section
680.10421.HR.D12 and D13	Haul Roads – Section A4 – Cross Sections

Drawing Number	Drawing Description
680.10421.HR.D14	Haul Roads – Section A5 – Long Section
680.10421.HR.D15	Haul Roads – Section A5 – Cross Sections
680.10421.HR.D16	Haul Roads – Section A6 – Long Section
680.10421.HR.D17	Haul Roads – Section A6 – Cross Sections
680.10421.HR.D18	Haul Roads – Section A7 – Long Section
680.10421.HR.D19	Haul Roads – Section A7 – Cross Sections
680.10421.HR.D20	Haul Roads – Section A8 – Long Section
680.10421.HR.D21	Haul Roads – Section A8 – Cross Sections
680.10421.HR.D22 and D23	Haul Roads – Section A9 – Long Section
680.10421.HR.D24 to D26	Haul Roads – Section A9 – Cross Sections
680.10421.CUL.D01	Reinstatement of East Branch Finniss River Haul Road Additional Culvert Detail
Diversion Drain Crossing	
680.10421.C0.CS.01	Haul Road Crossing – Cover Sheet and Drawing List
680.10421.C1.BD.01	Haul Road Crossing – Basis of Design
680.10421.C1.GN.01	Haul Road Crossing – General Arrangement
680.10421.C5.RP.01	Haul Road Crossing – Plan and Profile
680.10421.C7.TD.01	Haul Road Crossing – Sections and Details

1.7 Scope of Works

The scope of works covered in the Technical Specification will incorporate the following main elements:

1. Surface Water and Erosion and Sediment Control Measures (during construction and post construction);
2. Access roads, haul roads and lay down pad construction;
3. Clearing, Grubbing and Stockpiling:
    a. Clearing and Grubbing of the West Waste Storage Facility (WWSF)
        - Vegetation removal in accordance with environmental and cultural requirements (**to be performed by the Principal**)
        - Strip topsoil and stockpile
    b. Clearing and Grubbing of the East Waste Storage Facility (EWSF)
        - Vegetation removal in accordance with environmental and cultural requirements (**to be performed by the Principal**)
        - Strip topsoil and stockpile
    c. Clearing and Grubbing of Access Roads
        - Vegetation removal in accordance with environmental and cultural requirements (**to be performed by the Principal**)
        - Strip topsoil and stockpile

d. Clearing and Grubbing of Borrow Areas A and B
   - Vegetation removal in accordance with environmental and cultural requirements (**to be performed by the Principal**)
   - Strip topsoil and stockpile

4. Clearing and Excavation Works
   a. Scavenging and stockpiling of rip-rap material from:
      - Main Waste Rock Dump (WRD)
      - Intermediate WRD
      - Dysons Pit Overburden
      - Dysons WRD
      - Various drainage channels across site
   b. Excavation and removal of existing WRDs:
      - Main WRD
      - Main North WRD
      - Main WRD Levee
      - Intermediate WRD
      - Dysons Pit Overburden
      - Dysons WRD
      - Mt Burton WRD
      - Mt Fitch WRD
   c. Excavation and removal of Radioactive Soils:
      - Radioactive Soils Area A
      - Radioactive Soils Area B
      - Radioactive Soils Area C
      - Radioactive Soils Area D
   d. Excavation and removal of Impacted Soil Areas:
      - Copper Heap Leach Area
      - Salt and Metal Impacted Areas A to F
      - Miscellaneous Rocky Waste Piles
5. Fill Placement
   a. West Waste Storage Facility (WWSF)
      - Preparation of surfaces
      - Forming Compacted Starter Embankments

- Placing Radiological Soils
  - Construction of an intermediary 500mm low permeability compacted clay cover
- Placing Waste Rock
  - Lime dosing
- Placing Impacted Soils
  - Copper Heap Leach Area
  - Salt and Metal Impacted Areas A to F
  - Miscellaneous Rocky Waste Piles
- Placing Final Cover System including:
  - Low Permeability Cover Layer
  - Linear Low-Density Polyethylene (LLDPE) (Crest of WWSF only)
  - Protection geotextile
  - Growth Medium Layer
  - Support revegetation works (**performed by Principal**)

b. East Waste Storage Facility (EWSF)

- Preparation of surfaces
- Forming Compacted Starter Embankments
- Placing Radiological Soils
  - Construction of a 500mm low permeability cover
- Placing Waste Rock
  - Lime dosing
- Placing Contaminated Soils
- Placing Copper Extraction Area Soils
- Placing Final Cover System including:
  - Low Permeability Cover Layer
  - LLDPE (Crest of EWSF only)
  - Protection geotextile
  - Growth Medium Layer
  - Support revegetation works (**performed by Principal**)

6. Rehabilitation of Excavated Footprints and other disturbed areas

- Lime dosing Supply and Condition;
- Placing Growth Medium Layer from Borrow Area A; and
- Support revegetation works (**performed by Principal**).

7. Main Pit Support Works
    - Site compound earthworks
    - Water training berms
    - Exclusion zone bunding
    - Construction of Main Pit access ramp
    - Sand Bedding Material haulage
    - Waste Rock Material haulage
    - Main Pit rim reprofiling
8. Water Treatment Plant Support Works
    - Site compound earthworks
    - Access road
9. Realignment of the EBFR.
10. Removal of site infrastructure.
11. Cultural Centre design and construction.
12. As-constructed surveys.

1.8 Management Plans

The Management Plans as summarised in **Table 3** shall be read in conjunction with this Specification.

Table 3 Management Plans

Management Plan	Application
Radiation Management Plan, Rum Jungle Mine Rehabilitation (ECOZ, 2019)	The intent of the document is to ensure the Rum Jungle rehabilitation project meets all of its regulatory obligations for the management of radiation and radioactive materials at the site during the construction and excavation project. Compliance with this plan will ensure that radiation exposure to contractors and members of the public is minimised and kept as low as reasonably achievable (ALARA), as defined by the International Commission on Radiological Protection (ICRP) – the premier international body for radiation protection.
Erosion and Sediment Control Plan	The Erosion and Sediment Control Plan (ESCP) has been prepared to manage potential ESC impacts of the proposed works in accordance with the 'Best Practice Erosion and Sediment Control' guideline (IECA, 2008), the Project Draft Environmental Impact Statement (NT-DPIR, December 2019) and best practice. The ESCP report and the associated design drawings provide a preliminary strategy and detail for implementation of erosion and sediment controls during the construction works at Rum Jungle, and document minimum requirements. It is assumed that the Construction Contractor(s) will refine and update details of progressive ESCP's as the works take place.

Cultural Heritage Engagement and Management Plan	To be developed by Principal prior to construction
Asbestos Management Plan	To be prepared by Contractor
Waste Management Plan	To be prepared by Contractor
Traffic Management Plan	To be prepared by Contractor
Weed Management Plan	To be developed by Principal prior to construction
Fire Management Plan	To be developed by Principal prior to construction
Feral Animal Management Plan	To be developed by Principal prior to construction
Revegetation Management Plan	To be developed by Principal prior to construction
Vegetation Clearance and Cycad Salvaging Plan	To be developed by Principal prior to construction
Other	Any other plans identified by the Principal during tender phase

1.9 Construction Quality Control and Construction Quality Assurance

Construction Quality Control (CQC) and Construction Quality Assurance (CQA) will be provided by the CQA Consultant to ensure all materials used in the Works meet the material requirements as set out in this Specification and the Works are carried out and completed in accordance with the Contract Documents and with this Specification.

1.9.1 Construction Quality Control

All CQC testing shall be arranged by the Contractor at the direction of the CQA Consultant and shall be carried out by appropriately qualified personnel.

Copies of all test results shall be sent to the Superintendent within two days of becoming available to the Contractor. The minimum testing frequencies shall be as nominated within the various parts of the Specification.

At any stage throughout the Works, the Superintendent may arrange for independent testing or surveying to be carried out. If that testing reveals that any Works are found to be non-compliant with the Contract, the Contractor shall undertake rectification of the non-compliant items and conduct any re-testing required in accordance with the Specification.

1.9.2 Construction Quality Assurance

A CQA Plan will be developed prior to construction and will be implemented by the Principal to ensure that the Works are undertaken in a manner that demonstrates compliance with the Contract Documents and with this Specification.

The Principal shall appoint a CQA Consultant to undertake all aspects of quality assurance for the Works. If required by the Principal, the CQA Consultant shall supply a CQA Representative to site, who has suitable experience in undertaking CQA activities. All following references to the CQA Consultant are subject to the role being engaged by the Principal.

The Contractor shall allow the CQA Consultant and the Superintendent (or their designated representatives) full access to the Works to undertake their responsibilities.

1.10 Meetings

1.10.1 Pre-construction Meeting

A Pre-Construction Meeting will be called prior to initiating construction works between the Contractor, Superintendent, CQA Consultant and other representatives as determined by the Principal. At a minimum, the following items will be covered in the meeting:

- Reviewing the Contract Scope of Works;
- Reviewing the responsibilities of each party;
- Reviewing the lines of authority and communication;
- Defining the boundary of the Works;
- WH&S issues and areas needing particular attention or consideration (identification of any buried services, relocation of the existing shed, office, infrastructure and traffic management, etc.);
- Reviewing the procedures for review and approval of construction submittals and requests for information;
- Reviewing the proposed work method statements for the various phases of construction (including equipment), with specific emphasis on methods of select grading, haulage, placement, compaction, stockpiling, processing, moisture conditioning, maintenance of the HDPE prior to installation, geosynthetics deployment, drainage aggregate placement, CQC/CQA activities and other items as determined by the Superintendent;
- Reviewing the procedures for field and laboratory CQC/CQA testing;
- Compiling field and laboratory CQC and CQA test data for inclusion in the construction completion reports;
- Establishment of procedures for correcting construction deficiencies and documenting remediation of construction deficiencies; and
- Reviewing the construction schedule and completion dates.

1.10.2 Project Control Meetings

Throughout the construction phase of the Works, regular project control meetings will be held as required to ensure the activities of all parties are coordinated effectively and efficiently. Construction and design issues shall also be reviewed and discussed at project control meetings.

1.10.3 Meeting Agendas and Meeting Minutes

Preparation of an agenda and minutes for all formal meetings involving the Contractor, Superintendent and other support personnel shall be taken by the Superintendent and distributed to all attending personnel/parties.

1.11 Personnel and Relevant Experience

The Contractor shall give or provide all necessary supervision during the execution of the Works and as long thereafter as the Superintendent may consider necessary. Such supervision shall be given by an experienced person having adequate knowledge of the operations to be carried out (including the construction methods and techniques required, construction quality control procedures, the hazards likely to be encountered and the methods of preventing and responding to accidents) as may be requisite for the satisfactory construction of the Works.

The Contractor shall maintain an experienced management, supervisory and quality control team under the nominated Project Manager that is committed to achieving and maintaining the standards specified for the works.

Prior to commencement of the Works, the Contractor shall provide to the Superintendent a list of key personnel they propose to employ, together with a resume of their experience and qualifications. The list of key personnel shall include the name of the full-time Project Manager as well as contact details for all key personnel. The list will be accompanied with a chart showing the key personnel on the project and who / what they are responsible for. The list of key personnel shall be maintained and updated by the Contractor throughout the construction period.

1.12 Plant and Equipment

The Contractor shall use plant of suitable and appropriate capacity to carry out the work in accordance with the Specification and the Works timeframe proposed. Each item of plant will be maintained and operated in a safe manner in accordance with the plant manufacturer's recommendations. Plant operators are to be trained and certified by an approved body for the plant they are operating. The Contractor will consider the potential safety hazards of the proposed Works and adapt plant and vehicles accordingly.

1.13 Construction Compound

The Contractor shall provide as a minimum the following in the Head Contractor Compound:

- A fuel farm to meet the requirements of the Australian Standard for The Storage and Handling of Flammable and Combustible Liquids (AS 1940-2017);
- Appropriate NATA laboratories;
- Offices;
- Telecommunications;
- Owners Team (Principal) offices;
- Car parking;
- Electricity supply;
- Drinking water supply;
- First aid treatment room;
- Perimeter fencing and visual screens;
- Change rooms:

- must have wash in wash out for when working around Radiological Soils;
- compostable toilets if possible.

- Crib sheds;

Requirements include:

- Located more than 50 m away from a waterway;
- Have ready access to road network;
- Be sited on relatively level land;
- Require minimal vegetation clearing (preferably none);
- Be above the 20 ARI Flood level unless a contingency plan to manage flooding is prepared and implemented;
- Provide sufficient area for the storage of raw materials to minimise, to the greatest extent practical, the number of deliveries outside standard construction hours; and
- Located at least 100 m from any aboriginal significant sites.

On closure all facilities and access points shall be rehabilitated to at least their pre-construction condition or better unless otherwise agreed by the Principal.

1.14 Vehicle Decontamination Area

The Contractor shall note that in order to avoid excessive decontamination works, vehicle movement on and off site will therefore be limited to 'Public Access Zone' and 'Construction Only Access Zone' as follows:

- The Construction Only Zone will be everything inside the Rum Jungle Boundary and the Finniss River Aboriginal Land Trust (FRALT) borrow area (Borrow Area B). This would include all construction equipment, including light vehicles and trucks that bring material from the FRALT borrow area; and
- The Public Access Zone will include areas outside the Rum Jungle Boundary and the Coomalie Council borrow area (Borrow Area A). This would include all personnel vehicles and trucks bringing material from the Coomalie Council borrow area.

To facilitate the restricted vehicle movements, a staging area will be required near the access to the Rum Jungle Mine site. The location of this staging area, which will involve vehicle parking either side of the boundary, will need to be agreed with the Principal.

The exception to the above restrictions would be delivery vehicles, specifically fuel and lime supply. These vehicles would need to undergo decontamination after every delivery. It is understood (DPIR communication) that this process takes approximately 3 hours.

2 Site Establishment, Setting Out and Surveys

2.1 Compound Areas

The Contractor shall be responsible for providing civil earthworks for the compounds for the following Contractor Compounds:

- **Earthworks Works Package** (this package);
- Main Pit Backfill Works Package; and
- Water Treatment Plant Package.

Earthworks to be carried out under direction of the Main Pit and WTP Contractors and should meet the requirements below and in **Section 1.13** as appropriate.

2.1.1 Main Pit Backfill Works Package

2.1.1.1 Compound Set Up

The works for site establishment includes the following scope:

- Superintendent to perform Main Pit Slope Risk Assessment (SRA) and general site suitability assessment prior to establishment (*performed under Main Pit Backfill Works Package*);
- Superintendent to install exclusion zone demarcation and assess proposed locations for Main Pit backfill operations (Offices, Laydown Yard, Stockpile Area, Material Processing Area, Crane outrigger locations, Conveyor locations/foundation (if applicable), etc) (*performed under Main Pit Backfill Works Package*);
- Site clearance, including de-vegetation where required, and setting out Works area (this **Earthworks Works Package**);
- Construction of diversion bunding around Main Pit to prevent surface water runoff entering Main Pit (**this Earthworks Works Package**);
- Construction Main Pit inlet flow exclusion and Diversion Channel Modifications (this **Earthworks Works Package**);
- Construct and Commission Main Pit dewatering system (*performed under Water Treatment Plant Work Package*);
- Construction of access ramp to Main Pit (this **Earthworks Works Package** under instruction of Main Pit Backfill Contractor);
- Construction of site compounds and platforms for lay-down and stockpile areas, vehicle parking, amenities, etc (this **Earthworks Works Package** under instruction of Main Pit Backfill Contractor); and
- Bathymetric survey of the Main Pit to establish a baseline survey for backfill design (*performed under Main Pit Backfill Works Package)*.

2.1.1.2 Materials Haulage, Processing and Stockpile Management

Haulage of waste rock and sand bedding materials to the Main Pit Backfill Operations will be performed under this **Earthworks Works Package**.

The works for material processing and stockpile management will be conducted under the *Main Pit Backfill Works Package* and includes the following (for information only):

- Construction of facilities for housing screening, mixing and materials testing plant for inspection and acceptance of site-won, imported backfill materials and lime on to the Works area;
- Supply of hydrated and granulated lime;
- Operation of segregating, stockpiling, screening, testing, lime dosing/mixing and managing stockpiles of various materials; and
- Measurable and auditable lime dosing and mixing appropriate to the backfill material prior to subaqueous placement.

2.1.2 Water Treatment Plant Works Package

The works for site establishment to be included in the **Earthworks Works Package** includes:

- Excavation and lining of ponds;
- Excavation of sumps;
- Access roadways and paths; and
- Fencing.

2.2 Set Out and Survey

The Contractor shall establish whatever survey control that is necessary for set out of the Works and shall ensure all available survey reference stations are suitably protected from disturbance at all times. The Superintendent will make available plans (AutoCAD compatible) of the site and suitable survey benchmarks to enable the Contractor to set out the work in accordance with the Construction Drawings and the Specification. The Contractor shall set out the Works from the data shown on the Construction Drawings.

Drawing 680.10421.GEN.D01 provides an indication of current ground levels and shall provide a basis for measurement purposes.

Prior to using the site survey marks provided, the Contractor shall satisfy themselves that the survey marks are the correct marks and at the correct level shown on the Construction Drawings and that they have not been disturbed. Any discrepancies identified by the Contractor between the site conditions and the setting out details within the Construction Drawings are to be notified to the Superintendent immediately.

The Contractor shall monitor all earthworks and shall be responsible for verifying the quantities of cut and fill available for constructing the finished contours. Quantities of cut and fill provided in the tender documents are provided for bidding purposes only and do not account for shrinkage and swell, excess material or waste.

If the Contractor's survey of pre-construction ground levels differs to the ground levels shown in **Drawing 680.10421.GEN.D01**, the Contractor's survey shall be sent to the Superintendent for confirmation and issuance to the Design Consultant to ensure the proposed design is still applicable.

2.2.1 Earthworks Works Package Survey Requirements

The Contractor shall carry out as-constructed surveys to confirm and record finished surface elevations at each of the following stages of earthworks and at other times as may be necessary to confirm compliance with the Construction Drawings and Specification to measure quantities for payment purposes:

MAIN PIT AND EAST BRANCH FINNIS RIVER REINSTATEMENT

- Main Pit access ramp survey
- On completion of the re-alignment of the EBFR

WEST WASTE STORAGE FACILITY (WWSF)

- Existing surface survey
- Surface following topsoil strip survey
- Radioactive soils final surface profile survey
- Intermediary Compacted Clay Layer survey
- Starter bund from Dysons WRD material survey
- WWSF final waste rock surface survey
- Compacted Clay Liner for cap survey
- Linear Low Density Polyethylene (crest of WWSF only) including panel layout survey
- Growth medium layer survey

EAST WASTE STORAGE FACILITY (EWSF)

- Existing surface survey
- Surface following topsoil strip survey
- EWSF final waste rock surface survey
- Compacted Clay Liner for cap survey
- Linear Low Density Polyethylene (crest of EWSF only) including panel layout survey
- Growth medium layer survey

WASTE ROCK DUMPS AND CONTAMINATED SOILS

- Main WRD profile survey before and after rip rap removed
- Waste WRD Levee profile survey
- Main North WRD profile survey
- Intermediate WRD profile survey before and after rip-rap removed
- Dysons WRD profile survey before and after rip-rap removed
- Dysons Pit Overburden footprint profile survey before and after rip-rap removed
- Mt Burton WRD profile survey
- Mt Fitch WRD profile survey

EXCAVATED FOOTPRINTS

- Main WRD footprint survey
- Main WRD Levee footprint survey
- Main North WRD footprint survey
- Intermediate WRD footprint survey
- Dysons WRD footprint survey
- Dysons Pit Overburden footprint survey
- Mt Burton WRD footprint survey
- Mt Fitch WRD footprint survey

SEDIMENT POND VOLUMES

- Survey of HDPE liner (including panel layout) for all sediment ponds

The Contractor shall give sufficient notice of the intention to survey to enable the Superintendent to conduct a joint survey or check the Contractor's survey. No finished survey shall be undertaken until the Works represented by the survey have been approved by the Superintendent.

Topographic surveys shall be undertaken using a fixed 10 m x 10 m check grid, or an alternative layout as agreed with the Superintendent and CQA Consultant. Surveys will be used as a basis to prove quantities and layer thicknesses are in accordance with the Specification.

The Contractor shall forward a hard copy drawing and electronic copy (in an AutoCAD compatible format) of the topographic survey within 5 days of undertaking the topographic survey to the Superintendent. Proceeding with installation of an overlying layer, prior to confirmation that the thickness requirements of the proceeding layer have been attained as calculated by survey, is at the Contractor's own risk. The Superintendent will assess the topographic surveys and provide initial response to the Contractor within two working days from the day the topographic survey is received.

2.2.2 Main Pit Backfill Survey Requirements

The Contractor shall carry out as-constructed surveys to confirm and record finished surface elevations at each of the following stages of backfilling and at other times as may be deemed necessary to confirm compliance with the Construction Drawings, with the Specification and to measure quantities for payment purposes:

- On completion of the Main Pit access ramp;
- On completion of re-profiling Main Pit rim side slopes; and
- On completion of the re-alignment of the EBFR.

The Contractor shall give sufficient notice of the intention to survey to enable the Superintendent to conduct a joint survey or check the Contractor's survey. No finished survey shall be undertaken until the Works represented by the survey have been approved by the Superintendent.

The Contractor shall forward a hard copy drawing and electronic copy (in an AutoCAD compatible format) of the topographic surveys within two (2) days of undertaking the topographic surveys to the Superintendent.

Proceeding with re-profiling the Main Pit rim side slopes shall not commence until the target elevation and extent of the Main Pit inert capping layer has been approved by the Superintendent. The Superintendent will assess the topographic surveys and provide initial response to the Contractor within two (2) days from the day the topographic survey is received.

2.3 Tolerance limits

2.3.1 Waste Storage Facilities and General Earthworks

Excavations shall be finished to conform within the following limits to the levels, lines, grades and cross sections specified or shown on the Construction Drawings.

The tolerance limits for the Works shall be as follows:

- Heights of bunds shall be no less than those indicated on the Construction Drawings and shall not exceed them by more than 100mm;
- Elevation tolerance: -100mm to +100mm; and
- Unless agreed to by the Design Consultant and Superintendent, the level at any point shall not differ by more than 100mm from the Construction Drawings.

2.3.2 Main Pit Operations Enabling and Recontouring Works

The tolerance limits for Main Pit operations enabling and recontouring Earthworks shall be as follows:

- Elevation tolerance: -100mm to +100mm;
- Final grade tolerance: +/- 1%; and
- Unless agreed to by the Design Consultant and Superintendent, the level at any point of the works shall not differ by more than 50mm from the Construction Drawings.

2.4 Existing Services and Utilities

The locations of all existing services within the area of the Works shall be identified by the Contractor prior to commencement of works. Such services include existing surface water pipes, drainage channels and associated features, as well as any telecommunications, electrical and water supply services. There may be a need to either relocate or redirect a number of existing services to complete the Works as specified, which shall be arranged by the Superintendent.

The Contractor shall make every effort to avoid damage or disturbance to any existing services or structures located within the site. The Contractor shall erect and maintain temporary barriers, boardings, etc. and shall alter their work practices, as may be required, for the protection of such installations.

Should any service be damaged, the Superintendent is to be notified immediately. Damage to services caused by the Works, or by the Contractor's activities, is to be repaired at the Contractor's expense and shall be carried out in the shortest possible time.

2.5 Non-conformances

Any non-conformance will be documented by the contractor, detailing the non-conformance and proposed rectification measures undertaken to rectify the non-conformance.

2.6 Stockpiles

The Contractor shall agree with the Principal regarding the location and management of material stockpiles.

The Principal's prior approval must be obtained for all stockpiles on the site particularly with respect to the height. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

Formation and excavation from stockpiles shall be carried out in such a manner that the stockpiles are maintained in a stable condition at all times. It is the Contractor's responsibility to ensure stockpiles do not adversely affect the stability of any other excavation at the site.

Stockpiles must be sealed to prevent water ingress and graded to ensure surface water runoff at the end of every working day or on cessation of use/import, whichever occurs first.

All stockpiles shall:

- Have adequate management measures for dust suppression/control;
- Be surrounded by filter/sedimentation fences and straw bales to minimise sediment runoff;
- The topsoil stockpile is not to be compacted by machinery and be a maximum height of 3m; and
- No stockpile volume of waste rock to be greater than 7-days worth of movement.

2.7 Groundwater

If groundwater is encountered during the Works, the Contractor must de-water such sections of the site as necessary and in accordance with the Superintendent's requirements. De-watering will be conducted at no cost to the Principal to permit Works to proceed as required under the Contract. The Contractor must take such measures as may be approved by the Superintendent.

The Contractor shall comply with all applicable conditions of the Environmental Impact Statement (NT-DPIR, December 2019), Waste Discharge Licence and NTEPA Authorisation in managing groundwater, including treatment and disposal of contaminated groundwater from de-watering. The Contractor shall include all costs for provision of testing and NATA-certified tests results for issuance to the Superintendent within the various items of Work.

Contaminated groundwater must not be discharged into any drainage or sewer conveyance systems without the prior approval from the Superintendent and relevant authorities.

2.8 De-watering

The Contractor must carry out all works necessary to prevent ponding in the Works areas and carry out all necessary de-watering works. The Contractor's construction schedule must make allowances for these works and no extensions of time will be granted for failure to comply with this requirement.

2.9 Sediment and Erosion Control

The Contractor shall provide temporary sediment and erosion control management measures as necessary to comply with all applicable conditions of the Environmental Impact Statement, Waste Discharge Licence and NTEPA Authorisation and any other operational requirements of the site. An Erosion and Sediment Control Plan has been prepared by SLR and provided with this tender package (SLR Consulting, 2020c).

Any surface waters which contact, or are exposed in any way to, waste rock materials shall be transferred to the Main Pit and/or the Water Treatment Plant as directed by the Superintendent.

Soil and water management works include:

- Diversion of up-gradient stormwaters waters around the Works areas;
- Erosion and sediment control measures that minimise sediment pollution to downgradient lands and waterways; and
- Erosion and sediment control measures to minimise soil migration within the Works area.

2.10 Existing Roads and Drainage

All existing roads and surface water drainage systems affected by the Works shall be inspected regularly and immediately after periods of inclement weather by the Contractor to ensure no construction-related debris, silt or other materials pollute the site or adjacent properties. The Contractor shall notify the Superintendent prior to conducting these inspections.

Any damage to perimeter roads or other structures caused by the actions of the Contractor in executing the Works shall be repaired to the satisfaction of the Superintendent, at the Contractor's expense.

2.11 Site Maintenance and Cleanliness

The Works area and surrounding roads affected by the Contractor’s operation shall be kept in a clean and tidy condition for the duration of the Works. Waste material, debris, etc. shall be removed regularly to minimise their accumulation. On completion of the Works and before acceptance by the Principal, the Contractor is to clean up all debris, to the satisfaction of the Superintendent and leave the Works areas in an orderly condition for future works to continue.

2.12 Traffic Management

Traffic control and management measures are required where earthmoving plant must cross on-site thoroughfares, including haul roads, driveways and pedestrian paths. The Contractor is to prepare a Traffic Management Plan for review and approval by the Superintendent prior to commencement of the Works, so that Works do not adversely affect traffic at the Site.

2.13 Deliveries to Site

The Contractor shall be responsible for the safe delivery of all necessary materials to the required working area. Prior to scheduled deliveries, the Contractor must liaise with the Superintendent and shall give the Superintendent at least 48 hours’ notice. Unless pre-approved by the Superintendent, all deliveries shall occur during the Sites normal business hours.

The Contractor shall arrange for all plant and equipment required to undertake the Works. The Contractor shall be responsible for the unloading and safe storage of the plant / materials on site. The Superintendent or Site staff shall not take delivery of the Contractor’s plant, equipment or materials. Any unsatisfactory items must be removed from site at the Contractor’s cost.

Vehicle truck movement on and off site will be limited to 'Public Access Zone' and 'Construction Only Access Zone' as defined in **Section 1.14**. The exception to the restrictions is for delivery vehicles, specifically fuel and lime supply. The Contractor is to ensure that Delivery vehicles undergo decontamination after every delivery.

3 Culture, Health, Safety and Environment

3.1 Culture

The Main Pit is an area significant to the Traditional Owners of the site – the Kungarakan and Warai. Staff working at the Main Pit will be required to undergo cultural awareness training and learn from sacred site Custodians what they must do to respect and care for the sites around the Main Pit.

3.2 Occupational Health and Safety

The attention of the Contractor is drawn to the *Work Health and Safety Act 2011* (as amended and in force on 1 July 2018), which requires that employers ensure the health, safety and welfare of their employees.

The Contractor shall prepare a Work Health and Safety Plan (WH&S Plan) for review by the Superintendent before Work commences at the site. The Contractor's WH&S Plan will be submitted to the Superintendent a minimum of two weeks prior to the scheduled commencement of construction works.

The Contractor's employees and equipment may be required from time to time to train for and respond to site emergencies such as bushfire.

3.3 Testing Standards

Geotechnical soil and rock testing standards to confirm material compliance:

- Methods of Sampling AS 1411.11 & AS 1141.12;
- Particle Size Distribution AS 1289.3.6.1;
- Atterberg Limits AS 1289.3.1.1 & AS 1289.3.2.1; and
- Emerson Class Number AS 1289 3.8.1.

Geochemical soil and rock testing requirements to confirm material compliance have been developed specifically for this project. Refer **Section 7**.

3.4 Nuisance

The Contractor shall minimise inconvenience to local residents and site workers on or near the site of the Works by avoiding or controlling noise, vibration, dust, mud and any other nuisance.

The Contractor shall maintain their plant in good working condition. Operation of plant will be subject to the approval of the Superintendent. The Superintendent may, from time to time, determine on site what constitutes an inconvenience to local residents/site workers/site visitors on/near the site and require the Contractor to change the way plant is being operated or the construction site is managed.

This condition does not apply to the delivery of material/s outside the hours of operation. Should small items, such as pumps, be required to operate outside operating hours, the Contractor is to ensure their operation will not breach conditions of EIS Section 2.5.2 "*Shifts will be 12 hours per day, seven days per week*" and EIS Section 14.3 "*Project Activities will only occur within daylight hours*" (NT-DPIR, December 2019).

3.5 Site Security

Prior to ceasing works on each day, any

- Fencing, or gates, removed by the Contractor for the purpose of the Works shall be reinstated by the Contractor; and
- Open excavation(s) shall be made safe by barricading, as a minimum, provision of emergency access and egress points into/out of the excavation, benching and/or battering of excavation walls or, preferably, temporarily backfilling the excavation if possible.

3.6 Work Method Statements

The Contractor shall produce work method statements for each major element of the Works included herein. Work method statements shall detail how the works are to be undertaken, in a safe manner, in order to meet the Specification, site rules and regulatory requirements.

All work method statements are to be reviewed by the Superintendent and the CQA Consultant. Method statements shall be provided to the Superintendent for distribution to the other parties for comment at least 1 week prior to commencing the specific task.

3.7 Relevant Standards

The Contractor shall comply with all regulations of local and other legally constituted authorities and give all notices, obtain all permits and certificates and pay all fees required by such Authorities. Plant, materials and workmanship shall comply (at a minimum) with the requirements of current industry standards and Codes of Practices, as well as the most current applicable Australian Standard in effect at the time of construction. All materials and workmanship not covered by an Australian Standard shall be of such kind as is suitable for the environment and conditions under which the Works are to be constructed.

3.8 Inclement Weather

Works will be suspended when weather conditions are such that the quality of the Works, or the conditions of the materials, may be impaired. The decision to suspend work on account of inclement weather will be made following agreement between the Contractor and the Superintendent. The Contractor shall notify the Superintendent whenever Works are suspended due to inclement weather and shall advise the Superintendent on the proposed date that Work shall be resumed.

Where, in the opinion of the Superintendent, any Works carried out in inclement weather conditions have been adversely affected, these Works shall be removed and made good.

Following inclement weather conditions, any standing water on the surface of the Works which may delay the resumption of Work or impact the quality of the Works shall be removed by the Contractor at the earliest opportunity, or as directed by the CQA Consultant or the Superintendent.

Earthworks placement operations following inclement weather conditions shall not proceed without prior approval of the CQA Consultant and the Superintendent.

The Contractor shall provide in the construction schedule for inclement weather delays.

3.9 Information Outside of Contract

Additional information concerning the site may be provided to the Contractor from time to time, if such information is considered likely to assist the Contractor in the Works. Such information is not part of the Contract and shall be used by the Contractor at their discretion and at their risk.

4 Sequence and Hold Points

The Superintendent shall make regular inspections of the works in progress. Works shall not proceed until each Hold Point (or portion of Hold Point) has been approved by the Superintendent and CQA Consultant.

Where the Hold Point involves an inspection of the Works by the Superintendent and/or CQA Consultant (i.e. re-profiling works), the Contractor shall give the Superintendent at least 24 hours' notice of the required inspection. The Contractor shall uncover at their own expense any Work which is buried, concealed or made inaccessible to the Superintendent or CQA Consultant for purposes of undertaking a Hold Point inspection.

Where the Hold Point relates to the condition of a surface or installed material, the Contractor shall verify via CQC testing or topographic surveys that the completed surface has achieved full conformance with all respects of this Specification. The Superintendent's approval of the completed items is required prior to the release of each hold point and shall be subject to the provision of CQC/CQA test results and the Contractor's topographic surveys.

Table 4 below includes a summary of activities to which Hold Points apply in the Specification with additional details discussed in the following points.

Table 4 Hold Point Summary

Hold Point	Description	Approval Criteria
Preliminaries		
1	Management plans	Submitted to Superintendent for approval
2	Material quality control	Approval from the CQA Consultant of all construction materials including manufacturer/supplier certificates, warranties, recommendations and installation guidelines for materials used in the Works, prior to delivery of the materials to the site (e.g. LLDPE, Lime, CCL material, Growth Medium Layer)
Site Establishment		
3	Site establishment survey	Topographic survey of the Works to be submitted to the Superintendent to form baseline survey for review and approval.
4	Scavenge and stockpile rip-rap	Post weed treatment (by Principal), the surface of identified existing WRD and overburden areas are stripped and scavenged for rip-rap. Stockpiled in accordance with **Section 2.6**.
5	Access road and laydown pad construction	The completed compacted access roads and laydown pads are constructed to the specified design levels and grades to provide a firm, stable surface of sufficient bearing capacity.
West Waste Storage Facility		
6	WWSF surface preparation	The surface of the WWSF is in accordance with **Section 8.3**, providing an even, firm and unyielding foundation sufficient to permit the movement of vehicles without causing rutting or other deleterious effects.
7	WWSF surface survey	In accordance with specified design levels and grades.
8	WWSF starter embankments	The embankments are in accordance with **Section 8.3**, providing an even, firm and unyielding embankment sufficient to permit the movement of vehicles without causing rutting or other deleterious effects.

Hold Point	Description	Approval Criteria
9	WWSF waste rock placement and lime dosing	Waste rock placement will be in accordance with **Section 8.3.** An equivalent density of 90 % of Standard Maximum Density and a moisture content within the range of ± 3 % of Standard Optimum Moisture Content. Lime spreading and mixing will be in accordance with **Section 7**.
10	WWSF intermediate clay layer	The completed clay layer is constructed to the specified design levels and grades to ensure a firm, stable, smooth surface of sufficient bearing capacity on which to install the geosynthetic lining system.
11	WWSF intermediate clay layer survey	Survey of clay layer confirms minimum thickness and in accordance with specified design levels and grades.
12	WWSF final waste rock surface survey	Survey to confirm final waste rock surface profile in accordance with specified design levels and grades.
13	WWSF compacted clay liner (CCL)	Inspect the completed compacted clay liner (CCL) to the specified design levels and grades to ensure a firm, stable, smooth surface of sufficient bearing capacity on which to install the geosynthetic lining system.
14	WWSF low permeability cover layer (CCL) survey	Survey of CCL to confirm minimum thickness and in accordance with specified design levels and grades.
15	WWSF Linear Low Density Polyethylene (LLDPE) liner (cover of WWSF)	Inspect the installation of the LLDPE geomembrane
16	Survey of LLDPE liner	Inspect survey to confirm appropriate dimensions, grades and alignment of LLDPE Panels.
17	WWSF growth medium layer	Inspect the completed growth medium layer to the specified design levels and grades.
18	WWSF growth medium layer survey	Survey of the growth medium layer to confirm minimum thickness and in accordance with specified design levels and grades.
	Seeding works	*Owners Team Requirement.*
East Waste Storage Facility		
19	EWSF surface preparation	The surface shall be in accordance with **Section 8.3**, providing an even, firm and unyielding foundation sufficient to permit the movement of vehicles without causing rutting or other deleterious effects.
20	EWSF surface survey	The EWSF surface survey is in accordance with specified design levels and grades.
21	EWSF starter embankments	The embankments shall be in accordance with **Section 8.3**, providing an even, firm and unyielding embankment sufficient to permit the movement of vehicles without causing rutting or other deleterious effects.
22	EWSF waste rock placement and lime dosing	Waste rock placement shall be in accordance with **Section 8.3.** An equivalent density of 90 % of Standard Maximum Density and a moisture content within the range of ± 3 % of Standard Optimum Moisture Content. Lime spreading and mixing will be in accordance with **Section 7**.
23	EWSF final waste rock surface survey	The survey confirms the final waste rock surface profile is in accordance with specified design levels and grades.

Hold Point	Description	Approval Criteria
24	EWSF compacted clay liner (CCL)	The CCL meets the specified design levels and grades to ensure a firm, stable, smooth surface of sufficient bearing capacity on which to install the geosynthetic lining system.
25	EWSF low permeability cover layer (CCL) survey	The survey of CCL confirms minimum thickness and in accordance with specified design levels and grades.
26	EWSF Linear Low Density Polyethylene (LLDPE) liner (Cover of EWSF)	LLDPE installation, welding, repairs, non-destructive and destructive testing of seams is undertaken in accordance with the Technical Specification.
27	Survey of LLDPE liner	Inspect survey to confirm appropriate dimensions, grades and alignment of LLDPE Panels.
28	EWSF growth medium layer	The completed growth medium layer is constructed to the specified design levels and grades.
29	EWSF growth medium layer Survey	Survey of the growth medium layer to confirm minimum thickness and in accordance with specified design levels and grades.
	Seeding works	*Owners Team Requirement.*
Rehabilitation of Excavated Footprints		
30	Excavated footprint survey	Topographic survey of all excavated footprints to be submitted to the Superintendent for review and approval.
31	WRD and Dysons overburden excavated footprint lime dosing	Lime spreading and mixing is in accordance with **Section 7**.
32	Growth medium layer installation	The completed growth medium layer is constructed to the specified design levels and grades.
33	Growth medium layer survey	Survey of the growth medium layer to confirm minimum thickness and in accordance with specified design levels and grades.
34	*Seeding works*	*Owners Team Requirement.*
35	Dysons overburden footprint low permeability cover layer (CCL)	The CCL meets the specified design levels and grades to ensure a firm, stable, smooth surface of sufficient bearing capacity.
36	Dysons overburden footprint low permeability cover layer (CCL) survey	The survey of CCL confirms minimum thickness and in accordance with specified design levels and grades.
37	Dysons overburden footprint rock blanket	The completed rock blanket meets the specified design levels and grades to ensure a firm, stable surface.
38	Dysons overburden footprint rock blanket survey	The survey of the rock blanket confirms minimum thickness and in accordance with specified design levels and grades.
40	Sediment Basin 1-6 construction	The sediment ponds subgrade, embankment, key and HDPE liners are constructed in accordance with specified design levels and grades.
	Seeding works	*Owners Team Requirement.*

Hold Point	Description	Approval Criteria
Haul Roads, Access Roads and Bridges		
41	Haul roads	The survey of haul roads confirms minimum thickness and in accordance with specified design levels and grades.
42	Access roads	The survey of all access roads confirms minimum thickness and in accordance with specified design levels and grades.
43	Bridges	All constructed bridges confirm minimum thickness and in accordance with specified design levels and grades.
Demolition		
44	Demolition of existing buildings	The demolition areas containing or potentially containing asbestos are verified as being 'asbestos free' by an independent third party consultant.
Main Pit Backfill		
45	Construct access ramp to allow entry to Main Pit	Principal's Geotechnical Representative to inspect and confirm safe and suitable for use
46	Re-profile Main Pit Rim crest	Contractor to submit finished topographic survey to Superintendent for Approval Superintendent to inspect works.
EBFR Realignment		
47	Survey	The survey of the EBFR confirms accordance with specified design levels and grades.

5 Erosion and Sediment Controls

5.1 ESC Construction Requirements

General vegetation clearing and soil stripping will not be undertaken until earthwork operations are ready to commence and all proposed Erosion and Sediment Control (ESC) measures are implemented. The Contractor is responsible for installing ESC measures in accordance with the ESCP report and design drawings (SLR Consulting, 2020c) and 'Best Practice Erosion and Sediment Control' Guideline (IECA, 2008) including the following to minimise the impact on the downstream water quality:

- Conducting best practice land clearing procedures for all proposed disturbance areas;
- Undertake disturbance works, as much as is practically possible, during the dry season (May to November) and during periods when good weather is forecast;
- Stabilised rock pads (vibration grid) and/or wash down facilities be installed at all site entry/exit points during the construction and rehabilitation works;
- Appropriate storage of soil stockpiles in areas away from roadways and other drainage lines. Suitable sediment control measures will be installed downslope of soil stockpiles and upslope clean water runoff diverted (where possible);
- Minimising the disturbance footprint;
- Coordinating works to minimise the exposure duration of disturbed soils;
- Separation/diversion of 'clean' water catchment runoff from disturbed areas (where practical) to minimise sediment-laden runoff volumes requiring treatment;
- Containment of all contaminated water on-site prior to treatment or disposal of in a suitable manner;
- Ensuring sediment-laden runoff is treated via designated sediment control devices;
- Clearly identifying/communicating no-go areas to maintain disturbance areas and traffic movement to the designated areas without and damage to any trees and pasture areas outside the limits to be cleared;
- Restricting the areas to be cleared of existing vegetation to the areas being actively worked as well as no closer than 50m from all existing second order watercourses and 100m from all existing third order watercourses (except for the creek crossing and creek diversion remediation works);
- Limiting the number of roads and tracks established;
- Conducting bank stabilisation works for vegetation clearing required at creek crossings;
- Revegetation of disturbed areas as soon as possible following the completion of ground disturbance activities;
- Effective dust suppression measures;
- Suitable disposal of all surplus and unsuitable materials. Unsuitable material includes:
    - All excavated material which does not satisfy the requirements for use in construction of the works (materials which visibly heave when trafficked by earthworks plant, or subgrades with assessed CBR of less than 2%);
    - All disused materials resulting from clearing (such as trees, stumps, brush, fencing and structural debris); and

- All rubbish.

- Provide adequate standby dewatering equipment in critical areas where failure of the system could lead to danger to life or damage to partially completed structures;
- Dispose of the water from the work in a suitable manner in accordance with environmental requirements and without damaging the works or adjacent property. No water shall be drained into construction areas without the prior consent of the Superintendent;
- Any liquid wastes, fuels and oils stored on-site will be sufficiently bunded to contain any potential spills. Accidental spillage or poor management of fuels, oils, lubricants, hydraulic fluids, solvents and other chemicals during the construction phase will be controlled through spill management actions (including the availability of spill kits) to prevent water quality and ecological impacts and no further mitigation measures are considered necessary. Captured liquid wastes, fuels and oils should be pumped out by a liquid waste contractor and disposed of at an appropriately licenced facility; and
- Implementing an effective monitoring and maintenance program for the site.

The full cost of installation, maintenance, inspection and removal of these measures for the duration of the Contract (including ongoing maintenance periods) shall be included in the Contractors fee for the work under the Contract. The Contractor's construction schedule must also make allowances for these works and no extensions of time will be granted for failure to comply with these requirements.

The Superintendent shall inform the Contractor and any Sub-Contractors of their responsibilities in minimising the potential for soil erosion and pollution of downslope lands and waterways. If any Indigenous objects are identified during the construction works then work shall stop immediately and a suitable qualified archaeologist contacted to assess the object.

The Contractor shall employ acceptable methods to minimise the opportunity for surface water to contact waste rock through the installation of diversion drains or perimeter cut off bunds to re-direct surface water away from the WSF work area. Where the water is unable to be directed to the Main Pit, the water shall be captured and disposed of as directed by the Superintendent, the costs of which shall be covered by the Principal.

5.2 ESC Structure Construction

Sediment dams will be constructed with suitably designed spillways to manage overflows during significant storm events in accordance with the ESCP design drawings. The Contractor shall ensure that the dams are constructed such that they are safe to people, vehicles and wildlife during their operation.

Runoff from areas exposed during the works (including the WSFs batters) will be controlled by construction of temporary conveyance channels and bunds/back push banks that will direct sediment laden runoff to suitably designed and constructed ESC devices. The Contractor shall ensure that all conveyance channels are constructed in accordance with the ESCP design drawings. This includes the use of armouring (i.e. geofabric, rock, jute mesh, hydromulch, etc) energy dissipation and sediment trapping structures (i.e. check dams) as required to minimise erosion.

Check dams can be made from a number of different materials including rock, sandbags, coir logs, hay bales, etc. Check dams are typically installed at regular intervals which are typically closer together on steeper slopes. It is important that check dams are installed such that flows cannot pass around the sides and that they overflow over the check dams themselves. The use of sandbags and hay bales are limited to temporary erosion and sediment control in channels during construction, as these devices tend to deteriorate over time. Where sandbags are used, it is important not to overfill them as this can cause gaps when the sandbags are wedged together. Three quarters to two thirds full is generally the right amount of material within each sandbag.

The Contractor shall also ensure that all sediment fences are installed in accordance with the ESCP design drawings and downslope of any additional small disturbance areas that are not subject to concentrated overland flows and that are not adequately protected by existing structures. Sediment fences temporarily detain runoff, trapping sediment and allowing filtered water to pass. They are placed on the contour or slightly convex to the contour and each end of the fence should be turned to create a stilling pond up slope of the fence.

5.3 Roads / Access Tracks

To ensure any potential surface water impacts associated with the site access tracks and haul roads are minimised, the Contractor will undertake the following in accordance with the ESCP design drawings:

- Provide cross fall drainage at 3% either side of the road crown (or from infall and outfall cross falls) to shed runoff from the road surface;
- Table drains, mitre drains, culverts and cross drains are to be used where required to safely convey the water from the haul road and access track surfaces so to prevent runoff from eroding them or adjacent land. Mitre drain spacing should not exceed 50m even on soils with low erodibility. Cross Drains are placed every 20 to 90 m depending on the road grade and soil erodibility as required;
- Sediment fencing, sand bags or vegetation filters are used to control the sediment at the end of mitre drains, and controls are periodically inspected to maintain their performance; and
- Cut and fill batters associated with service tracks are formed to a safe slope and stabilised by vegetation. Where cut batters are greater than 1.5m, stabilisation methods are to be applied to these areas such as laying back, revegetation and drainage. Stabilisation is assisted by spreading topsoil and/or by applying chemical or organic mulch over the exposed batter surface. Fill batters are constructed with grades no steeper than greater than 2(H):1(V).

5.4 Works Within the Existing EBFR Diversion

Unless adequately managed, in-stream disturbance activities can represent a significant environmental hazard. These works can cause an increase to both turbidity and bed load sediment. These impacts have the potential to directly affect downstream ecological processes.

Works are proposed within the existing EBFR Diversion including:

- A new culvert crossing;
- Upgrade works to the existing crossing; and
- Remediation and rehabilitation works.

Suitable ESC measures will be implemented by the Contractor prior to the proposed works within the Finniss River Diversion as specified in the design drawings. Specific ESC measures that may be applicable to the in-stream works include the following:

- Only undertaking works during the dry season (May to November) and when good weather has been forecast;
- Staging of works to minimise risk at any given time;
- Downslope temporary sediment control measures (i.e. coir logs, sediment fences, check dams, etc);
- Bank stabilisation with rip-rap material;
- Upslope coffer dams; and
- Bank rehabilitation works as soon as practically possible after completion of Main Pit backfill works and EBFR reinstatement including:
    - Regrading to a maximum slope of 3(H):1(V);
    - The use of suitable topsoil to 100mm;
    - Ameliorisation with gypsum at a rate of 1kg/m^2;
    - Backfilling eroded areas, as required; and
    - Revegetation using suitable riparian seed mixes.

The importance of maintaining a natural vegetation buffer, of at least 25m between waterways and any disturbed areas, is also recognised and adhered to as far as practicable.

5.5 ESC Monitoring and Maintenance

5.5.1 Monitoring

The performance of ESC devices will decline if they are not maintained. The Contractor shall inspect all ESC devices (including sediment dams) regularly and undertake monthly reporting as part of the site's environmental inspection program. Notifications of non-compliance shall specify the type(s) of non-compliance, the corrective actions needed and a time schedule for achieving compliance.

Regular visual inspections of rehabilitated areas will be undertaken by the Contractor to ensure water is safely conveyed from the areas and that a stable landform is being created. The inspections will also include assessing vegetation cover to ensure that erosion potential is minimised.

Table 5 contains the Contractor inspection schedule used to ensure the ESC's are functioning effectively at the site. The inspections will also determine the scheduling of maintenance required for the ESC structures.

Table 5 ESC Inspection Schedule

To Be Inspected	Frequency
All ESC Structures and Stockpiles	Weekly (December to April), monthly (May to November) or following significant rainfall events (i.e > 15mm in 24hr period)

To Be Inspected	Frequency
Rehabilitated Areas (Water Management Structures and Vegetation Cover)	Monthly or following heavy rainfall events (i.e > 15mm in 24hr period)
Road Drainage works	Quarterly or following heavy rainfall events (i.e > 15mm in 24hr period)
Equipment That Utilise Hydrocarbons	Daily for spills and leaks

Inspections of the proposed sediment dams, once constructed, will include the general condition of the dams, evidence of overflow, water colour, evidence of eroding surfaces, approximate retained capacity recorded and whether any desilting is required (if sediment has accumulated to the Sediment Storage Zone).

Water quality sampling shall also be undertaken prior to any controlled release of water to ensure that the water quality is suitable for release. Water quality parameters that are to be tested for and generally accepted water quality limits for offsite release within the region are described as the Construction Phase Locally Derived Water Quality Trigger Values**.** These values are reported within the EIS and supporting documentation.

Runoff that does not meet the relevant quality criteria will be contained on-site and will be treated, if required, to allow it to be discharged off-site. Flocculation of the water contained within the sediment dams can be undertaken with an approved flocculant to improve the Total Suspended Solids (TSS) of the water prior to release. Similarly, pH dosing with approved substances (e.g. lime) can also be undertaken to improve the pH of the water prior to release.

5.5.2 Maintenance

All erosion and sediment control measures are to be maintained by the Contractor in a functioning condition until individual areas have been deemed “successfully” rehabilitated. Where controls are observed to not be functioning correctly, the controls are restored to meet the required standard. Where significant erosion is observed to be occurring on a regular basis, additional controls are to be implemented.

5.5.2.1 Sediment Dams

Sediment dams are to be regularly drawn down following rainfall (within 5 days) and desilted (if required) to ensure that the Settling Zone Volume is available within the dams to accept runoff from future rainfall events. This is to ensure that the dams are operated in accordance with the requirements of the IECA guidelines to minimise the chances of an uncontrolled discharge. The drawn down water can be released downstream, provided the water quality requirements are met, or can be transferred into the Main Pit or the Water Treatment Plant (WTP).

If sediment does build up to the Sediment Zone Volume the dams will need to be desilted with the sediment disposed of in a suitable manner. It is recommended that depth markers are installed to assist with determining when the sediment dams require desilting. It is believed that the sediment dams will require desilting, on average, once a year which would typically be undertaken at the commencement of the wet season.

5.5.2.2 Drainage Channels

Any signs of erosion along the length of the drains should be noted by the Contractor and remedial works undertaken as required. Where significant erosion is observed, additional erosion controls are to be implemented e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock check dams) of the channel surface.

5.5.2.3 Temporary ESC Structures

The Contractor shall undertake regular visual checks of any temporary sediment controls such as sediment fences, check dams, etc. to ensure that they are functioning adequately and repaired where required.

Sediment fences require regular maintenance. Trapped sediments should be removed, pickets straightened, filter cloth re-secured and tightened as required.

5.5.2.4 Roads/Access Tracks

Periodic maintenance of the haul roads and access tracks by the Contractor will include checking the drainage systems to remove any debris that may block culverts, cross drain outlets and table drains. Any erosion will be remediated with additional ESC measures implemented, as required.

In order to minimise water use, water for dust suppression can be sourced from sediment dams (if available), groundwater bores and the adjacent Brown's Oxide site (subject to a suitable water use agreement). Water from potable water sources (i.e. trucked-in) would only be used as a last resort. Both the Main and Intermediate Pit quality is not suitable for use as dust suppression, though may be suitable for WSF construction water.

5.5.2.5 Rehabilitated Areas

Regular visual inspections of the rehabilitated areas are to be undertaken by the Superintendent in accordance with **Table 5** and the Rehabilitation Plan. This highlights any maintenance that needs to be undertaken to ensure water is safely conveyed from the areas and that a stable landform is being created. The inspections also include assessing vegetation cover to ensure that erosion potential is minimised. Where required, bald or patchy areas are either re-ripped and seeded or have a maintenance application of fertiliser to encourage growth.

5.6 ESC Decommissioning

ESC structures shall be decommissioned by the Superintendent once they are no longer required in accordance with the IECA guideline requirements. This may be due to the following reasons:

- Runoff from the upslope disturbed catchment area no longer flows to the structure (e.g. due to final landform shaping works, etc);
- The upslope catchment area has achieved a grass coverage of 70% or greater and downstream water quality objectives are being met; and
- The upslope disturbance area has been effectively sealed (e.g. bitumen, concrete, etc).

Dams could either be removed via earthworks or configured to attenuate into the landscape via geomorphological processes, mitigating any requirement for ongoing maintenance and management. The Contractor shall ensure that any flow paths through areas of decommissioned ESC measures (i.e. sediment dams) are stable with additional stabilisation works undertaken as required. Any disturbance areas created

during decommissioning works shall be rehabilitated and mulched over as soon as is practically possible. During decommissioning, any materials associated with the ESC structures will be removed and suitably disposed of.

6 Clearing and Excavation

Excavation and Removal, Clearing and Grubbing works will be required for the following construction elements as depicted in the Design Drawings:

1. Clearing and Excavation Works
    a. Excavation and removal of rip-rap from existing waste rock dumps (WRD) and drainage channels;
    b. Excavation and removal of existing WRDs;
    c. Excavation and removal of radioactive soils;
    d. Excavation and removal of impacted soil areas;
    e. Clearing and Grubbing of the West Waste Storage Facility (WWSF); and
    f. Clearing and Grubbing of the East Waste Storage Facility (EWSF).
2. Clearing, Grubbing and Stockpiling
    a. Clearing and Grubbing of the WWSF
        – Strip topsoil and stockpile
    b. Clearing and Grubbing of the EWSF
        – Strip topsoil and stockpile
3. Demolition of Existing Buildings
    a. Asbestos management
4. Main Pit Access Ramp and Construction Compound Areas
5. Haul Roads
6. Water Treatment Plant Enabling Works
7. Borrow Areas
8. River Diversion Works

6.1 Definitions

The following definitions shall apply to the Specification with respect to excavation and/or fill material.

Grubbing – defined as the removal of all stumps and roots, greater than 100mm in diameter to a depth of 600mm below the natural surface and removal of all other vegetation and boulders (particles greater than 200mm in diameter) to a depth of 300m below the natural surface.

Rock – Hard strata found in ledges or masses in its original, naturally occurring position which in normal excavation would have to be loosened by blasting or pneumatic rock tools or, if by hand, using wedges and sledge hammer; strata requiring the use of diamond or tungsten carbide bits when drilled.

6.2 Clearing and Grubbing

6.2.1 Clearing

The Contractor shall clear the area of the Works such as for borrow areas and construction of haul roads, equipment yards, etc. and only where approved, directed or marked out by the Superintendent and supervision co-ordinated with the Principals Owners Team.

Clearing shall be as per the Vegetation Clearance and Cycad Removal Management Plan prepared by the Principal.

In addition, clearing works should avoid removal of habitat vegetation, and removing trees and brush should be done in a manner that preserves all materials for reuse in the work program.

Material segregation will include hollow logs, general vegetation, rocks and other debris to be reused in the revegetation systems. Necessary clearing and grubbing shall only be in undertaken in the Works area or to allow access to the Works area. Cleared vegetation material shall be retained on site and segregated for reuse.

Supervision will generally require supervision by Traditional Owners and/or a fauna spotter/catcher. Cycads are to be removed before clearing works occur. No mulching is allowed.

All natural landscape features, including natural rock outcrops, natural vegetation, soil and watercourses are to remain undisturbed except where affected by the Works and only if expressly approved by the Superintendent and the Principal.

6.2.2 Grubbing

Disposal or reuse of all materials that have been cleared and grubbed must also be undertaken as part of these Works. Grubbing shall include the complete removal of all stumps, roots and other embedded debris. Grubbing methods shall not result in unnecessary waste of materials suitable for use. All stumps together with all roots and other debris shall be disposed of by removal to locations directed by the Superintendent.

6.2.3 Rip-rap Scavenging

The Contractor shall be required to scavenge all rip-rap from WRDs and drainage lines and stockpile as defined in the Design Drawings.

Rip-rap will be sprayed with weed killer (glyphosate) prior to exaction (Owners Team Scope). Ongoing weed management will be by the Owners Team. Reused rip-rap (for example in new drainage channels) will be treated with weed killer after placement and until establishment achieved (both Owners Team Scope).

6.2.4 Topsoil and Growth Media Stripping

The Contractor shall be required to selectively strip all topsoil materials within the Works area and stockpile as defined in the Design Drawings. Determination of the soil material type and depth of strip will be confirmed by a suitably qualified third-party soil scientist on site prior to carrying out the stripping Works from the areas detailed in **Drawing 680.10421.BOR.D01 to D04 and 680.10421.WSF.D02**. The topsoil and subsoils shall be removed to a nominated topsoil and subsoil stockpiles as directed by the Superintendent.

6.2.5 Demolition of Existing Buildings and Concrete Footings

The Contractor shall demolish and remove all existing buildings, including concrete footings to a facility licenced to dispose of such wastes. The Contractor shall isolate any asbestos materials at the Rum Jungle site from environmental and human receptors by removing and relocating to the new WSFs or by another approved means offsite.

6.3 Excavation

6.3.1 General

All excavation work shall be undertaken using conventional earthmoving equipment and methods typical for the construction of Waste Storage Facilities. Blasting is not permitted.

The Contractor is to comply with the requirements of Australian Standard AS 3798-2007 *Guidelines on earthworks for commercial and residential developments*, Queensland *Excavation Work Code of Practice* (July 2018) and any other relevant regulations for excavations with a depth greater than 1.5m.

The Contractor shall be deemed to have satisfied themselves as to the nature of fill, soils and rock on site and have included within their rates for the selective excavation of each material. Details of expected sub-surface materials within the Works Area can be ascertained from the *Rum Jungle Rehabilitation – Stage 2A Detailed Design Geotechnical Investigation Waste Storage Facilities and Borrow Areas* (SLR Consulting, 2020a).

6.3.2 Excavation Limits

All excavations shall be to the minimum grades shown on the Drawings or required by the Superintendent. During the progress of the Work, the Superintendent may find it necessary to revise grades of any part of the excavations to suit site encountered conditions, or for any other reason. The Contractor shall carry out any additional work in accordance with the Specification and as directed by the Superintendent and/or CQA Consultant.

The Contractor shall not excavate beyond the lines and grades shown on the Drawings or designated by the Superintendent without prior written approval of the Superintendent. All necessary precautions shall be taken to preserve in the soundest possible condition the material below the excavation extent. Any damage done to the work including the loosening of material or excavation beyond the required extent and grades which is performed by the Contractor for any purpose or reason whatsoever, shall be rectified at the expense of the Contractor. If in the opinion of the Superintendent such excavation should require to be backfilled, such backfilling shall be done to the satisfaction of the Superintendent with material similar to the fill to be placed against the excavated surface, and at the expense of the Contractor.

The excavation levels shall be rolled where applicable, to provide a smooth surface, free from debris, roots, angular or sharp rocks. The subgrade will provide a firm unyielding foundation sufficient to permit the movement of vehicles without causing rutting or other deleterious effects. It shall have no sharp or abrupt changes in grade and shall be free from areas of soft material. All excavated or fill surfaces shall be graded to provide good drainage and prevent ponding of water. Surface water shall be controlled to avoid damage to adjoining properties or to finish work on the site.

All soft spots identified by the Superintendent following the rolling of the excavation levels shall be removed and re-filled with compacted suitable general fill and placed in accordance with **Section 8.3**.

The Contractor shall undertake the works so that the area outside the limits of the excavations is not unduly disturbed. Any slope failures or slippages of material that occur within the Works area, or on the Works periphery, due to the Contractor's negligence, or use of inappropriate methods, shall be removed and reinstated by the Contractor and at no cost to the Principal. The Contractor shall ensure all excavations remain stable at all times.

On no account will any unauthorised discharge from Works excavations be permitted to leave the site without prior consent of the Superintendent. The Contractor shall adhere to all applicable conditions of Section 7.3 of EIS (NT-DPIR, December 2019).

The Contractor will not be entitled to a contract variation or extension of time for excavation in excess of that required by the Contract and which has not been approved by the Superintendent, nor for any consequent additional backfilling, compacting or CQC/CQA testing as a result of the over excavation.

6.3.3 Suitable Fill Excavation

Where the excavation reveals a combination of suitable fill material and unsuitable material, the Contractor shall, unless otherwise agreed with the Superintendent, carry out the excavation in such a manner that suitable fill materials are excavated without contamination by unsuitable materials. Excavated materials shall be immediately transported to a stockpile location agreed with the Superintendent or for, suitable excavated material, placed directly to fill if feasible.

The Contractor shall inform the Superintendent should unsuitable material be encountered within the excavation.

6.4 Borrow Pit Management

6.4.1 Clearing and Grubbing

The Northern Territory Government (NTG) Owners Team will be responsible for:

- Relocating target vegetation species to suitable rehabilitation areas; and
- Developing and maintaining weed control.

The Contractor will undertake borrow pit clearing and grubbing works in the following manner:

- Remaining vegetation is to be cleared and grubbed from the area shown on **Drawings 680.10421.BOR.D01 to D04** prior to area development. Clearing shall occur on seasonal basis to minimise exposure of sub-grade to seasonal rainfall and mitigate soil wash away.
- All trees, bushes and other vegetative matter not removed shall be chipped and stockpile in nominated location or placed elsewhere as directed by Superintendent.
- The chipped vegetation stockpile shall not exceed 2m in height or have side slopes steeper than 1V:3H.
- Prior to any cutting earthworks, grubbing shall be carried out for the full extent of areas to be developed. Grubbing is defined at the removal of all stumps and roots, greater than 100mm in diameter to a depth of 600mm below the natural surface and removal of all other vegetation and boulders (particles greater than 200mm in diameter) to a depth of 300m below the natural surface.
- Clearing and grubbing shall not result in unnecessary waste of materials required for use elsewhere.
- The grubbed debris shall be deposited in the designated stockpile areas.

6.4.2 Topsoil Stripping

On completion of clearing, the Contractor shall strip and remove the topsoil from the Work area to the approval of the Superintendent. The stripped topsoil shall be placed in stockpiles not exceeding 2m in height. Side slopes shall not be steeper than 1V:3H. A 250mm thick layer of chipped vegetation shall be placed on top of completed stockpiles to assist in erosional soil loss.

Topsoil shall be defined as soil of any gradation or degree of plasticity which contains significant quantities of visually identifiable vegetative matter, sod, roots or humus. Stripping means the removal of all topsoil to a nominal depth of 200mm below natural surface or as directed by Superintendent.

6.4.3 Excavation Works

Maximum excavation depths are presented in **Drawings 680.10421.BOR.D01 to D04**. The Contractor will ensure:

- All excavations shall be to the minimum lines and grades shown on the **Drawings 680.10421.BOR.D01 to D04** or to the satisfaction of the Superintendent.
- Excavation Works shall not commence in any zone prior to inspection and approval of the Contractor(s)'s survey markers in that zone by the Superintendent.
- Excavations shall include all operations necessary to excavate, irrespective of type and subsurface conditions including the selection of material as specified or otherwise directed, to dispose of all surplus excavated materials not required, to shape formation, drains and batters, all as specified herein or as otherwise to the satisfaction of the Superintendent.
- To minimise re-handling, borrow materials will be extracted on an as-required basis negating the need for stockpiles and minimising disturbed area.
- Effective erosion and sedimentation control measures shall be installed and maintained for the duration of the construction. Furthermore, adequate drainage of all working areas shall be maintained throughout the period of construction to ensure runoff of water without ponding expect where ponding forms part of the planned erosion and sedimentation control system.

6.4.4 Treatment

6.4.4.1 Borrow Area A

Clay Materials to be used as Low Permeability Clay Layer in the WSFs may require processing (screening) to bring the material up to specification (SLR Consulting, 2020a). Processing is to occur prior to transport to minimise haul volumes.

6.4.4.2 Borrow Area B

Sand bedding material processing is to be performed by the Main Pit Backfill Contractor at the Main Pit Backfill processing area.

6.4.5 Stability of Excavations

The sides of all excavations shall be battered at no steeper than 1V:6H as shown in drawings. Any temporary excavation steeper than the angle of repose of the material and not self-supporting, shall be benched, battered or adequately supported by bracing or shoring, if necessary, to ensure against slides, cave-ins or danger to persons or structures. The cost of all bracing, shoring or treatment to excavations shall be included by the Contractor in the tendered amount for excavation. All slips of unstable masses of materials outside the limits of excavations and specified cut batters shall be rectified by the Contractor(s) at his expense.

Shoring and trench protection shall be constructed in accordance with the relevant statutory safety regulations. Where required or directed by the Superintendent, the Contractor(s) shall use benching techniques to ensure the stability of bulk excavations. Benches shall be sloped inwards and the inside edge of the bench shall be adequately drained.

6.5 Haulage

6.5.1 Borrow Area A

The Contractor will undertake haulage for Borrow Area A northward on Poett's Road, east on Litchfield National Park Road and entry into the Rum Jungle internal haul road system via Litchfield National Park and Rum Jungle Road intersection. The reverse haulage path will occur for return.

Poett's Road, Litchfield Park Road and Litchfield Park Road and Rum Jungle Road intersection are public roads subject to seasonal traffic variation. Truck wash facilities will be required for haulage vehicles prior to exiting the borrow area and Rum Jungle Site. Requirement of truck wash will be subject to prevailing weather conditions and is the responsibility of the Contractor to prevent tracking soil materials onto the public roads.

6.5.2 Borrow Area B

Haulage from Borrow Area B will be via internal haul roads.

6.6 Temporary Batters and Slopes

Temporary excavations or trenches in the residual soil (laterite, saprolite) and weathered rock profile would be expected to stand close to vertical in the short-term (1-day). Unsupported short-term excavations or trenches may undergo local slumping into the excavation where seepage or heavy inflow (surface runoff or rainfall) occurs. Temporary excavations in the slightly weathered rock profile would stand vertical but care would be required to remove any large rock masses or loose material.

Excavations in the vicinity of existing road embankments or structures shall be fully supported in accordance with the design to ensure no inadvertent instability affecting adjacent infrastructure.

Where personnel are to enter excavations, options for short-term excavations include benching or battering back of the excavations to 1 Vertical to 1 Horizontal (1H:1V) within the stiff or better residual soil and extremely weathered rock profile, or the support of excavations. Short-term excavations within the more competent rock may be battered at steeper than 1V:1H and may not require support, however this would require the Contractor to undertake a specific geotechnical assessment, subject to approval by the Principal.

6.7 Rehabilitation of Borrow Areas

Upon completion of borrow activities, the borrow pit excavation walls will be graded to 1V:6H angle, blended with the surrounding areas and topsoiled.

Revegetation is to be undertaken according to the Projects Rehabilitation (being undertaken by others). It is recommended that the side walls be seeded immediately upon regrading to aid in reducing erosive soil loss.

All temporary access and haul roads will be removed and blended with the adjacent landform.

7 Lime Spreading and Mixing

To prevent acid mine drainage (AMD) from the WSFs, the waste rock materials and contaminated footprints are to be placed and treated in line with strict geochemical quality requirements. The following outlines the minimum lime (finely crushed limestone) treatment rate, spreading and mixing requirements to be adopted. These rates may vary at the time of works depending on the results of the field geochemistry procedure described below.

7.1 Lime Treatment Rate

The following lime treatment rate is required as detailed in **Table 6.**

Table 6 Lime Treatment Rate and Estimated Quantities

Material to Treat	Placement Location	Lime Treatment Rate	Total Lime*
Intermediate WRD	Main Pit	24kg $CaCO_3$ per tonne of WRD	44,652 tonnes
Dyson's Overburden WRD	Main Pit	24kg $CaCO_3$ per tonne of WRD	26,940 tonnes
Main WRD	Main Pit	15kg $CaCO_3$ per tonne of WRD	9,307 tonnes
Main WRD	WSFs	max 15kg $CaCO_3$ per tonne of WRD	160,375 tonnes (max)
Main North WRD	WSFs	max 15kg $CaCO_3$ per tonne of WRD	4,519 tonnes (max)
Dysons WRD	WSFs	max 4.9kg $CaCO_3$ per tonne of WRD	14,765 tonnes (max)
Contaminated Footprints			
Intermediate WRD Footprint	Top 0.20m In-Situ	24kg $CaCO_3$ per tonne of footprint	927 tonnes
Dyson's Overburden WRD Footprint	Top 0.20m In-Situ	24kg $CaCO_3$ per tonne of footprint	632 tonnes
Main WRD Footprint	Top 0.20m In-situ	15kg $CaCO_3$ per tonne of footprint	2,176 tonnes
Main North WRD Footprint	Top 0.20m In-situ	15kg $CaCO_3$ per tonne of footprint	446 tonnes
Dysons WRD Footprint	Top 0.20m In-situ	4.9kg $CaCO_3$ per tonne of footprint	202 tonnes

*: Total lime assumes a lime availability of 79%.

7.2 Lime Spreading

7.2.1 Spreading Method

Self-unloading trucks or tailers will be used to distribute lime pneumatically or mechanically using aggregate-type spreaders. Equipment capable of negotiating adverse ground conditions will be required.

Lime can be nominated by the Contractor to be applied as a dry power, aggregate or slurry with the method subject to approval by the Principal. Spreading equipment must utilise monitoring equipment (utilizing GPS tracking and load cells) to ensure even application across sites to monitor lime rates and quantities applied.

The contractor must supply the lime application data of each 500mm waste rock lift to the CQA Consultant for review and approval.

7.3 Lime Mixing

Ensuring homogenous mixing of the lime through the waste rock is paramount to the success of the project.

The Contractor is required to consider larger cobbles/boulders will be present within the waste rock materials (> 1.0m diameter) as encountered within previous investigations. Such boulders are occasional within the dumps but are likely to pose a jamming and breakage risk to typical road soil mixers.

It is envisioned mixing of the lime will occur using either a grader pulled or tractor pulled ripper/tyne/harrow that will be able to manage the expected undulating terrain and occasional larger pieces within the waste rock.

The proposed method by the Contractor of lime mixing will be reviewed and either accepted or rejected by the Site Geochemist following assessment of the field procedure, prior to full-scale operations.

7.4 Field Procedure

Reference: Robertson GeoConsultants Inc. and Jones, D. R., 2019, Physical and Geochemical Characterisation of Waste Rock and Contaminated Materials (Rev 2), prepared for NT Government, (RGC & Jones, 2019).

The safe long-term waste rock storage within the WSFs requires that the existing acidity within this waste rock is neutralised during the construction of the new WSFs.

The geochemical control program is required to be incorporated with geotechnical control over the waste rock placement.

The Contractor is to carry out the following procedure for neutralant (finely crushed limestone) dosing of waste rock for long term storage within the Waste Storage Facilities (WSF) to achieve a target matrix pH of 7. This procedure forms a component of the documentation for the **Earthworks Works Package**.

The Contractor is required to engage personnel experienced in geochemical and geotechnical Quality Assurance/Quality Control (CQA/CQC) carry out the Field Procedure. The following personnel are required to carry out the Field Procedure:

- WSF Construction Supervisor – responsible for managing the operations on the construction face and ensuring adherence to safe work systems and the QA/QC process.
- Shift Geotechnician – responsible for running of the geotechnical QA/QC processes for the construction works.
- Shift Geochemical technician – responsible for running the geochemical QA/QC processes for the construction works.

The Contractor is to prepare a health and safety plan for undertaking lime dosing works.

7.4.1 Part A – Procedure for Lime Dosing Every Block

The Contractor is required to carry out the following procedure for lime dosing every block:

7.4.1.1 Step 1 – Determine paste pH

1. Waste rock is to be paddock dumped then loosely levelled in 0.5m thick loose layers within designated blocks for the purpose of volumetric calculations. In this example, a block of 50m x 100m will be assumed (2,500m^3 block). Additionally, the loose density will be assumed to be:
    a. In situ density within current WRDs: 2.0 t/m^3.
    b. Swell factor: 30%.

c. Therefore, placed density loose on WSF: 1.54 t/m^3.

d. Therefore, placed loose mass per block: 3,850t.

2. For each 2,500m^3 block ten composite grab samples shall be taken across a rough 25m x 25m grid across the block to test for paste pH from which to determine the correct lime dosing rate. Map the sample layout for each block for recording purposes. The 10 subsamples should be:

   a. Taken from the full 0.5m thick profile at each sample point.

   b. Sieved on site to retain the < 2mm sample fraction for paste pH field analysis.

   c. If weather conditions are wet (cannot field sieve), take 10 x 2kg subsamples to laboratory for drying and processing.

3. Weigh out 25g of sample and mix with 50g of deionised water for a 2:1 paste pH.

4. Allow the sample to equilibrate for 1hr with mixing of the sample at 15min intervals.

5. Measure pH of settled solution with a calibrated field probe.

7.4.1.2 Step 2 – Determine the lime dosing rate

1. For each block with 10 samples use the following table to determine the correct lime dosing rate:

Table 7 Dose Rates Main Waste Rock Dump Materials

	If 5 or more samples paste pH < 5.5	If 4 or more samples paste pH >5.5
Existing Acidity	14.7kg H_2SO_4/t	3.2kg H_2SO_4/t
Equivalent Demand Factor	1.02	1.02
Neutralant Demand	15.0kg $CaCO_3$/t	3.3kg $CaCO_3$/t

Table 8 Dose Rates Dysons Waste Rock Dump Materials

	If 5 or more samples paste pH <5.5	If 4 or more samples paste pH >5.5
Existing Acidity	4.8kg H_2SO_4/t	0.2kg H_2SO_4/t
Equivalent Demand Factor	1.02	1.02
Neutralant Demand	4.9kg $CaCO_3$/t	0.2kg $CaCO_3$/t

2. Select correct Existing Acidity to use for dose calculation. Convert this value to lime t to add to the block. *For example*:

   a. For a block of waste rock from Main Waste Rock Dump (**Table 6**), 8 samples return pH < 5.5, therefore select 15.0kg $CaCO_3$/t.

   b. Adjust Neutralant Demand to account for activity of the crushed limestone (as an example 79%).

   c. Calculate mass of limestone for the block.

   d. Convert mass of limestone for the block to t.

Total Block Limestone Mass = 15.0kg $CaCO_3$/t x (1/0.79) x 3,850t x (1/1000)

Total Block Limestone Mass = 73t

3. Review the layout of results over the block to determine if a portion of the block should receive a slightly higher portion of the total lime dose for the block. This is not to be quantified but rather a qualitative approach. Record the calculated lime dose for the block.

7.4.1.3 Step 3 Lime Dosing and Mixing

For the dosing and mixing of the lime onto the block. The following minimum steps will apply.

1. Once the dose rate is determined by the site geochemist, the value is to be relayed immediately to the WSF Construction Supervisor.
2. The block is to be well ripped with the grader tynes at full depth prior to lime dosing.
3. The lime is to be dosed evenly over to the block following the specified procedure. The delivered mass of lime to the block is to be documented for each block and recorded as part of the QA/QC process. This will be checked off against the calculated dose rate by the WSF Construction Supervisor.
4. Record the actual lime mass dosed to the block.
5. The grader at full tyne depth is to make a minimum of three full passes over the block to ensure adequate mixing of lime and waste rock. Future test work during establishment phase may confirm that this can be reduced.
6. Once mixed, the block supervisor is to moisture condition and compact to the geotechnical specifications.
7. Multiple work blocks may need to be operational to allow for return of lime dose values from the geochemical technician.
8. Work blocks must be signed off as passed by the WSF Construction Supervisor before additional layers can be placed.

7.4.2 Part B – Validation Program

A validation program is required for 1 block in every 10 blocks to confirm that the paste pH method is performing as expected. To do this, 1 block in 10 should be sampled and analysed as described here.

At a high level, five x 5kg samples of < 2cm material should be taken from the block to compare the paste pH with the total existing acidity as determined by:

1. dry and then crush the 5kg sample of < 2cm material to < 75µm (pulp).
2. determine titratable (i.e. immediately available) acidity by titrating a subsample of the pulp with sodium hydroxide solution to pH7:
    a. **Titratable acidity**: Titratable acidity is determined by slowly titrating (to pH 7) a slurry that consists of 75g of high purity water and 15g of a crushed, subsample of waste rock (i.e. a 5:1 liquid-to-solid ratio).
3. Determine water soluble and total sulfate, with the difference between the 2 numbers being used (methods below):
    a. **Water soluble sulfate**: measured by water extraction, ALS method ED040S.

b. **Total extractable sulfate**: measured by leaching with sodium carbonate solution (ALS method GRA06). This method involves:

   i) Boiling a sample with a sodium carbonate solution for 30 minutes.

   ii) Removing any insoluble materials by filtration (and reducing ferric iron to ferrous iron by the addition of hydroxylamine hydrochloride).

   iii) Precipitating barium sulphate by adding barium chloride to the filtrate.

   iv) Filtering, igniting and weighing the precipitate to determine the SO_4 and jarosite content of the original sample (which is expressed as % S).

4. Total acidity is the sum of titratable and jarosite acidity

5. Compare this value to the paste pH. Compare the values of total acidity with the dose rate determined using the paste pH for the block. If the values of total acidity are greater than or comparable with the dose rate determined using pH, then the pH approach is validated. If the reverse is found then further investigation will be required to determine what modifications will be needed to the pH procedure. Over time, continuing data patterns may allow for reduction in the block testing regime if the material is found to be more consistent than predicted.

8 Waste Rock and Impacted Soil Placement

8.1 General

Preparation of surfaces, forming compacted starter embankments and placing waste rock and soils will be required as part of the Works, summarised below and depicted in the Design Drawings:

1. West Waste Storage Facility (WWSF)
    - Preparation of surfaces;
    - Forming compacted starter embankments using Dysons WRD material;
    - Placing radiological soils;
    - Placing low permeability clay material over radiological soils;
    - Placing waste rock from various WRDs;
    - Placing Contaminated Soils; and
    - Placing Copper Extraction Area Soils.
2. East Waste Storage Facility (EWSF)
    - Preparation of surfaces;
    - Forming compacted starter embankments using Dysons WRD material;
    - Placing waste rock from various WRDs;
    - Placing Contaminated Soils; and
    - Placing Copper Extraction Area Soils.

Prior to commencement of work there shall be agreement between the Contractor and the Superintendent concerning the existing ground levels and start surfaces. There will be agreement between the Contractor and the Superintendent concerning the methods and equipment to be used by the Contractor for fill activities. This agreement will not relieve the Contractor of his responsibilities for any other contractual aspects of the Works.

Suitable fill material shall be sourced from excavations or borrow areas located within the site, as nominated by the Superintendent.

Notwithstanding the Superintendent's approval of any construction equipment and the methods of employing such equipment, where in the opinion of the Superintendent such equipment and methods result in undesirable effects on any part of the Works, the Contractor shall at his own expense replace or modify such equipment and change such methods to the satisfaction of the Superintendent.

The Contractor shall construct the fill of the embankments in compliance with the requirements for zoning and to the lines and grades shown on the Drawings or required by the Superintendent. No additional payment will be made for materials placed outside the design lines as shown on the drawings.

8.2 Definitions

The following definitions shall apply to the Specification with respect to fill material.

Suitable fill material – Material which is in accordance with the Contract for use in the Works and deemed by the Superintendent to be suitable. Suitable fill material is to be used as general fill material.

Unsuitable material – Material other than suitable fill materials, including:

- Logs, stumps and perishable material;
- Any industrial, commercial or domestic waste;
- Construction or demolition waste, non-natural material or deleterious materials;
- For low permeable layer and growth medium layer – materials having a moisture content greater than the maximum or less than the minimum permitted for such materials in the Specification unless otherwise permitted by the Superintendent;
- Over wet Waste Rock; and
- Any material considered by the Superintendent to be unsuitable.

8.3 General Placement and Compaction Procedures

The following sections provide requirements for placement and compaction of fill material where required to achieve design levels.

8.3.1 WSF Foundation Compaction

Placement and compaction of the WSF foundation is to be undertaken in accordance with Australian Standard AS 3798-2007 *Guidelines on earthworks for commercial and residential developments.*

The WSF foundation is to be ripped and the top 300mm is to be compacted with a padfoot compactor to:

- An equivalent density of 98% of Standard Maximum Density; and
- At a moisture content within the range of ± 3% of Standard Optimum Moisture Content.

Prior to compaction, the foundation will be visually inspected by the Contractor and all unsuitable materials shall be removed.

The foundation shall provide an even, firm and unyielding foundation sufficient to permit the movement of vehicles without causing rutting or other deleterious effects. The foundation shall have no sudden, sharp or abrupt changes in grade and shall be free from areas excessively softened by high water content.

Filled slopes shall be neatly trimmed and left without excessive loose surface materials. Fill slopes steeper than 1V:3H shall be overfilled, then trimmed back with an item of plant equipped with a smooth blade, to ensure all fill in the slope is adequately compacted. Any soft spots identified in the surface shall be excavated to the satisfaction of the Superintendent and reinstated in accordance with **Sections 8.3.3** and **8.5**.

Any areas which exhibits shrinkage cracking, but does not require re-compaction, should be wetted and rolled until the shrinkage cracks do not reappear. However, care should be exercised to ensure the surface does not become soft or saturated as a result of this rework.

The Contractor shall seek approval from the CQA Consultant and Superintendent as to the adequacy of the finished surface prior to the starter bund construction. No fill shall be placed upon the WSF foundation until all of the required surface treatment works have been completed.

8.3.2 Waste Rock Starter Bund Compaction

Placement and compaction of the waste rock fill starter bund layers is to be undertaken in accordance with Australian Standard AS 3798-2007 *Guidelines on earthworks for commercial and residential developments* and **Table 9** below.

Table 9 Waste Rock Starter Bund Specification Requirements

Parameter	Specification
Material Source	Dyson's Waste Rock Dump
Starter Bund Maximum Height	1.00m
Starter Bund Maximum Crest Width	7.0m
Starter bund outer slope	In accordance with WSF Landform Design
Maximum Lift thickness	0.25m
Number of Lifts	≥ 4
Maximum Particle Size	200mm
Maximum Lime Dose Rate	4.9kg $CaCO_3$/tonne placed
Compaction Density/Placement Requirements	• An equivalent density of 95% of Standard Maximum Density; • At a moisture content within the range of ± 3% of Standard Optimum Moisture Content; • No deformation or spring observed in proof roll; and • No observed water ponding or over wet zones in layer.

Prior to compaction, each discrete lift will be visually inspected by the Contractor and all unsuitable materials shall be removed.

Haulage of suitable materials to the areas of placement shall only proceed when sufficient spreading and compaction plant is operating at the place of deposition. There shall be minimum delay between placement and compaction

8.3.3 Waste Rock Placement and Compaction

Placement and compaction of the waste rock fill layers is to be undertaken in accordance with **Table 10** below.

Table 10 Placement and Compaction Requirements

Parameter	Specification
Material Source	Main WRD, Main North WRD, Salt Effected Soils, Radiation Effected Soils, Mt Burton WRD, Copper Leachate Pad Effected Soils & Miscellaneous Soils
Maximum Lift thickness	Waste rock materials are to be placed in lifts (each discrete lift having a loose thickness of 500mm thick)

Compaction Density/Placement Requirements	• Lift thickness 0.50m;
	• An equivalent density of ≥ 90% of Standard Maximum Density;
	• Lime dose rates as appropriate for each material source;
	• No soft spots or over moistened areas prior to placement of next layer;
	• Prior to compaction, each discrete lift will be visually inspected by the Contractor and all unsuitable materials shall be removed;
	• Larger rock sizes incorporated into layer to no protrude above layer surface to hinder compaction;
	• Dry density and moisture content are to be confirmed via Control Testing (**Section 8.5**); and
	• Compaction via vibratory steel drum rollers.
	  ◦ Vibrations in the range of 1,200 to 1,500vpm. Roller speed of approximately 3.2 km/hr.
	  ◦ Static drum weight ≥ 8 tonne, Dynamic Drum Weight ≥ 15 tonne.
	  ◦ 4 to 6 passes (to be determined in trials).

Prior to compaction, each discrete lift will be visually inspected by the Contractor and all unsuitable materials shall be removed.

Haulage of suitable materials to the areas of placement shall only proceed when sufficient spreading and compaction plant is operating at the place of deposition. There shall be minimum delay between placement and compaction

8.4 Field Trials

A detailed placement, spreading of lime, mixing of lime and compaction methods for Starter Bunds and Waste Rock shall be developed for the Works during the first week of activities. Recommended guidelines for field trials are provided in (A. Breitenbach, 1993).

Testing shall be performed by a suitably qualified third-party geotechnical inspection and testing authority.

Prior to undertaking the field trial, the Contractor shall prepare and submit a Work Method Statement detailing the proposed field trial methodology and plant, including completed waste rock layer maintenance works, for review by the Superintendent.

The Contractor is required to provide a manufacturers data sheet regarding the proposed plant for the field trial pad. Where possible, the data shall include details of the type, dimensions, weight and operating speed of the compaction plant and details of the rollers.

On completion of the trial the following shall be undertaken:

- A copy of the certified control test results to be provided for review by the CQA Consultant and Superintendent.

If the results demonstrate that the methodology and plant used for the field trial achieve the Specification requirements, works may proceed with placement of the clay liner. The field trial clay liner may be incorporated into the permanent works, if it has been constructed within the area of the Works.

8.4.1 Trial Fill Limits

The test fill base shall be on level, dry and firm ground, preferably within the limits of a proposed WSF envelope (following foundation preparation ref: **Section 8.3.1**).

The minimum width of the trial pad area shall be determined by the size of the equipment used. Minimum width is typically set at three times the width of the roller in addition to three times the height of the final test fill surface plus three times the height of the final test fill. The area shall not be less than 30m x 30m.

The field trial will be constructed to a total compacted depth of 1,500mm, with minimum lifts as detailed in layer specification. The Contractor may propose to alter the minimum number of lifts contingent on approval by the Superintendent and provision of evidence and supporting documentation (i.e. test results), which confirm compliance with this Specification's moisture, density and permeability requirements.

The field trial area must include a portion starter bund, waste rock backfill, low permeability clay layer and growth medium layer. Low permeability clay layer trial details are provided in **Section 9.1.2,** growth medium trial details are provided in **Section 11.3.**

8.4.2 Lift Thicknesses

8.4.2.1 Waste Rock

Lift thicknesses specified herein this specification are considered upper limits in order to achieve required compaction. Assessment of lift thickness can be evaluated against frequency of maximum particle size, breakdown of lager particles under placement and achievement of compaction requirements.

8.4.3 Roller Passes

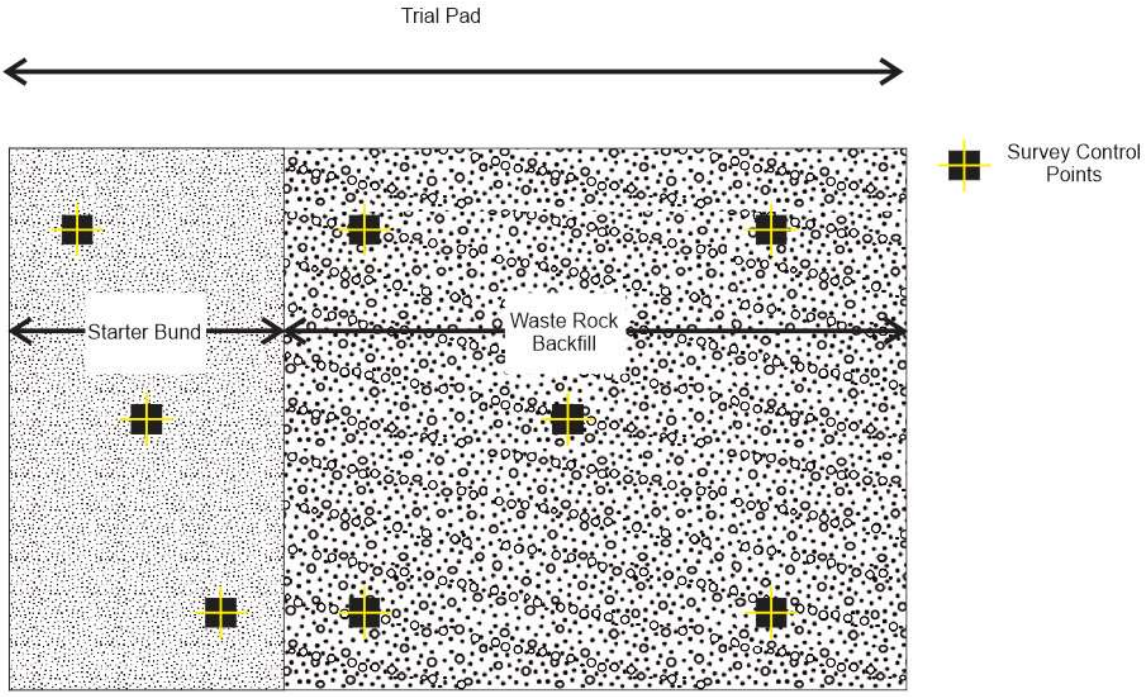
8.4.3.1 Waste Rock

After the loose lift is placed, an initial survey of the lift surface can be conducted by spray painting a cross pattern with a test point number at each control point to be surveyed. Occasional rock protrusions in the selected control point areas are removed and filled in with smaller rock or the fill surface is proof rolled by a single pass. Or a smooth drum roller without vibration to seat the rock for survey readings.

Control points are surveyed for elevation (settlement) readings versus roller passes. Control points are assessed by using a minimum 0.30m square plate with a centre mark and cross pattern. The cross pattern on the plate is lined up to match the control point cross patter on the fill surface for consistent readings.

A minimum of five control points within the backfilled waste rock and three control points along the starter bund layer for each lift are to be analysed.

Figure 1 Example Survey Control Point Layout per layer - Plan View (not-to-scale)



A minimum of 8 passes with survey every two increments are to be performed for each test fill lift to evaluate settlement versus roller passes and determine the required number of passes for acceptable placement. Additional passes should be performed until "flattening" of the settlement curve versus roller passes is observed.

In general, the require number of passes is set 80% number of roller passes required to flatten the settlement versus roller pass curve (typically, between 4 to 6 passes).

In evaluating the number of passes, assessment of the material breakdown, diminishing compaction improvement with additional passes and construction scheduling shall be considered.

8.4.4 Density and Graduation

8.4.4.1 Waste Rock

Proof Rolling

Survey control points and large-scale bulk density testing locations shall be proof rolled and observed by the relevant third-party geotechnical inspection and testing authority prior to nuclear density and large-scale density tests. Visual observations shall be recorded and correlated to large scale bulk density results and nuclear density results.

- Proof rolls shall be performed on ≥ 8 tonne roller on static.
- Proof rolling shall be performed immediately following compaction completion.
- Proof rolling procedure shall be submitted to the Superintendent for approval.

Large Scale Bulk Density Tests in Rockfill

Following trial placement and settlement survey tests, in-place large scale bulk density and graduation shall be performed to verify rockfill procedures against design assumptions. A combination of large-scale density tests supplemented with nuclear density tests shall be performed to establish relationship between the density (nuclear and large-scale density), compaction technique, roller passes and lift thicknesses.

Large-scale density test shall be conducted at the completion of trial pad for Level 1 and Level 2.

Large scale bulk density tests shall be performed in accordance with AS 1289.5.3.5 *Soil compaction and density tests – Determination of the field dry density of a soil – Water Replacement Method*.

For the trial pad, a minimum of two large scale bulk density tests shall be performed within the crest of the starter bund and minimum of one test shall be performed within the backfilled waste rock.

Nuclear Density Tests in Rockfill

For trial pad, nuclear field density tests are to be performed at test locations correlating to survey points. In addition, further tests are to be performed at proposed large scale density test locations prior to commencement of large-scale density tests.

Nuclear field density tests are to be performed in accordance with:

- AS 1289.5.8.1-2007 *Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge-direct transmission*; or
- AS 1289.5.8.1 Cl 1 if more than 20% by mass of particles retained on the 37.5mm sieve.

In creating the vertical annular space by driving a rod into the layer required for testing, several attempts maybe required due to the presence of larger particles within the layer.

Per nuclear field density location, a minimum of 3 nuclear density readings shall be taken at the same probe test hole location on the rockfill surface with the machine rotated approximately 120 degrees between each test. Density reading for each test and the average for the three tests shall be determined.

Nuclear density tests shall be performed for each lift.

Estimation of the of the moisture content for the layer may be determined from the 19mm minus fraction of representative subsample taken from the nuclear density test location. Subsample quantities for trial shall be taken in accordance with:

- AS 1289.1.1-2001 *Sampling and preparation of soils – Preparation of disturbed samples for testing*; and
- AS 1289.1.2.1 *Sampling and preparation of soils – Disturbed Samples-Standard Method.*

Assignment of Maximum Dry Density and Optimum Moisture Content Values

Assignment of Maximum Dry Density and Optimum Moisture Content may be performed in accordance with AS 1289.5.4.2. Assignment values are to be updated in accordance with the Standard frequency rates.

8.4.5 Lime Dosage and Mixing

The lime mixing method will be trialled and laboratory testing performed to identify the required number of passes of the mixing equipment to achieve the degree of mixing acceptable to the Geochemist.

The Principal and CQA Consultant will approve the proposed placement, spreading of lime, mixing of lime and compaction methods for Starter Bunds and Waste Rock, prior to full-scale operations. This shall be a **hold point**.

8.4.6 General

If the fill material to be placed is in a condition, or attains a condition (e.g. as a result of inclement weather), such that it cannot be placed or compacted in compliance with the Specification, the following courses of action shall be undertaken:

- The affected material shall be removed and discarded or stored until it attains a suitable condition; or
- The material shall be treated by wetting, or being allowed to dry, as appropriate.

Any soft or heave areas should be excavated down at least 500mm and backfilled with appropriate suitable fill material.

Haulage of suitable materials to the areas of placement shall only proceed when sufficient spreading and compaction plant is operating at the place of deposition. There shall be minimum delay between placement and compaction.

8.5 Quality Control testing

To provide confirmation that placement and compaction is being conducted in accordance with the Specifications, control testing shall be conducted on the placed and compacted select fill material. Control testing is to be performed in accordance with AS 3798-2007 Level 1 Supervision.

8.5.1 WSF Foundation

Control testing for density and moisture is to be arranged by the Contractor as per test locations stipulated by the CQA Consultant. Control testing for density and moisture of the compacted clay liner is to be conducted at one of the following frequencies[1] (whichever that results in the largest total number of tests):

- 1 test per per material type, per 2,500 m^2; or
- 1 test per 500 m^3 of placed material, distributed reasonably evenly throughout the full depth and area; or
- 3 tests per lot (as defined in Clause 1.2.8 of Australian Standard AS 3798-2007[2]).

8.5.2 Starter Bunds

Starter bund control testing is to be conducted by a suitably qualified third-party geotechnical inspection and testing authority.

8.5.2.1 Nuclear Density Test

Nuclear field density tests are to be performed in accordance with AS 1289.5.8.1-2007 *Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge-direct transmission*.

[1] Testing frequencies for "Type 1 Large scale operations" as per Table 8.1 of AS 3798-2007.
[2] AS 3798-2007 defines a Lot as: "A lot is an area of work that is essentially homogeneous in relation to material type and moisture condition, rolling response and compaction technique, and which has been used for the assessment of the relative compaction of an area of work."

Per nuclear field density location, a minimum of 3 nuclear density readings shall be taken at the same probe test hole location on the rockfill surface with the machine rotated approximately 120 degrees between each test. Density reading for each test and the average for the three tests shall be determined.

- Nuclear Density Test: 1 test per 5000m^3 of placed material.

8.5.2.2 Large Scale Density Test

Large scale bulk density tests shall be performed in accordance with AS 1289.5.3.5 *Soil compaction and density tests – Determination of the field dry density of a soil – Water Replacement Method*.

- 1 large scale bulk density test per 1 calendar month.

8.5.2.3 Proof Roll

Quality control testing of starter bunds is to be conducted by proof rolling under guidance from Northern Territory Department of Infrastructure, Planning and Logistics (DIPL) "*Standard Specification for Roadworks, 2017*". Control testing of the Starter Bunds is to be conducted with the following requirements;

- Static steel drum rollers with a mass of not less than 8 tonnes;
- Proof roll immediately following completion of compaction. If carried out at later time, water the surface and roll with test roller prior to proof rolling.
    - 1 proof roll per 35,000m^3 of material placed or 1 test per week, whichever yields the most tests. Proof rolls should be at least the length of the placed layer for the width of plant used with -5m allowance for the edge of placed layer. Proof rolling should avoid testing strips of the same placed layer but rather cross strips where practicable.
    - Proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation or springing.

If doubt exists surrounding strength of placed layer, perform additional proof rolls over subject area in accordance with above. Proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation or springing.

8.5.2.4 Maximum Dry Density and Optimum Moisture Content Assigned Values

As per Australian Standard AS 1289.5.4.2 *Assignment of Maximum Dry Density and Optimum Moisture Content Values* (whichever yields the least amount of tests):

- 1 test per 10,000 tonnes supplied; or
- 1 test per fortnight.

8.5.2.5 Particle Size Distribution

- Particle size distribution: 1 test per 15,000m^3 of placed material.

8.5.3 Waste Rock

Waste Rock Quality control testing is to be conducted by a suitably qualified third-party geotechnical inspection and testing authority.

Waste rock – lime dosing, mixing, watering and rolling routine through development of trial sections and nominate a verified routine to be approved by Superintendent.

8.5.3.1 Visual Inspection

Undertake visual inspection of placed layer to assess for soft spots, over moistened areas and adequate lime mixing.

- Minimum 1 inspection per day of material placed.

8.5.3.2 Nuclear Density Test

Nuclear field density tests are to be performed in accordance with AS 1289.5.8.1-2007 *Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge-direct transmission*.

Per nuclear field density location, a minimum of 3 Nuclear Density readings shall be taken at the same probe test hole location on the rockfill surface with the machine rotated approximately 120 degrees between each test. Density reading for each test and the average for the three tests shall be determined.

- Nuclear Density Test: 1 test per 5,000m^3 of placed material.

8.5.3.3 Large Scale Density Test

Large scale bulk density tests shall be performed in accordance with AS 1289.5.3.5 *Soil compaction and density tests – Determination of the field dry density of a soil – Water Replacement Method*.

- Large Scale Density Test: 1 large scale bulk density test per 1 calendar month.

8.5.3.4 Proof Roll

Quality control testing of waste rock is to be conducted by proof rolling under guidance from Northern Territory Department of Infrastructure, Planning and Logistics (DIPL) "*Standard Specification for Roadworks, 2017*". Control testing of the waste rock is to be conducted with the following requirements;

- Static steel drum rollers with a mass of not less than 8 tonnes;
- Proof roll immediately following completion of compaction. If carried out at later time, water the surface and roll with test roller prior to proof rolling.
    - 1 proof roll per 35,000m^3 of material placed or 1 test per week, whichever yields the most tests. Proof rolls should be at least the length of the placed layer for the width of plant used with -5m allowance for the edge of placed layer. Proof rolling should avoid testing strips of the same placed layer but rather cross strips where practicable.
    - Proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation or springing.

If doubt exists surrounding strength of placed layer, perform additional proof rolls over subject area in accordance with above. Proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation or springing.

If area is wet or over moistened, allow to dry out prior to placing next layer. Remedial actions to address failed control tests are described in **Section 8.5.4**.

8.5.3.5 Maximum Dry Density and Optimum Moisture Content Assigned Values

As per Australian Standard AS 1289.5.4.2 *Assignment of Maximum Dry Density and Optimum Moisture Content Values* (whichever yields the least amount of tests):

- 1 test per 10,000 tonnes supplied; or
- 1 test per fortnight.

8.5.4 Remedial Works

Where control testing indicates non-compliances with the Specification, the Contractor is required to undertake remedial actions to address the non-compliances at the Contractor's cost. Remedial actions include:

- Material in non-compliant areas are treated by wetting, or being allowed to dry, as appropriate; and/or
- Material in non-compliant areas are subject to additional compaction; and/or
- Material in non-compliant areas is removed and those areas reinstated with other suitable fill material in accordance with **Sections 8.3.3**.

Re-testing will be conducted on the remediated areas to assess the effectiveness of the remedial actions taken. Field density testing shall be carried out within 48hrs of completion of compaction of the layer to be tested.

Test results shall be provided to the nearest 0.5% for both density and moisture content variation. Results that fall outside the requirements by 0.5% or greater will constitute a failure.

Relevant calibration certificates shall be provided at the start of the Contract and any other time as requested by the Superintendent.

Field test logs shall be submitted at regular intervals as per Superintendent instructions and include location of test, lift/layer location, date, time, person performing test, equipment; type, number and calibration number as a minimum.

It is expected that the Contractor's Works program will include consideration of control testing to avoid or minimise project delays. Any fill placement and compaction works undertaken by the Contractor, in advance of confirmation that the placed and compacted fill meets Specification requirements, are undertaken at the Contractor's risk.

9 Compacted Clay Liner

The Compacted Clay Liner (CCL) is to be constructed as part of the EWSF and WWSF Cover Systems and for the capping of radioactive soils within the WWSF.

9.1 Materials Requirements and Field Trial

9.1.1 Materials Requirements

Suitable fill materials for the Compacted Clay Layer (CCL) shall:

- Comprise cohesive materials of high plasticity;
- Be free of organic material;
- Have the following properties:
    - An in-situ co-efficient of permeability/hydraulic conductivity of less than $1x10^{-9}$ m/s when measured in a triaxial cell;
    - Maximum particle size of 50mm;
    - Soil plasticity index > 10%;
    - ≥ 50% material passing 4.75mm sieve;
    - ≥ 30% material passing 0.075mm sieve; and
    - > 10% materials passing 0.002mm sieve.

Materials *not* suitable for the Compacted Low Permeability Clay Capping Layer are those that are, or contain:

- Peat, vegetation, waste rock, organic, soluble or perishable material;
- Construction or demolition waste, non-natural material or deleterious materials;
- Actual or potential acid sulfate soils;
- Organic clays and silts;
- Hazardous, dangerous or toxic material; or
- Material susceptible to combustion.

CCL material is to be **progressively tested and approved by the GITA and Principal prior to importation and placement** as part of the EWSF, WWSF and capping of radioactive soils within the WWSF in accordance with **Table 11**.

Table 11 Source Testing Requirements

Property	Test Method	Control Test Frequency
Particle size distribution	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	1 test per 5000m^3
Liquid limit and plasticity index	AS 1289.3.1.1, 3.2.1 & 3.3.1	1 test per 5000m^3
Coefficient of permeability	AS 1289.6.7.2-2001	1 test per 5,000m^3

Material testing is to be arranged by the Contractor as per test locations stipulated by the CQA Consultant. Material testing of the compacted clay liner is to be conducted at one of the following frequencies as specified in **Section 9.3**.

9.1.2 Field Trial

Prior to construction of the compacted low permeability clay capping layer, a field trial shall be carried out to prove that the Contractor's proposed construction methodology, plant and the proposed clay capping material will meet the Specification requirements.

Prior to undertaking the field trial, the Contractor shall prepare and submit a Work Method Statement detailing the proposed field trial methodology and plant, including completed compacted clay liner maintenance works, for review by the Superintendent.

The Contractor is required to provide a manufacturers data sheet regarding the proposed plant for the field trial pad (and subsequent placement of the compacted clay liner). Where possible, the data shall include details of the type, dimensions, weight and operating speed of the compaction plant and details of the rollers.

The field trial should be carried out where the low permeability layer will be constructed, and in an area not less than 20m x 20m. The field trial is to be incorporated into the waste rock and starter bund trial detailed in **Section 8.4**.

The field trial clay capping layer will be constructed to a total compacted depth of 650mm, with a minimum of three lifts. The Contractor may propose to alter the minimum number of lifts contingent on approval by the Superintendent and provision of evidence and supporting documentation (i.e. test results), which confirm compliance with this Specification's moisture, density and permeability requirements.

To determine the optimum number of passes to achieve Specification requirements, the first lift of the trial clay layer shall be compacted with a total of ten passes of the compaction plant, with tests for field compaction and moisture content (refer to **Section 9.2**) conducted after six, eight and ten passes of the compaction plant.

On completion of testing and sampling of the first lift, the upper surface of the trial capping shall be scarified, the next lift placed, compacted with the optimum number of passes (as determined from the first lift) and tested for field compaction and moisture content. This process shall be repeated until the trial clay cap has been constructed to the required 650mm depth (500mm non-scarified).

On completion of the trial clay capping, the following shall be undertaken:

- A copy of the certified control test results to be provided for review by the CQA Consultant and Superintendent;
- The final rolled surface shall be scarified to a maximum depth of 150mm to provide a rough, firm and unyielding surface to lay the growth medium layer;
- Four Nuclear Field Density Tests in accordance with AS 1289 5.8.1 supplemented by laboratory Standard Proctor Density Tests in accordance with AS 1289 5.1.1 at a NATA accredited laboratory will be performed at designated sample locations, beneath the scarified (remove 150mm scarified material within vicinity of test) layer ideally within proximity to the proposed core sample locations outlined below. The results of the field and laboratory assessment will be used to correlated against laboratory results from the below points.

- Four undisturbed core samples shall be collected for permeability testing in a NATA accredited laboratory in accordance with Australian Standard AS 1289.6.7.3-2016 *Methods of testing soils for engineering purposes – Soil strength and consolidation tests – Determination of permeability of soil – Constant head method using a flexible wall permeameter.* The four undisturbed core samples are to be collected from locations evenly distributed across the lateral and vertical extents of the completed trial layer; and
- A section shall be excavated through the trial clay layer to demonstrate the adequacy of inter-lift bonding and thickness of layer resulting from the Contractor's proposed methodology and plant.

If results of the field trial prove unsuccessful, the placement methodology and/or compaction plant shall be changed and a further trial carried out to assess the revisions. This process shall continue until the CQA Consultant and Superintendent are satisfied that the proposed plant and methodology will produce satisfactory results. If the field trial is carried out within the area of the Works, any non-conforming material shall be removed prior to initiating further low permeability clay capping layer construction.

If the results demonstrate that the methodology and plant used for the field trial achieve the Specification requirements, works may proceed with placement of the clay cap. The field trial clay cap may be incorporated into the permanent works, if it has been constructed within the area of the Works.

9.2 Construction Requirements

The compacted low permeability clay layer is to be constructed over the waste rock in accordance with the Construction Drawings. Placement and compaction of fill material is to be undertaken in accordance with Australian Standard AS 3798-2007 *Guidelines on earthworks for commercial and residential developments.*

- The material shall be placed in loose layers such that when compacted, each layer does not exceed 250mm thickness.
- Each layer is to be compacted to a dry density of at least 98% of Standard Maximum Dry Density, with moisture content within the range of -1 % to +3 % of Optimum Moisture Content.
- Dry density and moisture content are to be confirmed via Control Testing (**Section 3.3**).
- The finished low permeability clay layer must have a minimum (non-scarified) thickness of 500mm measured at right angles to the slope as shown on the Construction Drawings.
- Clay capping on the WSF slopes to have a thickness of 650mm and have the surface scarified to a maximum depth of 150mm (WSF Slopes only). Scarification to occur immediately prior to growth medium placement to prevent drying out of the clay layer.

Prior to compaction, each discrete lift will be visually inspected by the Contractor and all unsuitable materials shall be removed.

Should connections be required between adjacent lift layers or to tie-in to existing edges/faces will be trimmed back to remove any desiccated material such that the material exposed in the face complies with this Specification. The clay cap material to be placed is to be benched into the existing face/edge.

Haulage of suitable materials to the areas of placement shall only proceed when sufficient spreading and compaction plant is operating at the place of deposition. There shall be minimum delay between placement and compaction.

9.3 Control Testing

To provide confirmation that placement and compaction of the low permeability clay capping lifts are to be conducted in accordance with the Specifications, control testing for compaction density and moisture content (see **Section 3.1.1** for material properties and **Section 3.2** for density and moisture requirements) shall be conducted on the placed and compacted clay material.

Control testing will involve field testing by an appropriately qualified Geotechnical Inspection and Testing Authority (GITA) with a nuclear densometer and collection of representative samples for laboratory testing by a NATA accredited geotechnical laboratory.

Control testing is to be arranged by the Contractor. Control testing of the low permeability compacted clay cap is to be conducted at one of the frequencies[3] in **Table 12** (whichever that results in the largest total number of tests):

Table 12 Low Permeability CCL Testing Requirements

Property	Test Method	Control Test Frequency
Density and moisture	AS 3798-2007	• 1 test per layer, per material type, per 2500m^2; or • 1 test per 500 m^3 of placed material, distributed reasonably evenly throughout the full depth and area; or • 3 tests per lot (as defined in Clause 1.2.8 of Australian Standard AS 3798-2007[4]).
Particle size distribution	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	1 test per 2500m^3 of placed material
Liquid limit and plasticity index	AS 1289.3.1.1, 3.2.1 & 3.3.1	1 test per 2500m^3 of placed material
Coefficient of permeability (triaxial)	AS 1289.6.7.3	1 test per 10,000m^3 of placed material

Remedial actions to address failed control tests are described in **Section 9.4**.

9.4 Remedial Works

If the fill material to be placed is in a condition, or attains a condition (e.g. as a result of inclement weather), such that it cannot be placed or compacted in compliance with this Specification, the following courses of action shall be undertaken:

- The affected material shall be removed and discarded or stored until it attains a suitable condition; or
- The material shall be treated by wetting, or being allowed to dry, as appropriate.

[3] Testing frequencies for "Type 1 Large scale operations" as per Table 8.1 of AS 3798-2007.
[4] AS 3798-2007 defines a Lot as: "A lot is an area of work that is essentially homogeneous in relation to material type and moisture condition, rolling response and compaction technique, and which has been used for the assessment of the relative compaction of an area of work."

Should remedial works be considered necessary to address issues with the compacted clay layer (e.g. desiccation cracks ≥ 25mm in width, swelling, heaving), the Contractor shall:

- Scarify the clay cap to the required depth and subsequently re-compact to meet requirements of this Specification; and/or
- Replacement of the affected portion of the clay layer. The minimum thickness of replacement clay cap shall be 150mm, to provide a satisfactory key with the existing compacted clay capping.

Where control testing indicates non-compliances with the Specification, the Contractor is required to:

- Undertake additional works on the area represented by the failed test as necessary such that subsequent testing of the area meets the required density and/or moisture requirements. Additional works may include wetting up or drying of placed materials, additional passes of the compacting plant; and/or
- Remove the part of the layer demonstrated to have not met the required density and/or moisture requirements and replace it to the satisfaction of the CQA Consultant and/or Superintendent.

Re-testing will be conducted on all remediated areas to assess the effectiveness of the remedial actions taken.

The CQA Consultant shall record all locations/areas of non-compliance together with remedial actions taken and shall advise the Superintendent not to permit placement of a subsequent layer on the area until compliance is achieved and documented.

It is anticipated that the Contractor's Works program will include consideration of control testing so as to avoid or minimise project delays. Any fill placement and compaction works undertaken by the Contractor, in advance of confirmation that the placed and compacted fill meets Specification requirements, are undertaken at the Contractor's risk.

9.5 Finished Surface of Low Permeability Clay Capping (WSF Slopes)

The low permeability clay cap shall be finished, and maintained, as necessary by the Contractor to:

- Scarify maximum depth of 150mm from top surface to allow adhesion of growth medium layer to low permeability clay capping layer. Scarification may only be performed immediately prior to growth medium placement;
- Provide a firm unyielding foundation, sufficient to permit the movement of vehicles without causing deleterious effects;
- Be free from areas excessively desiccated or softened by high moisture content;
- Produce an even and stable surface, without any significant bumps, hollows or areas that may collect standing water;
- Be free from any sudden breaks in grade;
- Be free from any timber, waste/construction debris and roots;
- Be free from any sharp or angular particles of any size; and
- Be free from any protrusions (including objects) larger than 50 mm from the finished surface on the crest of the EWSF and the WWSF.

The Contractor shall protect the surface from erosion and desiccation.

The Superintendent will accept in writing to the Contractor that the final clay fill surface complies with the Specification, or whether any additional works are required for acceptance. Prior to receipt of the Superintendent's acceptance, any damage to the compacted clay liner surface due to the Contractor's activities or the elements shall be repaired (**Section 3.4**) at the Contractor's expense. The acceptance of the final clay surface shall not relieve the Contractor of their responsibility to continuously maintain the finished clay cap as described in this section.

9.6 Finished Surface of Low Permeability Clay Capping (WSF Plateaus)

The low permeability clay cap shall be finished, and maintained, as necessary by the Contractor to:

- Provide a firm unyielding foundation, sufficient to permit the movement of vehicles and welding equipment over the seal bearing layer without causing rutting or other deleterious effects;
- Be free from areas excessively desiccated or softened by high moisture content;
- Produce an even and stable surface, without any significant bumps, hollows or areas that may collect standing water;
- Be free from any sudden breaks in grade;
- Be free from any timber, waste/construction debris and roots;
- Be free from any sharp or angular particles of any size; and
- Be free from any protrusions (including objects) larger than 50 mm from the finished surface on the crest of the EWSF and the WWSF.

The Contractor shall protect the surface from erosion and desiccation.

The Superintendent will accept in writing to the Contractor that the final clay fill surface complies with the Specification, or whether any additional works are required for acceptance. Prior to receipt of the Superintendent's acceptance, any damage to the low permeability clay capping surface due to the Contractor's activities or the elements shall be repaired (**Section 3.4**) at the Contractor's expense. The acceptance of the final clay surface shall not relieve the Contractor of their responsibility to continuously maintain the finished compacted clay liner as described in this section.

9.7 Compacted Clay Fill Survey

The thickness of the compacted clay liner will be verified through as-built survey data.

10 Geomembrane Liner

The linear low density polyethylene (LLDPE) geomembrane liner is to be installed across the upper surface of the compacted clay liner on the crest of the EWSF and the WWSF. A high density polyethylene (HDPE) geomembrane liner is to be installed across the upper surface of the sediment basin floor and embankment walls.

10.1 Geomembrane Materials Requirements

The LLDPE geomembrane shall:

- Consist of 1.5mm thick, unlaminated LLDPE;
- Be textured on both sides;
- Be produced from pure (non-recycled) resins and contain no fillers, plasticisers or additives of any kind, with the exception of carbon black; and
- Comply with the Materials Criteria in **Table 13.**

The HDPE geomembrane shall:

- Consist of 1.5mm thick, unlaminated HDPE;
- Be textured on both sides;
- Be produced from pure (non-recycled) resins and contain no fillers, plasticisers or additives of any kind, with the exception of carbon black; and
- Comply with the Materials Criteria in **Table 13.**

10.2 Materials Acceptance Procedure

10.2.1 General

The materials acceptance procedure for the geomembrane proposed to be used requires materials information from the manufacturer and results of conformance testing to be provided by the Contractor for review by the CQA Consultant and Superintendent.

Acceptance of the proposed geomembrane is a staged procedure, involving the following steps:

1. Review of manufacturer's quality control information by CQA Consultant and Superintendent;
2. Provisional written approval for shipment to site;
3. Conformance testing of materials delivered to site and review of conformance testing results by CQA Consultant and Superintendent; and
4. Final written approval for use of geomembrane.

10.2.2 Manufacturer's Quality Control Information

The Contractor is responsible for nominating the geomembrane manufacturer, the geomembrane product for use and providing the required manufacturer's information for review by the CQA Consultant and Superintendent.

The geomembrane manufacturer shall:

- Be Certified AS/NZS ISO 9001:2000;
- Meet or exceed the requirements for manufacture and performance contained in the relevant specifications published by the Geosynthetic Research Institute (Folsom, PA, USA) for high density polyethylene geomembranes; and
- Meet or exceed the requirements listed in **Table 13** or **Table 14** as appropriate.

Table 13 LLDPE Geomembrane Requirements

Property	Test Method	Required Value	Minimum Test Frequency
Thickness	ASTM D5994 (textured)	1.5mm	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Asperity Height	ASTM D7466	0.40mm	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Density (max)	ASTM D1505 / D792	≥ 0.939 g/ml	1 test per 5,000 m², including the first and last rolls (based on production order): minimum of two tests
Tensile Properties - Break strength (textured LLDPE)	ASTM D6693	≥ 16 N/mm	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Tensile Properties - Elongation at yield (textured LLDPE)		≥ 250%	
Puncture Resistance (textured)	ASTM 4833	≥ 300N	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Tear Resistance	ASTM D1004	≥ 150N	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Carbon Black Content	ASTM D4218	2.0% to 3.0%	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Carbon Black Dispersion	ASTM D5596	90 % Cat 1 or Cat 2; 10 % Cat 3	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Axi-symmetric break resistance strain	ASTM D5617	30%	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests
Standard Oxidative Induction Time	ASTM D3895	≥ 100 minutes	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests

Property	Test Method	Required Value	Minimum Test Frequency
High Pressure oxidative induction time	ASTM D5885	≥ 400 minutes	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests

LLDPE Geomembrane Requirements from GRI Test Method GM17 "*Standard Specification for Test Methods, Test Properties and Testing Frequency for Linear Low-Density Polyethylene (LLDPE) Smooth and Textured Geomembranes*" Revision 12.

Table 14 HDPE Geomembrane Requirements

Property	Test Method	Required Value	Minimum Test Frequency
Thickness	ASTM D5994 (textured)	2mm	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Asperity Height	ASTM D7466	0.40mm	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Density (minimum)	ASTM D1505 / D792	≥ 0.94 g/cm^3	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Tensile Properties - Yield strength (textured HDPE)	ASTM D6693	≥ 29 kN/m	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Tensile Properties - Break strength (textured HDPE)		≥ 21 kN/m	
Tensile Properties - Elongation at yield (textured HDPE)		≥ 12%	
Tensile Properties - Elongation at break (textured HDPE)		≥ 100%	
Puncture Resistance (textured)	ASTM 4833	≥ 534N	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Tear Resistance	ASTM D1004	≥ 249N	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Carbon Black Content	ASTM D4218	2.0% to 3.0%	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Carbon Black Dispersion	ASTM D5596	90 % Cat 1 or Cat 2; 10 % Cat 3	1 test per 5,000m², including the first and last rolls (based on production order): minimum of two tests
Stress Crack Resistance	ASTM D5397	500hr	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests

Property	Test Method	Required Value	Minimum Test Frequency
Standard Oxidative Induction Time	ASTM D3895	≥ 100 minutes	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests
High Pressure Oxidative Induction Time	ASTM D5885	≥ 400 minutes	1 test per 10,000m², or resin type or manufacturing run (whichever results in the greatest number of tests), including the first and last rolls (based on production order): minimum of two tests

HDPE Geomembrane Requirements from GRI Test Method GM13 "Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes" Revision 14.

In lieu of the above certification, alternative independently audited standards may be considered but not necessarily accepted by the Superintendent.

For each batch of material proposed for delivery to site, the Contractor shall provide the following:

- Origin of the resin (resin supplier's name, resin production plant);
- Identification of the resin (brand name, batch number);
- Production date of the resin;
- A copy of the quality control certificates issued by the resin supplier noting results of density, melt index and carbon back tests;
- Date of production, plant location, resin batch number, manufacturing lot/batch number, roll identification number and size (m^2) of each geomembrane roll. Rolls shall be listed in the order of production with the status of the roll;
- Documentation that demonstrates compliance with the geomembrane manufacturer's quality control program for all geomembrane proposed for use; and
- Reports on tests conducted by the resin and/or geomembrane manufacturer in line with **Table 13**.

10.2.3 Conformance testing

As soon as practicable after the delivery of geomembrane to the site, the Contractor shall label and cut a sample 1000 mm wide across the entire width of selected rolls under the direction of the CQA Consultant for conformance testing.

Each sample will be separated into three subsamples of equal size:

- On subsample to be submitted to an independent, NATA-accredited laboratory for testing as per **Table 13**;
- One subsample to be retained by the Contractor; and
- One subsample to be retained by the CQA Consultant.

The Contractor shall furnish to the Superintendent a copy of the certified laboratory test results as soon as possible after receipt.

If a conformance sample cut from a roll fails to meet the materials requirements in **Table 13** the CQA Consultant may accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing that the material does meet the materials requirements in **Table 13**. Any such further testing shall be undertaken at the Contractor's expense. Alternatively, the roll may be rejected, and a replacement roll considered for the Works as per requirements of **Sections 10.1, 10.2, 10.3 and 10.4** of the Specification.

If rolls on site from previous projects are being used in the Works, at least 1 conformance sample must be taken from each batch number from these rolls. Rolls on site from previous projects shall only be considered for use if the roll number, batch number and manufacturer's details are known and appropriate manufacturer's certification(s) and associated quality control testing information is provided to the CQA Consultant and Superintendent.

10.3 Geomembrane Roll Labelling

All rolls of geomembrane delivered to site must be clearly and legibly labelled with the following information:

- Name of manufacturer;
- Product identification number;
- Date and location of production;
- Product type and grade;
- Roll identification number;
- Lot or batch number; and
- Length and width of the geomembrane.

The label information shall be affixed or attached to the roll at all times during deployment of the roll. The Contractor shall record the roll number of every roll of geomembrane liner used, together with its approximate location within the finished works.

10.4 Delivery, Handling and Storage

The geomembrane liner shall be stored in accordance with the geomembrane manufacturer's recommendations at a location to be agreed on site with the Superintendent.

The storage area shall be firm, clean and rolled flat to avoid damage to the geomembrane liner.

No materials shall be placed on top of the stacked geomembrane liner.

The Contractor shall provide adequate and acceptable measures for protecting the materials at all stages of the work from all sources of potential damage, including adverse weather conditions until completion of the Works.

A copy of the geomembrane shipping documents, including an inventory of all received geomembrane (with associated roll numbers and batch numbers) shall be provided to the Superintendent within 48 hours of the material arriving on site.

10.5 Geomembrane Installer's Experience

The geomembrane installer shall have previously installed LLDPE or HDPE geomembrane on a minimum of 3 similar projects, each of which required installation of at least 50,000m^2 of LLDPE or HDPE geomembrane under quality-controlled conditions.

The geomembrane installer's welding team leader should hold a welder's certificate complying with Australian Standard AS 1796-2001 *Certification of welders and welding supervisors*, or a qualification in either engineering, metallurgy or welding and at least three years' experience in welding fabrication and be fully accredited to applicable geosynthetic membrane industry standards (e.g. Geosynthetic Certification Institute).

Trainee technicians may be allowed to carry out welding activities provided they are at all times under the direct supervision of the welding team leader.

10.6 Geomembrane Deployment

10.6.1 Work Method Statement and Panel Layout Plan

A minimum of ten work days prior to the planned geomembrane installation start date, the Contractor shall prepare and submit to the CQA Consultant and Superintendent for review and approval a work method statement detailing the proposed methodology, equipment and construction quality control procedures for installing the geomembrane.

The Contractor shall submit to the CQA Consultant and Superintendent for review and approval a detailed Panel Layout Plan showing the proposed layout and sequence of geomembrane placement not less than one week prior to commencing installation. The Panel Layout Plan shall also include an identification code assigned to each field panel.

Geomembrane panels shall be installed in accordance with the approved Panel Layout Plan.

10.6.2 Geomembrane Installation Practices

Geomembrane will be installed with the following considerations:

- The geomembrane shall be positioned as shown on the Construction Drawings. The geomembrane shall be placed to the back edge of the anchor trench and shall be free from cuts, holes, blisters, abrasions or other surface blemishes or defects;
- Overlaps between parallel panels of geomembrane shall be between 150mm and 200mm;
- Tie-in between side-wall panels and floor panels shall be at least 1000mm from the toe of the batter;
- The Contractor will mark the panel number, roll number and date deployed on all geomembrane panels placed during the works;
- For each geomembrane panel used in the Works, the Contractor shall record the identification code, location and date of installation;
- 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.

- Care is to be taken to protect the underlying layers from damage during geomembrane installation. Any damage to the clay or subgrade surface resulting from geomembrane installation will require the Contractor to carry out remedial work to ensure compliance with **Section 6** of the Specification. As a minimum, the Contractor is expected to:
    - Deploy the geomembrane close to its final position as practically possible to minimise the need for pulling the panel over the CCL liner;
    - Keep free edges of geomembrane panels adequately weighed down with sand bags, or other means approved by the CQA Consultant and Superintendent;
    - Avoiding, where possible, driving plant or moving equipment directly on the underlying CCL; and
    - Report to the CQA Consultant any damage that occurs to the underlying CCL.
- To minimise the likelihood for damage to the geomembrane, the geomembrane installation crew are required to:
    - Wear suitable footwear such that damage to the LLDPE/HDPE geomembrane liner does not occur;
    - Ensure no naked flames are used during the works;
    - Not smoke at any time when handling or working with the geomembrane liner; and
    - Ensure no hydrocarbon sources are permitted onto the exposed geomembrane liner.
- The Contractor shall inspect each panel after placement and prior to seaming for damage and shall advise the CQA Consultant which panels or portions of panels are offered for acceptance or are to be repaired. Rejected panels, or portions of panels, shall be marked and their removal from the Work area shall be recorded by the Contractor. Repairs shall be made according to **Section 7.7**;
- The Contractor shall be responsible for the geomembrane at all times during the Contract and shall adopt whatever measures are necessary to ensure its stability and protect it from damage. These measures shall include the use of sufficient temporary surcharge in the form of durable sandbags, tyres or similar weights without sharp edges, to be placed on the geomembrane immediately after laying and before seaming to prevent slipping and damage by wind or other agents prior to covering; and
- Any problems arising from the Contractor's failure to secure the geomembrane adequately during the contract shall be remedied at the Contractor's expense.

10.6.3 Seaming

10.6.3.1 Seaming Equipment

Geomembrane panels are to be seamed using:

- Fusion (hot wedge) welding, for main seams between panels of geomembrane, including pipe-boots; and
- Extrusion welding, for repairs and patches.

10.6.3.2 Trial Seams

Trial seams will have to be prepared at the following times:

- Prior to commencement of each welding shift;
- After every four hours of continuous welding for a given machine;

- At a change of machine setting (e.g. temperature, speed);
- At a change of welding technician for a given machine;
- Following any period of machine shut down longer than 30 minutes;
- As weather conditions dictate; or
- After an unsatisfactory trial seam.

LLDPE trial seams will be considered satisfactory when all of the following requirements are met:

- Trial seam conducted at the appropriate time (see above);
- Peel and shear field tests on the trial seam (to be conducted with a field tensiometer) show for at least five seam samples tested consecutively that:
    - Peel and shear failures occur only in the sheet and not within the seam;
    - Separation-in-plane failures do not extend beyond 65% of the nearest weld-track width;
    - Peel strength of ≥ 328N (fusion welds) and ≥ 290N (extrusion welds); and
    - Shear strength of ≥ 394N.

HDPE trial seams will be considered satisfactory when all of the following requirements are met:

- Trial seam conducted at the appropriate time (see above);
- Peel and shear field tests on the trial seam (to be conducted with a field tensiometer) show for at least five seam samples tested consecutively that:
    - Peel and shear failures occur only in the sheet and not within the seam;
    - Separation-in-plane failures do not extend beyond 65% of the nearest weld-track width;
    - Peel strength of ≥ 530N (fusion welds) and ≥ 455N (extrusion welds); and
    - Shear strength of ≥ 701N.

Production seams may only be undertaken upon approval by the CQA Consultant and with satisfactory results of trial seams.

If a trial seam is unsatisfactory, the seaming machine and the operator shall not be allowed to conduct production seaming until the deficiencies are corrected and both machine and operator have achieved a two consecutive satisfactory trial seams.

10.6.3.3 Production Seams

Completed production seams shall have overlaps of between 150mm and 200mm between parallel panels of geomembrane.

All production seams are subject to the following stipulations:

- All surfaces to be seamed are required to be clean, dry, free from dust, dirt and other loose particles;
- If seam overlap grinding is required to produce a clean surface for seaming:
    - Less than 10% of the nominal thickness of the geomembrane shall be removed;

  - Seaming is completed no later than one hour after grinding in order to mitigate oxidation of the sheet; and
  - Grinding does not extend beyond the edges of the weld.
- Seaming is not allowed during rain, 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 shall not take place during high winds;
- Ambient air temperature for seaming shall be between 5˚C and below 35˚C;
- Seams are aligned with the fewest possible number of wrinkles;
- All cross seams are to be reinforced at the T-joins with a geomembrane patch, which is to be extrusion welded to cover the intersection to a radius of at least 100mm;
- 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 10.7**; and
- During construction the specified overlap shall be clearly marked on the edge of the underlying sheet prior to seaming. Failure to maintain the minimum overlap may be cause for rejection of the seam.

10.6.4 Testing

10.6.4.1 Seam Field Testing

The continuity of all seams, including seams carried out for repair work, will be field tested by the Contractor by air pressure testing (for fusion welded seams) or vacuum testing (for extrusion welded seams).

Air pressure testing is to be conducted in accordance with ASTM D5820 *Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.*

Vacuum testing is to be conducted in accordance with ASTM 5641 *Standard Practice for Geomembrane Sean Evaluation by Vacuum Chamber.*

The Contractor shall write the date of the test, start and finish times of the test, test results (including starting and end air pressures, for air pressure tests) and test personnel on the relevant geomembrane panel, which will be checked and confirmed by the CQA Consultant.

Passing conditions for air pressure and vacuum testing are:

- Air pressure testing:
  - From an initial pressure of 40psi, the loss of pressure is < 2psi over a 5 minute period.
- For vacuum testing:
  - No developing air bubbles for a period of at least 15 seconds from commencement of test.

Where testing indicates a failure along a seam, the test length shall be incrementally reduced until the failure area has been clearly identified and can be repaired. The Contractor shall subject the repair to further testing, and further repairs as necessary, until the tests indicate passing conditions for the seam.

10.6.4.2 Destructive Testing (for fusion welded seams only)

Destructive testing shall be conducted at a rate equivalent to one test per every 200m of fusion welded seaming completed by the Contractor. Locations for destructive testing shall be nominated by the CQA Consultant.

Destructive testing will comprise the following:

- A length is cut from the completed field seam;
- One portion of the sample of the field seam is to be field tested as per the method for Trial Seams (**Section 10.6.4.2**).
- The second portion of the sample of the field seam is to be submitted by the Contractor to an independent, NATA accredited laboratory for shear and peel testing in accordance with ASTM D6392 *Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.*

Passing conditions for LLDPE destructive samples are:

- Peel and shear field tests show, for 100% of weld samples tested:
    - Peel and shear failures occurring in the parent material and not within the seam;
    - Peel strength of ≥ 328N (fusion welds) and ≥ 290N (extrusion welds); and
    - Shear strength of ≥ 394N.
- Peel and shear laboratory tests show 100% of weld samples tested:
    - Peel and shear failures occurring in the parent material and not within the seam;
    - Peel strength of ≥ 328N (fusion welds) and ≥ 290N (extrusion welds); and
    - Shear strength of ≥ 394N.

Passing conditions for HDPE destructive samples are:

- Peel and shear field tests show, for 100% of weld samples tested:
    - Peel and shear failures occurring in the parent material and not within the seam;
    - Peel strength of ≥ 530N (fusion welds) and ≥ 455N (extrusion welds); and
    - Shear strength of ≥ 701N.
- Peel and shear laboratory tests show 100% of weld samples tested:
    - Peel and shear failures occurring in the parent material and not within the seam;
    - Peel strength of ≥ 530N (fusion welds) and ≥ 455N (extrusion welds); and
    - Shear strength of ≥ 701N.

If a seam fails destructive testing, the Contractor shall field test the seam to each side of the failed sample as specified in **Section 10.6.5.1**. The Contractor shall cut further laboratory samples from each side of the failed section and perform laboratory tests upon them at their own expense until the failed seam is bounded by two passed locations.

The Contractor shall then reconstruct the failed seam in accordance with **Section 10.7**.

The Contractor shall provide the CQA Consultant and the Superintendent a copy of the formal report from the independent testing laboratory detailing the procedures used for testing and including a summary and certification of all results, as soon as possible upon issue of the report.

10.7 Defects and Repairs

All defects/faults/damage in the geomembrane shall be repaired and tested by the Contractor as described in the sections below. Repairs that fail testing are to be re-done until a passing test is achieved.

All repairs involving patching with a separate piece of geomembrane will be recorded by the Contractor.

10.7.1 Point Defects

Point defects will generally be repaired by applying a layer of extrudate over the defect via extrusion welding, following the stipulations in **Section 10.6.4.3** and field tested as per **Section 10.6.5.1**. The extrudate shall cover the defect and an additional 20 mm in all directions.

10.7.2 Large Defects

The defect portion of the geomembrane will be removed and the resulting hole overlain with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions. The repair will be extrusion welded following the stipulations in **Section 10.6.4.3** and field tested as per **Section 10.6.5.1**.

10.7.3 Seam Defects

Defective sections of extrusion welded seams shall be overlain with a single piece of compatible geomembrane with a minimum overlap of 100 mm in all directions to form a cap strip. The repair is then to be completed as per **Section 10.7.2**.

For defective sections of fusion welded seams, the upper geomembrane layer over the defect shall be removed to expose the defective weld. The repair is then to be completed as per **Section 10.7.1** or **Section 10.7.2**, whichever is appropriate.

10.8 Geomembrane Deployment Records

The geomembrane installer shall prepare and submit to the Superintendent for review and approval a construction quality control report which contains copies of the geomembrane installer's daily quality control reports, subgrade inspection forms, construction quality control test results (including seam and welding equipment testing), geomembrane panel as-built drawings showing the locations of all geomembrane panels, panel numbers, seam numbers, defect/repair locations and destructive test sample locations.

10.9 Anchor Trenches

Anchor trenches are not required.

10.10 Protection Geotextile

Protection geotextile will be installed above and across the full extent of the EWSF and WWSF LLDPE geomembrane liner. The purpose of the protection geotextile is to provide a protective layer to prevent damage occurring to the HDPE or LLDPE geomembrane liner from installation and the overlying capping layers.

10.10.1 Protection Geotextile Materials Requirements

Protection geotextile shall:

- Not have been previously used;
- Be non-woven, needle punched, resin or heat bonded and be manufactured from polyester, polyethylene or polypropylene;
- Be needle-free;
- Be rot-proof, water-repellent, chemically stable and with filaments resistant to delamination;
- Be mildew, insect and rodent resistant;
- Be free of any flaws;
- Be demonstrated, from site-specific liner testing (see below), to be of sufficient mass, strength and thickness to protect the underlying geomembrane from puncture and from excess stresses and strains due to indentations from overlying gravel particles or from ribbing, edges and joints of drainage geo-composites;
- Comply with requirements of AS 3706 *Geotextiles – Methods of test*;
- Meet or exceed the requirements for manufacture and performance contained in the relevant specifications published by the Geosynthetic Research Institute (Geosynthetic Research Institute (Folsom, PA, USA), 2012), or in equivalent recognised industry standard specifications.
- Meet or exceed the requirements of **Table 15**.

Table 15 Protection Geotextile Requirements

Materials Property	Materials Criteria (Minimum)	Test Frequency *	Test Method
Mass	≥ 500 g/m^2	1 sample per 5000m^2	AS 3706.1
Grab tensile strength	≥ 2620N		AS 3706.2b
Trapezoidal tear strength	≥ 830N		AS 3706.3
CBR Burst Strength	≥ 6400N		AS 3706.4

*: Testing frequencies required conformance testing (**Section 10.10.4**)

10.10.2 Materials Acceptance

The materials acceptance procedure for the protection geotextile to be used requires materials information from the manufacturer and results of conformance testing to be provided by the Contractor for review by the CQA Consultant and Superintendent.

Acceptance of the proposed geomembrane is a staged procedure, involving the following steps:

1. Review of manufacturer's quality control information by CQA Consultant and Superintendent;
2. Conformance testing;
3. Inspection of material shipped to site by CQA Consultant; and
4. Final written approval for use of geotextile.

10.10.3 Manufacturer's Quality Control Information

The Contractor is responsible for nominating the geotextile manufacturer, the geotextile product for use and providing the required manufacturer's information for review by the CQA Consultant and Superintendent.

For each batch of geotextile proposed for delivery to site, the Contractor shall provide the following:

- Date of production, plant location, manufacturing lot/batch number, roll identification number and size (m^2) of each geotextile roll. Rolls shall be listed in the order of production with the status of the roll;
- Documentation that demonstrates compliance with the geotextile manufacturer's quality control program for all geotextile proposed for use; and
- Reports on tests conducted by the geotextile manufacturer demonstrating that the geotextile meets the mass, thickness and strength requirements as determined from site-specific liner testing.

10.10.4 Conformance Testing

Criteria for thickness, mass per unit area and strengths for conformance testing will be in accordance with mass, thickness and strength requirements as defined in **Table 15**.

The Contractor is to arrange for rolls of geotextile proposed to be, or which have been, delivered to site to be tested by an independent, NATA accredited laboratory in accordance with the testing frequencies in **Table 15**.

The Contractor is to provide copies of the test results reports to the CQA Consultant and Superintendent as soon as possible after receipt for review and approval.

If a conformance sample cut from a roll fails to meet the materials requirements, the CQA Consultant may accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing that the material does meet the materials requirements. Any such further testing shall be undertaken at the Contractor's expense.

If rolls on site from previous projects are being used in the Works, at least 1 conformance sample must be taken from each batch number from these rolls. Rolls on site from previous projects shall only be considered for use if they have been stored on site in accordance with manufacturer's recommendations, the roll number, batch number and manufacturer's details are known and appropriate manufacturer's certification(s) and associated quality control testing information is provided to the CQA Consultant and Superintendent.

10.10.5 Geotextile Roll Labelling

All rolls of geotextile delivered to site must be clearly and legibly labelled with the following information:

- Name of manufacturer;
- Product identification number;
- Date and location of production;
- Product type and grade;
- Roll identification number;
- Lot or batch number; and
- Length and width of the geotextile.

The label information shall be affixed or attached to the roll at all times during deployment of the roll. The Contractor shall record the roll number of every roll of geotextile used, together with its approximate location within the finished works.

10.10.6 Delivery, Handling and Storage

- Geotextiles shall always be protected against physical and chemical damage;
- Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the Works;
- The rolls of geotextile shall be stored on level ground and stacked not more than 4 rolls high and no other material shall be stacked on top of the geotextile; and
- Geotextile failing the requirements of the Specification or damaged during transportation, storage and handling shall be removed from the Works and replaced at the Contractor's expense.

10.10.7 Protection Geotextile Installation and Seaming

- A minimum of ten work days prior to the planned geotextile installation start date, the Contractor shall prepare and submit to the Superintendent for review and approval a work method statement detailing the proposed installation methodology, equipment and construction quality control procedures for installing the geotextiles;
- The geotextile may only be installed over a clean geomembrane surface which is free from stones, soil, excessive dust, sand bags and other foreign debris;
- The method of installation shall not impose stresses or strains likely to cause damage to the geotextiles;
- Construction equipment must not operate directly on the geotextile;
- The geotextile panels shall be deployed by hand in either pre-cut lengths or pulled from a spreader bar attached to an excavator outside of the geomembrane lined area;
- On side slopes, the geotextile shall be secured at the top of the slope and rolled down the slope in such a manner to minimise folds, wrinkles, stretching or bridging;
- Any cutting of the geotextile must be done in such a way as to prevent damage to the underlying geomembrane;

- To mitigate wind uplift, geotextile panels shall be temporarily fixated with bags filled with approved leachate drainage aggregate, or a suitable equivalent, approved by the CQA Consultant and Superintendent. The ballast shall remain in place on the geotextile until the leachate drainage layer has been placed. Any bags containing materials not approved for the leachate drainage layer must be removed prior to completion of construction of the leachate drainage layer;
- Protection geotextile shall be installed within a partially backfilled anchor trench, to allow preferential pull-out of the geotextile if the lining system becomes in tension;
- The Contractor is to allow for the surcharging of the separation geotextile within the placement rate.
- Geotextile panels will be seamed by hot air welding or stitching with the following overlaps:
    - Hot air welding: 250mm; and
    - Stitching: 150mm.

10.10.8 Repairs

All defects/faults/damage in the geotextile shall be repaired by the Contractor and inspected by the CQA Consultant.

Repairs shall be conducted by first removing any offending or deleterious matter, then fixing a patch of protection geotextile of a sufficient size to provide a minimum 300mm overlap in all directions around the defect. The geotextile patch is to be secured by hot air welding or stitching.

10.10.9 CQA summary for protection geotextile installation

The CQA Consultant is to:

- Ensure all protection geotextile used meets the materials requirements;
- Implement the materials acceptance procedure and maintain an inventory of protection geotextile materials delivered to site for the Works;
- Ensure protection geotextile is delivered, handled and stored appropriately;
- Inspect the protection geotextile delivered to site for evidence of damage and confirm acceptance of the delivered material for use in the Works;
- Visually inspect the receiving surface for the protection geotextile, identify any areas and/or aspects of the receiving surface requiring remediation and confirm the surface is suitable to receive the protection geotextile at all times;
- Ensure the entirety of the upper surface of the installed HDPE geomembrane is covered by protection geotextile;
- Inspect deployed panels of protection geotextile and identify any damage requiring repairs;
- Ensure overlaps between panels of protection geotextile are as required, at least 250 mm between panels, for hot-air welding;
- Inspect completed seams and identify any damage and/or defects requiring repairs; and
- Ensure all repairs are completed.

11 Growth Medium

The objective of the placement of the growth medium is to achieve a cover which will function as a long-term separation layer between the waste rock and vegetation thereby promoting evapotranspiration, resist erosion and limit the movement of rainfall into the waste.

11.1.1 Materials Requirements

Suitable fill materials for the growth medium shall:

- Contain no refuse or materials toxic to plant growth;
- Contain no acid sulfate or sodic soils;
- Contain no stumps, roots, clay lumps or stones with a maximum dimension larger than 150mm;
- Emerson Class Number ≥ 4; and
- Be free of weed and weed refuse material.

11.2 Placement and Compaction

The following should be observed when placing and spreading the topsoil layer:

- Low pressure tyred vehicles only are to be used;
- Graders and high-pressure tyred vehicles must not be used;
- To prevent areas of excess compaction and/or differential subsidence, routes of construction plant passing over completed areas of topsoil shall be varied;
- The layer shall be spread evenly and thoroughly mixed to obtain a near uniform condition across the entire layer;
- The finished topsoil layer must have a minimum thickness of 200mm measured at right angles to the slope as shown on the Construction Drawings; and
- The finished growth medium layer is to be ploughed along contours to a depth of 50mm but not deeper than 100mm.

In contrast to other compacted layers, the material compaction of the growth medium must be between 75% MDD and 85% MDD and at a moisture content within the range of ± 3 % of Standard Optimum Moisture Content. The compacted layers must not exceed the density that would limit the penetration of roots through the profile (85% MDD).

The required density may be achieved by placing the material loosely and then lightly compacting with machinery. An alternative method is to slightly over-compact the soil and then plough or rip it to reduce the density to that desired. There is no single ideal or recommended method of achieving the density required.

Material will be placed in thicker lifts with fewer passes. One method of placement is to place material in windrows and then push the windrow tops into the gaps. Alternatively, material may be placed by scrapers and then formed and ripped using a grader following behind.

11.3 Growth Medium Trial Pad

A trial placement will occur prior to placement of sub-soil. The contractor will place the sub-soil material at various lift thickness (0.3, 0.4, 0.5 and 0.6m lifts) and water contents (< OMC), tracking over the lift once or twice, and then the contractor will measure the resultant density of these lifts as per AS 1289.5.8.1 (Nuclear Surface).

If the density is less than specified, the machinery should be used to track over the lift(s) once or twice more and the density remeasured. Ploughing can be used to amend any over-compaction. Where the over-compaction is throughout the lift, deep ripping will be required. Where the over compaction is restricted to the surface layers, scarifying may be used, depending on the degree of compaction to be alleviated.

The Principal and CQA Consultant will approve the proposed compaction methods for the growth medium, prior to full-scale operations. This shall be a **hold point**.

11.4 Control Testing

Construction quality control testing for the growth medium shall be carried out at a frequency of **1 test per 6,000m^3** by an NATA Registered independent testing laboratory in accordance with **Table 16**.

Table 16 Growth Medium Control Testing Requirements

Item	Test	Material Requirement	Laboratory Test Method	Standard
1	Texture	• 0 to 20cm (SL to SCL texture – A1 horizon) • 20 to 60cm (SCL to CL,S texture – A2 horizon) • 60 to 120cm (CL,S to SLC texture – B21 horizon) • 120 to 200cm (SLC to SLMC texture – B22 horizon)	Field texture (supplemented by Emerson aggregate test where texture results are provided and PSA)	NCST, 2009, pp164-166 (National Committee on Soil and Terrain (NCST), 2009)
2	Colour	Dark or strong brown, red or yellow	Field colour supplemented by Emerson aggregate test where colour results are provided	Munsell colour charts
3	Mottling	No gleyed	Field assessment	NCST, 2009, pp159-161
4	Fabric	Earthy	Field assessment	NCST, 2009, pp181-182
5	Pedality	• 0 to 20cm (A1 horizon) massive • 20 to 60cm (A2 horizon) massive • 60 to 120cm (B21 horizon) massive to weak • 120 to 200cm (B22 horizon) massive to moderate	Field assessment	NCST, 2009, pp171-180
6	Surface coarse fragments	At 0cm: • 0% gravel > 60mm dia. • < 5% 20 to 60mm dia. • < 5% 6 to 20mm dia. • < 10% 2 to 6mm dia.	Field assessment	NCST, 2009, pp139-141
7	pH (1:5 water)	• 0 to 20cm (A1 horizon) range from 4.5 to 5.5 • 20 to 60cm (A2 horizon) range from 5.0 to 6.0 • 60 to 120cm (B21 horizon) range from 5.0 to 6.0 • 120 to 200cm (B22 horizon) range from 5.0 to 6.0	APHA 4500 H^+ -B	(American Public Health Association, Various)

Item	Test	Material Requirement	Laboratory Test Method	Standard
8	EC	• 0 to 20cm (A1 horizon) at least 10 µS/cm • 20 to 60cm (A2 horizon) at least 10 µS/cm • 60 to 120cm (B21 horizon) at least 2 µS/cm • 120 to 200cm (B22 horizon) at least 5 µS/cm	APHA 2510 B	(American Public Health Association, Various)
9	Chloride	• 0 to 20cm (A1 horizon) < 10 mg/kg • 20 to 60cm (A2 horizon) 10 mg/kg • 60 to 120cm (B21 horizon) 20 mg/kg • 120 to 200cm (B22 horizon) 50 mg/kg	APHA 4500 Cl^- -G	(American Public Health Association, Various)
11	Exchangeable cations and CEC, including exch. sodium percentage (ESP), Ca:Mg ratio	• CEC: At least 5.0 cmol+/kg • Ex Ca (% of CEC): 40 to 80 • Ex Mg (% of CEC): 10 to 40 • Ex K (% of CEC): 1 to 5 • Ex Na (% of CEC): < 6 • ESP: < 6% (non-sodic) • Ca:Mg ratio: > 1	Measuring soil cation exchange capacity and exchangeable cations (Soil Science Australia, 2013) (Soil Survey Test Method C5, Rayment & Lyons 2011 15A1 ED005 - Rayment & Lyons 2011 15G1)	(Soil Science Australia, 2013) (Rayment, GE and Lyons, DJ , 2011)
12	Particle size distribution (by sieve and hydrometer) for the following fractions: clay (< 2 µm), silt (0.002 (2 µm) to 0.02mm), fine sand (0.02 to 0.2mm), coarse sand (0.2 to 2mm) and gravel (> 2mm)	• SL: excl. gravel, Clay: 8 to 20, Silt: 2 to 10, Sand: 71 to 91 (gravel fractions of original soil matrix 0% > 60mm dia., < 5% 20 to 60mm dia., < 5% 6 to 20mm dia., < 10% 2 to 6mm dia.) • SCL: excl. gravel, Clay: 18 to 33, Silt: 2 to 8, Sand: 65 to 82, (gravel fractions of original soil matrix 0% > 60mm dia., < 5% 20 to 60mm dia., < 5% 6 to 20mm dia., < 10% 2 to 6 mm dia.) • CL,S: excl. gravel, Clay: 21 to 35, Silt: 6 to 15, Sand: 50 to 70, (gravel fractions of original soil matrix 0% > 60mm dia., < 5% 20 to 60mm dia., < 5% 6 to 20mm dia., < 10% 2 to 6mm dia.) • SLC: excl. gravel, Clay: 27 to 40, Silt: 2 to 20, Sand: 40 - 71, (gravel fractions of original soil matrix 0% > 200mm dia., < 5% 60 to 200mm dia., < 5% 20 to 60mm dia., < 5% 6 to 20 mm dia., < 10% 2 to 6mm dia.) • SLMC: excl. gravel, Clay: 40 to 45, Silt: 2 to 20, Sand: 35 to 58, (gravel fractions of original soil matrix < 5% > 200mm dia., < 5% 60 to 200mm dia., < 5% 20 to 60mm dia., < 5% 6 to 20mm dia., < 10% 2 to 6 mm dia.)	AS 1289 3.6.1, AS 1289 3.6.3, AS 1289.3.5.1, CSIRO 'Yellow Book'2	AS 1289 3.6.1, AS 1289 3.6.3, AS 1289.3.5.1, (Standards Australia, 2014) (National Committee on Soil and Terrain (NCST), 2009)
13	Emerson aggregate test (EAT)	All horizons: ≥ 5	AS 1289.3.8.1	AS 1289.3.8.1 (Standards Australia, 2014)
15	KCl-40 extractable sulfur	All horizons: < 20	Rayment & Lyons 2011 Method 10D1	(Rayment, GE and Lyons, DJ , 2011)
18	Nitrogen (total Kjeldahl)	• 0 to 20cm (A1 horizon) > 150 to 250 mg/kg • 20 to 40cm (A2 horizon) > 150 to 250 mg/kg	APHA 4500 N_{org} – D	(American Public Health Association, Various)

Item	Test	Material Requirement	Laboratory Test Method	Standard
19	Total P and bicarb. extractable (bce) P	• 0 to 20cm (A1 horizon) at least 50 mg/kg (total P) and at least moderate (> 20 to 40 mg/kg) (bce P) • 20 to 60cm (A2 horizon) at least 50 mg/kg (total P) and at least moderate (> 20 to 40 mg/kg) (bce P)	APHA 4500-P, Rayment & Lyons 2011 9B1	(American Public Health Association, Various)
20	Organic matter content plus total organic carbon (TOC) (%) by calculation (Walkley-Black)	• 0 to 20cm (A1 horizon) TOC at least moderate (> 1.5 to 2.5%) • 20 to 60cm (A2 horizon) at least moderate (> 1.5 to 2.5%)	AS 1289 4.1.1-1997/NEPM	AS 1289 4.1.1 - 1997/NEPM (Standards Australia, 2014)

The Superintendent may conduct additional tests at any time, where in the opinion of the Superintendent, additional testing is required and/or a deficiency is suspected. Such testing shall be at the Principal's cost.

Following a thorough re-working of a failed area, retesting will be performed by the Contractor to evaluate whether the re-worked area meets the requirements of the Specification. Re-testing of failed areas shall be at the Contractor's cost.

Sampling locations for testing shall be agreed with the Superintendent. The specified compaction and moisture tests shall be taken at the agreed locations. Prior to testing, the Contractor shall work the area to ensure uniform moisture content and compaction of all material within the area. The tests taken shall be considered to represent the total volume of material placed within the area. The finished surfaces of all earthworks of each stage of the phytocap shall be inspected by the Superintendent prior to commencement of the next stage.

11.5 Seeding

The Owners team shall be responsible for seeding, with the intention that all required surfaces will be seeded within 7 days after the installation of the topsoil layer (all long term landforms), the perimeter diversion drains and cap diversion drains or any other place deemed necessary as part of the ESCP. For the WSF cover, this installation should be within the optimal window (start of first seasonal showers) to support the vegetation cover development.

The seeded cover is to be adequately monitored and maintained by the Contractor during in which the period the Contractor is in possession of the site and then by the Superintendent after the Contractor has relinquished the site, to ensure the grass is well established on the revegetation layer.

Irrigation of the seeded areas is to be conducted by the Contractor under the direction of the Principal. Construction water of poor quality will detrimentally impact vegetation performance therefore all overspray from water carts it to be eliminated. Only good quality treated water is suitable for supporting irrigation.

12 Main Pit Backfill – Civil Earthworks Support Works

12.1 Access Ramp

The Main Pit Backfill Contractor is to instruct and guide Earthworks Contractor on Main Pit Access requirements if differing to details below.

The following is only applicable if the Contractor requires an entry/exit access ramp for the launching and removal of vessels to the Main Pit water body. Access Ramp construction will be performed under the Earthworks Work Package (if required). Should alternate means of launching vessels and craft to the Main Pit (for example crane) be preferred by the Contractor, Access Ramp construction may be withheld. Furthermore, changes to Ramp details may be subject to Contractors Backfill Methodology. Any alternate access arrangements proposed by the Contractor (e.g. installation of loading bay) shall be designed and provided to the Principal for review and approval prior to works.

12.1.1 Ramp Alignment

The Main Pit Access ramp shall align as reasonably practicable with the pre-existing old Main Pit Haul Road. The pre-existing old Main Pit Haul Road is currently submerged and nearest to surface at the south-western quadrant of the Main Pit based on 2014 Bathymetry Survey Data. Estimate Main Pit Access Ramp alignment is shown in **Drawing 680.10421.MPS.D03**.

Main Pit Access Ramp Construction and alignment shall have a minimum set back of 3.0m from the pre-existing old Main Pit Haul Road crest. The 3.0m setback to be demarcated with hi-visibility buoys or similar at 3.0m centre spacings along the haul road alignment.

12.1.2 Ramp Width

Ramp width shall be at a minimum 3m wider than the required ramp width for the widest anticipated vessel to use the Access Ramp. Anticipated vessel widths to use the Main Pit Access Ramp shall be provided to the Superintendent along with Access Ramp dimensions for approval prior to construction works.

12.1.3 Access Ramp Toe Depth

The ramp surface shall be sealed down to a depth of 2.5m below the Design Low Water Level (RL 59m AHD).

If a 1.0m depth below the Design Low Water Level cannot be practically achieved due to site constraints, a usability assessment should be undertaken to assess the viability of the access ramp facility. This shall involve a comparison between the available toe depth at the site over a water level record and the depth required for safe launching along with anticipated frequency of use.

12.1.4 Ramp Slope

The slope of the ramp should be steep enough so that a tow vehicle does not need to enter the water to launch a vessel and not so steep that the tow vehicle is unable to pull the vessel and trailer safely from the water. The ramp slope shall be no steeper than 1V:7H. The pre-existing Main Pit Haul Road has a slope of 1V:20H (~5% grade) based on 2014 Bathymetry data.

12.1.5 Ramp Crest

The ramp crest is the uppermost part of the ramp including the vertical curve. The crest of the ramp shall not be submerged during Design High Water Level (RL 61m AHD).

12.1.6 Ramp Length

The length of ramp below the ramp crest that is exposed at the Design High Water Level (61m RL) shall be greater than or equal to 10m.

12.1.7 Ramp Surface Finish

The surface finish of the ramp shall provide sufficient traction for tow vehicles and sound footing for pedestrians. Surface finish may include cast in situ concrete, precast concrete slabs or other alternatives to be approved by Superintendent prior to construction. Surface finishes shall allow the drainage of excess water and debris.

12.1.8 Access Ramp Batter Slopes

Access Ramp batter slopes are to be cut back not steeper than 1V:2H.

12.1.9 Erosion Protection

Access ramp slopes batter slopes shall be overlain with geotextile/geofabric or similar erosion protection installed as per supplier requirements. Erosion protection shall cover all cut batters to mitigate against erosion for the duration of Main Pit Backfilling works. Erosion protection and installation methodology shall be submitted to Superintendent for approval prior to construction.

12.1.10 Inspection/Monitoring

Visual inspection at low water for scour and/or other signs of degradation shall be performed every 6 months.

12.2 Access Pontoon

As a minimum, a temporary pontoon shall be constructed for quick access to the Main Pit water body. Pontoons shall be fit for purpose including, holding, loading and boarding and provide the provision of life saving equipment (e.g. lifesaving rings).

Pontoon will serve as the emergency egress point for Main Pit backfilling operations for persons on the Main Pit water body and shall have capacity at all times for emergency vessel access (launching and docking).

12.2.1 Pontoon Alignment

Pontoon alignment may be along the alignment of the Main Pit Access Ramp (on-ramp pontoon, if constructed) or at a preferred alignment suitable for backfilling operations. If an on-ramp pontoon is to be constructed, the width required for the ramp will be as per **Section 12.1.2** plus the required width for the pontoon.

12.3 Sand Bedding Materials Supply

The supply of sand bedding materials to the Main Pit Operations shall be the responsibility of the Earthworks Contractor.

The Main Pit Backfilling Operations shall be responsible for instructing the Earthworks Contractor for delivery of sand bedding materials to the required working area. The Main Pit Operations Contractor must liaise with the Earthworks Contractor and inform volumes, timing and delivery location with a minimum of 48 hrs notice. Unless pre-approved by the Superintendent, all sand bedding materials supply shall occur during the Main Pit Backfill Operations normal business hours.

The Contractor shall be responsible for the processing and safe storage of sand bedding materials following delivery. Any sand bedding materials delivered in accordance with instructions not used in backfilling and not stored in accordance with stockpile requirements must be returned to Borrow Area B. Screened stockpiled materials to be used at later stages (i.e. within the inert capping layer) are exempt from stockpile time restrictions and maybe stockpiled at site until such time that they are required for backfilling. If volumes are not to be used for backfilling or for the Waste Storage Facility, the material is to be returned to Borrow Area B at the Backfill Operations Contractor's cost.

12.4 Waste Rock Supply

The supply of waste rock to the Main Pit Operations shall be the responsibility of the Earthworks Contractor.

The Main Pit Backfilling Operations shall be responsible for instructing the Earthworks Contractor for delivery of waste rock materials to the required working area. The Main Pit Operations Contractor must liaise with the Earthworks Contractor and inform volumes, timing and delivery location with a minimum of 48 hrs notice. Unless pre-approved by the Superintendent, all waste rock supply shall occur during the Main Pit Backfill Operations normal business hours.

The Contractor shall be responsible for the processing and safe storage of waste rock materials following delivery. Any waste rock delivered in accordance with instructions not used in backfilling and not stored in accordance with stockpile requirements must be returned to the source Waste Rock Dump until time to use for Main Pit Backfilling or delivered to the Waste Storage Facility (if Main Pit capacity exhausted) at the Contractor's cost.

12.5 Main Pit Backfill Material Requirements

This section is extracted from the *Main Pit Backfill Works Package*, and is repeated here for information.

All backfill material is to be free of unsuitable material defined as follows:

- Logs, stumps and perishable material;
- Clay of liquid limit exceeding 80% and/or plasticity index exceeding 55%; and
- Hazardous or contaminated materials other than those permitted in the Contract.

It is anticipated that materials for the Bedding Layers shall be sourced from the nearby Borrow Area B on Finnis River Aboriginal Land Trust (FRALT) and hauled to site under the **Earthworks Works Package** and screened to the required maximum size. It should be noted the Unscreened Bedding Layer will still be required to undergo an initial screening to remove oversize particles greater than 53mm. It is envisioned the coarse fraction of material screened off the SBL-1 may be stockpiled and should be suitable for use as the SBL+1 layer.

In addition, SBL materials are to be mixed with neutralant (hydrated lime) at a 1%w/w rate. The purpose of this is to neutralise the top layers of tailings and the chemocline which are acidic. This will reduce the risk of acidic water releasing heavy metals into the water column above

Further detail on the material sourced from Borrow Area B are provided in the Geotechnical Investigation Report (SLR Consulting, 2020a).

It is anticipated that materials for the Waste Rock Layer shall be sourced from existing on site PAF Waste Rock Dumps. Waste Rock considered to have the highest potential of acid formation will be placed preferentially and shall be mixed with finely crushed limestone as per the dosing rates outlined in **Table 17**.

The order of sourcing and placing Waste Rock back fill material shall be defined by the season (wet or dry) in which the backfilling of waste rock material commences (i.e. following completion of sand bedding layer placement) as follows:

12.5.1 Backfilling of Waste Rock Materials if Commenced in Wet Season

Order of waste rock material sourced (1 = first, 3= last):

1. Dyson's Overburden Waste Rock Dump;
2. Intermediate Waste Rock Dump; then
3. Main Waste Rock Dump.

12.5.2 Backfilling of Waste Rock Materials if Commenced in Dry Season

Order of waste rock material sourced (1 = first, 3= last):

1. Intermediate Waste Rock Dump;
2. Dyson's Overburden Waste Rock Dump; then
3. Main Waste Rock Dump.

12.5.3 Dosing Requirements

Table 17 Lime Dosing Rate for Waste Rock Backfill

Material to Treat	Placement Location	Granulated Lime Treatment	Estimated Total Lime Weight*
Intermediate WRD	Main Pit	24kg $CaC0_3$/tonne Waste Rock	44,652 tonnes
Dyson's Overburden WRD	Main Pit	24kg $CaC0_3$/tonne Waste Rock	26,940 tonnes
Main WRD	Main Pit	15kg $CaC0_3$/tonne Waste Rock	9,307 tonnes

*: Volume will vary depending on final mass of waste rock required for backfilling and the activity of the finely crushed limestone.

Stockpiles shall be managed to avoid dilution and manage runoff to contain and neutralise acid leachate. Further detail on the physical and chemical characteristics of the Waste Rock material are provided in the (RGC & Jones, 2019).

Inert Capping Layer material will comprise coarse granular borrow material abstracted from extremely to highly weathered upper horizons at Borrow Area B and shall meet the specifications outlined in **Table 18** for engineering properties.

12.6 Material Testing Requirements

Control testing will involve field testing by an appropriately qualified and experienced geotechnical engineering consultant with collection of representative samples to be submitted for laboratory testing by a NATA accredited geotechnical laboratory to verify the material properties. This work is to be carried out under the **Earthworks Works Package**.

Testing shall be performed by the contractor to ensure all material used for the backfill layers achieve the properties identified in **Table 18** and is tested at the minimum frequency outlined in **Table 19**. Control testing is to be arranged by the Contractor as per test locations stipulated by the CQA Consultant.

Table 18 Specification Requirements for Engineering Properties of Backfill Materials

Constituent/Property	Test Method	Sand Bedding Layer (-1 mm) (SBL-1)	Sand Bedding Layer Unscreened[1] (SBL-U/S)	Sand Bedding Layer (+1mm) (SBL+1)	Waste Rock (WR) to RL 27m AHD	Waste Rock (WR) Above RL 27m AHD	Inert Capping Layer (ICL)
Maximum Passing	Particle Size Distribution						
% passing 1000mm	AS 1141.11, AS 1141.12 or AS 1289.3.6.1	-	-	-	-	100	-
% passing 500mm		-	-	-	-	-	-
% passing 300mm		-	-	-	-	-	-
% passing 200mm		-	-	-	-	-	-
% passing 100mm		-	-	-	100	-	-
% passing 75mm		-	-	100	-	-	-
% passing 53mm		-	100	-	-	-	-
% passing 19.0mm		-	-	-	-	-	-
% passing 9.5mm		-	-	-	-	-	-
% passing 2.36mm		100	-	-	-	-	-
% passing 1.18mm		85	-	15	-	-	-
% passing 75µm		≤ 25	≤ 25	-	≤ 30	-	-
	Atterberg Limits						
Liquid Limit	AS 1289.3.1.1 and 3.2.1	80	80	NA	80	80	60
Plasticity Index (PI) (%)		55	55	NA	55	55	12
% passing 0.425mm sieve x PI		NA	NA	NA	NA	NA	300 max
	Dispersivity						
Emerson Dispersion	AS 1289.3.8.1	NA	NA	NA	NA	NA	≥ Class 4

1: Initial screening required to remove oversize, > 53mm portion;

NA: not applicable

Table 19 Minimum Number of Tests per 5,000 tonnes of Stockpiled / Sourced Material[1,2]

Property	Sand Bedding Layer (-1mm) (SBL-1)	Sand Bedding Layer Unscreened (SBL -U/S)	Sand Bedding Layer (+1mm) (SBL +1mm)	Waste Rock (WR) To RL 27m AHD	Waste Rock (WR) Above RL 27m AHD	Inert Capping Layer (ICL)
Particle Size Distribution	10	10	10	5	5	NA
Emerson Dispersion	NA	NA	NA	NA	NA	5

NA: Not Applicable
Notes:

1. Where certified stockpiles or lots are smaller than 5,000 tonnes, a proportional reduction (rounded up) is permitted to the number of tests required above with a minimum of at least one test for stockpiles or lots of less than 1,000 tonnes.
2. Sampling must be carried out in accordance with the requirements of AS 1141. The testing must be undertaken by a NATA accredited laboratory, which must supply certificates identifying:
    a. The Stockpile source reference (if site-won) of Supplier's name (if imported)
    b. Material type and blend constituents
    c. Bulk sample number and certified stockpile identification number
    d. Quantity of material represented by the test results

12.7 Backfilling of Main Pit Access Ramp

Backfilling and recontouring of Main Pit access ramp is required.

The works for the backfilling and recontouring the Main Pit access ramp slopes includes the following:

1. Backfill Main Pit access ramp with stockpiled material from cut works, shortfall to be coming from Borrow Area B;
2. Backfill to ground surface level in keeping with adjacent landform topography; and
3. Place in layers not exceeding 300mm (loose) and compact to a density of 98% of Standard Maximum Density and at a moisture content within the range of ± 3% of Standard Optimum Moisture Content.

12.8 Reprofile of Main Pit Rim

Reprofiling of the Pit Rim Side Slopes is required.

The works for the reprofiling of the Main Pit crest side slopes includes the following:

1. Strip surface waste rock from within the 40m exclusion zone at the pit perimeter;
2. Reprofile over-steep and potentially unstable slopes along the rim of the Main Pit using conventional earth moving equipment and side casting style techniques to buttress the pit crest and shallow slopes to no steeper than 1 vertical to 6 horizontal (1V:6H);
3. Reprofile the material from Borrow Area B and backfill from Main Pit Rim towards the centre of the Main Pit at 1V:6H batters to surface of Capping Layer (RL 58m AHD);
4. Place in layers not exceeding 500mm (loose) and compact using minimum of 6 passes with >15 tonne tracked machinery.

5. Installing erosion protection to the re-profiled side slopes consisting of coarse granular borrow material as detailed in **Drawing 680.10421.MPS.D15** and **D16**.

13 Re-alignment of EBFR

Re-alignment of the Eastern Branch Finniss River is required.

The works for the re-alignment of the East Branch of Finniss River (EBFR) includes the following:

1. Re-direct EBFR onto its original aligment. This will run from thee EBFR into Main Pit, from Main Pit to Intermediate Pit, and from Interemediatee pit to the EBFR; and
2. Remediate EBFR diversion channel by cut and fill earthworks.

13.1 Rock for Rip-rap

Rock use in rip-rap shall be:

- Hard, tough and durable with a crushing strength of at least 25MPa;
- Free of defined cleavage planes, and must not be adversely affected by repeated wetting and drying;
- Predominantly angular in shape;
- Not more than 25% of rock, distributed throughout the gradation, having a length more than twice the breadth and thickness; and
- Meet or exceed the requirements of **Table 20**.

Table 20 Rock for Rip-rap Testing Requirements

Materials Property	Acceptance Criteria*	Test Frequency *	Test Method
Grading	Well graded angular material with less than 20% void space (when placed alone).	Fortnightly for each class of rock	NA
Length-to-Thickness Ratio	In accordance with the provision of this specification	Fortnightly for each class of rock	NA
Rock Density Test	≥ 2,600 kg/m^3	1 per 500 tonne from a given rock source	AS 4133.2.1.2
Los Angeles Abrasion Test	< 28%	1 per 500 tonne from a given rock source	AS 1141.23-2009
Wet / Dry Strength Variation Test	< 30% with minimum wet strength of 100kN	1 per 500 tonne from a given rock source	AS 1141.22-2008
Crushing Resistance	≥ 25MPa	1 per 500 tonne from a given rock source	Uniaxial Compressive Strength (UCS) test per AS 4133.4.2-2013
	≥ 1.25MPa	1 per 500 tonne from a given rock source	Point Load Strength Index (IS_{50}) test AS 4133.4.1-2007 (R2016)

*: Subject to review of the rock test results, relaxation to the above acceptance criteria and testing frequency may be granted by the Principal

13.2 Materials for Rip-rap Soil Sand Mixes

The mix of materials used in the sand/soil mixes shall be within the gradings shown on **Drawing 680.10421.RFR.D06.**

Growth Medium: shall be based on a nutrient rich natural soil with at least 20 to 40% organic content.

Sands and gravels: shall be natural materials (not recycled concrete or similar) and be certified as ENM free of contaminants.

Rip-rap: shall use rock meeting the specification above. Rip-rap must be a well graded angular material with less than 20% void space (when placed alone). Rip-rap with excessive void space may be rejected. It will not be acceptable to place rip-rap with voids then fill the voids with sand and soil.

The Contractor shall submit a 30kg sample of each component material to the Superintendent at least 4 weeks prior to planned trial on site.

13.3 Geotextile

Geotextile shall be Propex AS801 Non-woven geotextile or an alternative with equivalent properties, approved by the Superintendent.

Geotextile must be placed in accordance with the notes provided on the **Drawing 680.10421.RFR.D05 and 680.10421.RFR.D06**.

13.4 Placement

The sand soil rip-rap mixes must be thoroughly mixed prior placement. It will not be acceptable, for example, to place rip-rap then spread finer materials over the top.

13.5 Culvert

Culverts used for the reinstatement of the East Branch Finniss River are to be installed in accordance with detailed design **Drawing 680.10421.CUL.D01**.

13.6 Trial Mixes

Construct a trial section of rip-rap soil sand mix Type S1, S2 and S3 on site and in inspection of the graded rip-rap at least 4 weeks prior to planned commencement of full-scale transport of materials and commencement of full scale construction.

- Type S1 mix – trial 20m long by 4m wide;
- Type S2 mix – trial 20m long by 4m wide;
- Type S3 mix – trial 20m long by 4m wide; and
- Rip-rap – an inspection of the grading is required.

The trial mix and placement method will be inspected and reviewed by the Superintendent, who may request changes to the composition of materials, or approve the mix for use on site.

If the trial is approved by the Superintendent, it may be incorporated into the permanent works river re-alignment works.

The design profiles shown on the design drawings indicate general profiles for the proposed low flow channels and floodplain. These have been designed to replicate a natural stream, and the low flow alignment is deliberately 'wavy'. It is intended that there be minor fluctuation in the base width and bank slopes. The Contractor must exercise care to ensure that this natural look is built into the works as executed. The construction of straight 'industrial looking' trapezoidal channels will not be accepted.

It is not part of this Contract to incorporate channel 'furniture' such as logs, snags, and placement of larger stones.

13.7 Timing

The Contractor must schedule construction of the works in accordance with the following requirements:

1. The river re-alignment works are to commence as a priority in order to provide time for establishment of vegetation well before the re-alignment receives flows from the Main Pit.
2. The Contractor must coordinate other site activities to allow the re-alignment works to proceed as a priority.
3. Completion of spillway from the Main Pit will need to be delayed so that is does not receive overflows from the Main Pit during backfilling.
4. Completion of the spillway from the Intermediate Pit will need to be delayed to prevent flood flows from the EBFR entering the Pit.
5. If a flood bund is used to prevent flows into the Main Pit during construction, it must be designed and certified by a suitable qualified engineer to be capable of meeting the following requirements:
    a. flood immunity for a 1% AEP flood event plus 1.5m freeboard; and
    b. be capable of withstanding failure risks associated with pressure, seepage and erosion.

14 Construction of Cultural Centre

The Contractor is required to design and construct the Cultural Centre, in liaison with the Owners Team who will capture Traditional Owner requirements. As a minimum the following will be required:

- Storage shed for land management equipment;
- Undercover car park for:
    - Land management truck; and
    - Fire Fighting Truck.
- Training / meeting room;
- Ablution and lunchroom;
- Male and female change room, showers and toilets;
- Storage space for environmental monitoring and sampling equipment;
- 3 x offices;
- Electricity supply (Solar Power);
- Telecommunications supply;
- External car park for public and staff;
- 2 x 90,000L rain water tanks;
- Water Management for grey and black water
    - Recycle waste water onto garden grounds; and
- Low water toilets, taps and fittings.

15 References

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