Hydra Stream 3 Project – LNAR Stage 2B

Design Report

EnergyAustralia Pty Ltd

December 17, 2024

→ The Power of Commitment



Project name		Mt Piper Ash Repository – Stage 2 Detailed Design					
Document title		Hydra Stream 3 Project – LNAR Stage 2B | Design Report					
Project number		12610307					
File name		12610307-Mt Piper Ash Repository Design Report- Stage 2B.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	2	R Huynh	A. Roberts		D. Gamble		17/12/24
S4	1	R Huynh A Horlyck	A. Roberts	ON FILE	D. Gamble	ON FILE	24/10/24
S4	0	R Huynh A Horlyck	A. Roberts	ON FILE	D. Gamble	ON FILE	19/7/24

GHD Pty Ltd | ABN 39 008 488 373
Contact: Adrian Roberts, Team Leader, Design Element - Waste Management | GHD Pty Ltd
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmail@ghd.com | **www.ghd.com**

© GHD 2024
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.



Key terms and definitions

	Description
AHD	Australian Height Datum
AEP	Annual Exceedance Probability
BCA	Brine conditioned ash
BS	Brine solids
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CQA	Construction quality assurance
DN	Outside diameter
DPE	NSW Department of Planning and Environment
EPA	NSW Environment Protection Authority
EPA Guidelines	NSW Environment Protection Authority (2016) Environmental Guidelines Solid Waste Landfills (2nd Ed.)
EA	EnergyAustralia NSW Pty Ltd
ERM	Environmental Resources Australia Pty Ltd
FBA	Furnace bottom ash
FoS	Factor of safety
GCL	Geosynthetic clay liner
GITA	Geotechnical Inspection and Testing Authority
LLDPE	Linear low density polyethylene
LNAR	Lamberts North Ash Repository
LSAR	Lamberts South Ash Repository
MPPS	Mt Piper Power Station
MPAR	Mt Piper Ash Repository
MXS	Mixed lime salts
OEMP	Operational Environmental Management Plan
PE	Polyethylene
PP	Polypropylene
POEO Act	Protection of the Environment Operations Act 1997
QA	Quality Assurance
The Project	Mt Piper Ash Placement Project
RL	Reduced level
SDR	Standard dimension ratio
SHZ	Subsidence hazard zone
SiD	Safety in design
the Site	Lamberts North ash disposal area

	Description
Solid Mixed Salts	Mixed salts and lime salts
SWTP	Springvale Water Treatment Plant
WCA	Water Conditioned Ash
WOLS	Whole of life ash repository strategy

Contents

1. Introduction **1**
- 1.1 General 1
- 1.2 Purpose 1
- 1.3 Project understanding 1
- 1.4 Limitation and assumptions 2

2. Regulatory requirements and key guidance documents **3**
- 2.1 Waste classification 3
- 2.2 Project approval 3
- 2.3 Environment Protection Licence 5
- 2.4 NSW EPA Environmental Guidelines Solid Waste Landfills (2016) 6
- 2.5 Operational Environmental Management Plan 8

3. Site characteristics **9**
- 3.1 Site location and access 9
- 3.2 Land ownership 11
- 3.3 Existing site features and access 11
- 3.4 Climate 13
- 3.5 Topography 15
- 3.6 Geology and past coal mining 17
- 3.7 Hydrology 17
- 3.8 Hydrogeology 20
- 3.9 Material generation 21
- 3.10 Future site development 23

4. Basis of design **24**
- 4.1 General 24
- 4.2 Topographic survey 24
- 4.3 Containment type 24
- 4.4 Design considerations 24
- 4.5 Access 25
- 4.6 Mine subsidence and coal oxidation/combustion 26
- 4.7 Hydrogeology 26
- 4.8 Water management 26
- 4.9 Leachate management 26
- 4.10 Stability 27
- 4.11 Settlement 28
- 4.12 BCA and BS placement 28
- 4.13 Capping 28
- 4.14 Opportunities 29
- 4.15 Constraints 29

5. Mine subsidence **30**
- 5.1 Open cut mining 30

5.2 Remaining underground mine workings 30
5.3 Mine subsidence hazard zones 30
5.4 Mitigation measures 31
6. Cell design 33
6.1 Design philosophy 33
6.2 Sidewall seepage drainage system 35
6.3 Geotechnical assessment 35
6.4 Earthworks 36
6.5 Operational staging 36
7. Leachate management 37
7.1 General 37
7.2 Key principles of leachate management 37
7.3 Water balance 37
7.4 Leachate barrier system 37
7.5 Leachate collection system 39
8. Surface water management 42
8.1 General 42
8.2 Surface water management 42
9. Amenity control 43
9.1 Construction and operational impacts 43
9.2 Fire 43
10. Safety in design 44
10.1 Objective 44
10.2 Approach 44
10.3 Safety in design assessment 44
11. Construction management 46
11.1 Construction quality assurance 46
12. Operational handover 47
13. References 48
Appendix A Limitations and assumptions 53
Appendix B Design drawings 55
Appendix C Design calculations 56
Appendix D Technical specification 57
Appendix E Appointment of expert 59

Table index

Table 2.1 Relevant consent conditions (MP09_0186 MOD1) 4
Table 2.2 Required outcomes for leachate management 6
Table 2.3 Justification for alternative leachate barrier and capping system 7
Table 3.1 Surrounding hydrogeological units 20

Table 3.2	Materials to be emplaced within MPPS ash storage area	21
Table 4.1	Summary of design considerations	24
Table 4.2	Leachate barrier description	27
Table 5.1	Subsidence hazard zones	31
Table 5.2	Preliminary risk mitigation measures identified in mine subsidence assessment	32
Table 7.1	Design parameters – anchorage	38
Table 7.2	Design parameters – geonet drainage geocomposite	40
Table 10.1	Identified primary risks and recommended control measures	44

Figure index

Figure 2.1	Environmental monitoring locations (sourced from Lamberts North OEMP, EnergyAustralia, 2022)	8
Figure 3.1	Ash repository footprints (LNAR OEMP, 2022)	10
Figure 3.2	Site layout	12
Figure 3.3	Daily rainfall recorded at Mt Piper Power Station (January 2020 to July 2023)	13
Figure 3.4	Correlation of daily rainfall recorded at Mt Piper Power Station against SILO data for Lidsdale station (January 2020 to July 2023)	13
Figure 3.5	Average daily rainfall and evaporation	14
Figure 3.6	Annual rainfall from 1970 to 2022, sourced from SILO for Lidsdale Station	15
Figure 3.7	Lamberts North Ash Repository topography survey (prepared by CEH Survey, June 2024)	16
Figure 3.8	Regional catchment plan (figure sourced from Mt Piper Power Station Ash Placement Project Hydrology and Water Quality, SKM 2010)	18
Figure 3.9	Local hydrology (Figure sourced from Mt Piper Power Station Ash Placement Project Hydrology and Water Quality, SKM 2010)	19
Figure 3.10	Groundwater levels within LNAR (Figure sourced from Lamberts North Ash Placement Project Annual Water Quality Monitoring Report 2019/2020, ERM (2020c))	21
Figure 3.11	Forecast material volumes to unlined areas, provided by EA (* 2023 is half year only)	22
Figure 3.12	Forecast material volumes to lined cells, provided by EA (* 2023 is half year only)	22
Figure 6.1	Stage 2B cell footprint	34

Appendices

Appendix A	Limitations and assumptions
Appendix B	Design drawings
Appendix C	Design calculations
Appendix D	Technical specification
Appendix E	Appointment of expert

1. Introduction

1.1 General

EnergyAustralia NSW Pty Ltd (EA) own and operate the Mount Piper Power Station (MPPS), Blackmans Flat, New South Wales. Ash and other by-products generated at MPPS and Springvale Water Treatment Plant (SWTP) are disposed of to the following approved ash placement repositories:

– Mt Piper Ash Repository (MPAR) approved under development consent 80-10060
– Mt Piper Ash Placement Project (the Project) approved and modified under Project Approval MP09_0186-MOD1 comprising Lamberts North Ash Repository (LNAR) and Lamberts South Ash Repository (LSAR).

EA have engaged GHD Pty Ltd (GHD) to undertake planning and design for ash placement for both the LNAR and MPAR (the Site) and capping design for MPAR. The design work aims to address constructability issues, reuse of ash, stormwater drainage, groundwater, and geotechnical risks.

The planning and design work is separated into the following portions:

– A whole of life ash repository strategy (WOLS)
– Capping design for the MPAR
– Design for the LNAR Zone 2 (previously planned as the LNAR vertical wall design)
– Design for Stage 2 of the LNAR (split into two stages, Stage 2A and Stage 2B)

This report documents the detailed design for Stage 2B of the LNAR. It is noted that the Stage 2A is currently under construction. The design was developed in general accordance with the *NSW EPA Environmental Guidelines Solid Waste Landfills (2016)* herein referred to as EPA Guidelines.

1.2 Purpose

The purpose of this report is to document the key aspects of the detailed design of Stage 2B of LNAR. This includes consideration of refined subsidence hazard zones and geotechnical risks around ash placement and settlement. The proposed leachate barrier design is based on the preferred liner option as detailed in the agreed basis of design (GHD 2023a).

The Stage 2B ash repository design is in accordance with existing environmental approval and key guidance documents. This report provides the justification for the alternative leachate barrier and final cap design per the requirements of the EPA Guidelines.

1.3 Project understanding

EnergyAustralia owns and operates the ash repositories associated with the MPPS and SWTP in accordance with the following instruments:

– MPPS Development Consent 80-10060 granted April 1982 (MOD 8, 2019)
– Lamberts North Ash Repository Project Approval 09_0186 MOD 1
– Environment Protection Licence (EPL) 13007

EnergyAustralia currently places brine conditioned ash (BCA) in Mt Piper Ash Repository (MPAR) Area 1 (MP Area 1) and LNAR, noting that BCA can be emplaced within the LNAR in lined cells or when ash emplacement activities exceed an RL of 946 m AHD. Brine generated from MPPS and the Springvale Water Treatment Plant (SWTP) is conditioned with ash in the ash and dust plant conditioners. Brine solids (BS) (also referred to as Solid Mixed Salts) are delivered to the mixed salt and lime receival plant which takes deliveries from the SWTP and then feeds BS onto the Aerobelt conveyor for transportation to the repository silos. From the silos, mixed salt and lime salt (LS) would be transported using tipper trucks to LNAR once the level is above 946 m AHD. If the mixed salt and lime receival plant is unavailable it can be delivered to a prepared dumping pad on the repository by the SWTP for placement on the repository.

EA has development consent (80/10060) and Project Approval (09_0186) to co-place BCA with WCA within dedicated areas and RLs of the existing MPPS ash storage areas before reaching the maximum level for capping.

The current placement regime is requiring more BCA to be disposed of to the MPPS ash repository, which is currently restricted on the Lamberts north area due to limitations. Where WCA can only be placed below 946 m and BCA above this elevation.

The MPAR is at its maximum approved capacity of BCA. The MPAR will enter a closure and rehabilitation phase following the completion of relocation of the solid mixed salt to the eastern end of MPAR. LNAR Stage 1 was constructed in 2022 and is almost full. LNAR Stage 2A is required to come online by early to mid 2024. Construction of Stage 2A is currently under way.

Alongside LNAR Stage 2, as described above EA is developing and implementing an internal 'whole of life strategy' (WOLS) for the ash repository, considering a range of key inputs and factors such as generation rates, site capacity and material availability/balances. This internal strategy document is referenced where appropriate within this report.

1.4 Limitation and assumptions

This report must be read in conjunction with limitations provided in Appendix A and the commentary made throughout this report. Other key assumptions include:

– Reliance on EA provided MPAR landform Stage 1 design and fill plans
– GHD provided assistance in reviewing current EA approvals with respect to water management, with EA then confirming the required water management principles on which the design is based and are outlined in Section 4.8.
– Reliance on ash and salt production rates and quantities as provided by EA
– Reliance on operational feedback for access/egress sizing as provided by EA

2. Regulatory requirements and key guidance documents

2.1 Waste classification

Waste generated in NSW is required to be classified in accordance with the NSW EPA Waste Classification Guidelines (2014). Stage 2B ash repository is designed to accept brine BCA, WCA and BS from MPPS and SWTP. The ash types are a combination of four waste streams - ash, brine, brine solids (including lime salt and mixed salt) and water.

A waste classification assessment was undertaken in 2021 by GHD to classify the ash types for disposal. The findings of the assessment are summarised in the liner options review technical memorandum prepared by GHD (2023b). WCA, BS and BCA were classified as General Solid Waste. This classification has been adopted for the detailed design of Stage 2B.

2.2 Project approval

2.2.1 Development consent DA80/10060

The MPPS was approved by the then Minister for Planning in April 1982 under DA80/10060 and has been operational since 1994. Development approval allowed for the placement of wet and dry ash at the MPAR. The dry ash was required to be moisture conditioned with either brine or water before placement. Some relevant conditions for staging and closure of the MPAR include:

– The placement of brine conditioned ash may only occur between the levels of RL 946 m AHD (the end-point of the water conditioned ash layer) and RL 980 m AHD. (Condition 38Aiii)
– That the applicant shall, prior to any site works being carried out, submit to Division of Resources and Geoscience within the Department, its proposals for the restoration and rehabilitation of any coal mining operations on the lands the subject of the proposed development which mines are the responsibility of the applicant (Condition 19)
– That the applicant shall undertake to preserve vegetation on the escarpment to the south of the lands the subject of the proposed development and on the rocky outcrops and canyons in the north of the proposed Neubecks Creek ash disposal area (Condition 20)

2.2.2 Project approval MP09_0186

The Mount Piper Power Station - Ash Placement Project was approved by the Minister for Planning on 16 February 2012 (09_0186) which allowed for construction and operation of new ash placement areas at the Lamberts South and Lamberts North sites to cater for the ash generated from the existing MPPS and proposed MPPS extension.

The consent was modified on 21 September 2021 (MP09_0186 MOD 1) to include improvements to the water management system and design of the approved LNAR including:

– Minor adjustment to the LNAR footprint;
– Staged installation of double lined storage ponds;
– Replacement of the approved LNAR WCA perimeter layer with a low density polyethylene liner (LDPE) and;
– Staged installation of a leachate barrier system for placement of BCA, solid mixed salts, and other authorised wastes at levels below the approved height of RL 946 mAHD.

Ash placement is currently occurring within the northern portion of LNAR within Cells 1A and 1B. The approved detailed design of Cells 1A and 1B is provided in the Mt Piper LNAR Brine Liner System Detailed Design Report – Cells 1A and 1B (Golder 2022). LSAR is not available for ash placement as it is current being used for coal mining and processing activities.

Relevant consent conditions for the design of the LNAR are summarised in Table 2.1. Condition D3 outlines requirements for environmental management plans which have been prepared prior to the construction of Cell 1A and 1B. The design of the next stages of the LNAR is required to address the performance targets as outlined in the approved Operational Environmental Management Plan (OEMP) and sub-plans (EnergyAustralia 2022).

Table 2.1 Relevant consent conditions (MP09_0186 MOD1)

	Condition	Description	Reference
Design	B14	The ash placement areas shall be designed by a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary to ensure structural stability of the ash placement areas.	Appointment of David Gamble was approved by DPE on 29 September 2023 (refer Appendix E)
Soil and water	C13	Surface water drainage must be appropriately engineered and stabilised to convey run off without collapse or erosion. Surface water run off collection ponds are to be lined.	Section 8
	D3 c	c)…Soil and Surface Water Management Plan …must include, but not be limited to: … v) demonstration that the proposed erosion and sediment control measures will conform with, or exceed, the relevant requirements of Managing Urban Stormwater: Soils and Construction (Landcom, 2004); vi) details of the water management system including separation of clean and contaminated/polluted water flows, provisions for the treatment, recycling/reuse and/or discharge of flows; vii) site water balance including water usage for ash placement, sources of water and quantity of run-off generated; viii) details of the lining for the surface water collection ponds; ix) measures to minimise potential surface water infiltration;	Section 7.3, Section 8
Capping	D3eii	e) a Landscape/Revegetation Plan …must include, but not necessarily be limited to:… i) identification of design objectives and standards based on local environmental values, vistas, and land uses ii) identification of the timing and progressive implementation of revegetation works for ash placement areas as they are completed, including short-term and long term goals including landscape plans iii) a schedule of species to be used in revegetation, including the use of local native species in revegetation works selected by a qualified expert to ensure the rehabilitation works do not compromise the long term integrity of the capping	Staging constraints for rehabilitation are outlined in Section 6.5 and WOLS Schedule of species subject to outcome of revegetation trial in MPAR (OEMP 2022)
Final landform	D3fi	f) a Site Rehabilitation Management Plan …must include, but not necessarily be limited to:… i) reinstatement of geomorphologic stable drainage lines on the rehabilitated areas and a timeframe for rehabilitation	Section 4.13 The final landform will be generally consistent with the approved landform
Leachate management	D5	Prior to the commencement of operation of each stage of the ash placement process, the Proponent must demonstrate to the satisfaction of the Secretary, in consultation with the EPA, that the design of the leachate management system is generally consistent	Section 7

	Condition	Description	Reference
		with the Environmental Guidelines, Solid Waste Landfills (EPA, 2016), including: (a) the leachate barrier system, including liner and leachate collection system; and (b) the leachate storage dam/s including freeboard, appropriate sizing based on site water balance modelling and liner.	

Table 6-1 of the Response to Submissions Report (ERM, 2021) for the Modification identifies requirements for detailed design as follows:

– Detailed design of the leachate barrier system (liner) for each stage of the LNAR will be prepared prior to the installation of liner materials. This will generally include:
  - Geotechnical assessment (refer Section 6.3);
  - Leachate pond sizing and location (excluded from this package);
  - General water management logistics (i.e. pumping requirements, storage locations and drainage logistics) (refer section 7 and section 8);
  - Liner material requirements (refer technical specification Appendix D);
  - Liner staging including installation procedure and logistics (refer Section 6.5); and
  - Liner installation quality assurance and quality control procedures (refer section 11.1).
– NSW EPA (2016) requirements pertaining to stormwater management, leachate management, installation quality assurance (QA) requirements (including QA plan), aesthetics, capping and closure requirements will also be addressed by the detailed design for the LNAR (as modified).

2.3 Environment Protection Licence

Under the Protection of the Environment and Operation Act (POEO Act), environment protection licences are required to authorise and regulate certain activities relating to waste management and pollution control. EA operates the MPPS under Environment Protection Licence 13007 (version date 1 March 2024). The licence permits two scheduled activities – chemical storage and electricity generation.

It was suggested in the Assessment Report for MP09_0186 MOD 1 (NSW Department of Planning, Industry and Environment 2021) and NSW EPA submission letter (2021) that the licence would be varied for the modified project. In December 2021 Environment Protection Licence 13007 was updated to reflect a new site plan.

Condition L5.3 of the licence permits the following types of waste generated at the premises to be disposed of at the premises:

– Ash
– Mill pyrites
– Demineralisation and polisher plant effluents
– Chemical clean solutions
– Cooling tower sediments
– Ion exchange resins
– Fabric filter bags
– Brine conditioned fly ash
– Biomass co-firing ash
– Settling pond sediments
– Oil and grit trap sediments

The licence also allows for rehabilitation of the MPAR using excavated natural material and virgin excavated natural material from within the Bathurst and Lithgow local government areas only or from other locations in New South Wales with approval from the relevant consent authority.

2.4 NSW EPA Environmental Guidelines Solid Waste Landfills (2016)

Minimum standards for General Solid Waste landfill siting, design, construction, operation and closure are provided in the Environmental Guidelines for Solid waste landfills (NSW EPA 2016) – the 'EPA Guidelines'. Condition D5 of the project approval requires that the leachate management system for Stage 2B is generally consistent with these guidelines.

The EPA Guidelines contain acceptable design standards for primary leachate barrier systems including specification for liner systems and components. Required outcomes are summarised in Table 2.2. It should be noted that the required environmental outcomes provided in the EPA Guidelines reference a 'landfill' instead of an 'ash repository'. For the purposes of this design the required outcomes were modified to reference an ash repository instead of a landfill.

Table 2.2 Required outcomes for leachate management

	Required outcomes
Leachate barrier system	The ash repository must have a leachate barrier system to contain leachate and prevent the contamination of surface water and groundwater over the life of the repository
	Pollutants with the potential to degrade the quality of groundwater must not migrate through the strata to any point beyond the boundary of the premises or beyond 150 metres from the landfill footprint, whichever is smaller. If this occurs, additional engineered controls may be required to prevent further pollutant migration. It may also be necessary to remediate the existing pollution
Leachate storage and disposal	Collected leachate must be stored in appropriately sized dams or tanks and disposed of so as not to cause environmental harm
	There must be sufficient leachate disposal capacity to prevent the build-up of leachate and an increase in the risks of water pollution and offensive odours
	Untreated leachate must not be disposed of to off-site water or land, used for dust suppression, or used to supply the water needs of any process conducted at the landfill, such as composting. (GHD notes that treated leachate and/or leachate that conforms to required contamination levels could be used for dust suppression on BCA portion of repository)
Stormwater management	Controls must be implemented to minimise erosion and reduce the sediment load (suspended solids) of stormwater discharged from the site
Landfill gas management	minimise emissions of untreated landfill gas to air and through sub-surface strata and services
	minimise greenhouse gas emissions
	minimise emissions of offensive odour
	minimise the explosive risk to humans from gas build-up in confined spaces
	ensure that, wherever feasible, landfill gas is sustainably utilised for energy recovery
	minimise emissions of air pollutants from the combustion of landfill gas in flaring or electricity-generating equipment
Amenity issues	The ash repository must not adversely affect amenity in the locality, in particular: – offensive odour impacts must not occur at off-site locations – emission of nuisance dust and other particulate matter beyond the ash repository boundaries must be minimised – excessive noise must not be generated by activities at the site – local amenity must not be degraded by litter from the ash repository or by mud or litter attached to vehicles leaving the site – the risk of fire at the site must be minimised and the site must be adequately prepared in the event of fire.
Ash acceptance and site security procedures	– Only authorised wastes can be received at the site. – Any unauthorised wastes delivered to the site must be appropriately managed and disposed of lawfully.

	Required outcomes
	– Statutory record-keeping and reporting requirements must be complied with. – The premises must be secure, and unauthorised entry must be prevented.
Final capping and revegetation	All completed ash repository cells must be capped and revegetated as soon as practicable after the final delivery of ash to the cell. The final capping must: – reduce rainwater infiltration into the ash and thus minimise the generation of leachate (infiltration from the base of the final cap should be less than 5% of the annual rainfall) – stabilise the surface of the completed part of the landfill – reduce suspended sediment and contaminated runoff – minimise the escape of untreated landfill gas – minimise odour emissions, dust, litter, the presence of scavengers and vermin, and the risk of fire – prepare the site for its future use; this includes protecting people, fauna and flora on or near the site from exposure to pollutants still contained in, or escaping from, the landfill. – During the post-closure period, the occupier must monitor the integrity and performance of the final cap.
Closure	– The ash repository must continue to be non-polluting and not cause environmental harm after site closure. – The occupier must prepare a closure plan, setting out a program for making sure that the site does not cause environmental harm after closure. The occupier must implement the approved closure plan.

Section 1.10 and 9.3 allows for alternative leachate barriers and capping profiles to be proposed that depart from the conventional system and standards in the EPA Guidelines. In order to utilise onsite material and optimise airspace, GHD proposed an alternative leachate barrier that uses FBA for the leachate drainage layer and enhanced capping system. The alternatives must be able to achieve the required outcomes identified above. Required supporting information to justify the proposed alternative design is outlined in Table 2.3. The proposed alternative leachate barrier and capping system for Stage 2B is consistent with the approved design for completed Cells 1A / 1B and Stage 2A.

Table 2.3 Justification for alternative leachate barrier and capping system

Required information	Reference
Full description of the material properties and predicted performance of the alternative leachate barrier including:	
Thickness	Section 7.4.1, section 7.4.2
Hydraulic properties	Technical specification Appendix D
Strength	Section 7.4.5
Resistance to degradation	Section 7.4.6
Long-term behaviour	Section 7.4.6
Compatibility with adjoining layers and site leachate	Section 7.4.6
Slope stability	Section 7.4.1
Construction methods	Technical specification Appendix D
A hydrogeological investigation must characterise the surrounding soil and groundwater and must identify any risks to water bodies and other sensitive receptors in the locality. The assessment should be done in accordance with a recognised guideline for hydrogeological assessments.	An evaluation of groundwater levels at Lamberts North (CDM Smith, 2012b) was provided to DPI in May 2013. The groundwater level evaluation report demonstrated that the activities associated with preparation and re-profiling for Stage 2B LNAR had minimal impact on groundwater levels on and immediately adjacent to the site. At this stage, further hydrogeological investigations have not been proposed as part of the detailed design work.

2.5 Operational Environmental Management Plan

Environmental management of the site is undertaken in accordance with Lamberts North Ash Repository OEMP (EnergyAustralia, 2022). This plan is a requirement of the Lamberts North development consent (Project Approval 09_0186). In summary, this plan identifies the environmental targets and performance indicators and includes the following environmental sub plans:

– Operational noise management and monitoring plan
– Groundwater management plan
– Soil and surface water management plan
– Air quality management plan
– Landscape revegetation and rehabilitation plan
– Waste management plan

Environmental monitoring locations included in the above plans are shown on Figure 2.1. Any changes to the leachate and water management design and monitoring locations would need to be captured in the corresponding environmental management plan.

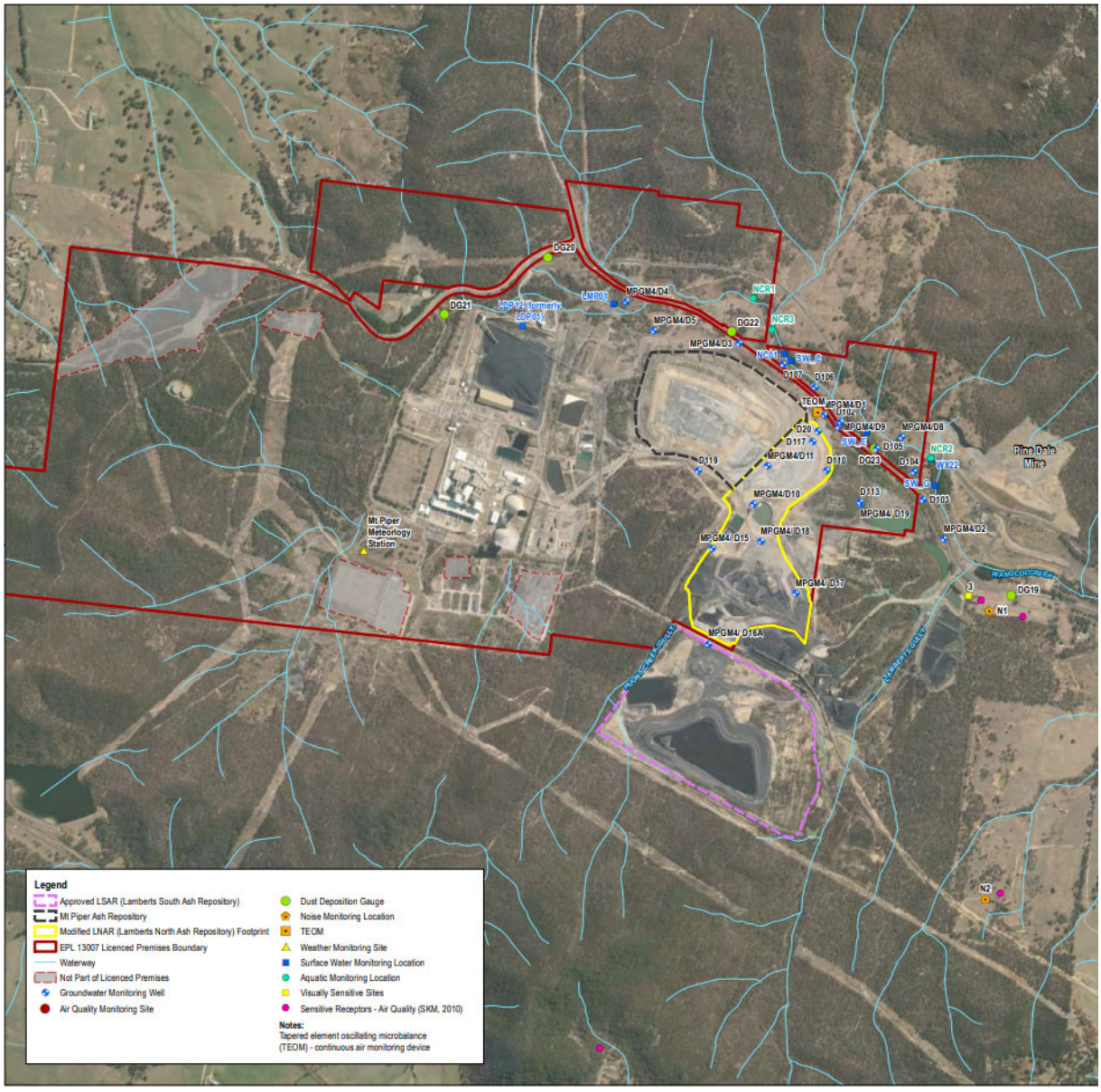


Figure 2.1 Environmental monitoring locations (sourced from Lamberts North OEMP, EnergyAustralia, 2022)

3. Site characteristics

This section describes the characteristics of the site and summarises relevant site investigations.

3.1 Site location and access

MPPS is located off the Castlereagh Highway, Blackmans Flat NSW approximately 17 kilometres northwest of Lithgow and is situated within Lithgow City Council Local Government Area.

MPAR and LNAR reside in the existing MPPS landholdings and is located east of MPPS, as shown in Figure 3.1.

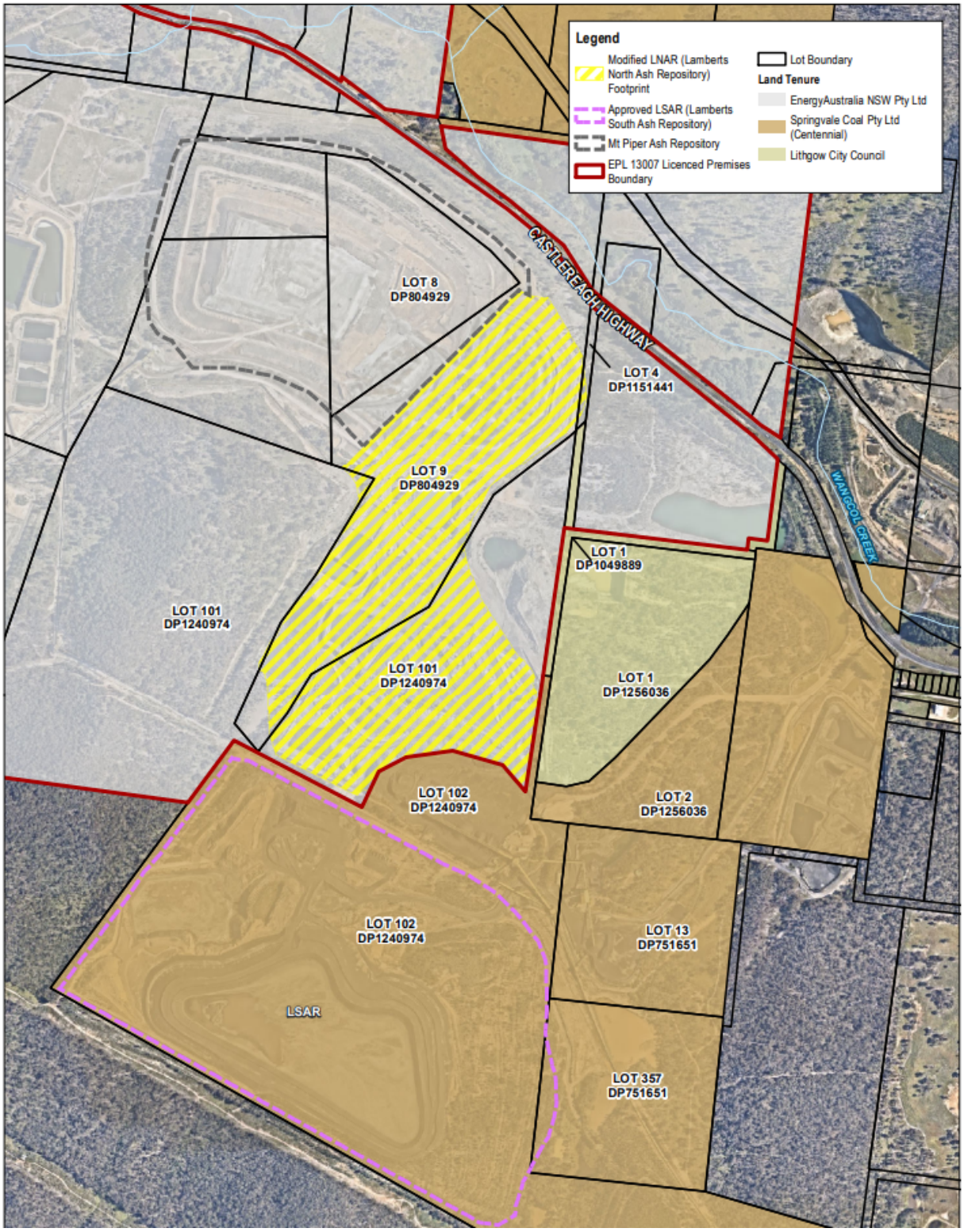


Figure 3.1 Ash repository footprints (LNAR OEMP, 2022)

Cells 1A and 1B are located at the north end of the LNAR design footprint (see Figure ***3.2***) and is designed with a liner system to accommodate future placement of Brine Conditioned Ash (BCA) above the existing Water Conditioned Ash (WCA). The footprint for Stage 2 and Stage 3 are shown Figure ***3.2***.

3.2 Land ownership

MPAR and LNAR is owned by EA. The southern portion of LNAR was recently remediated by Centennial Coal Services and returned to EA. LSAR area is currently operated by Centennial Coal Services for coal mining and processing activities.

3.3 Existing site features and access

Key features of the Site are shown in Figure ***3.2***. The Site is accessed via Boulder Road off Castlereagh Highway.

There are no known services located with the design footprint.

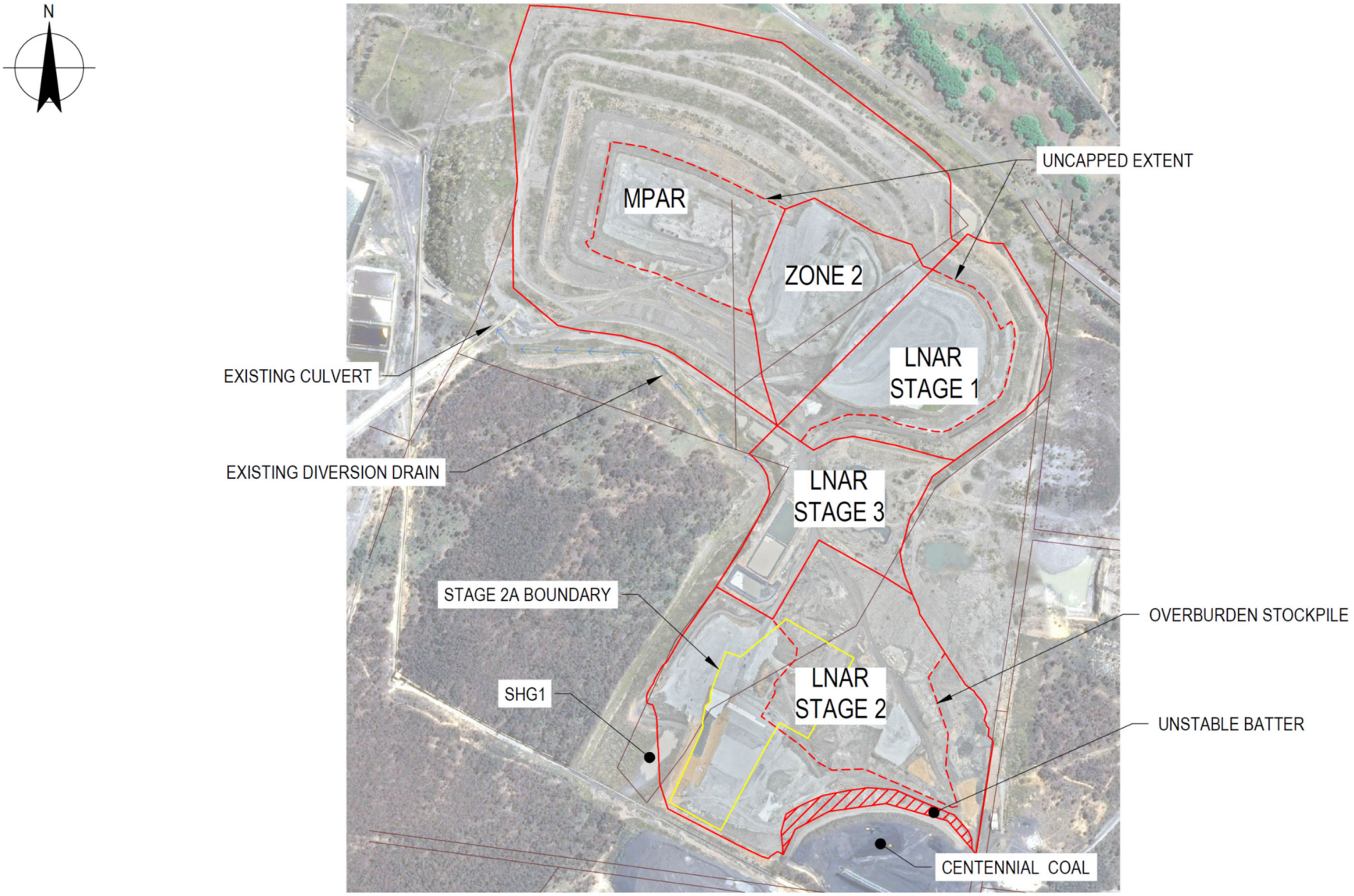


Figure 3.2 ***Site layout***

3.4 Climate

3.4.1 Daily rainfall and evaporation

Daily rainfall data was provided by EA environment team for the Mt Piper Power Station.

The period of rainfall data extended from January 2020 to July 2023 and is shown in Figure 3.3.

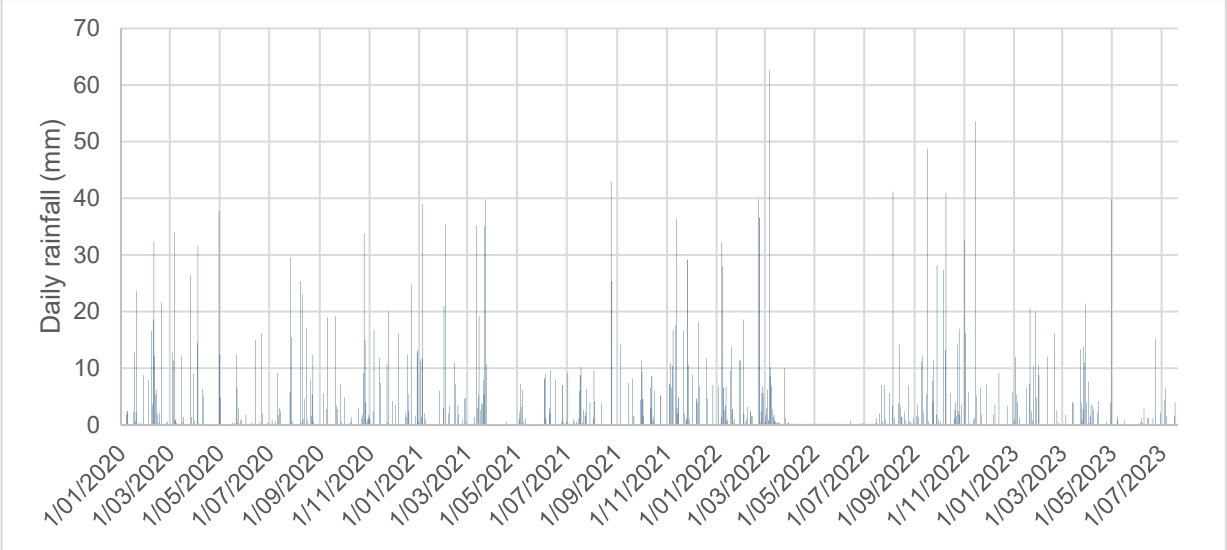


Figure 3.3 Daily rainfall recorded at Mt Piper Power Station (January 2020 to July 2023)

Data is also available from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Science, Information Technology and Innovation. SILO patched point data is based on historical data from a particular Bureau of Meteorology (BOM) station with missing data 'patched in' with interpolations from nearby stations.

SILO data was obtained for the local weather station, Lidsdale (Maddox Lane) Station (station number 63132) which is located approximately 4.6 km south-east of the Mt Piper Power Station.

The data specific to the site location was correlated against the data from SILO as shown in Figure 3.4.

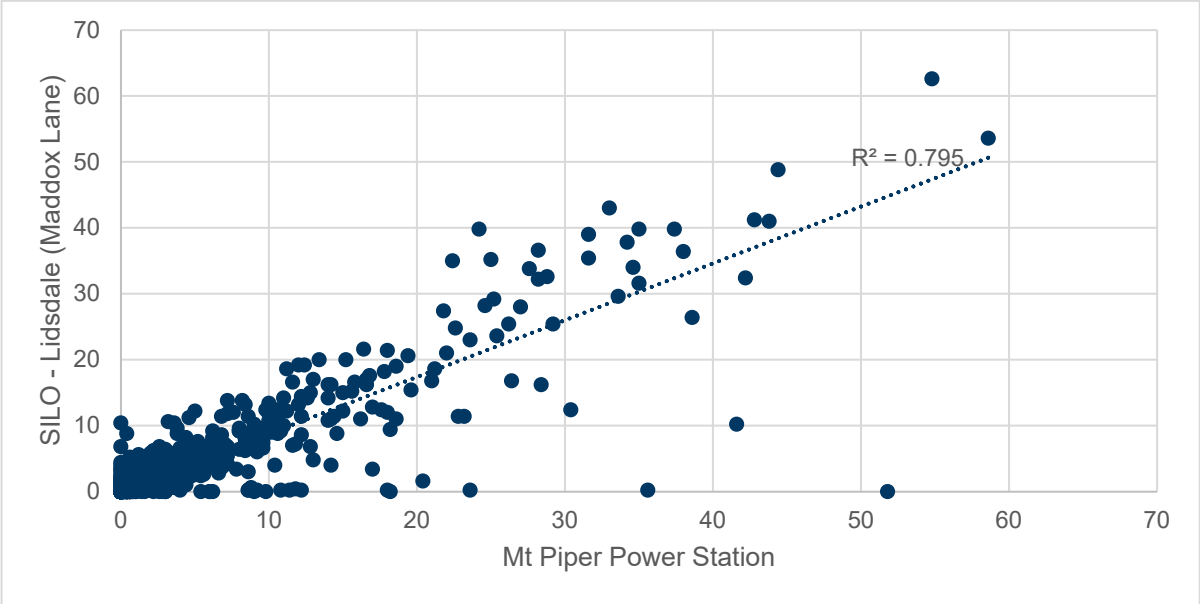


Figure 3.4 Correlation of daily rainfall recorded at Mt Piper Power Station against SILO data for Lidsdale station (January 2020 to July 2023)

The correlation produced an R^2 value of 0.795, which suggests that the additional information collected at the Lidsdale station should be representative of the conditions at the Mt Piper Power Station.

The daily rainfall statistics and average daily evaporation records were determined for the period of record from the Lidsdale (Maddox Lane) station, based on 52 years of data from 1970 to 2022. Average daily rainfall and evaporation is presented in Figure 3.5.

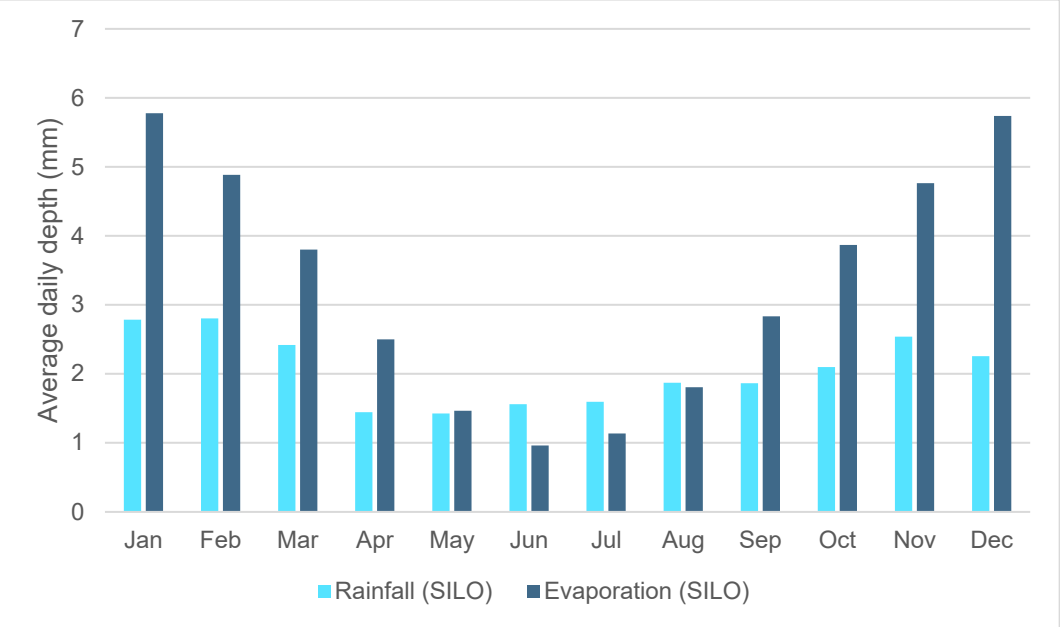


Figure 3.5 Average daily rainfall and evaporation

The average daily rainfall was observed to vary from a low of approximately 1.40 mm in May to a high of approximately 2.8 mm in February based on 52 years of data from 1970 to 2022. Figure 3.5 shows that evaporation varies seasonally, being higher in summer than in winter. There is also a similar, but less pronounced, seasonal variation in daily rainfall totals. This seasonal variation is typical of the mild and cool temperature climate of the site.

3.4.2 Annual rainfall

Annual rainfall figures were obtained from SILO for the Lidsdale weather station.

The period of rainfall data extracted from the site extended from January 1970 to December 2022 and is summarised as annual totals in Figure 3.6. The statistics for this rainfall set are:

- Minimum annual rainfall – 330 mm (2006)
- Average annual rainfall – 751 mm
- Median annual rainfall – 762 mm
- Maximum annual rainfall – 1206 mm (2022)

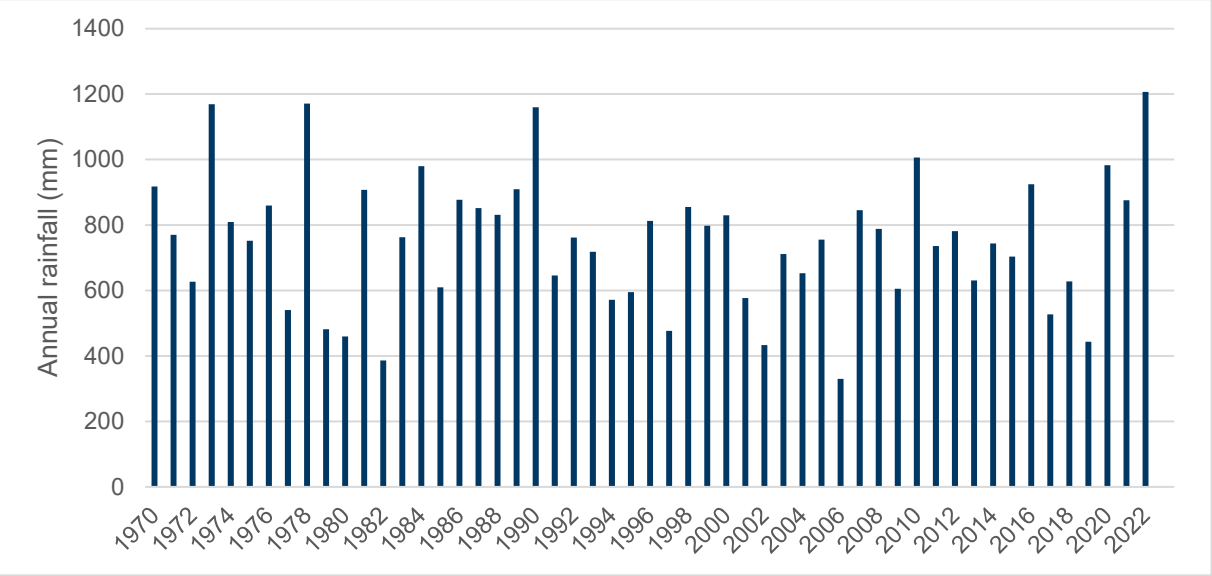


Figure 3.6 Annual rainfall from 1970 to 2022, sourced from SILO for Lidsdale Station

3.5 Topography

The site lies mid-slope between the rising hills to the south and the Wangcol Creek valley to the north. Terrain to the south rises to 1050 m Australian Height Datum (AHD), while the elevation of the site itself is between 960 mAHD to 920 mAHD, with the overall terrain sloping to the north-east.

Site topography (as surveyed by CEH Survey June 2024) is shown in Figure 3.7.



Figure 3.7 Lamberts North Ash Repository topography survey (prepared by CEH Survey, June 2024)

3.6 Geology and past coal mining

Underground coal mining in the Lithgow Seam was conducted as part of Western Main Colliery in the mid to late 1900's. The mined thickness of coal is reported to have been 2.0 to 2.1 m. The strata generally dips toward the northeast at about 1 in 45 (~1.3° to the horizontal). Initially, first workings were undertaken using bord and pillar techniques with a variety of layouts used. Pillar splitting and extraction (second working) was undertaken in selected areas as was open cut mining of both first workings and unmined coal. In some areas, open cut mining to only the shallower Lidsdale Seam (about 1.3 m thick) was undertaken. The thickness between the Lidsdale Seam and Lithgow Seam (inter-burden) is generally about 5 to 8 m. Generally, the Lithgow Seam has a roof of high strength almost massive sandstone, which tends to readily span between pillars and resist localised roof caving, thus contributing to the apparent rarity of pothole subsidence. Faults and other rock defects locally weaken the roof.

A desktop mine subsidence assessment was undertaken by GHD in 2020. The concept design of LNAR relied on the findings of the desktop assessment to identify areas of potential mine subsidence and to inform the selection of the leachate barrier system.

An updated mine subsidence assessment has been undertaken by GHD to support detailed design. This work includes an updated cover model to the top of the Lithgow Seam and revision of subsidence hazard zones and recommendations.

3.7 Hydrology

3.7.1 Regional hydrology

The Project is located within the upper Hawkesbury River catchment, which includes the greater Warragamba Dam catchment and the Upper Coxs River sub-catchment (refer Figure 3.8).

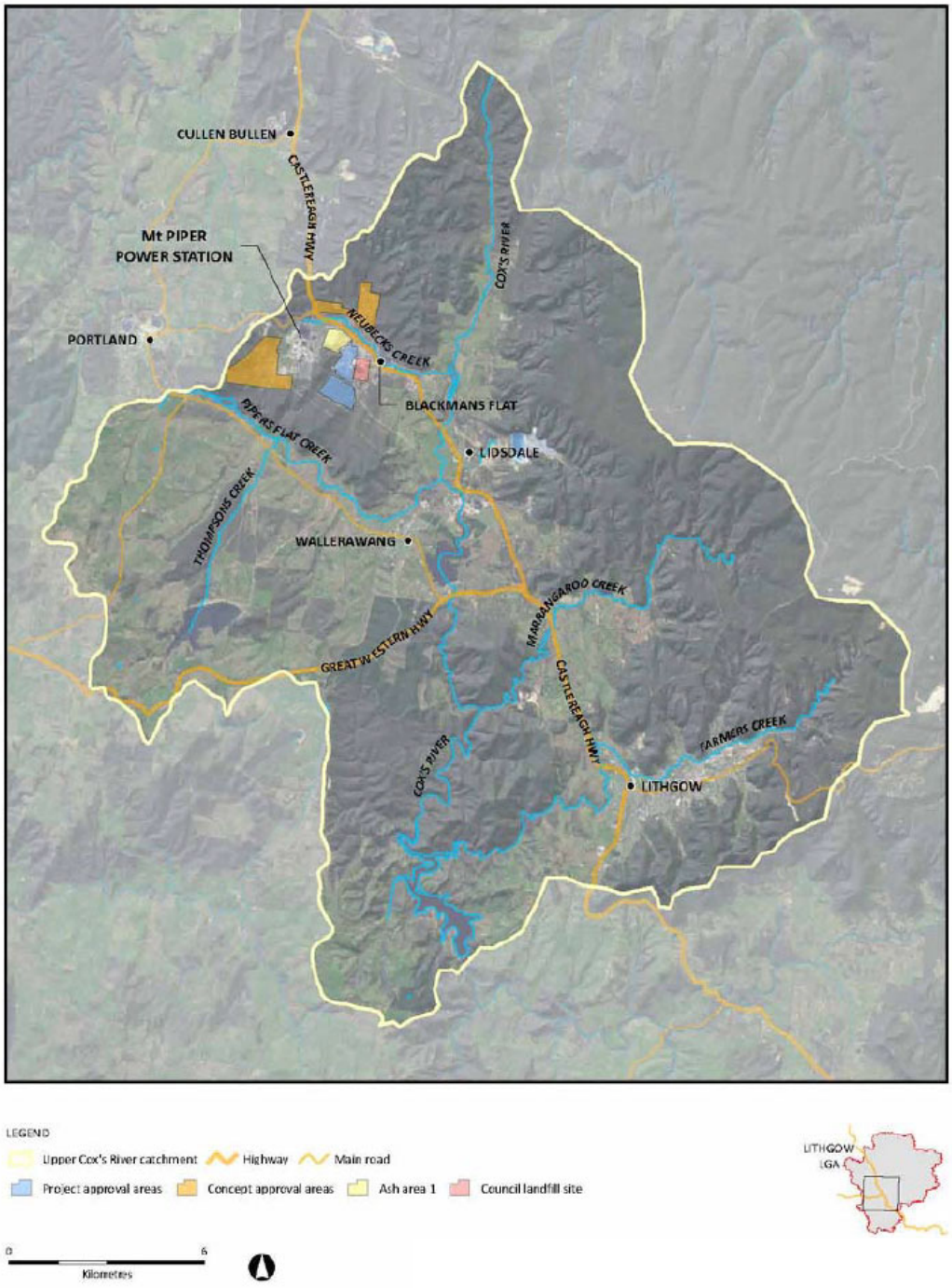


Figure 3.8 ***Regional catchment plan (figure sourced from Mt Piper Power Station Ash Placement Project Hydrology and Water Quality, SKM 2010)***

The Coxs River is a perennial river that drains a catchment area of approximately 1,700 km^2 and is part of the greater Hawkesbury/Nepean catchment. The river rises within the Ben Bullen State Forest east of Cullen Bullen and flows generally in a south-east direction into Lake Burragorang (impounded by Warragamba Dam), which is the primary reservoir for drinking water supply to Sydney. The flow in Coxs River is regulated by three reservoirs, Lake Wallace, Thompsons Creek Reservoir and Lake Lyell, which are used to supply water for power generation activities at MPPS.

3.7.2 Local hydrology

Lamberts North Ash Repository is located within the Wangcol Creek catchment. This creek is a highly modified stream that drains into the Coxs River approximately 3 km to the east of the LNAR. Wangcol Creek has also been diverted to assist in mining land uses historically.

The runoff from the ash repository will report to various sinks and where unlined, is likely to seep into the shallow groundwater system and seep towards Wangcol (Neubecks) Creek. The hydrology of the site has been significantly changed due to historical open cut and underground mining and related activities. The natural watercourse in Huon Gully now terminates in a surface water storage, Huon Gully sediment pond 1 (SHG1), as the gully has been disturbed by open cut mining and ash emplacement. Lamberts Gully enters Neubecks Creek via the existing Lamberts Gully Coal Mine (Western Coal Services) located to the east of Lamberts North (refer Figure 3.9). It should be noted that this figure was included to illustrate historic surface water drainage, noting that inaccuracies exist regarding the Approved LNAR footprint (shown as a dashed black line).

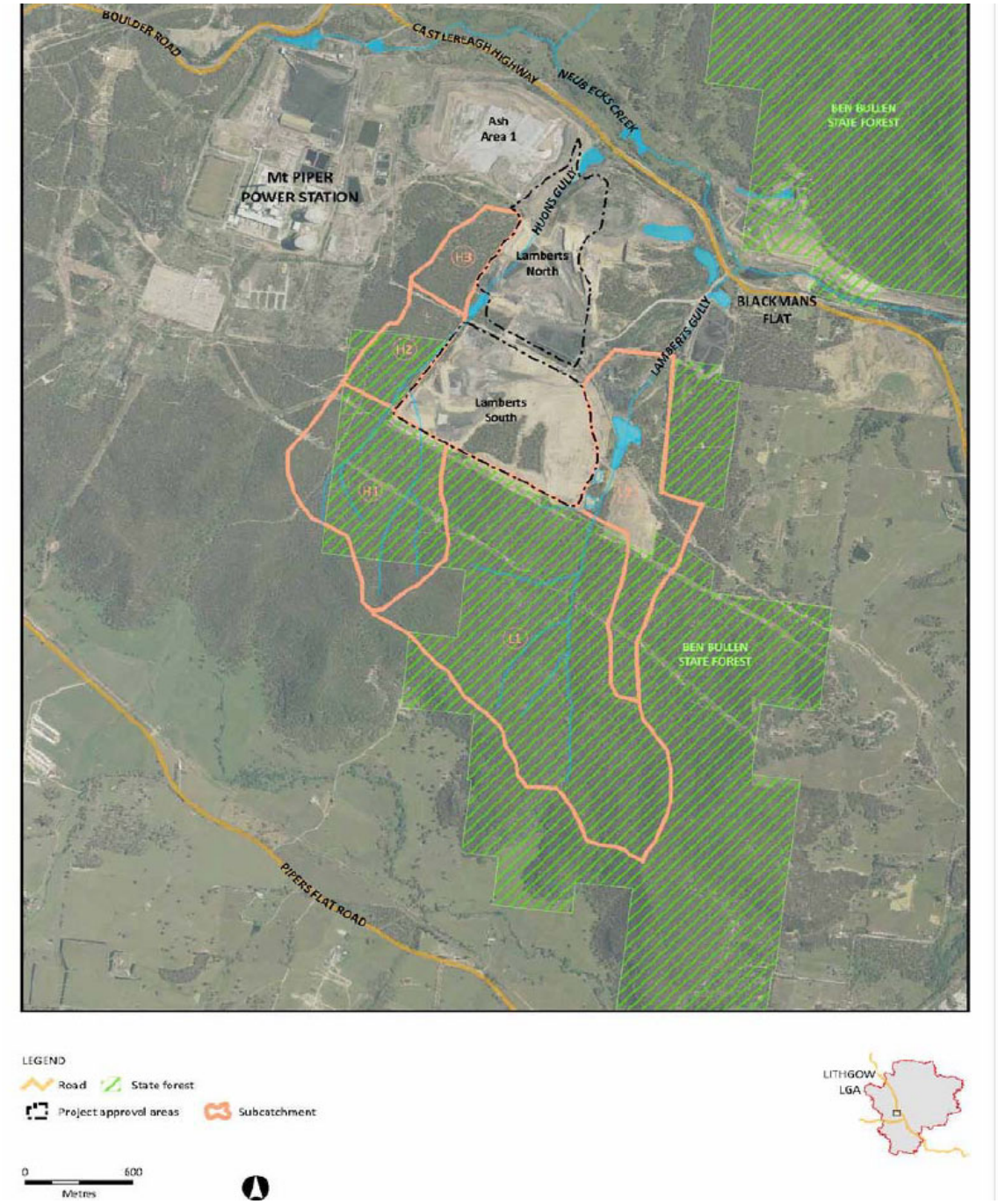


Figure 3.9 *Local hydrology (Figure sourced from Mt Piper Power Station Ash Placement Project Hydrology and Water Quality, SKM 2010)*

3.8 Hydrogeology

3.8.1 Regional

The geological conditions present within the vicinity of the Site create a range of aquifer systems associated with higher permeability sandstones and coal seams. These are likely separated by lower permeability aquitards associated with mudstones, claystones and shale layers.

Shallow sandstone aquifers are predominant across the region and are expected to be associated with the Gap and Ivanhoe sandstone units. These aquifers are likely to be weathered in their near-surface profile resulting in relatively high permeability with potential for significant hydraulic connection with surface water features, including Wangcol Creek.

Surrounding the Site, groundwater is connected to remnant open cut areas, some of which have been backfilled while others remain open. SKM (2010) indicate that following mining (pillar extraction), the connectivity between surface water and groundwater can increase up to three times due to changes in permeability and storage capacities above and within the mine workings. This is supported by observations at the Site where a number of groundwater recharge areas exist, which maintain an influencing factor over discharge volume and quality currently. The site has a long history of mining using both underground and open cut methods.

The mudstone and siltstone units that are present between the primary coals seams (the Lidsdale and Lithgow seams) and sandstones throughout the profile significantly retard vertical flow between aquifer units. Much of this material has been extracted through mining activities.

The primary hydrogeological units identified as part of the MPPS Ash Placement Project (SKM, 2010) and the Western Coal Services Project (RPS 2013b) are summarised in Table 3.1.

Table 3.1 Surrounding hydrogeological units

Unit	Comments
Quaternary alluvium	Isolated to Wangcol Creek, very little presence within the Springvale Coal Services site
Triassic sandstone	Areas of fracturing due to historical underground mining.
Permian Illawarra Coal Measures	Areas of Lidsdale and Lithgow seam have been mined historically.
Marrangaroo conglomerate	Outcrops to the south.
Basal unit comprising the Shoalhaven Group	Outcrops to the south with a high porosity but low permeability.

3.8.2 Local

CDM Smith (2012b), ERM (2018a) and ERM (2020c) were reviewed to determine the level of groundwater within LNAR.

Based on field investigations, CDM Smith (2012b) suggest there are two regional aquifers beneath LNAR. The shallow aquifer is approximately 30 metres below ground level (910 mAHD) and a deep aquifer is approximately 60 metres below ground level (880 mAHD). The aquifers are not connected and flow independently of each other. CDM Smith (2012b) conclude that the shallow aquifer is thought to flow in a north-eastern direction and the deep aquifer flow is thought to flow in a southerly direction.

ERM (2018a) identifies that groundwater levels fluctuate between approximately 906 mAHD to 916 mAHD across the boundary of LNAR.

ERM (2020c) completed a seasonal analysis of groundwater levels which included the preparation of groundwater contour plans for spring (October 2019), summer (January 2020), autumn (March 2020) and winter (June 2020). ERM (2020c) concluded that water levels in the groundwater monitoring bores were relatively stable across the monitoring periods.

The findings of CDM Smith (2012b), ERM (2018a) and ERM (2020c) are consistent with one another and therefore it is anticipated that groundwater resides to a maximum level of approximately

916 mAHD (southwest section of LNAR). Golder's detailed design adopted a conservative value of 924 mAHD for their Plaxis model.

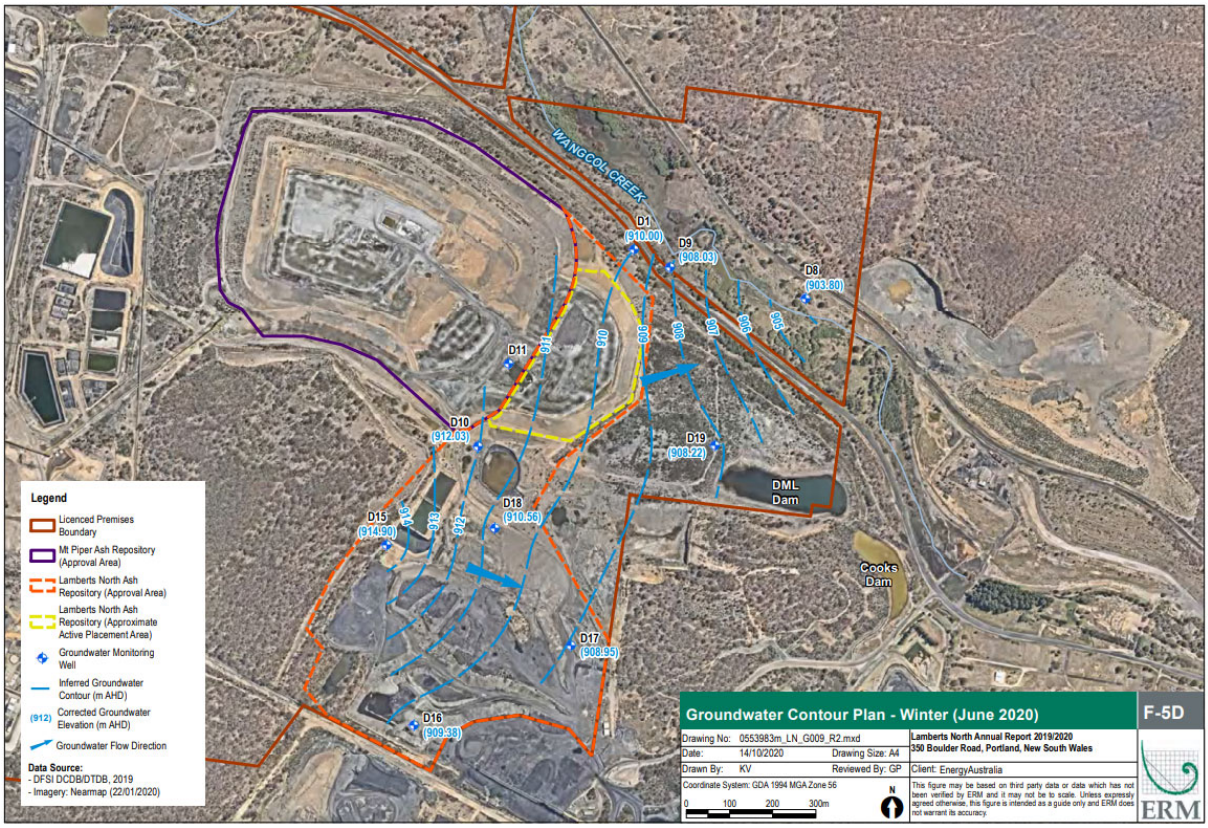


Figure 3.10 *Groundwater levels within LNAR (Figure sourced from Lamberts North Ash Placement Project Annual Water Quality Monitoring Report 2019/2020, ERM (2020c))*

3.9 Material generation

GHD's understanding of the estimated materials to be to be emplaced within the MPPS ash storage areas are summarised in Table 3.2.

Table 3.2 *Materials to be emplaced within MPPS ash storage area*[1]

Material	Total volume (m^3) generated May 2024 – Dec 2040[2]	Containment type	Notes
Water conditioned ash (WCA)	1,699,887	Unlined areas	To be reused where possible
Brine conditioned ash (BCA)	3,629,274	Lined cells only	Production subject to brine volumes produced
Furnace bottom ash (FBA)	777,314	Unlined areas	Fine grained but high permeability material. Currently used in road construction.
Mixed salts	195,138	Lined cells only	Received from third-party. Sets hard with water.
Lime salts	346,912	Lined cells only	Received from third-party. Low strength material.
Fabric filter bags	12,500	Unlined areas	750 m^3/year

[1] Fly ash takeoff removed
[2] Based on information provided by EA on 3 July 2024

Material	Total volume (m^3) generated May 2024 – Dec 2040[2]	Containment type	Notes
Pond silt volume	30,500	Lined cells only	1,500 m^3/year except for 4,000 m^3/year in 2026 and 2027
Pond silt volume	340,000	Unlined areas	20,000 m^3/year
Total	7,031,525		

Forecast annual volumes for the various material streams have been provided by EA and are illustrated in Figure 3.11 and Figure 3.12.

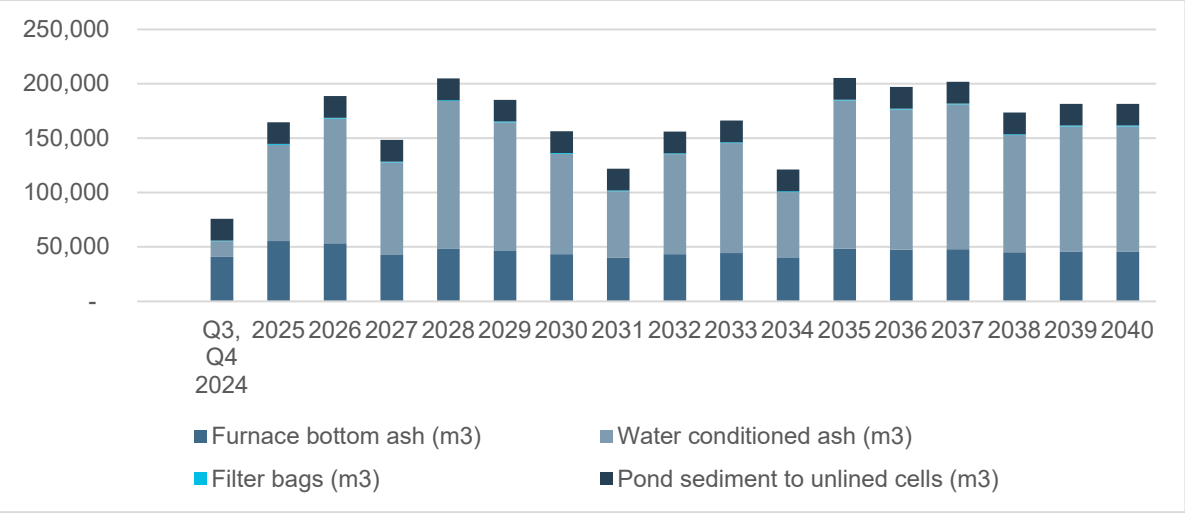


Figure 3.11 Forecast material volumes to unlined areas, provided by EA (2023 is half year only)*

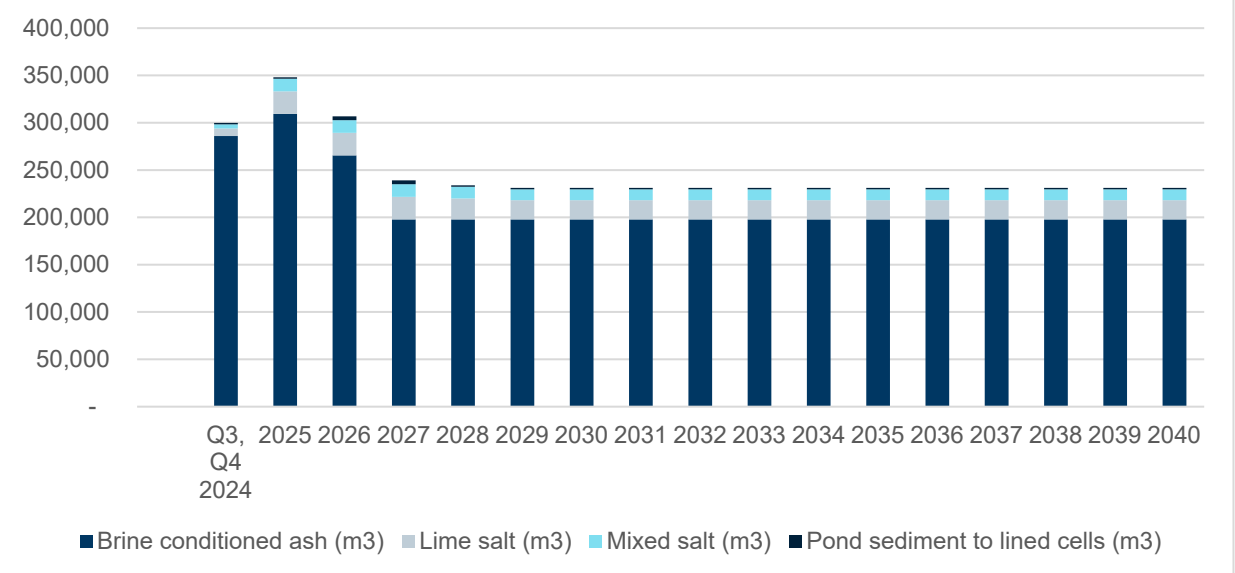


Figure 3.12 Forecast material volumes to lined cells, provided by EA (2023 is half year only)*

These volumes are based on the following assumptions as provided by EA:

- Provided generation rates for coal (tonnes/year), brine (kL/day), fly ash sale (m^3/year) and lime and mixed salt deliveries (tonnes/day)
- Total ash generation is 25% of coal consumption (conservative assumption)
- A portion of ash is sold for beneficial reuse and is transported offsite. EA has provided an annual breakdown of sales volumes.

– 1.2 tonnes of ash consumes 1 m^3 of airspace
– 10% of total ash generation is furnace bottom ash
– Brine is generated 365 days a year and is applied to ash at a rale of 250 L per cubic metre of ash to create brine conditioned ash
– Any remaining ash is emplaced as water conditioned ash
– Salts are received 365 days a year and 0.8 tonnes of salts consumes 1 m^3 of airspace
– For salts, 64% is lime salts and remaining is mixed salts

3.10 Future site development

Amendment to the approved operational areas or activities may require modification to the consent such as;

– The Montezuma extension
– Extension to the east to cater for ponds.
– Placement of BCA within Zone 2 over a piggyback liner on the existing MPAR batter
– Geosynthetic composite final cap for MPAR

It is noted that the expansion items identified above are not included in the Stage 2B detailed design. However, the extent of the site expansions works and future modifications are considered in the design of Stage 2B. Areas outside of the approved operational area are minimised or located within the approved area as much as reasonably practicable.

A detailed review by a qualified planner should be undertaken to verify required modifications to the consent as a result of the future site development.

4. Basis of design

This section documents the basis of the design for LNAR Stage 2B.

4.1 General

The basis of design considers the following:

– Site location, characteristics including the geological (including previous mining activities), hydrology, hydrogeology, topographical survey and existing services
– Classification of the ash types and quantities
– Surface water management
– Leachate management
– Site access
– Ash placement staging and filling
– Final landform
– Existing approvals and operational plans
– Environmental Guidelines: Solid waste landfills (NSW EPA 2016)
– Opportunities and constraints that apply to the development of the detailed design

The basis of the design is aimed at consistency with the current EPA Guidelines.

4.2 Topographic survey

June 2024 survey and aerial photography has been provided by EA. This formed the baseline for the development of the Stage 2B detailed design.

4.3 Containment type

– Stage 2B is to be lined to allow the placement of BCA, mixed salts, and lime salts which are classified as general solid waste and must be placed in lined cells.
– All water percolating through these materials must be collected and treated as brine/leachate
– Runoff will be collected separately and managed based on electrical conductivity (EC)
– Lined cells should be located to allow for leachate drainage and collection at the perimeter of the storage area to allow for extraction of leachate
– Lining systems can deteriorate if left exposed, so construction may need to be staged
– Operationally, large active footprint areas allow for greater disposal of brine water through irrigation
– Mixed and lime salts are proposed to be placed in the lined cells. The risk of clogging drainage systems is being assessed as part of other scopes of work (refer Section 4.12).

4.4 Design considerations

Main issues which require consideration for the design of Stage 2B are summarised in Table 4.1.

Table 4.1 Summary of design considerations

Area	Considerations
Overburden stockpile	A large overburden stockpile is located along the northern boundary of LNAR Stage 2B. It is noted that part of the overburden stockpile has been relocated at various locations on site. No information has been provided to delineate the extents or depth of the stockpile.

Area	Considerations
	This material will be used for the capping of MPAR and LNAR Stage 1 and could be utilised for the capping of the remainder of LNAR. Investigative works have been completed to assess the suitability for reuse.
Centennial Coal area	The area to the southern boundary of LNAR Stage 2B is controlled by Centennial Coal. GHD understands that: – No development works can occur beyond the site boundary which is approximately at the crest of the batter. – Access for construction may be gained from discussion with Centennial Coal but preference is to undertake all works from within EA area. – The eastern curved portion of the batter is very steep and observed to contain many large potentially unstable boulders. The current surface is unsuitable for the placement of liner materials.
Southern straight batter area	The eastern part straight portion of the southern batter was a near-vertical rock wall. Due to rock fall risks, a buttress of material (specification unknown) was constructed along the wall by Centennial Coal prior to handover to EA. A small portion of rock wall remains exposed at the crest. The current surface is unsuitable for the placement of liner materials.
Stage 2A	Stage 2A will be in operation during construction of Stage 2B. As the Stage 2B cell base will likely be lower than Stage 2A, it is necessary to consider the impacts of the construction of Stage 2B on the stability of the Stage 2A liner and placed ash batters. Stage 2A operational holding ponds may be located within the Stage 2B footprint for later incorporation into the Stage 2B lining system.
Surface water management	Construction of Stage 2B will require filling and lining of the H-Pit, the current low point located within the proposed Stage 2B footprint. Surface water reporting to the Stage 2B area will need to be segregated and diverted away from the new lining area. In particularly, the runoff from the remaining Centennial Coal batter and the overburden stockpile will be likely cause ponding on the eastern side of the Stage 2B. In addition, prior to construction of the Stage 2B, a new location for the temporary holding pond of Stage 2A which is currently proposed at the south western corner of Stage 2B will be required.
Groundwater management	Water ingress has been experienced within the Stage 2A construction works. The Stage 2B works may need to consider connection and discharge of any retained Stage 2A subsoil drainage systems, and consider if systems are required to manage infiltration through the southern batters.
Access and operational constraints	WCA and BCA would be delivered to the Site from a combination of ash conveyance from MPPS and heavy haulage trucks. Haulage trucks are loaded at the conveyor transfer point to transport ash to LNAR via internal EA owned roads which are also operated and maintained by EA. BS would be transported to the mixed Salt/Lime Salt Receival Plant and then conveyed to the Aerobelt conveyor for delivery to the ash repository silos. From the silos, mixed salt and lime salt would be transported using tipper trucks to LNAR and directly from SWTP to the repository during WCA production. As previously advised by EA during the design of Stage 2A, ash haul roads are constructed using FBA with a maximum grade of 1V:10H. The width for two vehicle access is 12 metres and single vehicle access 8 metres.

4.5 Access

Access requirements for this project include:

– Use of existing EnergyAustralia owned access roads from the site boundary to the cells, as well as the recently constructed road along the boundary of Stage 2A as appropriate.
– Haul roads as appropriate for each sub-stage
– Offset for perimeter access road.

4.6 Mine subsidence and coal oxidation/combustion

The Site is not within a designated Mine Subsidence District and as such, Subsidence Advisory NSW is not an approval authority under the NSW Mine Subsidence Compensation Act 2017. However, while much of the underground mine workings have been removed by open cut mining, remnant areas of mine workings exist, and risks associated these such as subsidence and heating (oxidation/combustion of coal) remain.

A preliminary assessment into the constraints and challenges that abandoned coal mine workings present to the proposed LNAR development was completed by GHD in 2020. An updated discussion on subsidence hazards and associated risks with respect to LNAR ash emplacement has been recently undertaken by GHD (2023c). It identified hazard zones and mitigation measures to be considered in the design of the leachate barrier system.

Details on this assessment are given in Section 5.

4.7 Hydrogeology

Based on the hydrogeological conditions of the Site as discussed in Section 3.8.2, a maximum groundwater level of 920 AHD across the entire Site has been assumed for the detailed design. This assumption was based on the available historical hydrogeology studies undertaken for the Site, and other anecdotal information such as ongoing management of SHG1 water level and substantial ash placement in the Stage 2A and 2B areas.

The Stage 2B cell design and staging would allow at least 2 metres between the cell base and shallow aquifer over the Site based on the available groundwater level data. A groundwater relief system is not required for construction and operation of the leachate management system however the Stage 2A construction works did uncover some water ingress in the western parts of the works area. This is discussed in Section 6.2.

4.8 Water management

The run-on that is flowing from areas upstream of the project site will be, as far as practical, conveyed around the project footprint via existing or proposed drains. It is noted that the Conditions of Approval states that leachate and water management should be in accordance with the Environmental Guidelines, Solid Waste Landfills (EPA, 2016). As the Environmental Guidelines, Solid Waste Landfills (EPA, 2016) references Managing Urban Stormwater: Soils and Construction Volume 2B Waste Landfills (NSW DECC, 2008a) for further guidance with relevance to stormwater management, the recommended design event for a temporary drainage control is to adopt a design storm event of a 20-year ARI event.

Runoff will be collected separately and managed based on EC.

A water balance analysis is being undertaken to estimate the quantity of leachate and surface water run-on and runoff that requires storage at the site. The analysis will be documented in a technical report to be provided separate to this design report.

4.9 Leachate management

The primary objective of the leachate management system is to contain leachate from BCA and BS placement areas within the Site to prevent pollution of waters and subsurface geology.

Leachate would be extracted from LNAR to retain a leachate level as low as possible to minimise leakage and not greater than 300 mm over the cells' basal liner.

The leachate management approach will be consistent with current practices at the site.

4.9.1 Leachate barrier

The leachate barrier recommended for Stage 2B will be generally the same as Stage 2A. Based on the actual conditions of the site during the construction of Stage 2A, a seepage control layer is added to the proposed liner profile for Stage 2B to reduce impact of groundwater/seepage to the liner construction as required. Full leachate barrier profile is described in Table 4.2.

Table 4.2 Leachate barrier description

Layers (from top to bottom)	Description
Leachate drainage layer	300 mm thick FBA
	Geonet drainage geocomposite and drainage aggregate
Barrier	LLDPE geomembrane
	Geosynthetic clay liner
Subgrade	Prepared existing surface or reworked WCA Min. depth to be established by geotechnical investigation/risk assessment
Settlement control layer (as required)	Coarse material in line with geogrid aperture size
	Geogrid
Seepage control layer (as required)	Geonet drainage geocomposite and piping network

4.9.2 Leachate collection

Leachate that percolates through the ash material will be captured by the 300 mm thick FBA drainage layer at the base of the cell. The floor of the cell will be graded towards a pipe network that will be installed overlying the leachate barrier to collect and drain leachate towards a central sump for extraction. The pipe longitudinal grades will be a minimum 2% and 3% in transverse directions at 25 m spacing in accordance with the recommendations of the NSW EPA Landfill Guidelines (2016).

4.9.3 Extraction and disposal

Leachate collected within the sumps will be pumped via transfer pipeline to the existing leachate storage ponds. The total current storage capacity is understood to be 60 ML.

The follow leachate disposal mechanisms will be employed at the MPPS.

– Irrigation and dust suppression within lined containment areas
– Evaporation using vaporisers
– Conditioning of ash
– Transfer to the MPPS water management system for treatment and reuse in electricity generation.

During extreme weather periods, excess leachate will be transferred from LNAR 3 to Waste Ponds using Tsurumi LH637 submersible seawater-resistant dewatering pumps. The pumps are designed to be corrosion resistant and will be positioned on each pond. The maximum pumping rate is approximately 40L/s.

4.10 Stability

The geotechnical design inputs adopted for this design include the following:

– Ash geomechanical properties (as per Golder 2021) unless modified by GHD through Lime Salt and Mixed Salt blending trials
– Seismic loading (as per AS 1170.4-2007)
– Target minimum factors of safety (FoS) for global stability (as per Golder 2021)
  - Short-term (construction): Min. FoS = 1.25
  - Long-term: Min. FoS = 1.50
  - Seismic: Min. FoS = 1.20
– Surface loading (as per Golder 2021 for consistency with MPAR)
– Construction loading of 10 kPa over 3 m wide strip for roller compaction and truck movements
– Maintenance access loading of 2.5 kPa over 2 m wide strip above final capping for light vehicle access in long-term condition

Geotechnical assessments completed by Golder for the Stage 1 LNAR are listed in Section 13.

4.11 Settlement

Potential sources for differential settlement or compressible/unstable zones within the MPPS ash storage areas include:

– Mine subsidence (refer Section 5)
– Filter bags
– Very soft materials
– Voided mine overburden (that allows loss of fines into voids and creation of higher cavities)
– Abrupt transitions in ground stiffness (such as along a buried mine highwall)
– Low temperature oxidation or combustion of coal/coal waste (of concern due to temperature or gas emissions more importantly)

Whilst the above ‘hazards’ are not expected to be present, there is potential for them and, if present they may affect the leachate management system. Unsuitable material removal and replacement methods have been included in the design drawings where needed.

4.12 BCA and BS placement

The BCA, lime salts and mixed salts produced by MPPS and SWTP are to be co-disposed with BCA in lined cells at the LNAR. The WCA will be placed last, as an inert cover over the salts and BCA in addition to engineered capping.

Management of lime salts and mixed salts will be based on testing and trialling completed in line with GHD (2023c and 2024).

4.13 Capping

It is understood that the final capping for MPAR and LNAR will be consistent with the approved capping design for LNAR as outlined in the Landscape and Rehabilitation Plan in the OEMP (EA 2022). The low permeability cap design comprises (from top to bottom):

– Vegetation growth medium
– Sub-surface drainage
– LLDPE geomembrane liner
– Seal bearing layer.

Cover and capping material would be sourced from the materials available onsite as a priority. Where available, material for rehabilitation of the Site would be sourced from Bathurst and Lithgow local government areas in accordance with the requirements of the Environment Protection Licence. The site will be progressively rehabilitated as outlined in the OEMP (EA 2022). The proposed planting species will be based on the outcome of current MPAR revegetation trials.

Based on the composition of the ash materials to be placed in the MPPS ash storage areas, generation of gas is not expected. Therefore, no gas management infrastructure is proposed as part of the capping design.

The above will be considered further as part of a separate package of works on the capping design.

4.14 Opportunities

Opportunities are favourable conditions or prospects that the project can leverage to achieve its objectives. Opportunities identified by GHD include:

– Existing H-pit void is to be utilised for the works
– Potential to incorporate temporary storage ponds required for the Stage 2A works into the Stage 2B construction.
– Design details from Stage 2A works can be utilised for Stage 2B

4.15 Constraints

Constraints represent limitations that may impact the design and development of the project. It is essential to be aware of these constraints to address them effectively. Constraints identified by GHD include:

– No access available from the top of the curved portion of the southern batter (Centennial Coal).
– The southern batters are unsuitable for lining
– Need to divert surface water flows away from the works area
– Potentially limited availability of WCA for construction activities
– Potential for settlement of underlying materials, in particular risk of static liquefaction of these materials based on recent observations
– Presence of filter bags within the cell subgrade area

5. Mine subsidence

This section outlines the key findings of the preliminary mine subsidence assessment in relation to LNAR Stage 2B.

5.1 Open cut mining

The extent of open cut mining operations within the Stage 2 footprint is described in the updated mine subsidence assessment (GHD 2023c). The Stage 2 area is located within the vicinity of both the RT83 open cut area and RT826 'H' Pit and RT826 'E' Pit.

The Western Main open cut mining (RT83) took place in the 1950s in the northern part of the LNAR site with mining only extending to the Lidsdale Seam at that time. Secondary extraction (pillar removal) of the underground workings generally occurred between 1990 and 1993 and further open cut mining as part of Western Main (RT83) occurred during the 1990s with mining extending to the floor of the Lithgow Seam.

Approval was granted for open cut mining within the LNAR site as Lamberts Gully (RT826) in 2006 in the 'H' Pit area and 2008 in the 'E' Pit area. The actual date of mining was between 2007 and 2010.

Examples of potentially problematic situations are:

– Over time, fill material can migrate into the mine voids and result in a surface sinkhole, or lines of sinkholes along the former open cut crest. This is more likely to occur where surface water infiltration and groundwater seepage aids transport of material, particularly dispersive soil or rock. An example is the Mt Piper A&B cooling pipeline sinkhole which formed south of cooling tower U2 in mid-2020.
– Groundwater travelling through mine workings, may become impeded by a backfilled open cut, potentially resulting in erosion or softening of pillars and the mine floor, possible leading to eventual pillar failure.

5.2 Remaining underground mine workings

Where pillars remain, or where an area of second workings is directly adjacent to unmined coal, mine voids within the Lithgow Seam are expected to exist. Such areas present a subsidence hazard through the following potential mechanisms:

– **Pothole subsidence**: whereby the roof above a mined roadway collapses (falls) and the resultant void propagates upward with subsequent roof fall events toward the ground surface or, in this case, a liner.
– **Sinkhole subsidence**: whereby soil and/or dispersive rock migrates downward into mined roadways/voids with groundwater flow through conduits such as subsidence cracks, faults or boreholes, resulting in formation of a cavity at the location where the soil/rock is moving from, usually around the entrance to the conduit.
– **Trough subsidence**: whereby coal pillars crush (fail) and the mine roof converge over a large area resulting in sagging of the overburden strata and surface subsidence that may be systematic (bowl shaped) or affected by anomalies such as faults or jointing in the overburden to be non-systematic (stepped).

Where pillars have been removed (second workings), roof convergence and trough subsidence are expected to have already occurred, provided that the area of extraction was wide enough such that the mine roof was not able to span over the extracted pillar/s without failing.

5.3 Mine subsidence hazard zones

Preliminary subsidence hazard zones (SHZs) have been identified by GHD through review of underground and open cut mine record tracings, available borehole information and the cover depth model (to July 2023 ground surface) with consideration of:

– The presence of first workings and hence trough subsidence potential.
– The presence of first workings with cover depth less than 20 to 30 m (not including ash) and hence pothole subsidence is of concern.
– The presence of likely spanning roof areas of second workings and hence trough (block) subsidence is of concern.
– Situations with less than 30 m cover (not including ash) where backfilled open cuts abut areas of first workings or expected open second workings and hence sinkhole subsidence is of concern.
– Situations with less than 30 m cover (not including ash) where cracked overburden (due to past trough subsidence over areas of second workings) is likely to provide conduits into mine voids and hence sinkhole subsidence is of concern.

Subsidence hazard zones located within the vicinity of the Stage 2B footprint are summarised in Table 5.1

Table 5.1 Subsidence hazard zones

	SHZ_9
Description	Area of 1st workings in Lithgow Seam between square pillars from 1993 and pillar extraction from 1993 with floor of about 908 m to 912 m AHD that was not removed by open cut mining (RT826 'H' Pit) which only extended to about 920 m AHD.
Current cover depth	Approx. 20 to 35 m
Subsidence hazard	Trough subsidence should pillars crush (very unlikely based on FoS). Possible pothole subsidence (unlikely). Sinkhole formation with migration of fines from backfilled open cut into voids.
Proximity to Stage 2B	Stage 2B cell is located to the south of SHZ_9 and avoids interaction with the identified subsidence hazard zone

The likelihood of sinkhole or pothole subsidence occurring and impacting an element at risk (e.g. the liner) cannot be reliably assessed without subsurface investigation data. Even with such data, a high degree of uncertainty would remain with respect to trigger mechanisms, frequency and propagation. As a preliminary guide, the following zones are considered more likely to produce sinkholes and/or potholes.

– SHZ_9: loss of open cut backfill into 1st workings as well as possible migration of fines through cracks around edge of zone.

Factor of safety calculations undertaken as part of the updated mine subsidence assessment (GHD 2023c) suggests the remaining first working pillars are long-term stable.

While the mechanisms of subsidence vary (pillar failure versus sinkholes versus potholes) each hazard has the potential to result in liner rupture and hence loss of contained waste (solid and liquid) into the mine voids below. Other consequences of subsidence may include:

– Increase in hydraulic connection (ground permeability) in lined and unlined situations.
– Damage to surface infrastructure such as roads, drains, utilities.
– Loss of water/brine (probably rapidly and catastrophically) from ponds and dams.
– Safety hazards to people during and after facility operation.

5.4 Mitigation measures

Mine subsidence mitigation measures are discussed in detail in Section 6 of the updated mine subsidence assessment (GHD 2023c). A summary of the proposed preliminary mitigation measures for the subsidence hazard zones present in the vicinity of Stage 2B are shown in Table 5.2. Risks associated to SHZ_9 have been mitigated through avoidance. The Stage 2B lined cell footprint avoids construction within this zone.

Table 5.2 Preliminary risk mitigation measures identified in mine subsidence assessment

Hazard zone	Subsidence hazards of concern	Mitigation measures (preliminary)	Geotechnical investigation recommended to progress
SHZ_9	Sinkholes	Grouting or geotextile	Geotechnical investigation should this area not be avoidable.
	Potholes	Investigate to characterise caving with possible geofabric or grouting solution. (20m+ cover already exists but much may be ash.)	

6. Cell design

This section outlines the cell design and filling approach for LNAR Stage 2B.

6.1 Design philosophy

The detailed design for Stage 2B LNAR uses well-proven principles and appropriate materials, and adopts industry guidelines. The design has been developed to take into account:

- The approved LNAR footprint and form of existing topography
- The location and risks associated to mine subsidence hazard zones
- Ease and safety of construction and ability to meet construction quality requirements
- The maximum capped height above existing ground level to be no greater than approved for the LNAR surface
- Spatial and safety requirements
- Use of existing surface water storage and leachate disposal infrastructure
- Cell batters and finished slopes to meet the requirements of the Lamberts North Approval and EPA Guidelines, including the construction and operational safety and maintenance aspects and that needed to minimise liner stress
- Stormwater management requirements
- The rate of ash and BS placement, cap progressive placement, practical number of intra-cell divisions for hydraulic separation and the length of time unfilled cells would remain open
- Minimisation of the cells aftercare and maintenance requirements

6.1.1 Location of cell

The Stage 2B LNAR lined cell is to occupy the southern portion of the LNAR design footprint, on the eastern side of Stage 2A as shown in Figure 6.1.

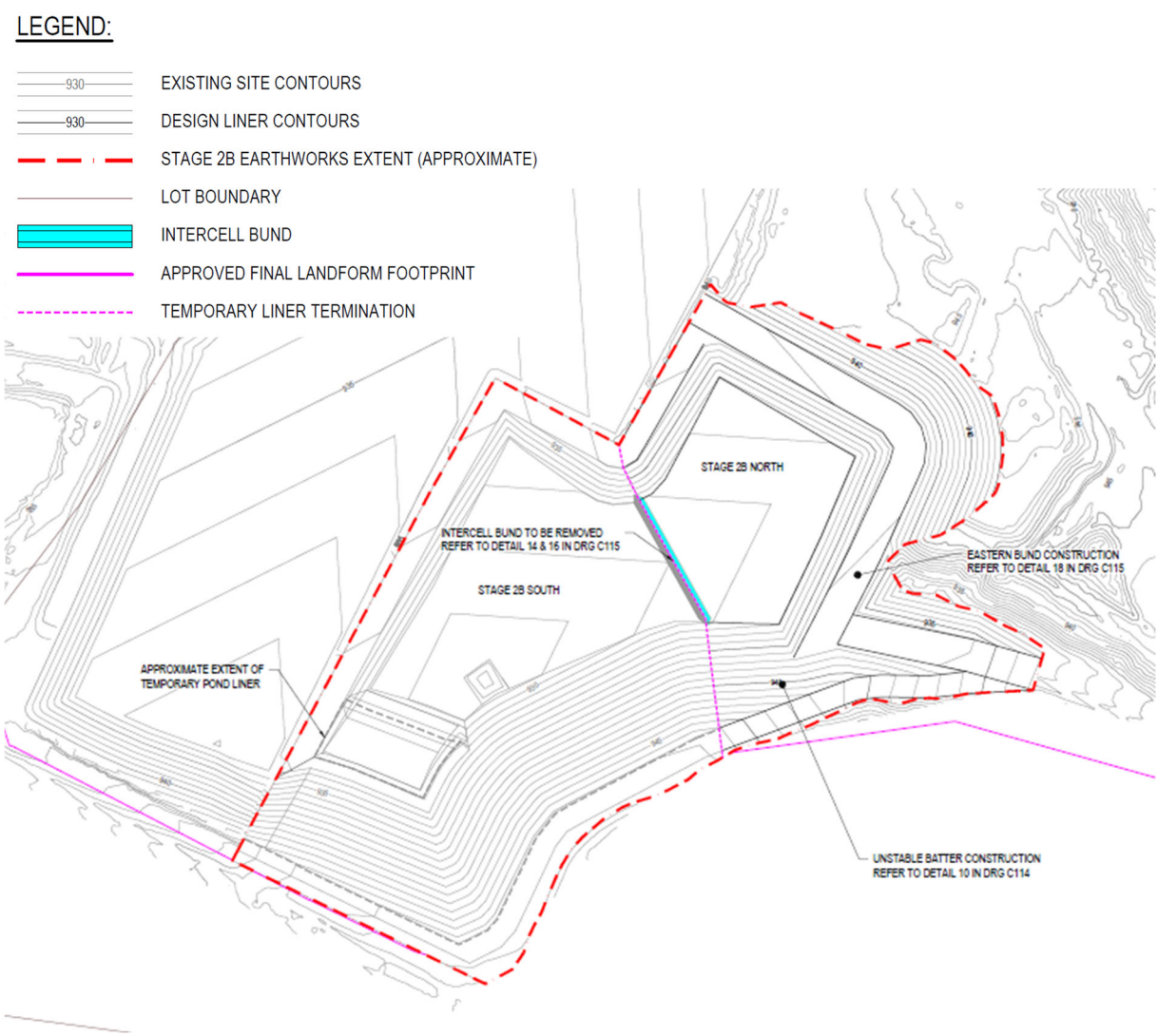


Figure 6.1 Stage 2B cell footprint

6.1.2 Interaction with surrounding infrastructure

Overburden stockpile

Excavation of the overburden stockpile is required as part of these works (Section 6.1.3).

Stormwater infrastructure

The existing H-pit, which is located within the Stage 2B footprint receives run-off from surrounding areas. Construction of Stage 2B will require diversion of stormwater away from the cell footprint.

Access

Access for construction and ash filling will be from the north and east via the existing haul roads.

The south western and southern batters have provision for vehicle access for liner construction and operational maintenance only. Safety berms/barriers will be required to demarcate the area.

Southern bundwall and Centennial Coal batter

The southern bundwall and the existing Centennial Coal batter will form part of the cell once completed. The grading of the wall will be altered to produce a stable batter for lining and filling. The batter slope will be at maximum 1(v) in 3(h).

Along the curve of the Centennial Coal area, a 10 m width bench will be created for access for construction, water management and future operation / maintenance activities.

Stage 2A

The work area is located directly to the east of Stage 2A. The Stage 2B lining system will be made continuous with the Stage 2A lining system.

6.1.3 Excavation requirements

Total excavation of approximately 108,500 m^3 of ash and overburden material is required to form the Stage 2B Cell, as well as minor additional excavation to remove unsuitable material such as filter bags. Bulk earthworks required for access roads and shaping of sidewall and basal liner, will be undertaken as part of the early works package.

A 10 m allowance has been provided between the Stage 2B perimeter bund and the toe of the excavation surface for access and surface water management.

6.2 Sidewall seepage drainage system

The excavation surface is located above the inferred groundwater levels as described in Section 3.8.2, therefore a groundwater drainage system is not expected to be required.

Seepage has been observed in the construction of Stage 2A, which softened some areas of the subgrade surface of the basal liner.

Therefore, a seepage control layer is proposed in the design which may be used for impacted areas as required during construction.

The seepage drainage system will however be excluded at this stage for the new southern batters (along the Centennial Coal site) due to low seepage risks.

6.3 Geotechnical assessment

6.3.1 General

The method of placement of the ash considers the geotechnical and geochemical implications of the placement of the different waste types within the MPAR and LNAR.

6.3.2 Ash placement

Temporary ash batters will be formed at no steeper than 1(v) in 3(h). The external batters would be constructed of a soil bund suitable for placing the final cap over. Parallel internal bunds will then be constructed to create a bunded area for placement and compaction of the ash material. Runoff from the tip face (active ash placement area) may be collected and managed separately as per Section 4.8.

The bund height is based on the typical lift thickness, which is typically 0.5 m to 1 m and may be adjusted based on cell geometry.

6.3.3 Southern batter

The existing southern batter includes limited spatial allowance within the LNAR approved boundary at the crest for perimeter road and construction access. Same as Stage 2A, additional fill material will be placed along the southern batter of Stage 2B to achieve a flatter subgrade for the placement of the sidewall liner. A continuous batter was adopted based on feedback from the construction contractor with regard to constructability, noting project-specific geosynthetic rolls will be procured to match the longer batter length. The construction will be a mixture of overburden for the lower depths and select fill at the top to provide an appropriate subgrade for the overlying layers. A nominal depth for the select fill was nominated in the design based on feedback from the construction contractor and will be finalised based on a field trial during construction.

6.3.4 Unstable batter in Centennial Coal area

Additional fill material will be placed along the existing rock fill batter of the Centennial Coal site to create an appropriate surface for the placement of the sidewall liner and to provide a 10 metre wide bench to improve constructability access and safety. Up to 3.0 metres of the bench width will be used for anchorage of the sidewall lining system and safety bund. A continuous batter was adopted based on feedback from the construction contractor with regard to constructability, noting project-specific geosynthetic rolls will be procured to match the longer batter length. The construction will be a mixture of overburden for the lower depths and select fill at the top to provide an appropriate subgrade for the overlying layers. A nominal depth for the select fill was nominated in the design based on feedback from the construction contractor and will be finalised based on a field trial during construction.

6.4 Earthworks

The placement of the ash materials will be conducted in accordance with the 'Ash excavation and placement' section of the Technical Specification (Appendix D), which is to be integrated with the liner and any waste mixing requirements.

This aspect will be further advanced on completion of the ash materials testing programme, which is currently in progress.

6.5 Operational staging

6.5.1 Staging description

The basis for the staging for Stage 2B was initially developed as part of the WOLS and further detailed as part of this report.

Stage 2 will be completed in two sub-stages.

Early works to establish Stage 2B will include

– Filling on the southern sidewall batters
– Removal of existing filter bags
– Desilting of existing water storage area
– Removal of the existing overburden stockpile at north of Stage 2B

Stage 2B is located immediately to the east of Stage 2A. The staging plan for the ash repository areas takes into account the concurrent filling of WCA in unlined cells.

Intra-stage bunds isolate unfilled areas from filling areas to reduce volumes of leachate affected water which needs to be managed.

6.5.2 Airspace estimates

The estimated design volume for Stage 2B is 850,000-900,000 m^3 (consistent with the previous whole of life strategy estimates).

7. Leachate management

This section details the leachate management plan for LNAR Stage 2B.

7.1 General

A separate report detailing the Water Balance has been prepared. Generation of leachate was assessed through the development of a water balance model which is detailed in the following the sections. The water balance was developed in general accordance with the EPA Guidelines (refer section 2.3 of the guidelines for further guidance). Site specific information was input to the model to simulate climate conditions at the site.

7.2 Key principles of leachate management

In developing the leachate management system, the following key principles were adopted:

– Minimisation including diversion of stormwater, compaction of the ash to reduce infiltration and progressive final capping.
– Containment by construction of a leachate barrier.
– Collection and storage utilising existing (or purpose built, if required) site infrastructure (not part of this assessment).
– Disposal via evaporation or spray irrigation.
– Transfer of leachate during extreme weather events to contingency storage (LNAR ponds, or MPPS ponds if required).

As per Section 7.3, water balance analysis is being undertaken to estimate the quantity of leachate and surface water run-on and runoff that requires storage at the site. The analysis will be documented in a technical report to be provided separate to this design report.

7.3 Water balance

A water balance analysis is being undertaken to estimate the quantity of leachate and surface water run-on and runoff that requires storage at the site. The analysis will be documented in a technical report to be provided separate to this design report. The types of flows that will be considered include:

– Upstream run-on
– Sediment laden runoff from WCA placement areas and other disturbed areas
– Runoff from BCA placement areas and subsurface leachate collection
– Runoff from rehabilitated site areas

7.4 Leachate barrier system

A low permeability leachate barrier system, which is consistent with the requirements of the EPA Guidelines, would be installed on all excavated surfaces where BCA placement will occur.

The required material properties for the leachate barrier system components are provided in the Technical Specification (Appendix D).

7.4.1 Basal liner profile

The basal liner will include the following components (top to bottom):

– Leachate drainage layer (300 mm FBA and pipework)
– Geonet drainage geocomposite
– 2 mm LLDPE smooth geomembrane liner
– Geosynthetic clay liner (GCL)

– Prepared existing subgrade surface, minimum 300 mm reworked WCA or settlement control layer to provide a smooth and firm bearing layer for the liner system above.

7.4.2 Sidewall liner profile

The sidewall liner for installation on slopes up to 1V:2.5H will include the following components (top to bottom):

– Sacrificial geotextile
– Geonet drainage geocomposite
– 2 mm LLDPE single sided textured geomembrane liner
– GCL
– Prepared existing subgrade surface, minimum 300 mm reworked WCA or settlement control layer to provide a smooth and firm bearing layer for the liner system above.

Geonet drainage geocomposite

A geonet drainage geocomposite is included over the full extent of the basal and side wall liner to prevent damage to the underlying geomembrane liner during installation of the overlying materials and act as a leachate collection layer.

Geomembrane liner

A 2 mm LLDPE geomembrane liner is included over the full extent of the basal and sidewall liner to form part of the primary barrier system and prevent leachate discharge. A single sided textured geomembrane is specified for the sidewalls to enhance interface shear strength.

GCL

A GCL is included over the full extent of the basal and sidewall liner to act as a hydraulic barrier layer to collect leachate.

7.4.3 Anchorage

Anchor trench design calculations will be completed for the 1V:2.5H batter using the longest design slope. The calculations will use the following key design parameters:

Table 7.1 Design parameters – anchorage

Parameter	Value	Comment
Slope angle	1V:2.5H	As per design
Vertical height of slope	18 m	As per design (maximum slope)
Friction angles	Various	Utilising typical laboratory values from GRI Report #30 (2005)

The anchor trenches are required to have a geometry of 0.5 m x 0.5 m across the side slopes.

7.4.4 Liner protection

The following measures are proposed to protect the geomembrane and GCL liner system.

– The required subgrade surface requirements are outlined in the Technical Specification (Appendix D). A smooth and firm subgrade surface shall be prepared for liner installation. A minimum 300 mm layer of reworked WCA will provide a physical barrier between the liner material and overlying ash material where the existing subgrade is not suitable for liner installation or where filling is required to shape the cell.
– The liner will be directly overlain by the geonet drainage geocomposite including leachate pipe alignments. Loading calculations undertaken for the geonet drainage geocomposite as further discussed in section 7.5.3, consider the maximum overlying ash thickness. The geocomposite will act as a cushioning layer above the geomembrane liner and provide protection during placement of the FBA drainage layer on the basal liner and ash on the sidewalls.

– The 300 mm layer of FBA overlying the basal liner system will provide physical separation to the liner. The gradation specifications as outlined in the material specification (Appendix D) require a maximum particle size of 19 mm and maximum fines content of 35%. Based on particle size distribution testing on FBA as outlined in the Stage 1 detailed design report (Golder 2022), FBA is typically well graded. Therefore, the puncture potential for the FBA material is considered to be limited.
– A sacrificial geotextile will be installed over the sidewall liner system to provide temporary UV protection prior to filling.

7.4.5 Liner shear strength

Landform stability design calculations are provided in Appendix C that assess the proposed dimensions of the Stage 2B landform design. The calculations estimate stability of the sidewall liner in the case of translational failure according to Qian et al (2003).

Key inputs include the unit weight of ash of 15 kN/m3 and internal friction of ash of 22 degrees. The worse-case scenario was predicted to occur at the east sidewall, south of the intercell bund.

The analysis targeted a factor of safety of 1.5 and used conservative slope heights (>15 m) and base widths (<80 m). This FoS was achieved by adopting a horizontal width of waste mass from the sidewall of 40 m, which should be achievable for the operational procedures proposed. The assessment assumed no seepage build up.

7.4.6 Liner compatibility

The materials proposed Stage 2B liner design will be the same as Stage 2A which were based on the compatibility testing for LLDPE geomembrane and GCL recommended by Golder (2022).

7.5 Leachate collection system

7.5.1 Cell base

A leachate collection layer will be installed on the base of the cell. The layer will consist of 300 mm thick FBA drainage layer overlying a geonet drainage geocomposite. Perforated leachate collection pipework in trenches and embedded in drainage aggregate will be installed to assist drainage. The pipes are arranged in a herringbone configuration to augment the drainage capacity of the FBA and geonet drainage geocomposite and follow the cell base grades to promote leachate drainage to the leachate sumps (Section 7.5.8).Pipe spacing on the cell base is confirmed in the geonet drainage geocomposite design calculations (Appendix C).

The primary leachate collection pipe will drain directly to the leachate sump and be placed at a minimum grade of 2%. The secondary leachate collection pipes that drain into the primary pipe will be placed at an approximate grade of 3%. Separation geotextile shall be placed above the drainage aggregate surrounding the pipework to reduce the ingress of fines from the overlying ash.

7.5.2 Sidewalls

Geonet drainage geocomposite only shall be used for sidewall leachate drainage. The sidewall slopes will promote collection of leachate towards the cell base collection system. Design calculations for the drainage layer on the sidewall are provided in Appendix C.

7.5.3 Geonet drainage geocomposite

The geonet drainage geocomposite shall comprise a drainage geonet core (bi-planar polypropylene) with non-woven, needle-punched, polypropylene geotextile factory bonded to both sides. The geonet drainage geocomposite is intended to have the dual purpose as a leachate drainage and liner protection layer. The composite drainage layer is preferred over the conventional drainage aggregate blanket due to material availability constraints in the region and constructability considerations.

A conservative approach was taken to specification of the material properties as the drainage capacity of the FBA layer was not taken into account. Calculations for the design of the geonet drainage geocomposite will be undertaken, using the following key design parameters:

Table 7.2 Design parameters – geonet drainage geocomposite

Parameter	Value		Comment
	Basal liner	Sidewall liner	
Slope angle	1V:50H	1V:2.5H	As per design
Vertical height of slope	0.5 m	18 m	Basal liner: different level of 2 secondary leachate pipes on cell base (at maximum 25m spacings) Sidewall liner: maximum slope as per design
Depth of overlying fill	37 m	37 m	Based on proposed final landform (maximum depth)
Reduction factors	Various	Various	In accordance with Qian (2002)

7.5.4 Furnace bottom ash drainage layer

A 300 mm FBA layer will supplement the geonet drainage geocomposite collection layer on the cell base. The suitability of FBA as a drainage layer was assessed as part of the detailed design for Stage 1 lined cell (Golder 2022). Geotechnical testing results supported the drainage performance of the FBA generated by MPPS including;

– Average permeability of 1 x 10^{-5} m/s
– Maximum particle size 19 mm and maximum fines content of 20% (13 out of 14 samples)
– Non plastic
– Based on the particle size distribution results a filter geotextile is not considered to be required.

7.5.5 Drainage aggregate

Drainage aggregate will be installed along the leachate collection pipe alignments and in the sump to augment the drainage capacity of the pipework and minimise the potential hydraulic head building up on the cell base. The drainage aggregate has been specified such that a durable, natural, chemically resistant aggregate will be selected and testing is required to be undertaken to show compliance with these requirements.

Preliminary review of petrographic analysis results for 20 mm graded coarse aggregate sourced from Metromix Quarries Marrangeroo indicated the potential for alkali-silica reactivity is low. Test results state that the aggregate was innocuous in relation to alkali carbonate reactivity suggesting that the performance of the aggregate as a drainage layer is unlikely to be degraded by alkaline leachate generated at the site.

7.5.6 Separation geotextile

A non-woven needle-punched polypropylene separation geotextile will be installed surrounding the drainage aggregate that encapsulates the leachate collection pipework. The purpose of the separation geotextile is to minimise clogging risk from the accumulation of fines from the overlying ash material. A minimum permittivity of 0.5 s^{-1} as outlined in the Material Specification (Appendix D) will allow for leachate that percolates through the emplaced ash material to drain through the separation geotextile.

7.5.7 Leachate collection pipes

The primary leachate collection pipes (SDR9 PE100 DN315) shall be at least 315 mm in diameter and shall be placed down the centre of the cell draining to the sump in the southern portion of the cell. The secondary leachate collection pipes (SDR 9 PE100 DN160) shall be at least 160 mm diameter and placed at intervals of not more than 25 metres in accordance with the EPA Guidelines (connecting to

the primary leachate collection pipe in a herringbone pattern). The collection pipes shall be perforated in accordance with the design drawings.

Pipe loading calculations were completed that considered the maximum operational loading on the pipework including vertical loading from overlying ash material and wheel loading from plant. The calculations have been included in Appendix C.

7.5.8 Leachate sump and riser

A leachate sump will be located at the cell low point in the southern portion of Stage 2B to allow pumping of leachate collected via leachate collection layer. The sump will contain a riser pipe (SDR11 PE100 DN450) that will allow for installation of a leachate pump and transfer leachate by pumping to lined leachate storage ponds north of Stage 2B. The pump and rising main design for leachate extraction from this sump will be included in the final version of the design.

8. Surface water management

This section details the surface water management plan for LNAR Stage 2B.

8.1 General

The Stage 2B surface water management system will follow many of the same stormwater principles currently enacted in the approved LNAR. The stormwater management plan focuses on:

– Reducing the ability for surface water to come into contact with the placed ash
– Preventing surrounding runoff from entering the Site
– Capturing and treating the runoff from the covered ash areas before it is delivered to the existing water management system
– Areas where ash is yet to be placed could be directly discharged from the Site in accordance the approved LNAR consent.

8.2 Surface water management

There are different types of surface water that require management at the site, and their integration into the design is outlined in the following sections.

8.2.1 Upstream run-on

The existing Huon Gully flow drainage line along the western boundary of the site will continue to report to SHG1 (other than water captured in the future by Centennial) utilising both existing diversion drains and new drains to be constructed on the reconstructed bunding surrounding the pond.

8.2.2 Potentially sediment laden runoff

Runoff from WCA or disturbed mine spoil areas outside of the Stage 2B filling area is expected to be potentially sediment laden and must be managed via the existing sediment laden water management drains and system.

8.2.3 Runoff from lined areas

Runoff from Stage 2B lined areas containing BCA or BS will be contained by perimeter bunding to prevent mixing with other surface water. In accordance with Section 4.8, the impacted surface water runoff will be collected separately and managed based on EC.

To provide additional storage for runoff from both Stage 2A and 2B, a temporary surface water storage area will be established in Stage 2B using a temporary liner. This will be continually pumped out to the relevant permanent storage/disposal location based on EC. Once filling has progressed sufficiently, the temporary storage area will be decommissioned and the permanent lining system installed below.

8.2.4 Runoff from rehabilitated area

Stage 2B is planned to be progressively rehabilitated. Any runoff from the final cap areas where the vegetation has been established is conveyed directly off site where practicable.

9. Amenity control

This section identifies and assesses the potential for the construction and operation of LNAR Stage 2B to impact the Site and surrounding environment amenity.

9.1 Construction and operational impacts

Environmental impacts associated with construction of the Stage 2B cell will be addressed in the OEMP. Based on feedback from EA, update to the existing CEMP under condition B4 of the consolidated consent (09_0186) is not required for the Stage 2B works as these are classified within the definition of operation. Under the approval, operation is defined to include ash haulage, ash truck movements, ash placement and management, installation of a leachate barrier system (liner and associated water management systems), operation of on-site water management systems, landscaping and revegetation/rehabilitation of the site but does not include commissioning trials of equipment or temporary use of parts of the project during construction.

An Operational Environmental Management Plan (OEMP) was prepared in 2022 that details the environmental management framework, practices and procedures to be followed during operation of the Project. Environmental monitoring will be carried out in accordance with the approved OEMP.

The OEMP will be updated to incorporate the leachate and surface water management systems as outlined in this report following completion of the 100% design. The OEMP will address specific issues associated to construction of Stage 2B including updated stormwater management, with other potential other updates to guidance on:

– Groundwater management
– Access and traffic management

Environmental impacts including odour, dust, noise, litter and fire associated with operation of Stage 2B are not anticipated to significantly increase relative to the currently approved LNAR Stage 1 operations. As such, with ongoing implementation of the approved mitigation measures, the Stage 2B works are not anticipated to result in significant impacts.

9.2 Fire

The emplaced ash and overlaying soil material do not pose a significant fire risk based their material properties. Therefore, the risk of fire in relation to the proposed works is limited to post capping where vegetation will be present. Vegetation will be planted that is consistent with the vegetation already approved for the Lamberts North Ash Placement Project, with mitigation measures applicable to fire management maintained as per the current approval. MPAR planting trials will inform the LNAR final cap vegetation species.

On this basis, the proposed works are not anticipated to result in additional risk in relation to fire and continuation of the currently approved mitigation measures is considered appropriate in relation to the proposed works. Adequate access for emergency vehicles is provided to the Stage 2B cell area.

10. Safety in design

This section identifies potential safety In design issues in relation to LNAR Stage 2B.

10.1 Objective

The primary objective of the Safety in Design (SiD) review process is to ensure that the design has been critically reviewed from a health and safety perspective, so that hazards and associated risks with construction, maintenance, operations, end users and disposal have been eliminated, or where this is not possible, reduced to as low as reasonably practicable.

10.2 Approach

Safety in design is a strategy aimed at preventing injuries by considering hazards as early as possible in the planning and design process, enhancing safety through choices in the design process. A safety in design approach considers the safety of those who construct, operate, maintain, clean, repair and demolish an asset (includes building, structure, plant or equipment). Parties involved in the planning and design stage of a project are in a position to reduce the risks that arise during the life cycle of the asset.

This assessment does not include general construction risks that should be directly addressed by the Contractor in their SWMS and OEMP documentation and implementation.

10.3 Safety in design assessment

GHD has undertaken a safety in design assessment as part of the detailed design works, including a workshop with EA and Service Stream. Key potential safety issues are summarised in Table 10.1.

Table 10.1 Identified primary risks and recommended control measures

Identified primary risk	Control measure
Steep slopes	Steep walls in liner subgrade design avoided unless required due to existing features. Filling along the southern batter to achieve a suitable grade.
Exposure of site workers to existing landfilled ash	Exhumation of ash minimised during earthworks design based on surveyed ash levels.
Unknown existing services	Design documentation shows services in Works Area where known. EA to supply services plans to Contractor where available.
Vehicle access/egress	Access/egress for Works Area defined in design documentation. Sufficient room allowed for Contractor to install appropriate safety measures where adjacent to steep slopes.
Inundation from significant rainfall	Surface water diversion away from Works Area maximised via design modelling and cell location. intercell bunds included with appropriate lining to mitigate rainfall intrusion in active filling area. Delineation of temporary water storage area from active filling.
Fire	EA to identify and utilise appropriate areas for stockpiling and laydown, including fire management controls as needed.
Instability of ash mass and sidewall liner	Operational staff to continue to place ash in horizontal lifts with maximum interim slopes in line with geotechnical advice. Design considers relevant operational scenarios.
Inundation from leachate drainage system blockage	Design allows for appropriate inspection and cleanout/rodding points.
Mine subsidence from historical workings	Design includes additional liner layers in areas of mine subsidence risk and subgrade stabilisation methods.
Unstable conditions (Centennial Coal batters)	Design includes flattening/stabilisation measures for the Centennial Coal batters for liner construction.

Identified primary risk	Control measure
Unstable conditions (Stage 2A)	EA to establish exclusion zones of ash placement in Stage 2A based on construction staging of Stage 2B.

11. Construction management

11.1 Construction quality assurance

Quality assurance measures will be implemented in compliance with the requirements of the EPA Guidelines. A CQA plan has been developed by GHD (2023d) that sets out the required testing, inspection and verification procedures during construction of the Stage 2B cell.

A series of hold points and witness points are identified at key stages during construction, including:

– Earthworks and subgrade preparation
– Liner installation
– Pipe installation
– Placement of drainage layers

A CQA report will be prepared that documents compliance with the approved designs and specifications. Any variations from the design will be identified.

11.1.1 CQA Engineer

The CQA Engineer will be responsible for assessing the compliance of the completed works with the Contract Documents. The CQA Engineer is to work with the Superintendent and Contractor to determine whether sufficient evidence has been provided to adequately document that the Works comply with the requirements of the Contract Documents. The CQA Engineer (and assigned CQA Monitors) will provide ongoing monitoring and inspection of the Works until completion.

12. Operational handover

With consideration to the detailed design, the following items need to be addressed as part of the ash placement operations once the first portion of Stage 2B cell is commissioned:

– No vehicles are to traffic directly on the liner as part of the ash placement operations.
– Ash should be placed in horizontal lifts across the cell area with maximum interim slopes in line with geotechnical advice.
– Suitable access is constructed into the cell that does not impact the constructed liners and associated infrastructure.
– Surface water infrastructure will be maintained to divert clean or sediment laden water around the Stage 2B cell.
– Cover and capping materials will be progressively installed in line with a suitable staging plan for the cell.
– The temporary surface water storage area should be continually pumped out to minimise risk of overflow.
– Once the temporary surface water storage area is ready for decommissioning, the temporary liner should be removed permanent liner installed and tied into as per the design drawings. Temporary water storage and diversion measures should be undertaken to facilitate these works.

13. References

Guidelines

– NSW EPA (2016) Environmental Guidelines Solid Waste Landfills (2nd Ed.)

Documentation

– CDM Smith (2012B) Lamberts North – Geotechnical Report
– CDM Smith (2012b) Lamberts North Ash Placement Project – Groundwater Modelling Report
– CEH Lithgow (2011) Conneq Services Infrastructure Mount Piper – Ash Emplacement Overall Plant with Underground Workings and Boreholes, DWG No MPA-UG-BH2
– EnergyAustralia NSW (Unknown) Explanation to the Salt deposits on the Ash Repository
– EnergyAustralia NSW (Unknown) Summary Design Criteria for the ash placement area Mt Piper
– EnergyAustralia NSW (2020a) Fly Ash Fabric Filter (ROS) Routine Certificate
– EnergyAustralia NSW (2020b) Fly Ash Conveyor Routine Certificate
– ERM (2018a) Mount Piper Ash Repository Groundwater and Surface Water Assessment, Soil and Groundwater Investigation – Stage 1
– ERM (2018b) South Lamberts North Ash Placement Project Due Diligence Environmental Review
– ERM (2019a) Mt. Piper Brine Conditioned Fly Ash Co-placement Project Annual Environmental Monitoring Report 2018/19
– ERM (2019b) Mount Piper Ash Repository Groundwater and Surface Water Assessment, Data Logging and Hydraulic Testing Report
– ERM (2020a) Mt Piper Ash Repositories Groundwater and Surface Water Assessment, Project Update, Numerical Groundwater Model Unsaturated Vertical Flow Next Steps
– ERM (2020b) Water Management and Monitoring Plan – Update for 60 ML Dam, Mt Piper Power Station Brine Conditioned Flyash Co-placement Extension Water Management and Monitoring Plant
– ERM (2020c) Lamberts North Ash Placement Project Annual Water Quality Monitoring Report 2019/2020
– ERM (2021) Project Approval 09_0186 for Mount Piper Ash Placement Project - Notice of Modification
– ERM (2022) Lamberts North Ash Repository Operational Environmental Management Plan (Revision 6)
– ERM (2022) LNAR Leachate Management System Water Balance Assessment
– GHD (2024) Salt Placement Field Trial Inspection Report (Draft)
– GHD (2023a) Mount Piper Ash Repository – Basis of Design Report dated 1 September 2023
– GHD (2023b) Brine Conditioned Ash Liner Review and Selection dated 15 August 2023
– GHD (2023c) Mount Piper Ash Repository – Mixed and Lime Salts Co-Disposal Strategy
– GHD (2023d) LNAR Stage 2 testing pitting and reconnaissance of furnace ash slip dated 6 October 2023
– GHD (2020a) Concept Design for Lamberts North Ash Repository Preliminary mine subsidence assessment
– GHD (2020b) Sampling Analysis and Quality Plan for Lamberts Ash Repository – Waste Classification Sampling
– GHD (2020c) Variation 01: Waste classification of brine and water conditioned ash at Mt Piper Ash for the Concept Design for Lamberts North Ash Repository
– GHD (2020d) Variation 02: Mine Subsidence Assessment at Mt Piper Ash Repository for the Concept Design Lamberts North Ash Repository dated 18 November 2020
– GHD (2020e) Concept Design for Lamberts North Ash Repository Waste classification report

- GHD (2019) Mt Piper Encapsulation Cell Concept Design for EnergyAustralia Development Pty Ltd and Re.Energy Pty Ltd
- GHD (2018) Springvale Water Treatment Plant – Compaction Test, Ash & Salt Waste Test work Report
- GHD (2016) Western Coal Services Project Modification 1: Water Resource Impact Assessment. Report 22/09098/77 prepared from Springvale Coal Pty Ltd by GHD Pty Ltd. Retrieved from **https://www.planningportal.nsw.gov.au/major-projects/project/6656**
- Golder (2014) Stability Assessment for Brine Pond (Revision 0)
- Golder (2014) Stability Assessment for Southern Bund Wall – Lamberts Ash Emplacement Area (Revision 1)
- Golder (2021) Geotechnical Site Investigation Factual Report (Revision 0)
- Golder (2021) Mt Piper LNAR Brine Liner System Detailed Design – Cells 1A & 1B Technical Specification
- Golder (2022) Mt Piper LNAR Liner Design – Detailed Design Report (Revision 0)
- Lendlease (2020) Monthly Client Report Mt Piper Contract E0009 June 2020
- Lendlease (2020) Mount Piper Power Station Salt/Ash Transfer System Addition of Salts Functional Specification (Revision 2.1)
- Lendlease (2021) Mount Piper Power Station Environmental Management Plan
- Macquarie Geotechnical (2018 – 2021) Field density and compaction test results – BCA and WCA
- NSW Environment Protection Authority (2016) Environmental Guidelines Solid Waste Landfills
- Rowe, R.K. (2014) "Long-term performance of barriers in landfills: basic concepts and leachate collection systems" Sustainable Landfilling monograph, Raffaello Cossu and Hans van der Sloot Eds, CISA
- Rowe, R.K., Quigley, R.M., Brachman, R.W.I., Booker, J.R. (2004) Barrier Systems for Waste Disposal Facilities, Taylor & Francis Books Ltd (E & FN Spon) London
- Scheirs, J (2009) A guide to polymeric geomembranes : a practical approach, John Wiley and Sons Ltd, West Sussex
- ServiceStream (2013) RFI Register – LNAR (Cell 1A)
- ServiceStream (2022) Repair Surface Water Erosion to Ash Surfaces and Batters
- SKM (2010) Mt Piper Power Station Ash Placement Project Hydrology and Water Quality
- SKM (2012) Mt Piper Power Station Ash Placement Project Consistency Report
- Symbio Laboratories (2020) Certificate of Analysis B911362 [R00]
- Veolia (2020) Service Provider Monthly Report October 2020
- WSP/Golder (2023) Brine Dust Suppression Proposal – Preliminary Risk and Opportunity Considerations

Drawings

- CEH (2011) Mount Piper – Ash Emplacement Overall plan with underground workings and boreholes, Drawing No: MPA-UG-BH2
- CEH Survey (2019) Mount Piper – Ash Placement Survey 19th July 2019, Drawing No: MPA0719
- CEH Survey (2020) Mount Piper – Ash Placement Survey 29th August 2020, Drawing No: MPA0720
- CEH Survey (2020) Mount Piper – Ash Placement Survey March 2020, Drawing No: MPA0320
- CEH Survey (2020) Mount Piper Ash Emplacement Survey February 2020, Drawing No: MPA0220
- CEH Survey (2020) Mount Piper Ash Emplacement, Drawing No: MPA0220
- CEH Survey (2023) Mount Piper Ash Placement Open Cut & Underground Workings (Stage 2)
- CEH Survey (2023) Mount Piper Ash Placement Survey 13th July 2023, Drawing No: MPA0723
- CEH Survey (2024) Mount Piper Ash Placement Survey 3rd June 2024, Drawing No: MPA0524

– Centennial Coal (2016) Western Main Colliery Groundwater Imaging Plan Showing Mine Workings & Surface Features
– Golder (2021) Mount Piper Power Station LNAR Brine Liner System Design Cells 1A & 1B, Drawing Nos: D001 to D038 (Rev 2)
– Lendlease (2021) MPAR/LNAR SURFACE WATER FLOW – BCA AND WCA
– MPA0221 annotated with MPAR Boundaries (CEH Survey 2021)
– MPA0522 annotated with zones and surface flows (CEH Survey 2022)
– MPA1222 annotated with irrigation areas and BCA/WCA placement for Stage 1 & 2 (CEH Survey 2022)
– Nearmap (2002) Repository survey
– SKM (2012) Mt Piper Power Station Ash Placement Project Proposed Alteration (Rev A)

Monitoring data

– Settling pond level and rainfall data (Jan 2020 to July 2023)
– Mt Piper Repository rainfall data (Jan 2020 to July 2023)
– Fresh water dust suppression requirements (July 2023)
– LNAR Pond tracking workbook (July 2023)
– BC Waste Pond and WTF OPUS Waste analysis data (2020)
– APA Daily assessment and irrigation record (2023)

Material tests

– Liner interface shear tests – Cell 1A and Cell 1B
– Test results – geogrid, GCD, LLDPE, GCL, cushion GTX, FBA, drainage sand, overburden material, clay, filter GTX, separation GTX, drainage aggregate, quarry material

Consents

Name	Date
EPL13007 - Mount Piper Power Station	August 2020
Mt Piper Ash Placement Project (MOD 1) - Determination - Consolidated Approval	September 2021
Letter to DPE – LNAR Modification 1 – Condition B14 Design	October 2021
Letter from DPE – Mount Piper Power Station - Ash Emplacement Specialist Approval	October 2021
Letter to DPE - LNAR Modification 1 - Condition D5	May 2024
Letter from DPE - Approval of LNAR Condition D5 documentation	April 2022
LNAR Stage 2 Advice – Approval documents	June 2023
EA Modification Report (including Appendix B and C)	May 2021
Mt Piper Ash Placement Project (MOD 1) - Determination - Instrument of Modification	September 2021
Letter from DPE - Mt Piper Ash Placement Project (MOD 1) Notice of Determination Approval	September 2021
Letter from EPA – LNAR Water Balance Assessment	April 2024
Project approval - 09_0186 - AALamberts North – Final conditions of approval	February 2012
MPPS Development Consent (80-10060) (MOD 8)	July 2019

Appendices

Appendix A

Limitations and assumptions

This report: has been prepared by GHD for EnergyAustralia NSW Pty Ltd and may only be used and relied on by EnergyAustralia NSW Pty Ltd for the purpose agreed between GHD and the EnergyAustralia NSW Pty Ltd as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than EnergyAustralia NSW Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by EnergyAustralia NSW Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

Appendix B

Design drawings

ENERGYAUSTRALIA NSW PTY LTD
PROJECT HYDRA STREAM 3
DESIGN SERVICES
LNAR STAGE 2B LINER DESIGN
12610307



LOCALITY PLAN
SCALE 1:10,000

DRAWING LIST

DRG No.	DRAWING TITLE
12610307-G101	COVER SHEET, LOCALITY PLAN AND DRAWING LIST
12610307-G102	EXISTING SITE PLAN
12610307-C101	STAGE 2B SOUTH EARLY WORKS
12610307-C102	STAGE 2B SOUTH LINING SYSTEM
12610307-C103	STAGE 2B SOUTH LEACHATE COLLECTION SYSTEM
12610307-C104	STAGE 2B NORTH EARLY WORKS
12610307-C105	STAGE 2B NORTH LINING SYSTEM
12610307-C106	STAGE 2B NORTH LEACHATE COLLECTION SYSTEM
12610307-C107	CUT AND FILL PLAN
12610307-C108	LONGITUDINAL SECTION
12610307-C109	CROSS SECTIONS - SHEET 1 OF 2
12610307-C110	CROSS SECTIONS - SHEET 2 OF 2
12610307-C111	TYPICAL SECTIONS AND DETAILS - SHEET 1 OF 6
12610307-C112	TYPICAL SECTIONS AND DETAILS - SHEET 2 OF 6
12610307-C113	TYPICAL SECTIONS AND DETAILS - SHEET 3 OF 6
12610307-C114	TYPICAL SECTIONS AND DETAILS - SHEET 4 OF 6
12610307-C115	TYPICAL SECTIONS AND DETAILS - SHEET 5 OF 6
12610307-C116	TYPICAL SECTIONS AND DETAILS - SHEET 5 OF 6
12610307-C117	PUMPING ARRANGEMENT PLAN

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 100 200 300 400 500m
SCALE 1:10,000 AT ORIGINAL SIZE

Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

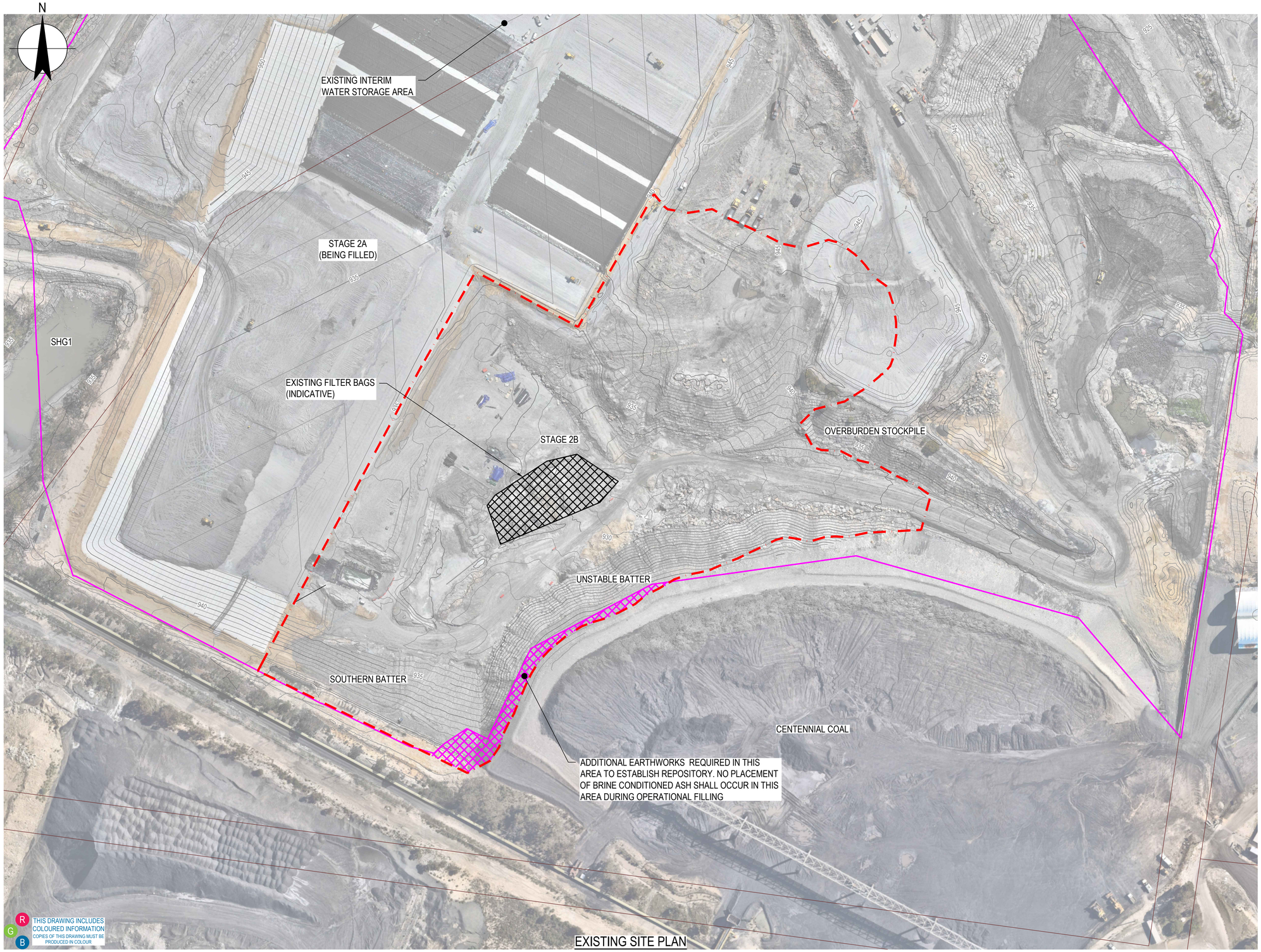
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title COVER SHEET, LOCALITY PLAN AND DRAWING LIST
Size A1
Drawing No. 12610307-G101
Rev 1

Plot Date: 24 October 2024 - 2:41 PM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-G101.dwg



EXISTING SITE PLAN

SCALE 1:1000

LEGEND:

- EXISTING SITE CONTOURS
- STAGE 2B EARTHWORS EXTENT (APPROXIMATE)
- LOT BOUNDARY
- APPROVED FINAL LANDFORM FOOTPRINT

GENERAL NOTES:

1. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE TECHNICAL SPECIFICATION.
2. ALL WORKS TO BE IN ACCORDANCE WITH THESE DRAWINGS & THE TECHNICAL SPECIFICATION UNLESS NOTED ELSEWHERE OR DIRECTED IN WRITING BY THE SUPERINTENDENT.
3. BASE INFORMATION INCLUDING EXISTING SERVICES INFORMATION PROVIDED BY
   a. SURVEY INFORMATION PROVIDED BY CEH SURVEY (DRAWING NO. MPA0424 (CONTOURS ONLY), DATED 01/10/2024).
   b. AERIAL IMAGE PROVIDED BY CEH SURVEY (DRAWING NO. MPA0424 (AS SURVEYED), DATED 01/10/2024).
4. NEW WORKS TO BE SETOUT BY A LICENSED SURVEYOR. A DIGITAL FILE (COMPRISING PLAN LAYOUT AND DESIGN SUBGRADE SURFACE MODEL) WILL BE PROVIDED BY THE PRINCIPAL FOR SET-OUT PURPOSES.
5. CONFIRM THE LOCATION, EXTENT AND DEPTH OF ALL ABOVE AND BELOW GROUND SERVICES PRIOR TO COMMENCEMENT OF WORKS. ALL SERVICES MAY NOT BE SHOWN ON THE DRAWINGS.
6. IT IS THE CONTRACTOR'S RESPONSIBILITY TO IDENTIFY AND LOCATE ALL SERVICES. EXISTING SERVICES TO REMAIN IN SERVICE AND TO BE PROTECTED FROM DAMAGE FOR DURATION OF WORKS.
7. ALL COSTS FOR DAMAGE TO EXISTING SERVICES SHALL BE BORNE BY THE CONTRACTOR. REINSTATE ALL SERVICES IF REQUIRED TO EQUAL OR BETTER CONDITION USING ONLY NEW MATERIALS.
8. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DECOMMISSION AND REMOVE ALL SERVICES WITHIN THE WORK AREA IF REQUIRED, INCLUDING ABANDONED SERVICES.
9. REFER ANY CONFLICT BETWEEN NEW WORKS AND EXISTING SERVICES TO THE SUPERINTENDENT.
10. CLEARING AND GRUBBING TO BE CONFINED TO THE AREA REQUIRED TO EXECUTE THE WORKS UNDER THE CONTRACT ONLY.
11. DO NOT OBTAIN DIMENSIONS BY SCALING FROM THE DRAWINGS. UNLESS OTHERWISE NOTED:
    a. ALL DETAIL DIMENSIONS ARE IN MILLIMETRES.
    b. ALL CHAINAGES ARE IN METRES.
12. VERIFY SETTING OUT DIMENSIONS SHOWN ON THE DRAWINGS BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED.
13. DRAWINGS TO BE PLOTTED IN COLOUR.
14. THESE NOTES APPLY TO ALL DRAWINGS UNLESS NOTED OTHERWISE.

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

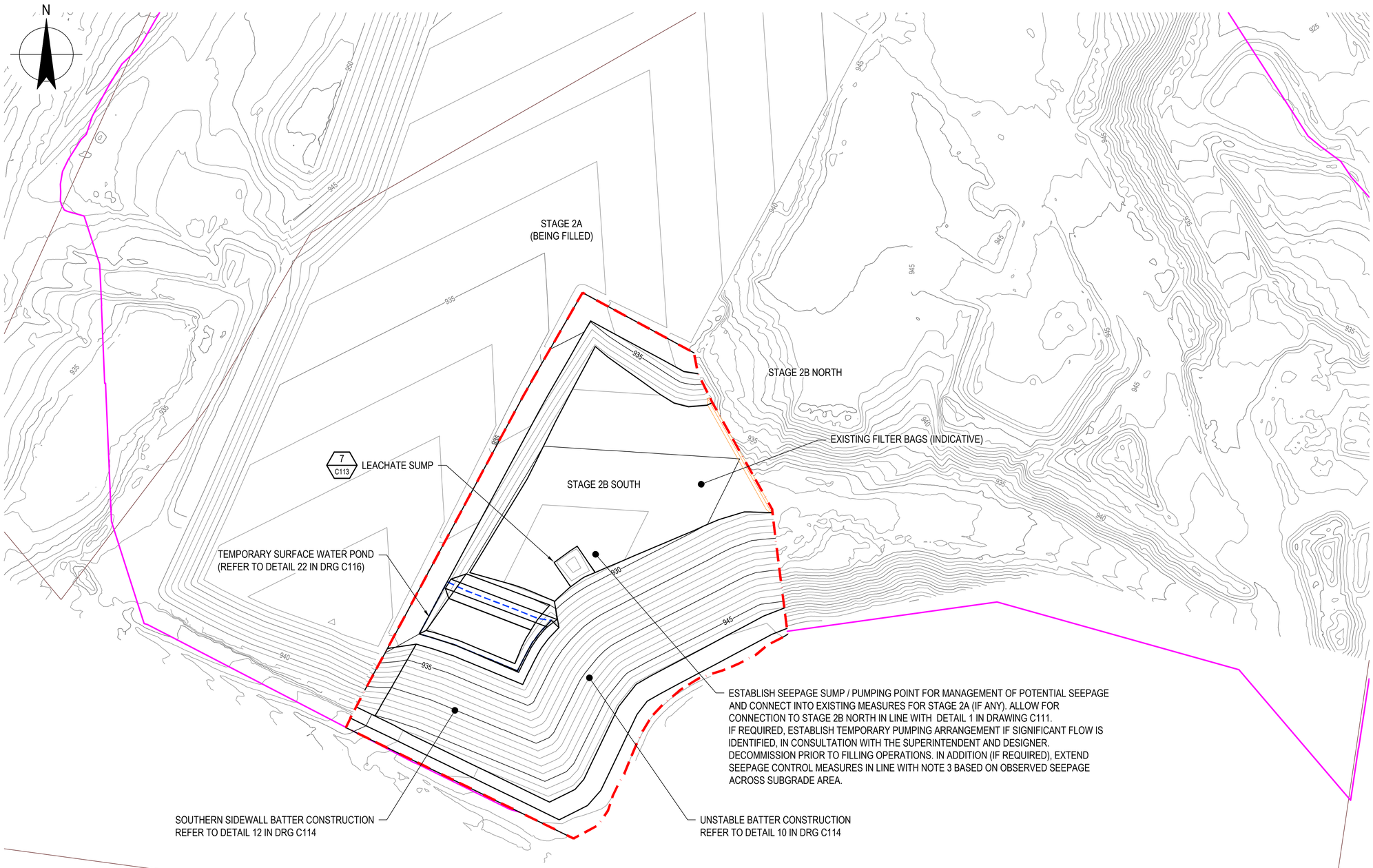
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title EXISTING SITE PLAN
Size A1
Drawing No. 12610307-G102
Rev 1

Plot Date: 23 October 2024 - 2:13 PM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-G102.dwg



LEGEND:

- EXISTING SITE CONTOURS
- DESIGN LINER CONTOURS
- STAGE 2B EARTHWORKS EXTENT (APPROXIMATE)
- DESIGN LINE
- LOT BOUNDARY
- APPROVED FINAL LANDFORM FOOTPRINT

NOTES:

1. SETTLEMENT MAY IMPACT SURVEY COMPLIANCE FOR LAYER THICKNESSES. ALTERNATIVE METHODS TO BE USED BY THE CONTRACTOR AS AGREED WITH THE SUPERINTENDENT, SUCH AS DEPTH MARKERS OR SIMILAR.
2. PRIOR TO BULK EARTHWORKS ON SLOPES STEEPER THAN 45 DEGREES, THE DESIGNER OR A SUITABLY QUALIFIED AND EXPERIENCED GEOTECHNICAL ENGINEER OR ENGINEERING GEOLOGIST SHALL INSPECT THESE AREAS TO IDENTIFY SAFETY MEASURES AND ANY ADDITIONAL ACTIONS TO BE UNDERTAKEN PRIOR TO AND DURING EARTHWORKS
3. WHERE SEEPAGE IS IDENTIFIED WITHIN THE WORKS AREA, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE SUPERINTENDENT. THE SUPERINTENDENT, IN CONSULTATION WITH THE DESIGNER, SHALL DIRECT THE EXTENT OF SEEPAGE CONTROLS (REFER DETAIL 1, DRAWING C111 FOR GENERAL GUIDANCE) TO BE INSTALLED IN THE SEEPAGE AREA, INCLUDING TIE-IN WITH TEMPORARY SUMP / PUMPING POINT.

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

STAGE 2B SOUTH EARLY WORKS

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

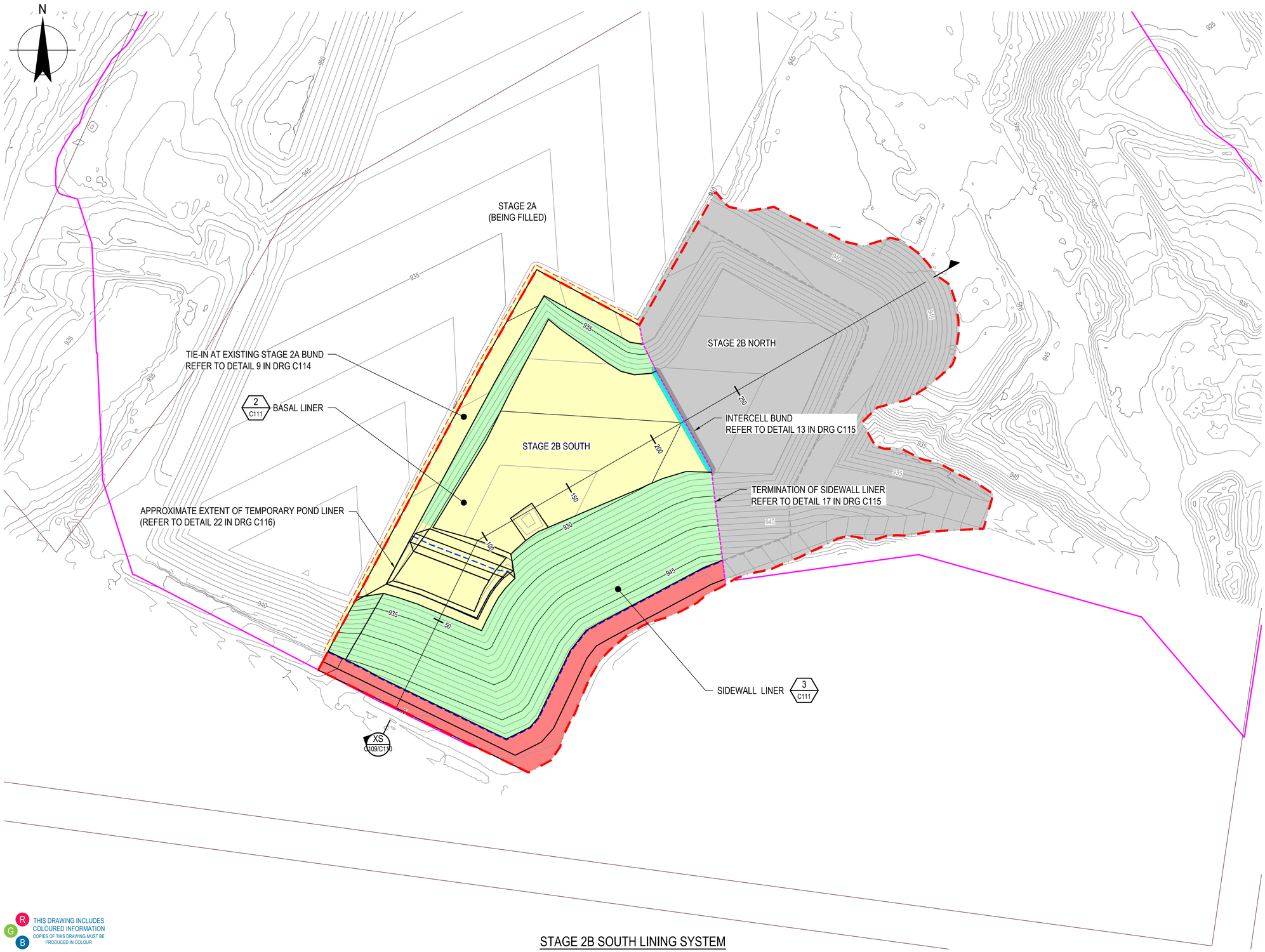
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title STAGE 2B SOUTH EARLY WORKS
Size A1
Drawing No. 12610307-C101
Rev 1

Plot Date: 24 October 2024 - 9:39 PM Plotted by: Chris Nivison-Smith File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C101.dwg



LEGEND:

- EXISTING SITE CONTOURS
- DESIGN LINER CONTOURS
- STAGE 2B EARTHWORKS EXTENT (APPROXIMATE)
- LOT BOUNDARY
- INTERCELL BUND
- APPROVED FINAL LANDFORM FOOTPRINT
- SIDEWALL LINER
- BASAL LINER
- EARTHWORKS EXTENT
- SELECT FILL
- CONNECTION WITH STAGE 2A (APPROXIMATE)
- ANCHOR TRENCH - STAGE 2B (APPROXIMATE)
- TEMPORARY LINER TERMINATION

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

STAGE 2B SOUTH LINING SYSTEM

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**

Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD

Project PROJECT HYDRA STREAM 3
DESIGN SERVICES LNAR STAGE 2B
LINER DESIGN

Status CONSTRUCTION Status Code S4

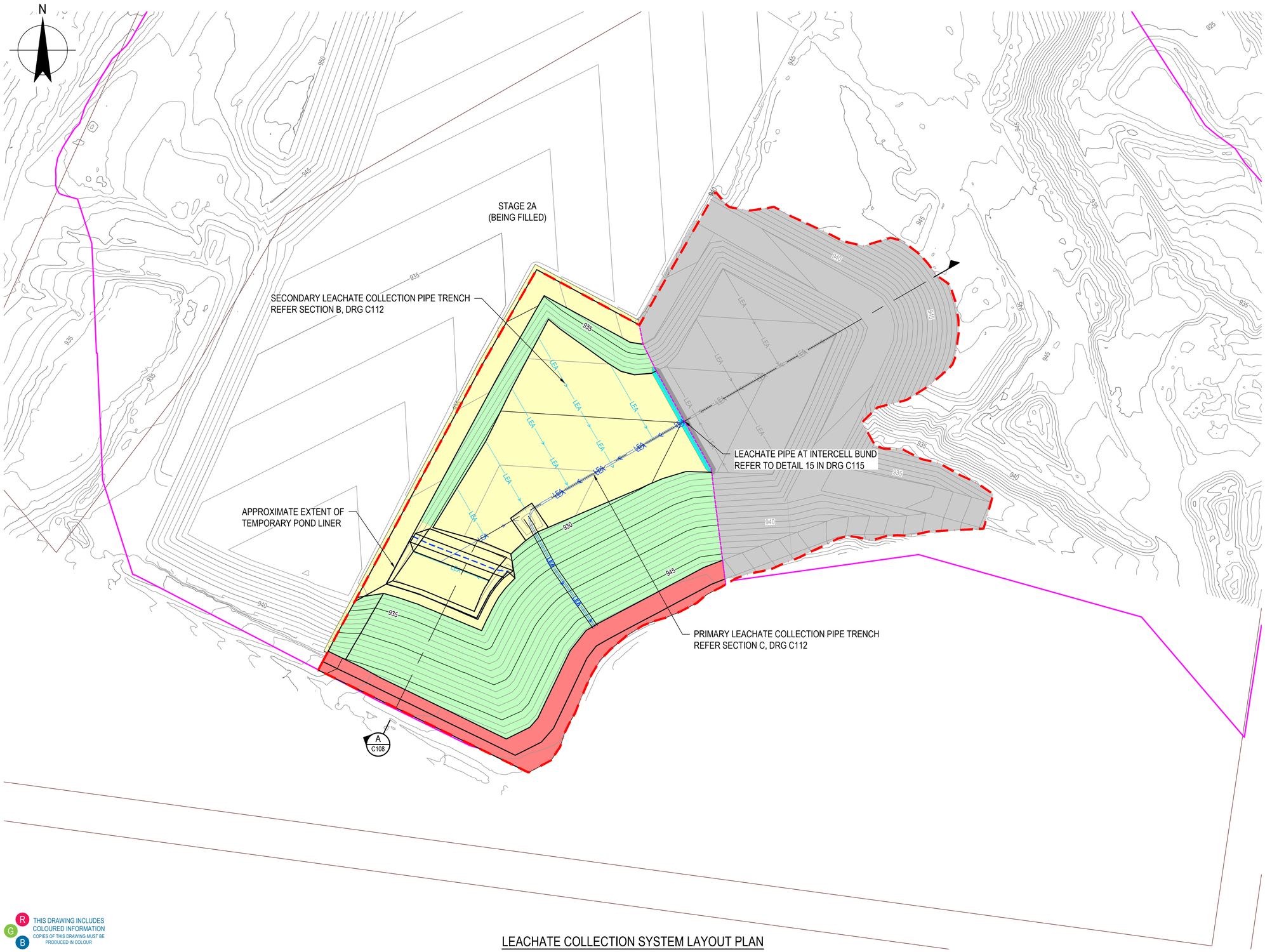
Drawing Title STAGE 2B SOUTH LINING SYSTEM

Size A1

Drawing No. 12610307-C102

Rev 1

Plot Date: 24 October 2024 - 9:42 PM Plotted by: Chris Nivison-Smith File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C102.dwg



THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

LEACHATE COLLECTION SYSTEM LAYOUT PLAN

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**

Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m

SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD

Project PROJECT HYDRA STREAM 3
DESIGN SERVICES LNAR STAGE 2B
LINER DESIGN

Status CONSTRUCTION Status Code S4

Drawing Title STAGE 2B SOUTH LEACHATE COLLECTION SYSTEM

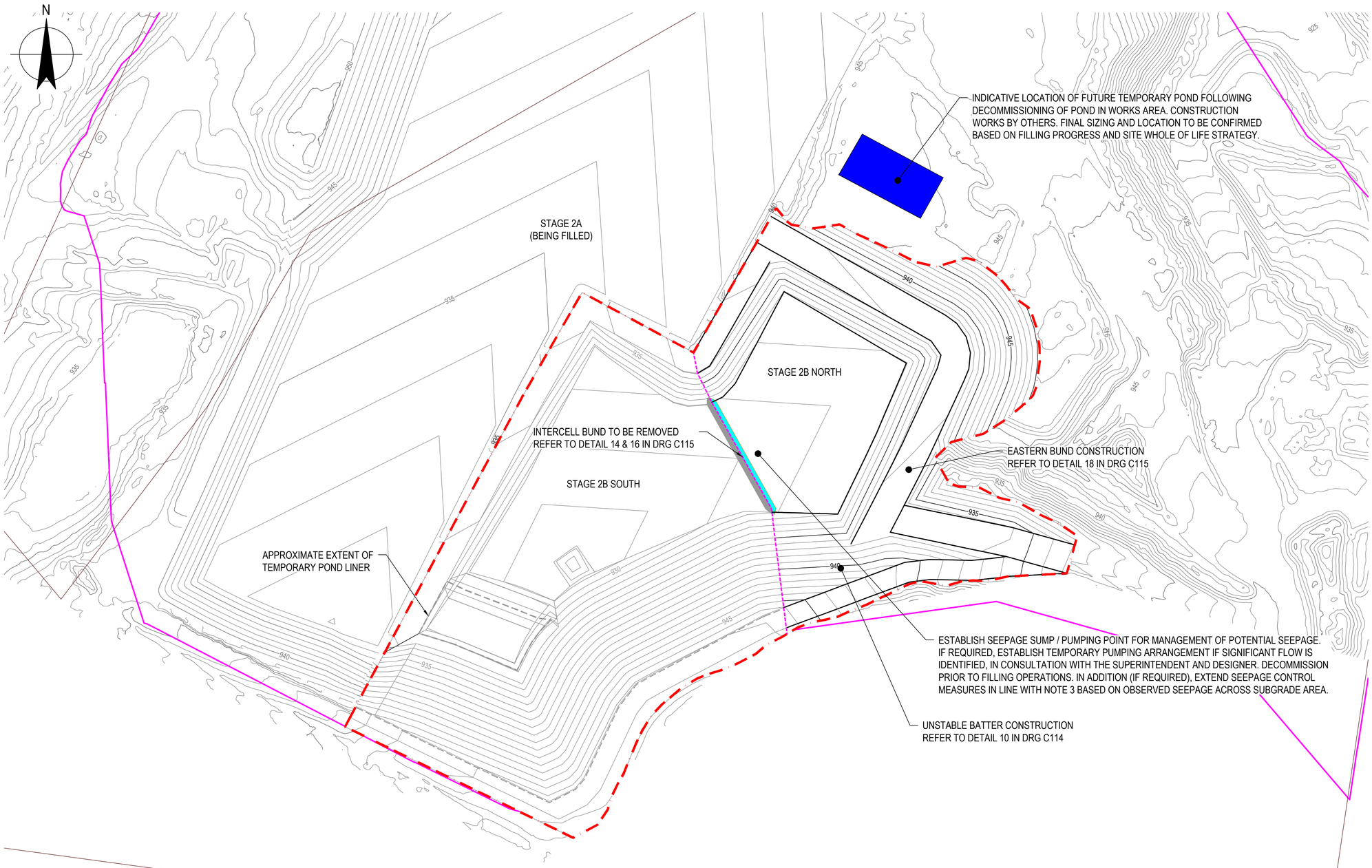
Size A1

Drawing No. 12610307-C103

Rev 1

Plot Date: 24 October 2024 - 9:45 PM Plotted by: Chris Nivison-Smith

File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C103.dwg



LEGEND:

- EXISTING SITE CONTOURS
- DESIGN LINER CONTOURS
- STAGE 2B EARTHWORKS EXTENT (APPROXIMATE)
- LOT BOUNDARY
- INTERCELL BUND
- APPROVED FINAL LANDFORM FOOTPRINT
- TEMPORARY LINER TERMINATION

NOTES:

1. SETTLEMENT MAY IMPACT SURVEY COMPLIANCE FOR LAYER THICKNESSES. ALTERNATIVE METHODS TO BE USED BY THE CONTRACTOR AS AGREED WITH THE SUPERINTENDENT, SUCH AS DEPTH MARKERS OR SIMILAR.
2. PRIOR TO BULK EARTHWORKS ON SLOPES STEEPER THAN 45 DEGREES, THE DESIGNER OR A SUITABLY QUALIFIED AND EXPERIENCED GEOTECHNICAL ENGINEER OR ENGINEERING GEOLOGIST SHALL INSPECT THESE AREAS TO IDENTIFY SAFETY MEASURES AND ANY ADDITIONAL ACTIONS TO BE UNDERTAKEN PRIOR TO AND DURING EARTHWORKS
3. WHERE SEEPAGE IS IDENTIFIED WITHIN THE WORKS AREA, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE SUPERINTENDENT. THE SUPERINTENDENT, IN CONSULTATION WITH THE DESIGNER, SHALL DIRECT THE EXTENT OF SEEPAGE CONTROLS (REFER DETAIL 1, DRAWING C111 FOR GENERAL GUIDANCE) TO BE INSTALLED IN THE SEEPAGE AREA, INCLUDING TIE-IN WITH TEMPORARY SUMP / PUMPING POINT.

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

STAGE 2B NORTH EARLY WORKS

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

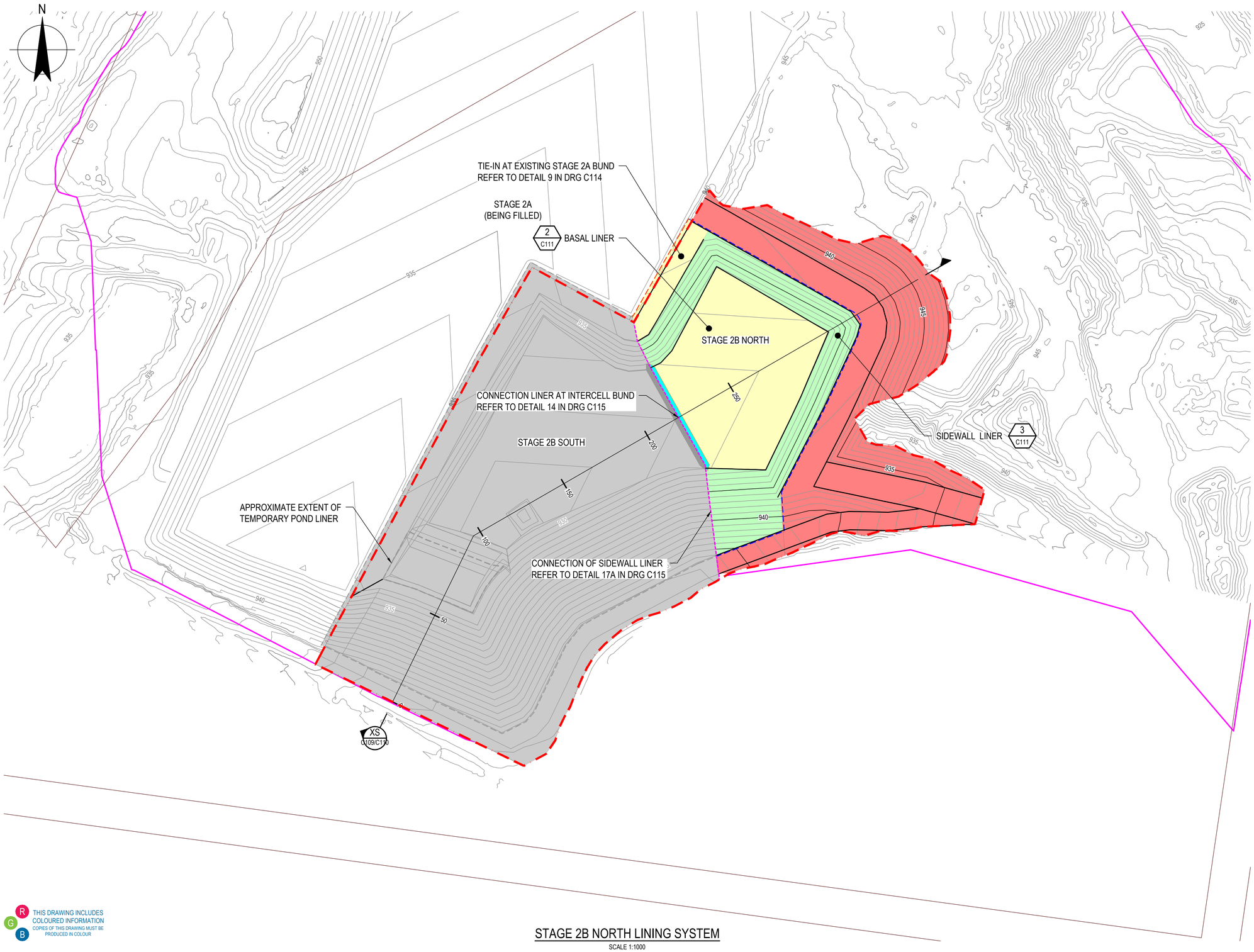
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title STAGE 2A NORTH EARLY WORKS
Size A1
Drawing No. 12610307-C104
Rev 1

Plot Date: 24 October 2024 - 9:47 PM Plotted by: Chris Nivison-Smith
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C104.dwg



THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

STAGE 2B NORTH LINING SYSTEM

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

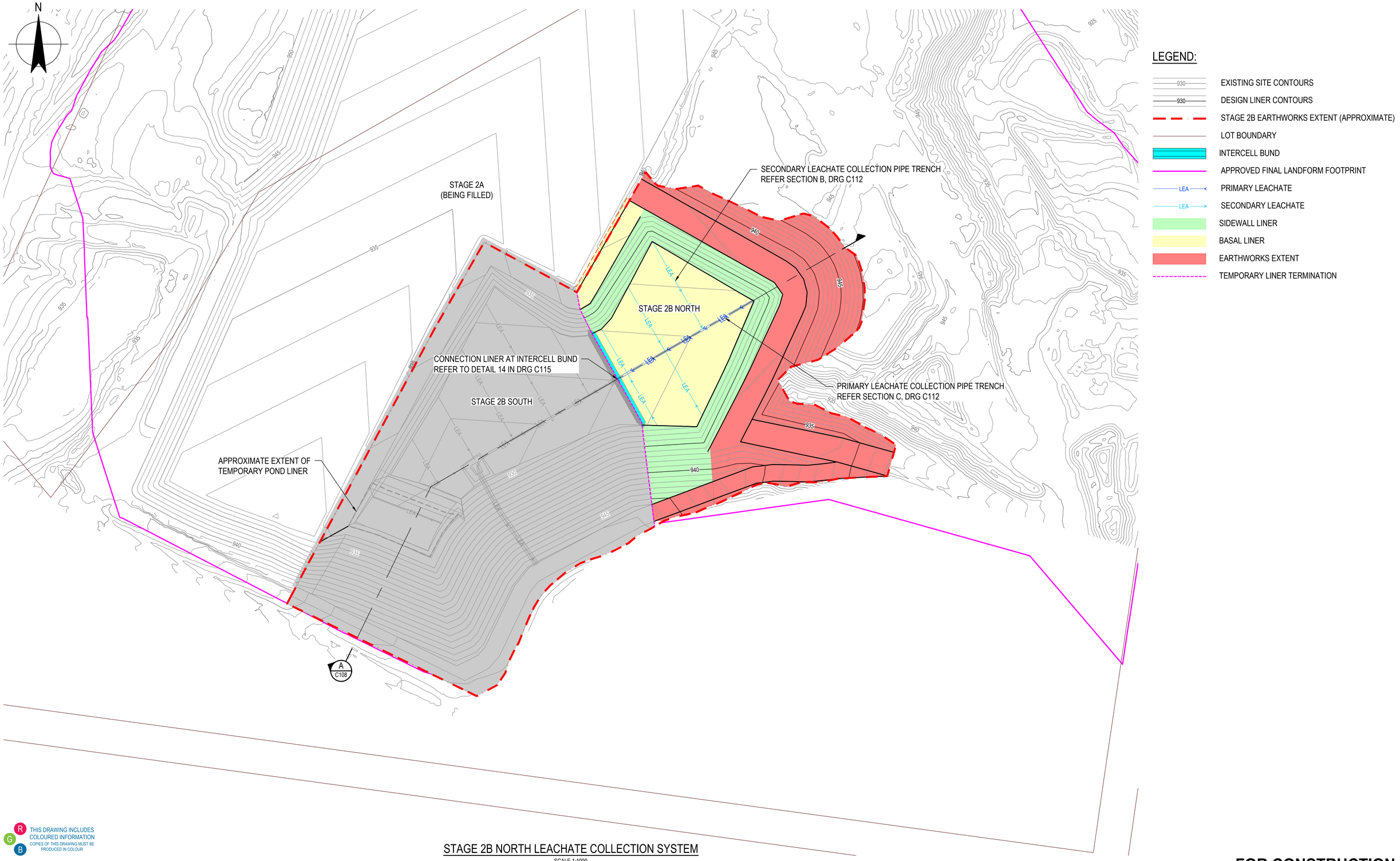
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title STAGE 2A NORTH LINING SYSTEM
Size A1
Drawing No. 12610307-C105
Rev 1

Plot Date: 24 October 2024 - 9:49 PM Plotted by: Chris Nivison-Smith File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C105.dwg



THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

STAGE 2B NORTH LEACHATE COLLECTION SYSTEM

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

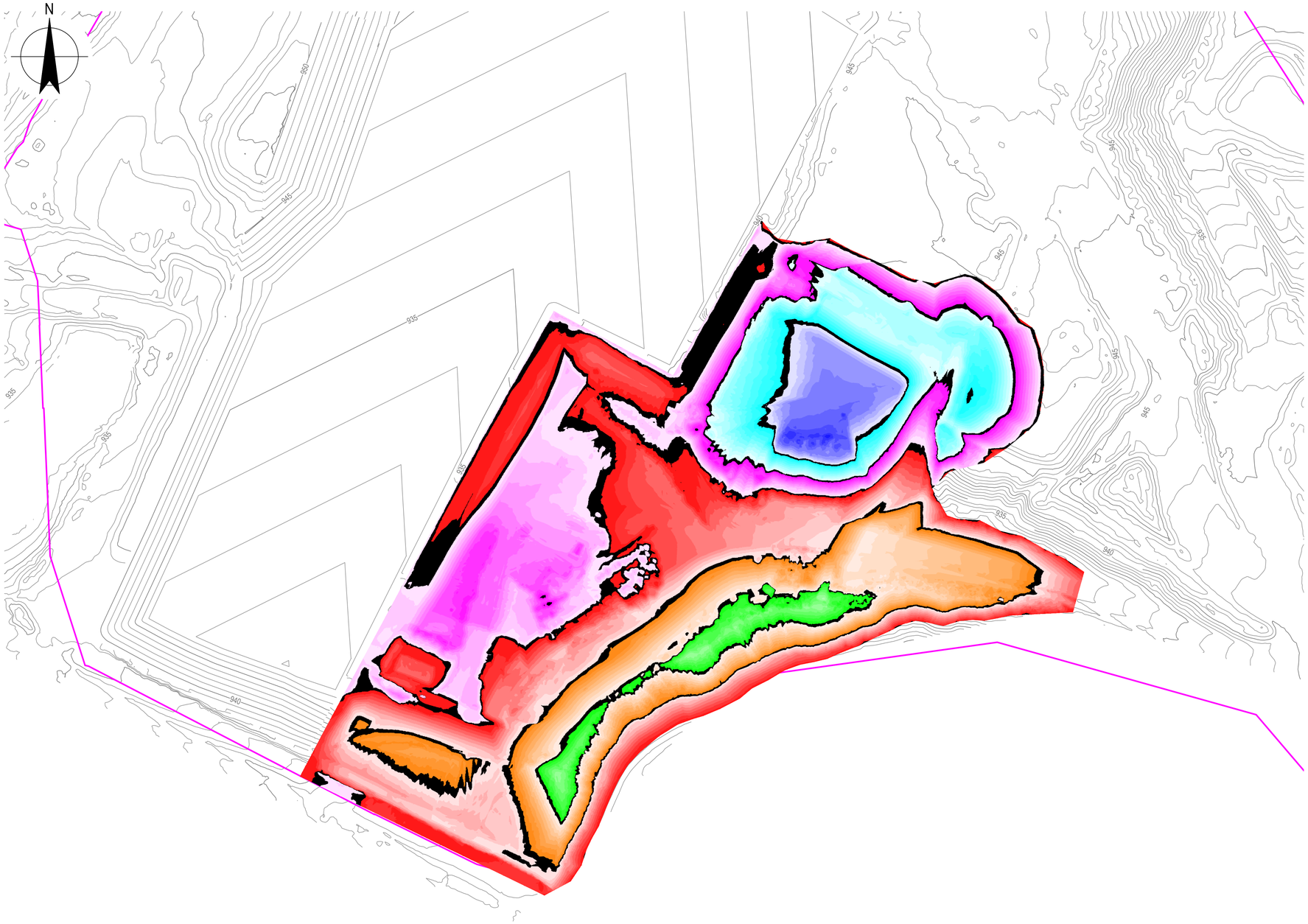
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3
DESIGN SERVICES LNAR STAGE 2B
LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title STAGE 2B NORTH LEACHATE COLLECTION SYSTEM
Drawing No. 12610307-C106
Size A1
Rev 1

Plot Date: 24 October 2024 - 9:51 PM Plotted by: Chris Nivison-Smith File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C106.dwg



LEGEND:

- EXISTING SITE CONTOURS
- APPROVED FINAL LANDFORM FOOTPRINT

EARTHWORKS DEPTH RANGE

LOWER_VALUE		UPPER_VALUE	COLOUR
-15.00	TO	-14.50 m	
-14.50	TO	-14.00 m	
-14.00	TO	-13.50 m	
-13.50	TO	-13.00 m	
-13.00	TO	-12.50 m	
-12.50	TO	-12.00 m	
-12.00	TO	-11.50 m	
-11.50	TO	-11.00 m	
-11.00	TO	-10.50 m	
-10.50	TO	-10.00 m	
-10.00	TO	-9.50 m	
-9.50	TO	-9.00 m	
-9.00	TO	-8.50 m	
-8.50	TO	-8.00 m	
-8.00	TO	-7.50 m	
-7.50	TO	-7.00 m	
-7.00	TO	-6.50 m	
-6.50	TO	-6.00 m	
-6.00	TO	-5.50 m	
-5.50	TO	-5.00 m	
-5.00	TO	-4.50 m	
-4.50	TO	-4.00 m	
-4.00	TO	-3.50 m	
-3.50	TO	-3.00 m	
-3.00	TO	-2.50 m	
-2.50	TO	-2.00 m	
-2.00	TO	-1.50 m	
-1.50	TO	-1.00 m	
-1.00	TO	-0.50 m	
-0.50	TO	0.00 m	

EARTHWORKS DEPTH RANGE

LOWER_VALUE		UPPER_VALUE	COLOUR
0.00	TO	0.50 m	
0.50	TO	1.00 m	
1.00	TO	1.50 m	
1.50	TO	2.00 m	
2.00	TO	2.50 m	
2.50	TO	3.00 m	
3.00	TO	3.50 m	
3.50	TO	4.00 m	
4.00	TO	4.50 m	
4.50	TO	5.00 m	
5.00	TO	5.50 m	
5.50	TO	6.00 m	
6.00	TO	6.50 m	
6.50	TO	7.00 m	
7.00	TO	7.50 m	
7.50	TO	8.00 m	
8.00	TO	8.50 m	
8.50	TO	9.00 m	
9.00	TO	9.50 m	
9.50	TO	10.00 m	
10.00	TO	10.50 m	
10.50	TO	11.00 m	
11.00	TO	11.50 m	
11.50	TO	12.00 m	
12.00	TO	12.50 m	
12.50	TO	13.00 m	
13.00	TO	13.50 m	
13.50	TO	14.00 m	
14.00	TO	14.50 m	
14.50	TO	15.00 m	

NOTES:

1. CUT/FILL SURFACE DOES NOT INCLUDE WCA1 OR OTHER EARTHWORKS OUTSIDE OF WORKS AREA. CONTRACTOR TO CONFIRM WITH SUPERINTENDENT IF ANY ADDITIONAL EARTHWORKS ARE REQUIRED BEYOND THIS EXTENT.

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

CUT AND FILL PLAN

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Author	Checked	Approved	Date
1	REVISED SUBGRADE	AR		DG	24/10/24
0	FOR CONSTRUCTION	AR		DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

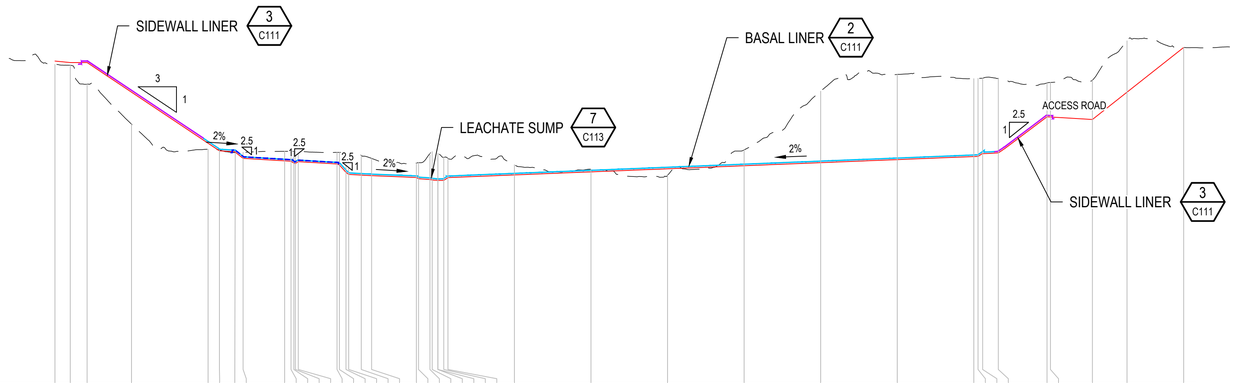
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

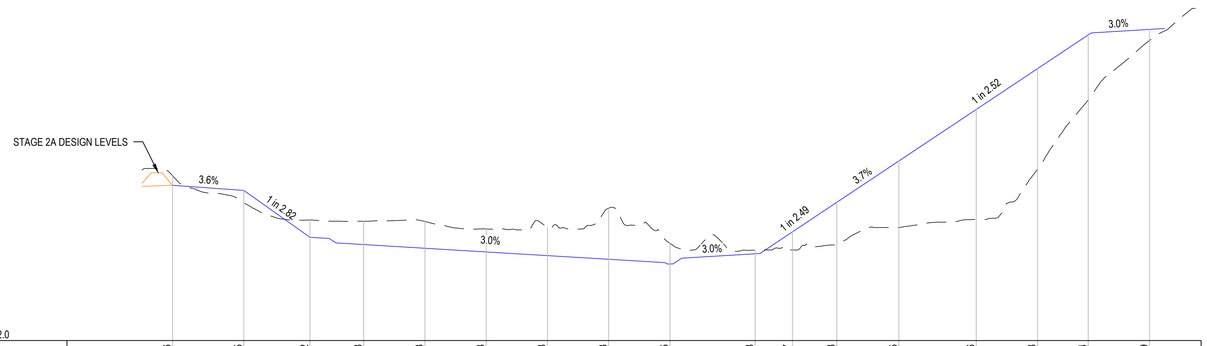
Drawing Title CUT AND FILL PLAN
Size A1
Drawing No. 12610307-C107
Rev 1

Plot Date: 24 October 2024 - 9:35 AM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C107.dwg



DATUM RL. 894.0

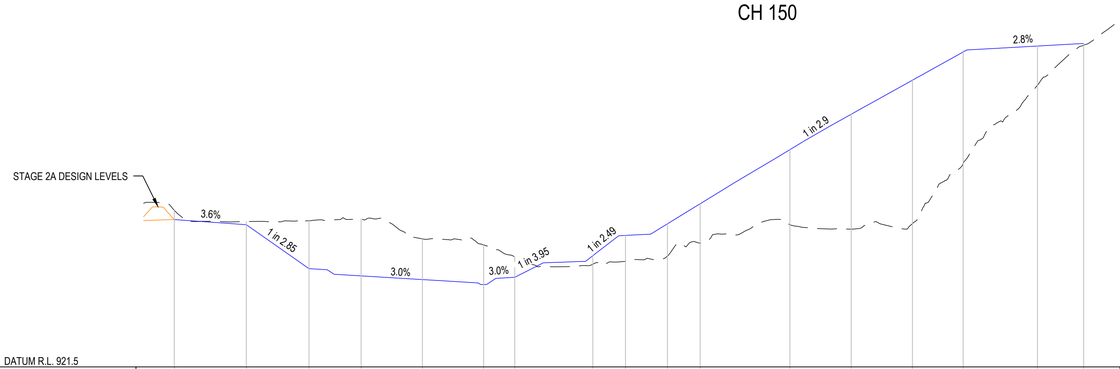
| | | |



DATUM R.L. 922.0

DESIGN LEVEL	934.66	934.25	930.42	929.83	929.53	929.23	928.93	928.63	928.25	929.08	930.87	933.28	936.65	940.86	944.18	946.94	947.39
EXISTING SURFACE	935.44	933.23	931.84	931.73	931.72	931.10	931.23	932.80	929.92	929.38	929.39	929.85	931.22	931.88	935.99	941.64	946.48
OFFSET	-81.163	-69.569	-58.770	-50.000	-40.000	-30.000	-20.000	-10.000	0.000	13.907	20.000	27.234	37.370	50.000	60.000	68.279	78.286

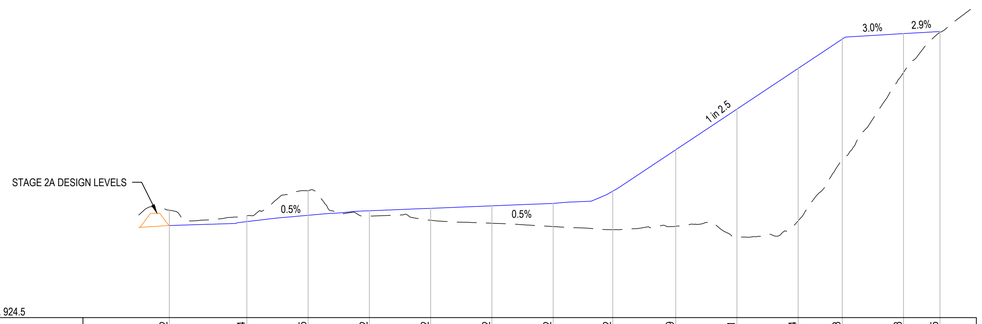
CH 150



DATUM R.L. 921.5

DESIGN LEVEL	933.53	933.11	929.52	928.93	928.63	928.22	928.82	930.58	932.23	933.18	934.82	939.23	942.12	944.90	947.20	947.69	947.90
EXISTING SURFACE	934.29	933.37	933.43	933.57	931.95	931.46	930.49	929.88	930.12	930.55	931.60	933.10	932.74	933.20	938.11	944.48	947.75
OFFSET	-50.507	-38.748	-28.511	-20.000	-10.000	0.000	5.081	17.826	23.155	30.000	35.345	50.000	60.000	70.000	78.269	90.397	97.944

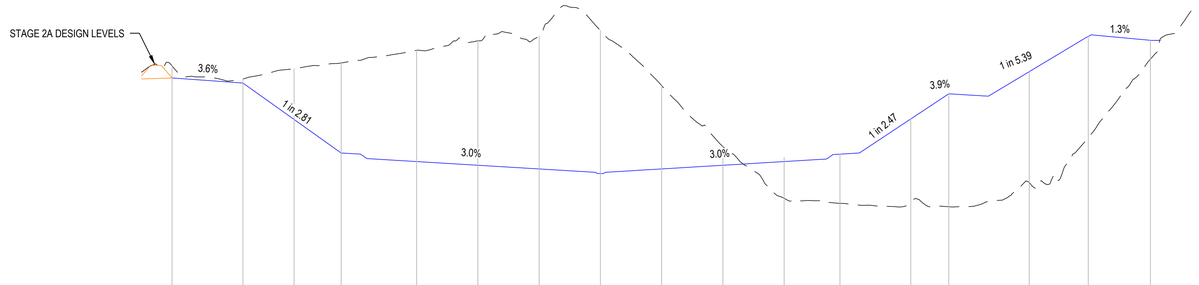
CH 100



DATUM R.L. 924.5

DESIGN LEVEL	932.02	932.34	932.85	933.22	933.42	933.62	933.82	934.82	938.19	941.51	944.84	947.23	947.68	947.85
EXISTING SURFACE	933.27	932.83	932.86	932.79	932.44	932.20	931.93	931.68	931.95	931.08	932.40	937.37	944.51	947.77
OFFSET	-42.682	-30.000	-20.000	-10.000	0.000	10.000	20.000	29.732	40.000	50.000	60.000	67.198	77.198	83.139

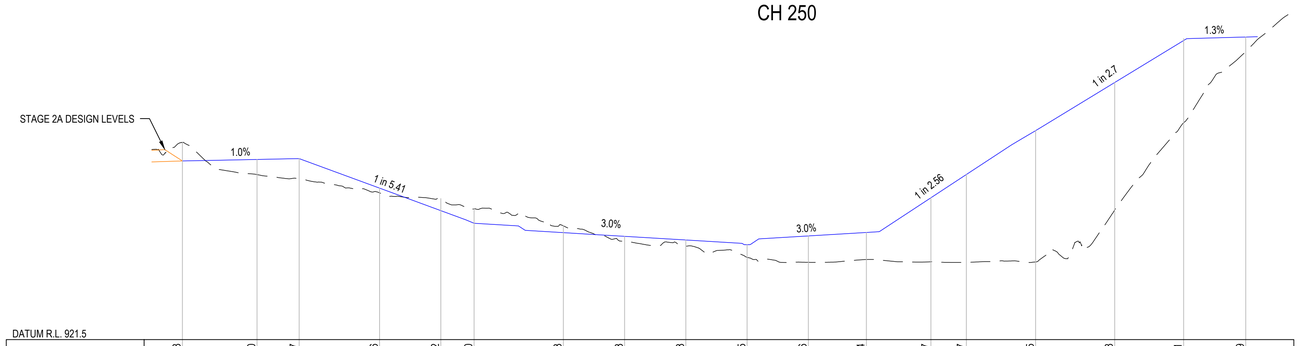
CH 50



DATUM R.L. 921.0

DESIGN LEVEL	938.05	937.64	934.66	931.93	931.23	930.93	930.63	930.25	930.63	930.93	931.23	931.83	934.71	936.76	938.56	941.44	941.12
EXISTING SURFACE	939.04	937.96	938.80	939.28	940.31	941.08	941.47	941.92	937.43	932.46	928.23	927.82	927.90	927.54	929.51	933.19	939.58
OFFSET	-69.920	-58.352	-50.000	-42.317	-30.000	-20.000	-10.000	0.000	10.000	20.000	30.000	39.110	50.667	56.867	70.000	79.649	89.789

CH 250



DATUM R.L. 921.5

DESIGN LEVEL	936.08	936.20	936.27	933.86	932.02	931.00	930.23	929.93	929.63	929.25	929.96	930.24	933.07	934.97	938.55	942.48	945.91	946.19
EXISTING SURFACE	937.58	934.97	934.63	933.48	933.01	932.17	930.79	929.57	929.12	928.21	927.81	929.04	927.85	927.80	927.84	932.08	939.19	945.01
OFFSET	-92.187	-80.000	-73.120	-60.000	-50.000	-44.569	-30.000	-20.000	-10.000	0.000	10.000	19.474	30.000	35.794	47.090	60.000	71.257	81.397

CH 200

NOTES:

1. LEACHATE COLLECTION PIPE TRENCHES NOT SHOWN.
2. SURFACE WATER DRAINS NOT SHOWN.
3. PERIMETER BUND NOT SHOWN.

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

VERTICAL 1:500 AT ORIGINAL SIZE
HORIZONTAL 1:1000 AT ORIGINAL SIZE
0 5 10 15 20 25m
0 10 20 30 40 50m

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 F 61 2 9239 7199
E sydmail@ghd.com W www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

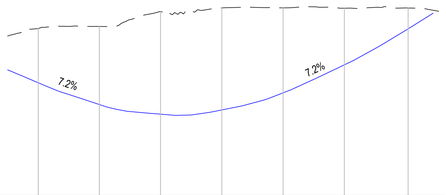
Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title CROSS SECTION - SHEET 1 OF 2
Size A1
Drawing No. 12610307-C109
Rev 1

Plot Date: 24 October 2024 - 2:42 PM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C109.dwg

NOTES:

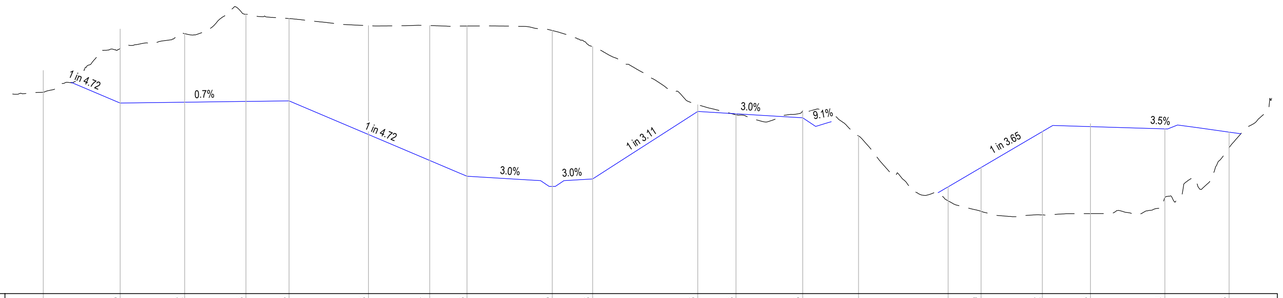
1. LEACHATE COLLECTION PIPE TRENCHES NOT SHOWN.
2. SURFACE WATER DRAINS NOT SHOWN.
3. PERIMETER BUND NOT SHOWN.



DATUM R.L. 935.0

DESIGN LEVEL	944.32	942.54	941.75	942.10	943.49	945.78	948.72
EXISTING SURFACE	948.74	948.91	950.13	950.43	950.43	950.40	950.41
OFFSET	-19.968	-10.000	0.000	10.000	20.000	30.000	40.417

CH 350



DATUM R.L. 922.5

DESIGN LEVEL		938.05	938.12	938.18	938.23	935.48	933.37	932.08	931.25	931.86	937.36	937.18	936.85	931.21	932.79	935.72	936.13	935.94	935.68			
EXISTING SURFACE	938.94	942.51	943.71	945.30	944.95	944.37	944.38	944.34	943.97	942.65	937.91	937.09	937.46	935.37	930.07	929.22	928.93	929.03	930.32	934.41		
OFFSET	-83.090	-70.540	-60.000	-50.000	-42.966	-30.000	-20.000	-13.912	0.000	6.597	23.750	30.000	40.884	50.000	64.622	70.000	80.000	87.856	100.000	110.488		

CH 300

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

VERTICAL 1:250 AT ORIGINAL SIZE
HORIZONTAL 1:500 AT ORIGINAL SIZE
0 2.5 5 7.5 10 12.5m
0 5 10 15 20 25m

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

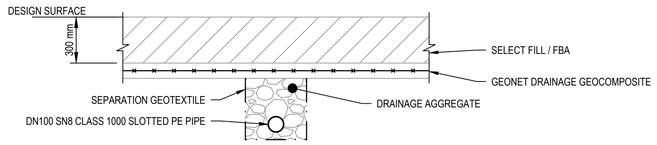
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

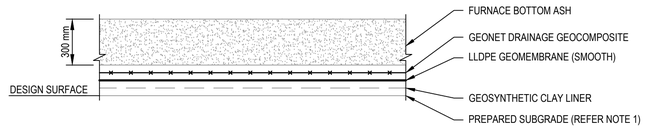
Drawing Title CROSS SECTIONS - SHEET 2 OF 2
Size A1
Drawing No. 12610307-C110
Rev 1

Plot Date: 24 October 2024 - 2:42 PM Plotted by: Riken Joshua Lopez File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C110.dwg



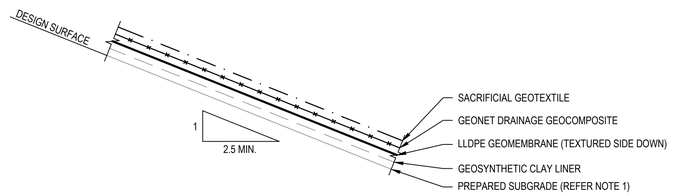
SEEPAGE CONTROL (REFER NOTE 2)

1 / - DETAIL
SCALE 1 : 20



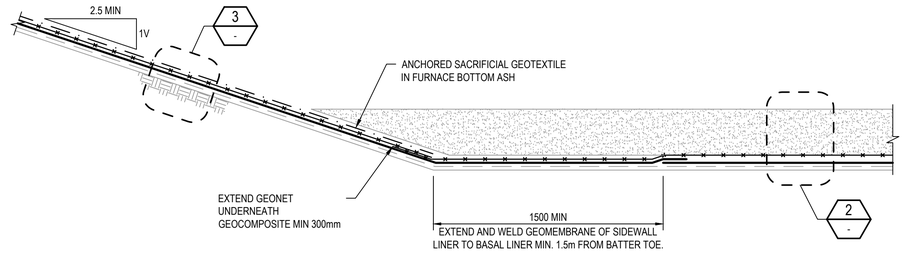
BASAL LINER PROFILE

2 / C102, 2 / C105, 2 / C109 DETAIL
SCALE 1 : 20



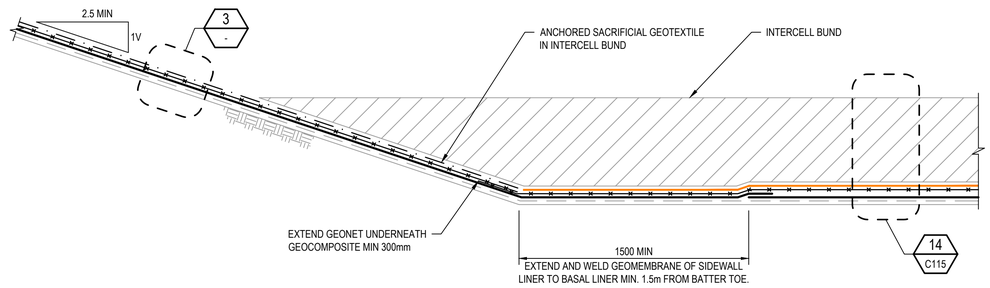
SIDEWALL LINER PROFILE

3 / C102, 3 / C105, 3 / C109 DETAIL
SCALE 1 : 20



TRANSITION BETWEEN SIDEWALL AND BASAL LINER

4 / C115 DETAIL
SCALE 1 : 20



TRANSITION BETWEEN SIDEWALL AND BASAL LINER AT INTERCELL BUND

4A / - DETAIL
SCALE 1 : 20

NOTES:

1. SUBGRADE SHALL CONSIST OF PREPARED FILL BATTER SURFACE, 300mm REWORKED WATER CONDITIONED ASH OR SELECT FILL LAYER PER DETAIL 1
2. SEEPAGE CONTROL LAYER TO BE INSTALLED AS REQUIRED. DESIGNER TO BE CONSULTED. REFER DRAWING C101 AND C104 FOR MORE DETAILS.

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

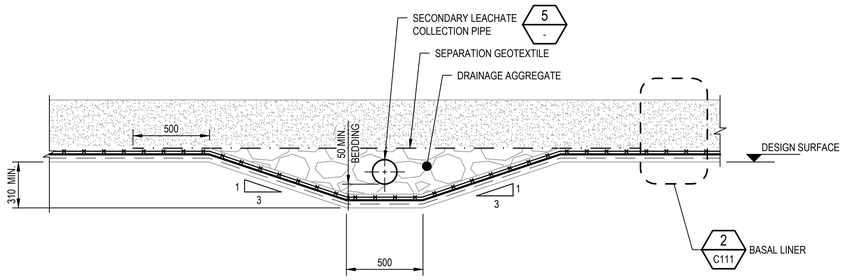
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title TYPICAL SECTIONS AND DETAILS SHEET 1 OF 6
Size A1
Drawing No. 12610307-C111
Rev 1

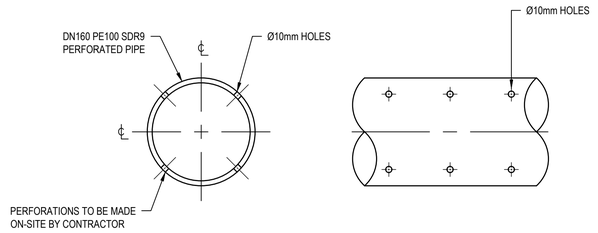
Plot Date: 23 October 2024 - 2:13 PM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C111.dwg



SECONDARY LEACHATE COLLECTION PIPE TRENCH

B / C103/C106 SECTION

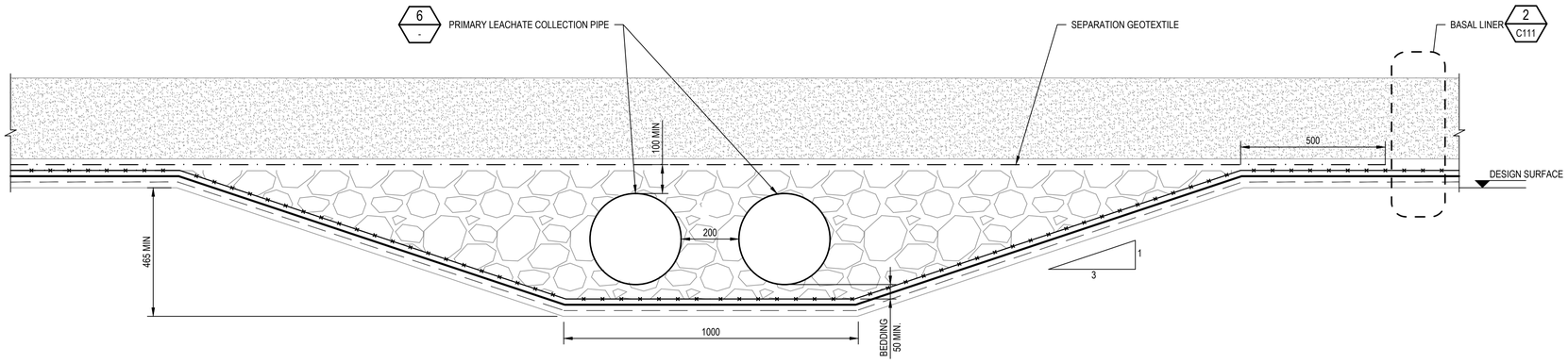
SCALE 1 : 10



SECONDARY LEACHATE COLLECTION PIPE PERFORATION

5 / - DETAIL

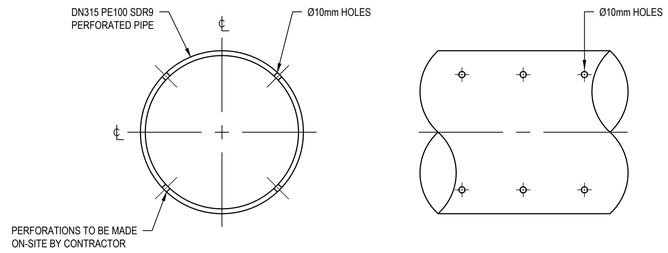
SCALE 1 : 5



C / C103/C106 SECTION

SCALE 1 : 10

PRIMARY LEACHATE COLLECTION PIPE TRENCH



PRIMARY LEACHATE COLLECTION PIPE PERFORATION

6 / - DETAIL

SCALE 1 : 5

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**

Designer R. HUYNH **Design Check** A. ROBERTS

0 50 100 150 200 250mm
SCALE 1:5 AT ORIGINAL SIZE

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD

Project PROJECT HYDRA STREAM 3
DESIGN SERVICES LNAR STAGE 2B
LINER DESIGN

Status CONSTRUCTION Status Code S4

Drawing Title TYPICAL SECTIONS AND DETAILS
SHEET 2 OF 6

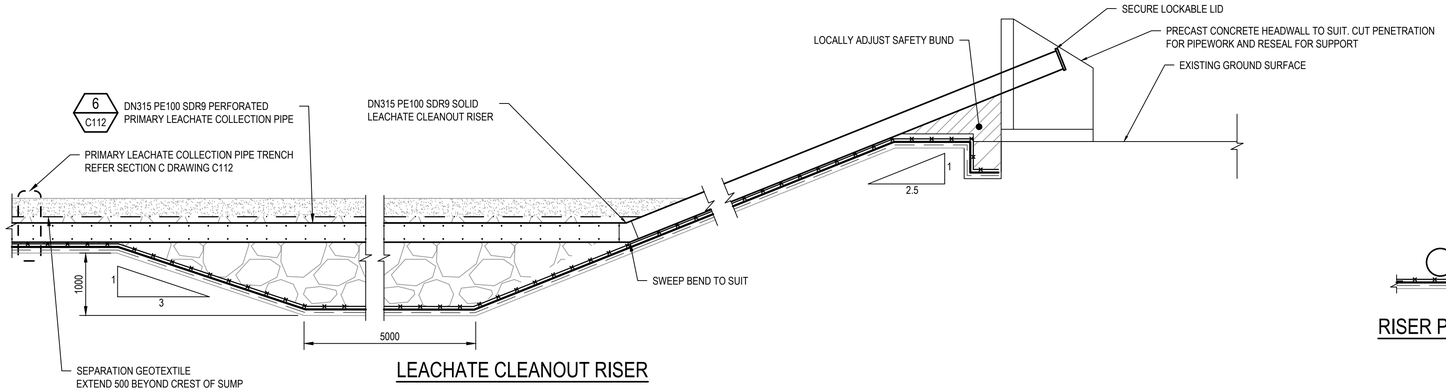
Size A1

Drawing No. 12610307-C112

Rev 1

Plot Date: 23 October 2024 - 2:13 PM Plotted by: Riken Joshua Lopez

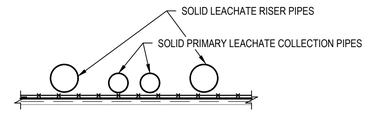
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C112.dwg



LEACHATE CLEANOUT RISER

E - SECTION

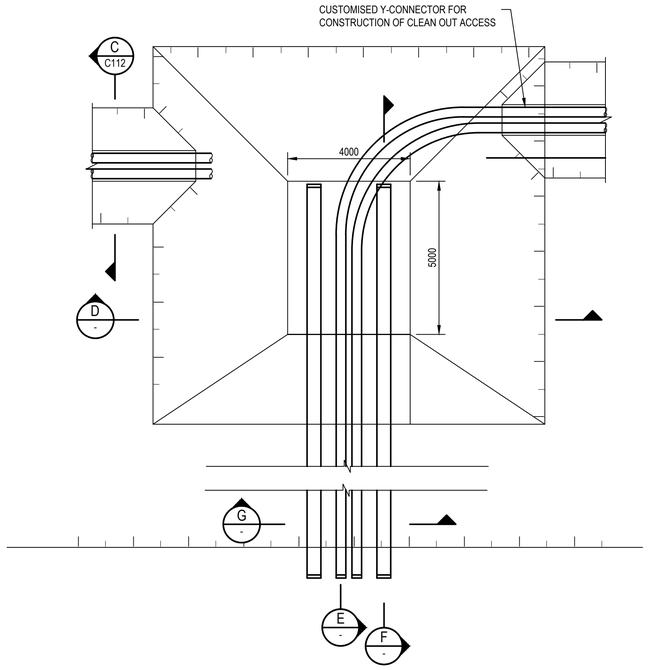
SCALE 1 : 50



RISER PIPES TYPICAL SECTION

G - SECTION

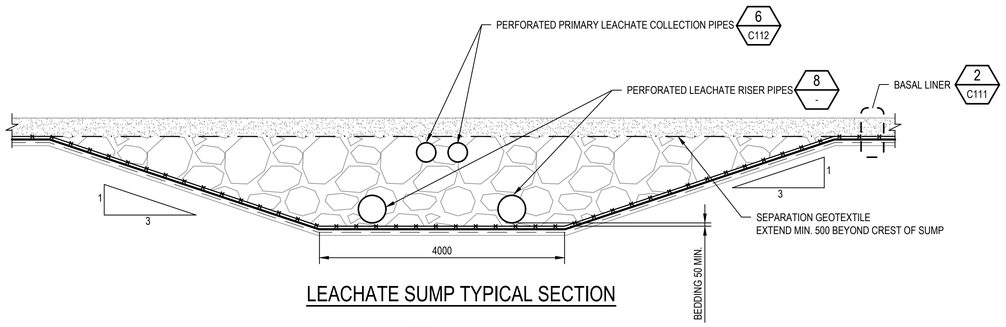
SCALE 1 : 50



7 C101 / 7 C109 DETAIL

SCALE 1 : 100

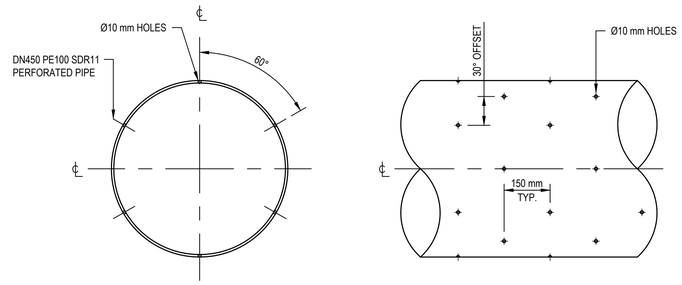
LEACHATE SUMP PLAN



LEACHATE SUMP TYPICAL SECTION

D - SECTION

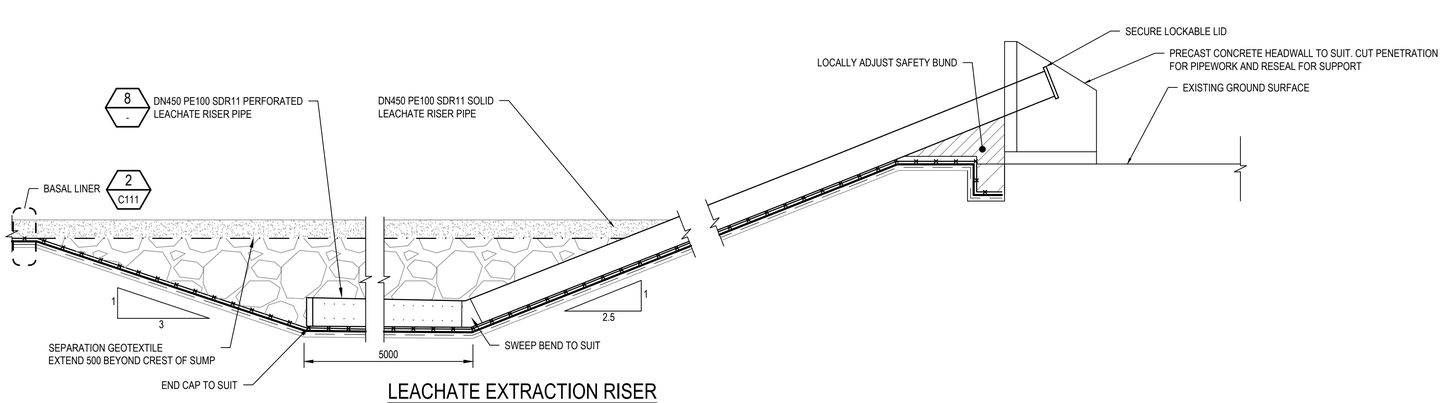
SCALE 1 : 50



LEACHATE RISER PIPE PERFORATION

8 - DETAIL

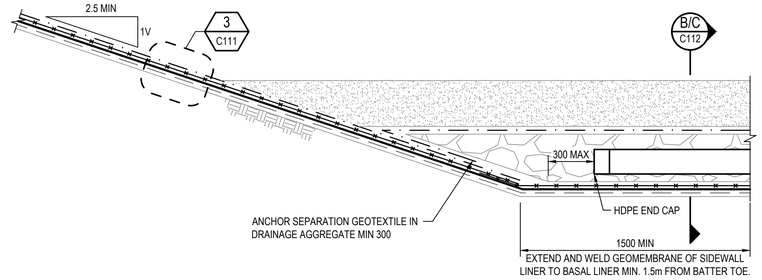
SCALE 1 : 10



LEACHATE EXTRACTION RISER

F - SECTION

SCALE 1 : 50



LEACHATE PIPE TRENCH TERMINATION AT SIDEWALL LINER BATTER TOE

J - SECTION

SCALE 1 : 20

R G B THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**

Designer R. HUYNH **Design Check** A. ROBERTS

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

0 1000 2000 3000 4000 5000mm
SCALE 1:100 AT ORIGINAL SIZE

0 500 1000 1500 2000 2500mm
SCALE 1:50 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD

Project PROJECT HYDRA STREAM 3
DESIGN SERVICES LNAR STAGE 2B
LINER DESIGN

Status CONSTRUCTION Status Code S4

Drawing Title TYPICAL SECTIONS AND DETAILS
SHEET 3 OF 6

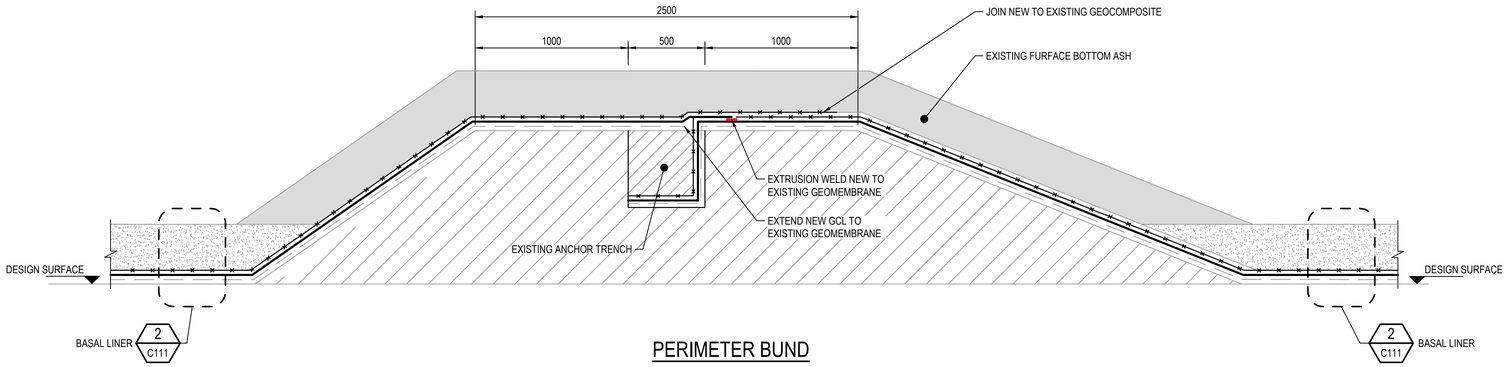
Size A1

Drawing No. 12610307-C113

Rev 1

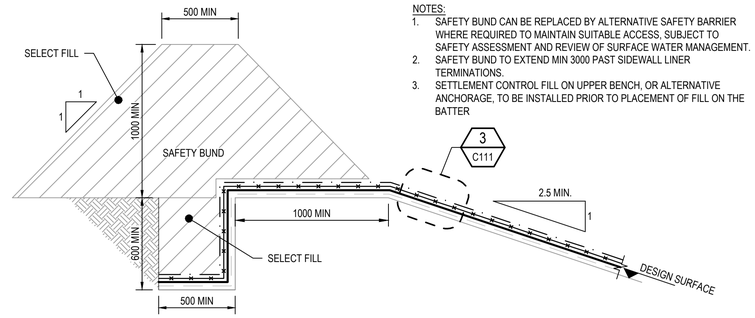
Plot Date: 24 October 2024 - 11:21 AM Plotted by: Riken Joshua Lopez

File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C113.dwg



PERIMETER BUND

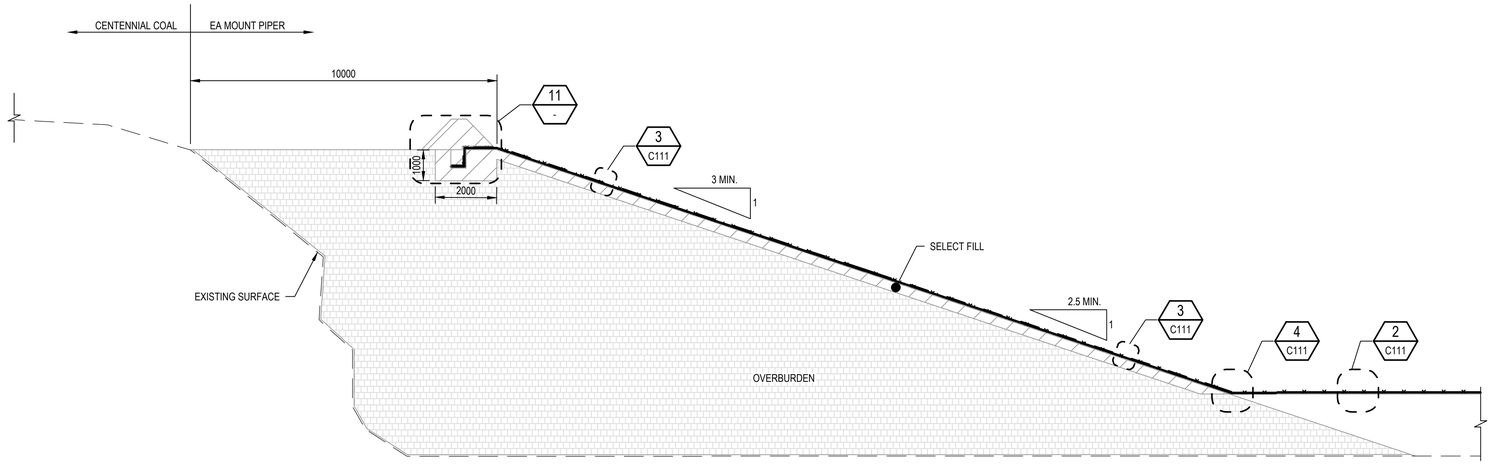
9 C105 DETAIL
SCALE 1 : 20



NOTES:
1. SAFETY BUND CAN BE REPLACED BY ALTERNATIVE SAFETY BARRIER WHERE REQUIRED TO MAINTAIN SUITABLE ACCESS, SUBJECT TO SAFETY ASSESSMENT AND REVIEW OF SURFACE WATER MANAGEMENT.
2. SAFETY BUND TO EXTEND MIN 3000 PAST SIDEWALL LINER TERMINATIONS.
3. SETTLEMENT CONTROL FILL ON UPPER BENCH, OR ALTERNATIVE ANCHORAGE, TO BE INSTALLED PRIOR TO PLACEMENT OF FILL ON THE BATTER

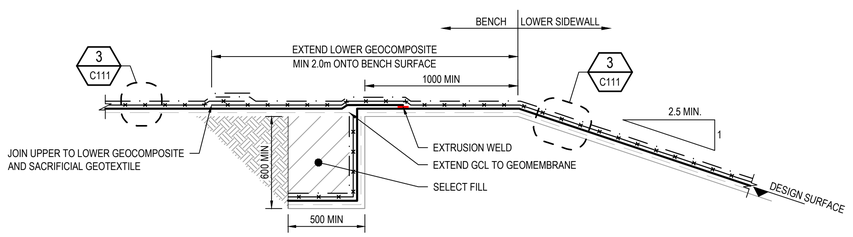
TYPICAL EDGE DETAIL AT CREST OF SIDEWALL LINER BATTER

11 - DETAIL
SCALE 1 : 20



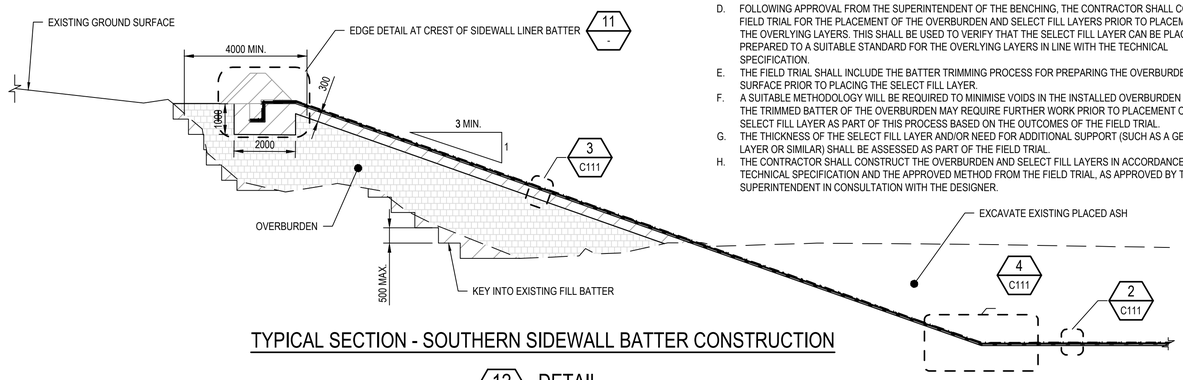
TYPICAL SECTION - UNSTABLE WALL BATTER CONSTRUCTION

10 C101 / 10 C104 DETAIL
SCALE 1 : 100



TYPICAL DETAIL ON BENCH OF SIDEWALL LINER BATTER

11A - DETAIL
SCALE 1 : 20



TYPICAL SECTION - SOUTHERN SIDEWALL BATTER CONSTRUCTION

12 C101 DETAIL
SCALE 1 : 100

NOTES FOR DETAIL 10 AND 12:

THE FOLLOWING METHODOLOGY SHALL BE IMPLEMENTED FOR THE SOUTHERN SIDEWALL BATTER CONSTRUCTION:

A. THE DESIGNER OR A SUITABLE QUALIFIED AND EXPERIENCED GEOTECHNICAL ENGINEER OR ENGINEERING GEOLOGIST SHALL INSPECT THESE AREAS TO IDENTIFY SAFETY MEASURES AND ANY ADDITIONAL ACTIONS TO BE UNDERTAKEN PRIOR TO AND DURING EARTHWORKS, AND ANY UNSUITABLE MATERIAL TO BE REMOVED.
B. THE CONTRACTOR SHALL COMPLETE UNSUITABLE MATERIAL REMOVAL AND SURFACE BENCHING BASED ON THE OUTCOMES OF THE INSPECTION ABOVE.
C. THE DESIGNER OR A SUITABLY QUALIFIED AND EXPERIENCED GEOTECHNICAL ENGINEER OR ENGINEERING GEOLOGIST SHALL INSPECT THESE AREAS FOLLOWING BENCHING TO CONFIRM THEY ARE SUITABLE FOR OVERLAYING MATERIAL PLACEMENT.
D. FOLLOWING APPROVAL FROM THE SUPERINTENDENT OF THE BENCHING, THE CONTRACTOR SHALL CONDUCT A FIELD TRIAL FOR THE PLACEMENT OF THE OVERBURDEN AND SELECT FILL LAYERS PRIOR TO PLACEMENT OF THE OVERLYING LAYERS. THIS SHALL BE USED TO VERIFY THAT THE SELECT FILL LAYER CAN BE PLACED AND PREPARED TO A SUITABLE STANDARD FOR THE OVERLYING LAYERS IN LINE WITH THE TECHNICAL SPECIFICATION.
E. THE FIELD TRIAL SHALL INCLUDE THE BATTER TRIMMING PROCESS FOR PREPARING THE OVERBURDEN SURFACE PRIOR TO PLACING THE SELECT FILL LAYER.
F. A SUITABLE METHODOLOGY WILL BE REQUIRED TO MINIMISE VOIDS IN THE INSTALLED OVERBURDEN LAYER. THE TRIMMED BATTER OF THE OVERBURDEN MAY REQUIRE FURTHER WORK PRIOR TO PLACEMENT OF THE SELECT FILL LAYER AS PART OF THIS PROCESS BASED ON THE OUTCOMES OF THE FIELD TRIAL.
G. THE THICKNESS OF THE SELECT FILL LAYER AND/OR NEED FOR ADDITIONAL SUPPORT (SUCH AS A GEOGRID LAYER OR SIMILAR) SHALL BE ASSESSED AS PART OF THE FIELD TRIAL.
H. THE CONTRACTOR SHALL CONSTRUCT THE OVERBURDEN AND SELECT FILL LAYERS IN ACCORDANCE WITH THE TECHNICAL SPECIFICATION AND THE APPROVED METHOD FROM THE FIELD TRIAL, AS APPROVED BY THE SUPERINTENDENT IN CONSULTATION WITH THE DESIGNER.

TYPICAL SECTION - SOUTHERN SIDEWALL BATTER CONSTRUCTION

12 C101 DETAIL
SCALE 1 : 100

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 50 100 150 200 250mm — SCALE 1:5 AT ORIGINAL SIZE
0 100 200 300 400 500mm — SCALE 1:10 AT ORIGINAL SIZE
0 200 400 600 800 1000mm — SCALE 1:20 AT ORIGINAL SIZE
0 250 500 750 1000 1250mm — SCALE 1:25 AT ORIGINAL SIZE
0 1000 2000 3000 4000 5000mm — SCALE 1:100 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 F 61 2 9239 7199
E sydmail@ghd.com W www.ghd.com
www.ghd.com

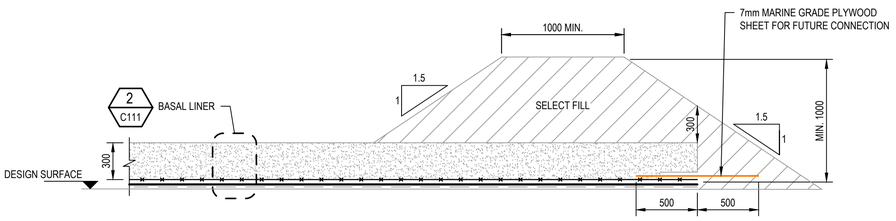
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

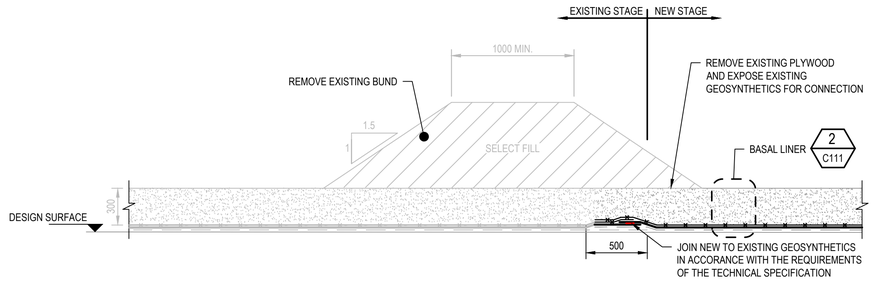
Drawing Title TYPICAL SECTIONS AND DETAILS SHEET 4 OF 6
Size A1
Drawing No. 12610307-C114
Rev 1

Plot Date: 24 October 2024 - 10:23 PM Plotted by: Chris Nivison-Smith
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C114.dwg



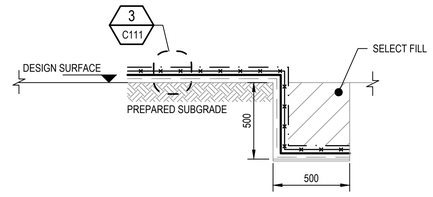
TYPICAL SECTION THROUGH INTERCELL BUND ON CELL BASE

13 C102 DETAIL SCALE 1 : 25



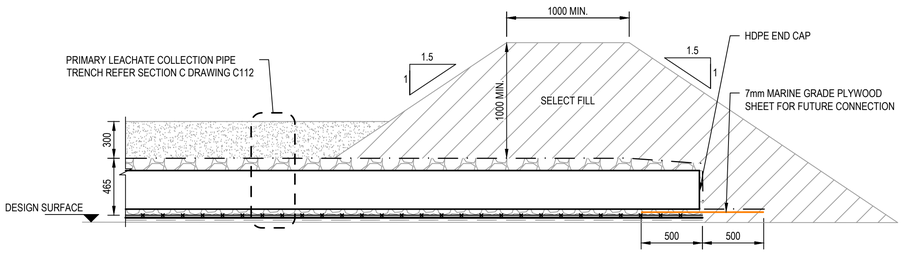
TYPICAL SECTION CONNECTION AT INTERCELL BUND ON CELL BASE

14 C104 | 14 C105 | 14 C106 DETAIL SCALE 1 : 25



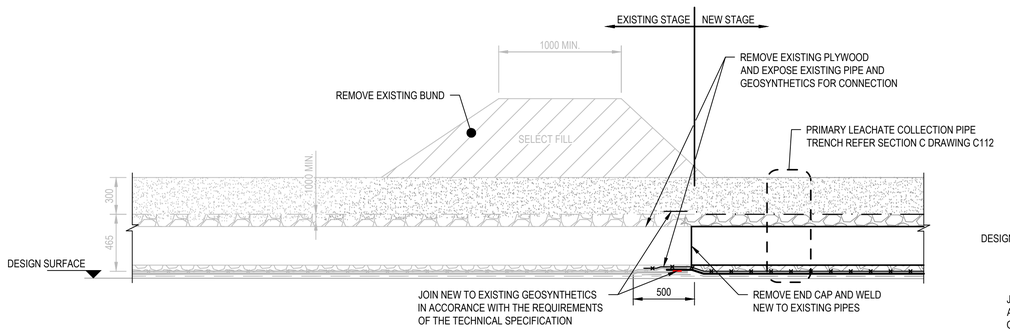
TYPICAL DETAIL - TERMINATION OF SIDEWALL LINER ON SLOPE

17 C102 DETAIL SCALE 1 : 20



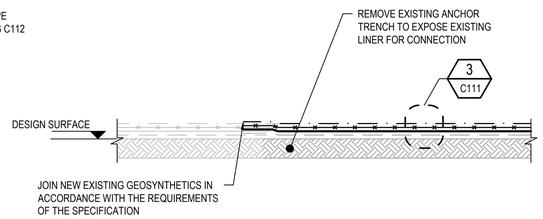
TYPICAL SECTION THROUGH INTERCELL BUND IN PRIMARY LEACHATE TRENCH

15 C103 DETAIL SCALE 1 : 25



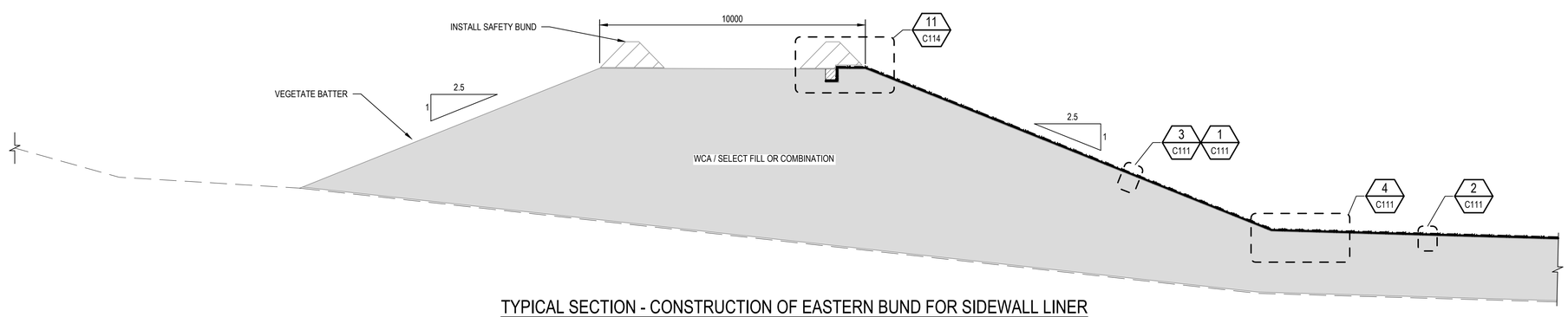
TYPICAL SECTION - CONNECTION AT INTERCELL BUND IN PRIMARY LEACHATE TRENCH

16 C104 DETAIL SCALE 1 : 25



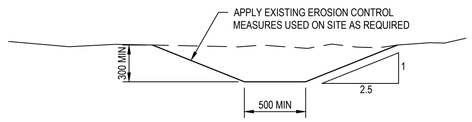
TYPICAL DETAIL - CONNECTION OF SIDEWALL LINER

17A C105 DETAIL SCALE 1 : 20



TYPICAL SECTION - CONSTRUCTION OF EASTERN BUND FOR SIDEWALL LINER

18 C104 DETAIL SCALE 1 : 100



TYPICAL DETAIL - STORMWATER DIVESION DRAIN

19 - DETAIL SCALE 1 : 25

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

0 1000 2000 3000 4000 5000mm
SCALE 1:100 AT ORIGINAL SIZE

0 250 500 750 1000 1250mm
SCALE 1:25 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

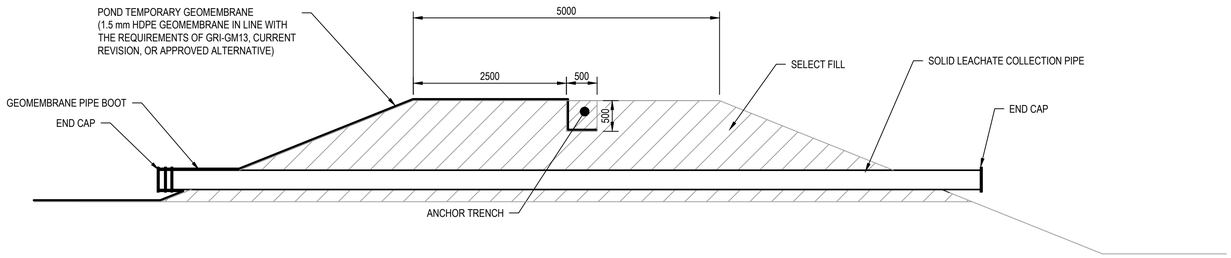
Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

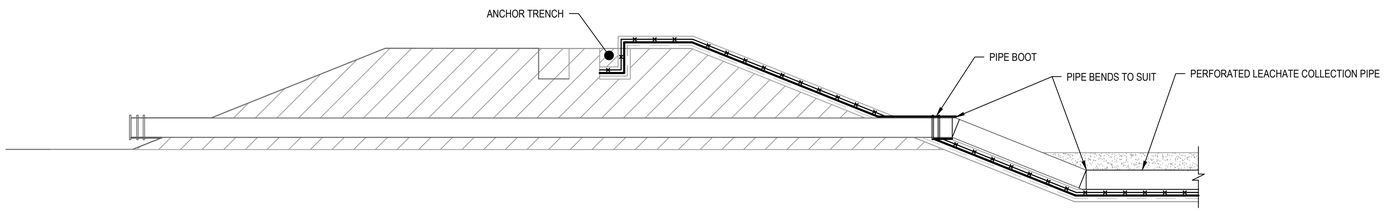
Drawing Title TYPICAL SECTIONS AND DETAILS SHEET 5 OF 6
Size A1
Drawing No. 12610307-C115
Rev 1

Plot Date: 23 October 2024 - 2:13 PM Plotted by: Riken Joshua Lopez File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C115.dwg



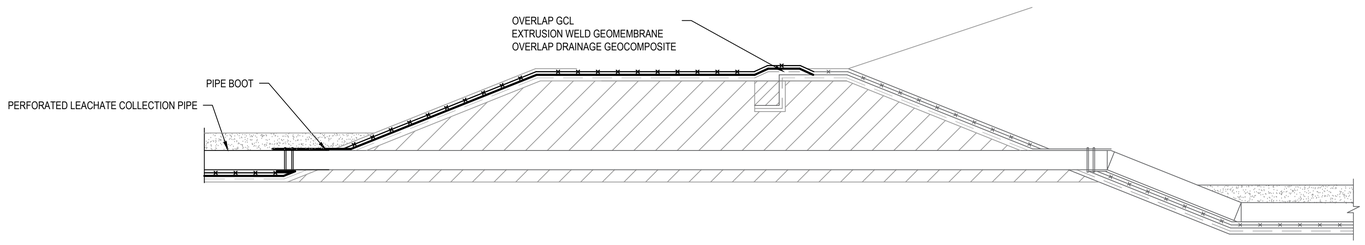
TEMPORARY POND LINER

20 C101 / 20 C102 DETAIL
SCALE 1 : 50



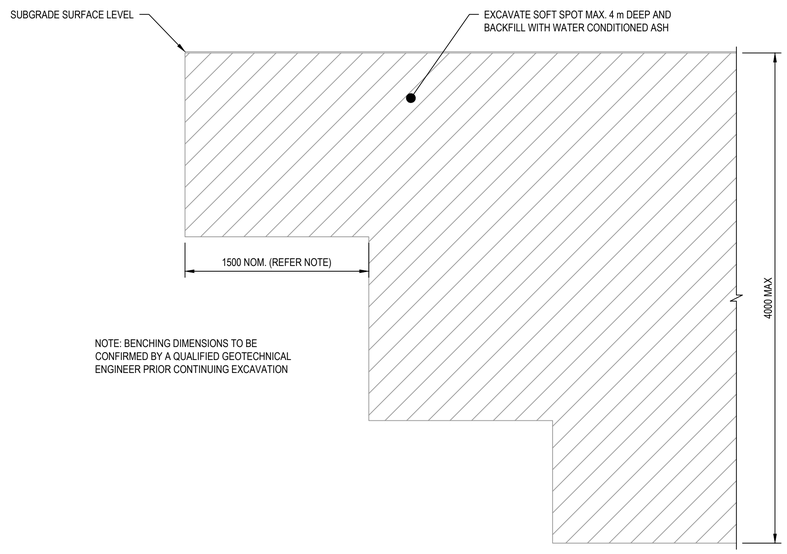
TERMINATION OF CELL LINER WITH TEMPORARY POND LINER

21 - DETAIL
SCALE 1 : 50



CONNECTION OF CELL LINER FOLLOWING DECOMMISSIONING OF TEMPORARY POND

22 - DETAIL
SCALE 1 : 50



TYPICAL SECTION - SOFT SPOT TREATMENT

23 - DETAIL
SCALE 1 : 25

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

FOR CONSTRUCTION

Rev	Description	Checked	Approved	Date
1	REVISED SUBGRADE	AR	DG	24/10/24
0	FOR CONSTRUCTION	AR	DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 250 500 750 1000 1250mm
SCALE 1:25 AT ORIGINAL SIZE

0 500 1000 1500 2000 2500mm
SCALE 1:50 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

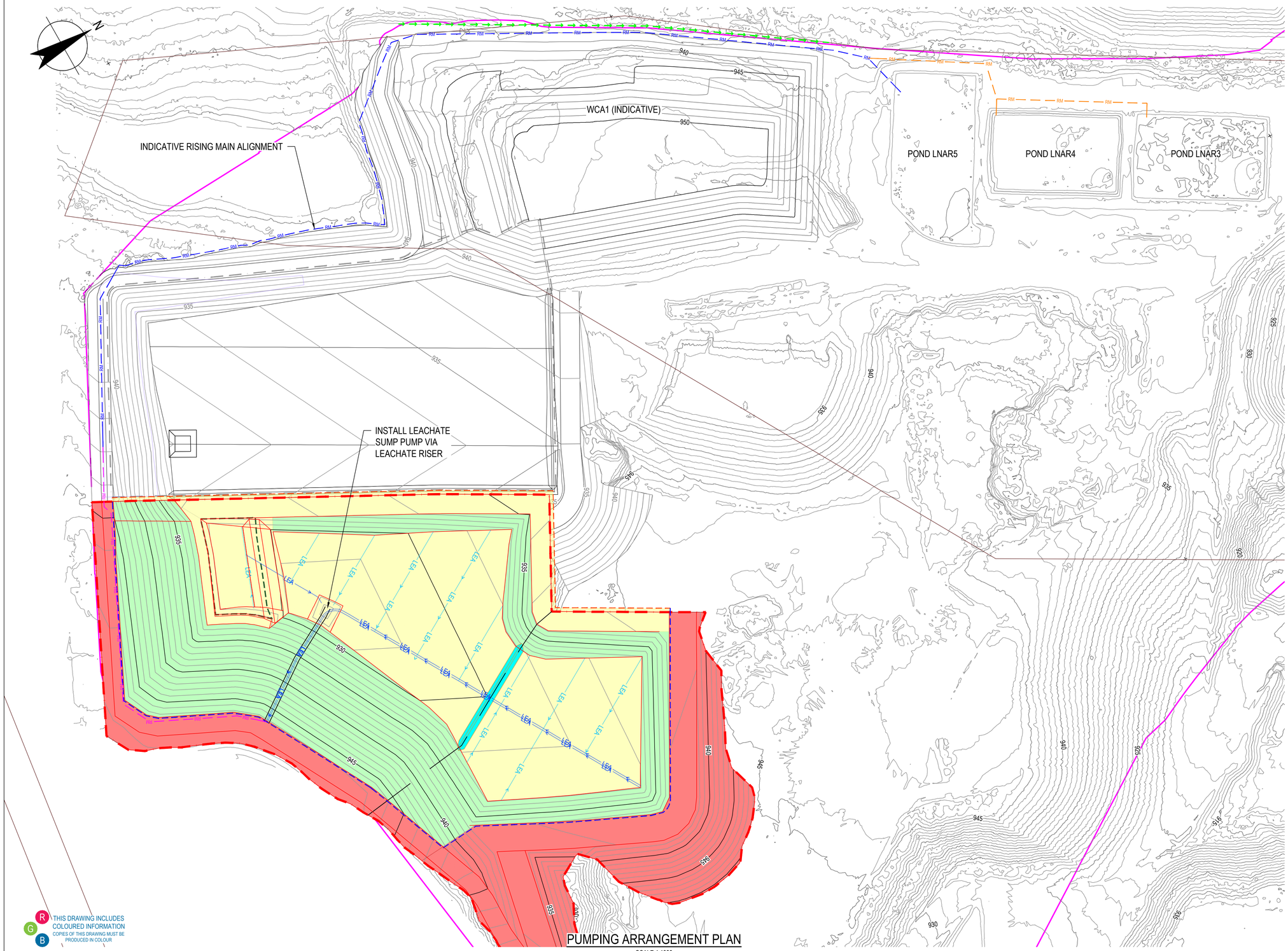
Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title TYPICAL SECTIONS AND DETAILS SHEET 6 OF 6

Size A1
Drawing No. 12610307-C116
Rev 1

Plot Date: 23 October 2024 - 2:13 PM Plotted by: Riken Joshua Lopez
File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C116.dwg



LEGEND:

- EXISTING SITE CONTOURS
- DESIGN LINER CONTOURS
- STAGE 2A EARTHWORKS EXTENT (APPROXIMATE)
- STAGE 2A LINER EXTENT (APPROXIMATE)
- LOT BOUNDARY
- PERIMETER BUND
- INTERCELL BUND
- APPROVED FINAL LANDFORM FOOTPRINT
- PRIMARY LEACHATE
- SECONDARY LEACHATE
- SIDEWALL LINER
- BASAL LINER
- WCA1 (INDICATIVE)
- EARTHWORKS EXTENT
- SELECT FILL

THIS DRAWING INCLUDES COLOURED INFORMATION
COPIES OF THIS DRAWING MUST BE PRODUCED IN COLOUR

PUMPING ARRANGEMENT PLAN

SCALE 1:1000

FOR CONSTRUCTION

Rev	Description	Author	Checked	Approved	Date
1	REVISED SUBGRADE	AR		DG	24/10/24
0	FOR CONSTRUCTION	AR		DG	19/07/24

Author R. LOPEZ **Drafting Check**
Designer R. HUYNH **Design Check** A. ROBERTS

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

GHD
Level 15, 133 Castlereagh Street,
Sydney NSW 2000 Australia
T 61 2 9239 7100 **F** 61 2 9239 7199
E sydmail@ghd.com **W** www.ghd.com
www.ghd.com

Conditions of Use. This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Project No. 12610307

Client ENERGYAUSTRALIA NSW PTY LTD
Project PROJECT HYDRA STREAM 3 DESIGN SERVICES LNAR STAGE 2B LINER DESIGN
Status CONSTRUCTION Status Code S4

Drawing Title PUMPING ARRANGEMENT PLAN
Size A1
Drawing No. 12610307-C117
Rev 1

Plot Date: 24 October 2024 - 10:02 PM Plotted by: Chris Nivison-Smith File Name: C:\12d\SW\data\P-00-12D-001\21-12610307 - Mt Piper - Ash Repository_2613\CADD\Drawings\12610307 - LNAR Stage 2B\12610307-C117.dwg

Appendix C

Design calculations

Client:	EnergyAustralia	**Project Number:**	12610307		
Project:	Hydra Stream 3 - Ash Repository Design Services	**Author:**	HL	**Date:**	13/11/2023
Subject:	Translational Failure Assessment	**Reviewer:**	AR	**Date:**	15/11/2023

Statement of design procedure	
This spreadsheet provides for translational failure analysis via a two-part wedge method.	
References	
Qian et al (2003). Translational Failure Analysis of Landfills. JOURNAL OF GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING	
Design cases / assumptions	
1	East sidewall
2	Not used
3	Not used
4	Not used

Assumptions
$FS_{min} = FS_V$ to be conservative
Waste is filled to the total height of the sidewall liner

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
	Waste parameters:							
1	Unit weight of ash	γ_{SW}	10.2				kN/m^3	Industry standard based on relevant literature
2	Internal friction angle of solid waste	ϕ_{SW}	30				degrees	Industry standard based on relevant literature
3	Internal friction angle of solid waste (converted)	ϕ_{SW}	0.52				radians	
	Friction parameters:							
4	Minimum interface friction angle of multilayer liner components beneath passive wedge - i.e. across basal liner	δ_P	23				degrees	Based on design critical interface (clay/geotextile)
5	Minimum interface friction angle of multilayer liner components beneath passive wedge - i.e. across basal liner (converted)	δ_P	0.40				radians	
6	Minimum interface friction angle of multilayer liner components beneath active wedge - i.e. across sidewall liner	δ_A	8				degrees	Based on design critical interface (smooth GM/GT)

7	Minimum interface friction angle of multilayer liner components beneath active wedge - i.e. across sidewall liner (converted)	δ_A	0.14				radians	
	Geometric parameters:							
8	Height of sidewall	H	15				m	Based on design
9	Top width of waste mass	B	40				m	Assumed to achieve FoS ~1.5
10	Sidewall grade	β	3				1:?	Based on design
11	Sidewall grade (converted)	β	0.32				radians	
12	Basal grade	θ	50				1:?	Based on design
13	Basal grade (converted)	θ	0.02				radians	
14	Waste batter grade	α	3				1:?	Proposed
15	Waste batter grade (converted)	α	0.32				radians	
	Weight of wedges:							
16	Weight of active wedge	W_A	3400				kN/m	
17	Weight of passive wedge	W_P	2894				kN/m	Equation 19 and 21
18	Total weight of active and passive wedges	W_T	6294				kN/m	Equation 20 and 22
	Interface FoS:							Equation 24
19	Quadratic parameter	a	1130					
20	Quadratic parameter	b	-1607					
21	Quadratic parameter	c	-58					
22	Quadratic calculator	x1	1.46					
23	Quadratic calculator	x2	-0.04					
24	Factor of safety at interface between active and passive wedges	FS_V	1.46					
		m_{SW}	0.40					
	FoS:							Equation 18
25	Quadratic parameter	a	1146					
26	Quadratic parameter	b	-1948					
27	Quadratic parameter	c	83					
28	Quadratic calculator	x1	1.66					
29	Quadratic calculator	x2	0.04					
30	Factor of safety	FoS	**1.66**					

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0	
Project:	Mt Piper Ash Repository	**Calcs by:**	H Liew	**Date:**	29/09/2023	
Subject:	Anchor trench calculations	**Checked by:**	R Huynh	**Date:**	14/11/2023	

Statement of design procedure

This spreadsheet provides design calculations for the anchor trench

References

Qian et al (2002) pg 106-113

Design cases / assumptions

1	Sidewall liner anchor trench for LLDPE geomembrane 1 in 3 batter
2	Sidewall liner anchor trench for geonet drainage geocomposite 1 in 3 batter
3	Sidewall liner anchor trench for LLDPE geomembrane 1 in 2 batter
4	
5	

Item	Description	Symbol	Case					Unit	Notes
			1	2	3	4	5		
Batter geometery - Initial									
1	Vertical height of batter	d	15	15	15	15		m	Longest slope
2	Batter angle	B	18.43	18.43	21.80	21.80		deg	
3	sinB	sinB	0.3	0.3	0.4	0.4			
4	cosB	cosB	0.9	0.9	0.9	0.9			
5	Critical interface		textured LLDPE membrane to GCL	GCD to smooth GMB	textured LLDPE membrane to GCL	textured LLDPE membrane to GCL			
6	Friction angle (resistance)	φ	17.0	8.0	17.0	8.0		degrees	Critical interface angle
7	tan(phi)	tan φ	0.306	0.141	0.306	0.141			
8	Factor of safety	FS	1.5	1.5	1.25	1.3			Assumed
Tensile force in liner									
Self weight of geosynthetic layers									
	Geomembrane								
	Resin density		0.93	0.13	0.93	0.13		g/cm3	From technical specification
	Thickness		2.0	12.0	2.0	12.0		mm	From technical specification
	Mass per area	γ_{geo}	1852	1560	1852	1560		g/m2	
	Geosynthetic mass per area	γ_{total}	1852	1560	1852	1560		g/m2	
	Subtotal tensile force in liner	$F_{L,v}$	**0.86**	**0.73**	**0.73**	**0.62**		kN/m	vertical
Weight of vehicle on liner									
12	Tensile force on liner (vertical)		15.5	5.8	18.2	6.8		kN/m	Assume 80t machine backing onto 8m wide roll with 2 wheels
13	Force of equipment breaking (vertical)		4.7	1.7	5.5	2.0		kN/m	
14	**Subtotal tensile force in liner**	$F_{v,v}$	20.16	7.56	23.68	8.88		kN/m	vertical

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0	
Project:	Mt Piper Ash Repository	**Calcs by:**	H Liew	**Date:**	29/09/2023	
Subject:	Anchor trench calculations	**Checked by:**	R Huynh	**Date:**	14/11/2023	

Statement of design procedure

This spreadsheet provides design calculations for the anchor trench

References

Qian et al (2002) pg 106-113

Design cases / assumptions

1	Sidewall liner anchor trench for LLDPE geomembrane 1 in 3 batter
2	Sidewall liner anchor trench for geonet drainage geocomposite 1 in 3 batter
3	Sidewall liner anchor trench for LLDPE geomembrane 1 in 2.5 batter
4	
5	

Item	Description	Symbol	Case					Unit	Notes
			1	2	3	4	5		
15	**TOTAL Tensile force in liner (vertical)**	$F_{tot,v}$	**21.03**	**8.29**	**24.42**	**9.50**		kN/m	
16	**TOTAL Tensile force in liner (along slope)**	$F_{tot,s}$	**0.55**	**1.52**	**2.14**	**2.29**		kN/m	
17	**TOTAL Tensile force in liner (along slope with FoS)**	$F_{tot,s}$	**0.83**	**2.27**	**2.67**	**2.97**		kN/m	
Anchor Trench									
18	Geosynthetic allowable strength	σ_{allow}	21.0	13.0	21.0	21.0		kN/m	GM17 Table2(b) for LLDPE gmb
19	Side slope angle	β	18.43	18.43	21.80	21.80		degrees	From design
20	Unit weight of cover and backfill soil	γs	15	15	15	15		kN/m	Assumed WCA
21	Friction angle of soil in anchor trench	Φs	22	22	22	22		degrees	Golder's report
22	Friction angle of geosynthetic and upper material (soil or geosynthetic)	δf	8.0	17.0	8.0	22.0		degrees	Case 1 & 3: smooth GMB - GDC Case 2 & 4: GDC to gtx
23	Friction angle of geosynthetic and lower material (soil or geosynthetic)	δc	17.0	8.0	17.0	8.0		degrees	Case 1 & 3: textured GMB - GCL Case 2 & 4: GDC to smooth GMB
24	Depth of cover soil over runout length	dcs	0	0	0	0		metres	From design, WCA
25	Runout length	Lro	0.5	0.5	0.5	0.5		metres	From design
26	Width of anchor trench	Lat	0.5	0.5	0.5	0.5		metres	From design
27	Depth of anchor trench	dat	0.5	0.5	0.5	0.5		metres	From design
28	Number of vertical sides contributing		1	1	1	1		sides	(1 or 2)
Calculations									
29	Applied normal stress runout	qB	0.0	0.0	0.0	0.0		kPa	
30	Coefficient of at rest earth pressure	Ko	0.6	0.6	0.6	0.6			
31	Average stress anchor trench	σ vave	3.8	3.8	3.8	3.8		kPa	
32	Applied normal stress anchor trench	σ vB	7.5	7.5	7.5	7.5		kPa	
33	Runout / anchor resistance capacity		2.6	2.4	2.7	3.1		kN/m	equ. 4.28, Qian et al (2002)
34	**Adequate design for pull out before material failure:**		**YES**	**YES**	**YES**	**YES**			

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0
Project:	Mt Piper Ash Repository	**Calcs by:**	HL	**Date:**	14/11/2023
Subject:	Pipe loading calculations	**Checked by:**	RH	**Date:**	14/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1	PE100 SDR9 DN315 Leachate collection - Construction loading
2	PE100 SDR9 DN160 Leachate Collection - Construction loading
3	PE100 SDR9 DN315 Leachate Collection - Operational loading
4	PE100 SDR9 DN160 Leachate Collection - Operational loading
5	

Item	Description	Symbol	1	2	3	4	Unit	Notes
1	**Ring-bending stiffness**							
1.1	DN		315	160	315	160	mm	
1.2	External diameter	D_e	0.3150	0.1600	0.3150	0.1600	m	
1.3	Wall thickness	t	0.0352	0.0179	0.0352	0.0179	m	Poliplex design book p 6-3
1.4	Initial (3-minute) ring bending modulus of elasticity	E_b	880	880	880	880	MPa	Poliplex design book p 7-46 and 3-13 (corrected for 26°C)
1.5	Long-term ring-bending modulus of elasticity	E_{bL}	178	178	178	178	MPa	Poliplex design book p 7-46 and 3-13 (corrected for 40°C)
1.6	Diameter of neutral axis	D	0.2798	0.1421	0.2798	0.1421	m	
1.7	Moment of inertia for ring bending	I_{xx}	3.6345E-06	4.7794E-07	3.6345E-06	4.7794E-07	m^4/m	Equation 2.2.1.2
1.8	Initial (3-minute) ring-bending stiffness	S_{DI}	146011	146581	146011	146581	N/m/m	Equation 2.2.1.1(1)
1.9	Long-term ring-bending stiffness	S_{DL}	29534	29649	29534	29649	N/m/m	Equation 2.2.1.1(2)
2	**Soil moduli**							
2.1	Width of trench or embedment measured at the spring line	B	1.3	1.9	1.3	1.9	m	Measured (see figures)
2.2	Native soil modulus	E'_n	5	5	5	5	MPa	Given
2.3	Embedment soil modulus	E'_e	10	10	10	10	MPa	Given
2.4		Δ_f	1.22	1.81	1.22	1.81	-	Equation 3.4.3(3)
2.5	Leonhardt Correction Factor	ξ	0.87	1.35	0.87	1.35	-	Equation 3.4.3(2)
2.6	Effective combined soil modulus	E'	8.65	13.50	8.65	13.50	MPa	Equation 3.4.3(1)
3	**Design loads due to trench fill and embankment fill**							
3.1	Cover, vertical distance between top of the pipe and the finished surface	H	0.30	0.39	41.00	41.00	m	Estimated from fill plan - design contours (3), (4). (1), (2) given.
3.2	Assessed unit weight of trench fill or embankment fill	γ	11.3	11.3	11.3	11.3	kN/m^3	Assumed
3.3	Vertical design load (pressure at top of pipe) due to soil dead load	w_g	3	4	463	463	kPa	Equation 4.3

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0
Project:	Mt Piper Ash Repository	**Calcs by:**	HL	**Date:**	14/11/2023
Subject:	Pipe loading calculations	**Checked by:**	RH	**Date:**	14/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1	PE100 SDR9 DN315 Leachate collection - Construction loading
2	PE100 SDR9 DN160 Leachate Collection - Construction loading
3	PE100 SDR9 DN315 Leachate Collection - Operational loading
4	PE100 SDR9 DN160 Leachate Collection - Operational loading
5	

Item	Description	Symbol	1	2	3	4	Unit	Notes
4	**Deflection**							
4.1	Bedding constant	K	0.1	0.1	0.1	0.1	-	Assumed value
4.2	Vertical design load due to surface-applied dead load	w_{gs}	0	0	0	0	kPa	Estimation
4.3	Wheel load (ΣP is the sum of the individual wheel loads)	P	510	510	510	510	kN	Largest likely plant
4.4	Length of wheel or track load contact area	a	0.4	0.4	0.4	0.4	m	Assumed
4.5	Width of wheel or track load contact area	b	4.4	4.4	4.4	4.4	m	Assumed
4.6	Allowable long-term vertical pipe deflection for non-pressure	Δ_{yall}/D	0.075	0.075	0.075	0.075	%	Poliplex design book p 7-52
4.7	Length of the base of the live load distribution, resulting from wheel or track loads, measured perpendicular to the direction of travel at the top of the pipe	L_1	4.84	4.97	63.85	63.85	m	Figure 4.2
4.8	Length of the base of the live load distribution, resulting from wheel or track loads, measured parallel to the direction of travel of the vehicle at the top of the pipe	L_2	0.84	0.97	59.85	59.85	m	Figure 4.2
4.9	Live load impact factor	α	1.355	1.3415	1.1	1.1	-	Equation 4.7.2(2)
4.10	Vertical design load due to surface-applied live load	w_q	171.2	142.7	0.1	0.1	kPa	Equation 4.7.2(1)
4.11	Predicted long-term vertical deflection	Δ_y/D	2.3%	1.4%	6.1%	4.4%	%	Equation 5.2(2)
4.12	**Is $\Delta_y/D \leq \Delta_{yall}/D$?**		YES	YES	YES	YES		
5	**External loadings**							
5.1	Allowable long-term ring-bending strain	ε_{ball}	4.0%	4.0%	4.0%	4.0%	%	Poliplex design book p 7-52
5.2	Effective wall thickness	t_{es}	0.0352	0.0179	0.0352	0.0179	m	Poliplex design book p 6-3
5.3	Shape factor	D_f	3.23	3.35	3.23	3.35	-	Equation 5.3.1(3)
5.4	Predicted long-term ring-bending strain	ε_b	0.93%	0.59%	2.47%	1.84%	%	Equation 5.3.1(2)
5.5	**Is $\varepsilon_b \leq \varepsilon_{ball}$?**		YES	YES	YES	YES		

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0
Project:	Mt Piper Ash Repository	**Calcs by:**	HL	**Date:**	14/11/2023
Subject:	Pipe loading calculations	**Checked by:**	RH	**Date:**	14/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1	PE100 SDR9 DN315 Leachate collection - Construction loading
2	PE100 SDR9 DN160 Leachate Collection - Construction loading
3	PE100 SDR9 DN315 Leachate Collection - Operational loading
4	PE100 SDR9 DN160 Leachate Collection - Operational loading
5	

Item	Description	Symbol	1	2	3	4	Unit	Notes
6	**Internal pressure**							
6.1	Internal working pressure	P_w	0.01	0.01	0.01	0.01	MPa	Given
6.2	Allowable long-term internal pressure	P_{all}	1.6	1.6	1.6	1.6	MPa	Poliplex design book p 3-9 using SDR=13.6 and safety factor of 1.25
6.3	**Is $P_w \leq P_{all}$?**		YES	YES	YES	YES		
7	**Combined loading**							
7.1	Factor of safety for long-term combined external load and internal pressure (combined loading)	η	1.5	1.5	1.5	1.5	-	Poliplex design book p 7-54
7.2	Factor of safety for long-term internal pressure	η_p	1.25	1.25	1.25	1.25	-	Poliplex design book p 3-4 (lower typical value)
7.3	Factor of safety for long-term ring-bending strain	η_b	2.5	2.5	2.5	2.5	-	Poliplex design book p 7-57
7.4	Re-rounding coefficient	r_c	0.997	0.997	0.997	0.997	-	Section 5.3.3
7.5	$P_w/\eta_p P_{all} + r_c\varepsilon_b/\eta_b\varepsilon_{ball}$		0.0975	0.0633	0.2507	0.1888	-	Equation 5.3.3
7.6	$1/\eta$		0.667	0.667	0.667	0.667	-	Equation 5.3.3
7.7	**Is $P_w/\eta_p P_{all} + r_c\varepsilon_b/\eta_b\varepsilon_{ball} \leq 1/\eta$?**		YES	YES	YES	YES		
8	**Buckling**							
8.1	Height of water surface above the top of the pipe	H_w	0.3	0.3	0.3	0.3	m	Given
8.2	Assessed unit weight of liquid external to the pipe	γ_L	10	10	10	10	kN/m^3	Assumed
8.3	Internal vacuum	q_v	0	0	0	0	kPa	Assumed
8.4	Design factor for buckling	F_s	2.5	2.5	2.5	2.5	-	Poliplex design book p 7-57
8.5	Poisson's ratio	v	0.4	0.4	0.4	0.4	-	Poliplex design book p 3-24
8.6	Specific gravity of soil particle	ρ_s	2.65	2.65	2.65	2.65	kN/m^3	Assumed (from p 25 of standard)

Client:	EnergyAustralia	**Job Number:**	12610307	**Revision:**	0
Project:	Mt Piper Ash Repository	**Calcs by:**	HL	**Date:**	14/11/2023
Subject:	Pipe loading calculations	**Checked by:**	RH	**Date:**	14/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1	PE100 SDR9 DN315 Leachate collection - Construction loading
2	PE100 SDR9 DN160 Leachate Collection - Construction loading
3	PE100 SDR9 DN315 Leachate Collection - Operational loading
4	PE100 SDR9 DN160 Leachate Collection - Operational loading
5	

Item	Description	Symbol	1	2	3	4	Unit	Notes
8.7	Allowable buckling pressure, based on pipe alone	q_{all1}	338	339	338	339	kPa	Equation 5.4(4)
8.8	Allowable buckling pressure, based on pipe/embedment interaction	q_{all2}	521	702	521	702	kPa	Equation 5.4(5)
8.9	Allowable buckling pressure for material	q_{all}	521	702	521	702	kPa	Max of q_{all1} and q_{all2}
8.10	Submerged unit weight of trench fill or embankment fill	γ_{sub}	7.04	7.04	7.04	7.04	kN/m^3	Equation 5.4(2)
8.11	$\gamma(H-H_w)+(\gamma_L+\gamma_{sub})(D_e/2+H_w)+w_{gs}+w_q+q_v$		179.0	150.2	467.9	466.5	kPa	Equation 5.4(1)
8.12	**Is $\gamma(H-H_w)+(\gamma_L+\gamma_{sub})(D_e/2+H_w)+w_{gs}+w_q+q_v \le q_{all}$?**		**YES**	**YES**	**YES**	**YES**		

Client:	EnergyAustralia	**Job Number:**	12610307		
Project:	Energy Australia - Hydra Stream 3 - Ash Repository Design Services	**Calcs by:**	H Liew	**Date:**	13/11/2023
Subject:	Gecomposite design	**Checked by:**	R Huynh	**Date:**	13/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the groundwater drainage system design

References

GSE drainage design manual, Bachus et al, June 2004

Design cases / assumptions

1 Leachate drainage system on base, secondary pipe 25m intervals

2 Leachate drainage layer on sidewall liner

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
			Floor	Batter				
1	Side slope	x	100	3			1 in x	Refer 12610307-C003 / C006
2	Side slope	β_s	0.010	0.346			rad	Use reduce slope for differential settlements
3	Vertical height of the slope	H_s	0.25	15			m	Refer 12610307-C003 / C006
4	Drainage length (sidewall)	L_{ds}	25.00	47.43			m	
5	Hydraulic gradient (side)	i_s	0.010	0.333			m/m	
6	Depth of fill	h	20.00	20.00			m	Approved final landform
7	Unit weight of fill	γ	15.00	15.00			kN/m3	Golder (2021) - Cell 1 design report
8	Infiltration	k	2.50E-07	2.50E-07			m/s	Assumed unit gradient and typical permeability of strata
9	Reduction factor - chemical clogging	RF_{cc}	1.5	1.5				Qian et al (2002) Table 8.8
10	Reduction factor - intrusion	RF_i	1.5	1.5				Qian et al (2002) Table 8.9
11	Reduction factor - biological clogging	RF_{bc}	1.5	1.5				Qian et al (2002) Table 8.10
12	Reduction factor - creep	RF_{cr}	1.4	1.4				Qian et al (2002) Table 8.11
13	Factor of safety (FOS) drainage	FS_d	2	2				Assumed
14	Factor of safety (FOS) applied stress	FS_s	2.5	2.5				Assumed
15	Transmissivity design value	θ_{req}	6.25E-04	3.49E-05			m2/s	
16	Specified transmissivity	θ_{allow}	**5.91E-03**	**3.30E-04**			m2/s	
17	Minimum applied normal stress for laboratory test conditions	σ_{test}	**300**	**300**			kN/m2	
18	Minimum average roll value normal stress determined by ASTM 1621	σ_{allow}	**750**	**750**				
19	Minimum gradient for laboratory test conditions	i_{test}	**0.010**	**0.333**			m/m	

Client:	Energy Australia	**Job Number:**	12610307		
Project:	Hydra Stream 3 - Ash Repository Design Services	**Calcs by:**	H Liew	**Date:**	15/11/2023
Subject:	Geogrid design	**Checked by:**	A Roberts	**Date:**	15/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the design of the geosynthetic reinforcement to provide the required design tensile load due to void induced differential settlement.

References

Richardson, C.P., 2009, "Municipal Landfill Design Calculations: An entry Level Manual of Pratice", Richardson Environmental Solutions & Design, LLC, pp. 196-205.

Design cases / assumptions

Ash overburden has minimum effective stress

1	Stage 2A liner system
2	Not used
3	Not used
4	Not used

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
1	Total Height of Material over Void	H	35.30				m	Page 198
2	Ash Fill Height	Hsw	35				m	Page 199
3	Radius of Differential Settlement Zone	r	0.925				m	Adjusted to achieve Tech Spec Tensile Load
4	Geomembrane Minimum Yield Strain	ε_y	8.00%					Assumed for LLDPE - adopted in Golder (2021)
5	Geogrid Rupture Strain	ε_r	5%					From Technical Specification
6	Soil Layer of Liner Thickness	H_l	0				m	From design
7	Soil Layer of Liner Friction Angle	ϕ_l	25				degrees	
8	Soil Layer of Liner Wet Unit Weight	γ_l	13				kN/m3	Page 199
9	Embedded Soil Thickness	H_b	0.3				m	Page 199
10	Embedded Soil Wet Unit Weight	γ_b	0.0				kN/m3	Page 199
11	Ash Above Liner Friction Angle	ϕ	22				degrees	Page 198, Golder (2021)
12	Ash Above Liner Wet Unit Weight	γ_{sw}	15				kN/m3	Page 199, Golder (2021)
13	Weighted Average Wet Unit Weight	γ_{ave}	14.19				kN/m3	Eq. 3, 4 & 5, Page 199
14	Cohesion	C	0				kN/m2	Page 198
15	Factor of Safety	FOS	1.5					Page 200
16	Active Earth Pressure Coefficient	Ka	0.45					Page 198
17	Lateral Earth Pressure Coefficient	K	0.66					Eq. 2, Page 198
18	Allowable Strain Geomembrane	ε_l	5.3%					
19	Allowable Strain Geogrid	ε_g	3%					
20	Governing Strain	ε	3.3%					
21	Dimensionless Function	Ω	1.10					Table 1, Page 200. Interpolation/extra
22	Vertical Stress	σ_v	24.50				kN/m2	Eq. 1, Page 197
23	Long Term Design Tensile Load	T_{req}	25.00				kN/m	Target to match Technical Specificatic
24								
25								

Client:	Energy Australia	**Job Number:**	12610307		
Project:	Hydra Stream 3 - Ash Repository Design Services	**Calcs by:**	H Liew	**Date:**	15/11/2023
Subject:	Geogrid design	**Checked by:**	A Roberts	**Date:**	15/11/2023

Statement of design procedure

This spreadsheet provides design calculations for the design of the geosynthetic reinforcement to provide the required design tensile load due to void induced differential settlement.

References

Richardson, C.P., 2009, “Municipal Landfill Design Calculations: An entry Level Manual of Pratice”, Richardson Environmental Solutions & Design, LLC, pp. 196-205.

Design cases / assumptions

Ash overburden has minimum effective stress

1	Stage 2A liner system
2	Not used
3	Not used
4	Not used

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
26								
27								

Appendix D

Technical specification

Hydra Stream 3 Project – LNAR Stage 2B

Technical Specification

EnergyAustralia Pty Ltd

19 July 2024

→ The Power of Commitment



Project name		Hydra Stream 3 - Ash Repository Design Services					
Document title		Hydra Stream 3 Project – LNAR Stage 2B | Technical Specification					
Project number		12610307					
File name		12610307-Mt Piper Ash Repository - Technical Specification Stage 2B.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	S. Kerle R. Huynh	C. Nivison-Smith		A. Roberts		19/7/24

GHD Pty Ltd | ABN 39 008 488 373
Contact: Adrian Roberts, Team Leader, Design Element - Waste Management | GHD
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmail@ghd.com | **ghd.com**

© GHD 2024
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

→ The Power of Commitment

Contents

1. Introduction 6

1.1 General 6
1.2 Definitions 6
1.3 Drawing list 7
1.4 Lines of communication 8
1.5 Construction sequencing and scheduling 8
1.6 Submittals 8
1.6.1 Pre-qualification of the Geosynthetic Installer 8
1.6.2 Pre-qualification of the Contractor's Independent Testing Firm 9
1.6.3 Construction quality control plan 9
1.7 Construction quality control testing 9
1.8 Construction quality assurance 10
1.9 Work method statements 10
1.10 Construction survey requirements 10
1.11 Witness and hold points 11
1.12 Variations to the design 13
1.13 Works as Executed Drawings 13
1.14 Standards 13
1.14.1 Australian Standards 13
1.14.2 American Society for Testing and Materials Standards 14
1.14.3 Geosynthetic Research Institute Standards 16
1.14.4 Water Services Association of Australia Standards 16

2. Earthworks 17

2.1 General 17
2.2 Submittals 17
2.2.1 Prior to placement of fill material 17
2.2.2 Following completion of earthworks 17
2.3 Equipment 17
2.4 Quantities 17
2.5 Extent of disturbed areas 17
2.6 Lines and levels 18
2.7 Excavation 18
2.8 Filling 18
2.8.1 General filling 18
2.8.2 Water conditioned ash filling 19
2.9 Inspection 19
2.10 Compaction 19
2.11 Proof rolling 19
2.12 Tolerances 19
2.13 Anchoring of geosynthetics 20
2.14 Defects and repairs 21
2.15 Acceptance 21

3. PE geomembrane 22
3.1 General 22
3.2 Submittals 22
3.2.1 Prior to installation of polyethylene geomembrane 22
3.2.2 Following installation of polyethylene geomembrane 22
3.3 Preparation of receiving surface 23
3.4 Installation 23
3.4.1 General 23
3.4.2 Weather conditions 23
3.4.3 Traffic 23
3.4.4 Placement 23
3.4.5 Seaming 24
3.5 Pipe boots 26
3.6 Trial seams 26
3.7 Field seam sampling and testing 27
3.7.1 General 27
3.7.2 Destructive seam testing 27
3.7.3 Non-destructive seam testing 28
3.7.4 Non-conforming test results 28
3.7.5 Field testing summary 28
3.8 Electrical leak location survey 29
3.8.1 General 29
3.8.2 Preparation and support 29
3.8.3 Execution 29
3.8.4 Reporting 29
3.8.5 Repairs 29
3.9 Defects and repairs 30
3.10 Acceptance 30
4. Geosynthetic clay liner 32
4.1 General 32
4.2 Submittals 32
4.2.1 Prior to installation of GCL 32
4.2.2 Following installation of GCL 32
4.3 Preparation of receiving surface 32
4.4 Installation 33
4.4.1 General 33
4.4.2 Weather conditions 33
4.4.3 Traffic 33
4.4.4 Placement 33
4.4.5 Seaming 34
4.5 Protection and covering 34
4.6 Pipe penetrations 35
4.7 Defects and repairs 35
4.8 Acceptance 35
5. Geonet drainage geocomposite 36
5.1 General 36
5.2 Submittals 36
5.2.1 Prior to installation of geonet drainage geocomposite 36

5.2.2 Following installation of geonet drainage geocomposite 36
5.3 Preparation of surface to receive geonet drainage geocomposite 36
5.4 Installation 37
5.5 Defects and repairs 38
5.6 Acceptance 38
6. Geotextile 39
6.1 General 39
6.2 Submittals 39
6.2.1 Prior to installation of geotextile 39
6.2.2 Following installation of geotextile 39
6.3 Preparation of receiving surface 39
6.4 Installation 40
6.4.1 General 40
6.4.2 Weather conditions 40
6.4.3 Traffic 40
6.4.4 Placement 40
6.4.5 Seaming 41
6.5 Defects and repairs 42
6.6 Acceptance 42
7. Ash excavation and placement 43
7.1 General 43
7.2 Submittals 43
7.3 Excavation 43
7.4 Placement 43
7.4.1 General 43
7.4.2 Protection of lining system 43
7.4.3 Compaction and lift thickness 44
7.4.4 Initial lift requirements 44
7.4.5 Setback from key-in locations 44
7.4.6 Leachate collection system 44
7.5 Access ramp 44
8. PE pipework 45
8.1 General 45
8.2 Submittals 45
8.2.1 Prior to installation of PE pipework 45
8.2.2 Following installation of PE pipework 45
8.3 Installation 45
8.3.1 General 45
8.4 Defects and repairs 46
8.5 Acceptance 46
9. Drainage aggregate 47
9.1 General 47
9.2 Submittals 47
9.2.1 Prior to placement of drainage aggregate 47
9.2.2 Following placement of drainage aggregate 47
9.3 Preparation of receiving surface 47
9.4 Installation 48

9.5 Construction quality control testing 48
9.6 Tolerances 48
9.7 Defects and repairs 49
9.8 Acceptance 49
10. Furnace bottom ash 50
10.1 General 50
10.2 Submittals 50
10.2.1 Prior to placement of furnace bottom ash 50
10.2.2 Following placement of furnace bottom ash 50
10.3 Preparation of receiving surface 50
10.4 Installation 50
10.5 Compaction 51
10.6 Construction quality control testing 51
10.7 Tolerances 51
10.8 Defects and repairs 52
10.9 Acceptance 52
11. Field trial 53
11.1 General 53
11.2 Submittals 53
11.2.1 Prior to conducting the field trial 53
11.2.2 Following completion of the field trial 53
11.3 Method 53
11.3.1 Proposed placement method 53
11.3.2 Field trial of placement method 54
11.3.3 Exhumation and inspection of the underlying geosynthetics 54
11.3.4 Reporting and update of the proposed placement method 54

Table index

Table 1 Definitions 6
Table 2 Drawing list 7
Table 3 Survey requirements 11
Table 4 Witness and hold points 11
Table 5 Tolerances 20
Table 6 Remedial actions for compacted fill 21
Table 7 Destructive seam testing requirements 27
Table 8 Non-destructive seam testing requirements 28
Table 9 Air pressure test schedule 28
Table 10 Construction quality control testing – drainage aggregate 48
Table 11 Construction quality control testing – furnace bottom ash 51

Figure index

Figure 1 Lines of communication 8

Appendices

Appendix A Work method statements
Appendix B Material Specification

1. Introduction

1.1 General

This Technical Specification contains the technical requirements for the procedures for the construction of the Stage 2B Cell (the Works) at the Mount Piper Power Station (MPPS) (the site) and must be read in conjunction with the other Contract Documents.

A separate Material Specification has been developed to allow early procurement of long lead time materials and is included as an appendix to this document (refer Appendix B), and shall be read in conjunction with this Technical Specification. If materials proposed for use in the Works are damaged while under the Contractor's care, the Contractor is responsible for replacing the materials at no expense to the Principal.

Where this Technical Specification and any other Contract Documents do not agree, the Contractor shall seek clarification from the Superintendent.

1.2 Definitions

The Definitions described in the Contract Documents apply to this document. The following additional terms used in this Technical Specification shall have the meanings ascribed to them below unless the context otherwise requires:

Table 1 Definitions

Term	Definition
Contract	The agreement between the Principal and Contractor
Contract Drawings	The construction drawings which form part of the Contract Documents
Contract Documents	The documents which form the Contract
Contractor	The person bound to execute the work under the Contract
Contractor's Independent Testing Firm	Independent testing firm(s) engaged by the Contractor to conduct construction quality control (CQC) testing
Construction Quality Assurance (CQA) Engineer	Suitably qualified professional responsible for administering the CQA requirements for the Works
Construction Quality Assurance (CQA) Engineer's Independent Testing Firm	Independent testing firm(s) engaged by the CQA Engineer to conduct CQA testing
Construction Quality Assurance (CQA) Plan	Plan forming part of the Contract Documents, describing the construction quality assurance requirements for the Works
Designer	GHD Pty Ltd (Contact: David Gamble)
Excavated Natural Material (ENM)	As defined in the NSW EPA excavated natural material exemption 2014 (**http://www.epa.nsw.gov.au/resources/waste/rre14-excavated-natural-material.pdf**)
Field Crew Foreman	Foreman for the Geosynthetic Installer's field crew, as defined by the Contractor
Geosynthetic	Synthetic material (man-made plastic and fabric) used in geotechnical and construction applications
Geosynthetic Installer	Firm subcontracted by the Contractor to complete the installation of geosynthetic for the Works
Leak Location Contractor	Independent testing firm engaged by the Contractor to conduct leak location surveys throughout the Works
Material Specification	Document which contains the technical requirements for materials to be implemented for the construction for the Works, which form part of the Contract Documents

Term	Definition
Minimum Average Roll Value (MARV)	Calculated as per GRI White Paper #10 The Dual Roles for Using MARV (**http://www.geosynthetic-institute.org/papers/paper10.pdf**)
Maximum Average Roll Value (MaxARV)	Calculated as per GRI White Paper #10 The Dual Roles for Using MARV (**http://www.geosynthetic-institute.org/papers/paper10.pdf**)
Principal	As defined in the Conditions of Contract
Regulatory Authority	Authority responsible for licencing the Works
Seaming Crew	Crew responsible for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor
Seaming Foreman	Foreman for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor
Superintendent	As defined in the Conditions of Contract
Technical Specification	This document
Virgin Excavated Natural Material (VENM)	Virgin excavated natural material. As defined in Schedule 1 of the *Protection of the Environment Operations Act 1997*
Work under the Contract	The work which the Contractor is or may be required to execute under the Contract and includes variations, remedial work, constructional plant and temporary works
Works	The whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract, which by the Contract is to be handed over to the Principal
Works Area	As shown on the Contract Drawings

1.3 Drawing list

This Technical Specification shall be considered in conjunction with the Contract Drawings described in Table 2.

Table 2 Drawing list

Drawing no.	Drawing title	Revision
12610307-G101	COVER SHEET, LOCALITY PLAN AND DRAWING LIST	0
12610307-G102	EXISTING SITE PLAN	0
12610307-C101	STAGE 2B SOUTH EARLY WORKS	0
12610307-C102	STAGE 2B SOUTH LINING SYSTEM	0
12610307-C103	STAGE 2B SOUTH LEACHATE COLLECTION SYSTEM	0
12610307-C104	STAGE 2B NORTH EARLY WORKS	0
12610307-C105	STAGE 2B NORTH LINING SYSTEM	0
12610307-C106	STAGE 2B NORTH LEACHATE COLLECTION SYSTEM	0
12610307-C107	CUT AND FILL PLAN	0
12610307-C109	LONG SECTION	0
12610307-C110	CROSS SECTIONS	0
12610307-C111	TYPICAL SECTIONS AND DETAILS - SHEET 1 OF 6	0
12610307-C112	TYPICAL SECTIONS AND DETAILS - SHEET 2 OF 6	0
12610307-C113	TYPICAL SECTIONS AND DETAILS - SHEET 3 OF 6	0
12610307-C114	TYPICAL SECTIONS AND DETAILS - SHEET 4 OF 6	0
12610307-C115	TYPICAL SECTIONS AND DETAILS - SHEET 5 OF 6	0
12610307-C116	TYPICAL SECTIONS AND DETAILS - SHEET 6 OF 6	0

Drawing no.	Drawing title	Revision
12610307-C117	PUMPING ARRANGEMENT PLAN	0

1.4 Lines of communication

The lines of communication for the Works are illustrated in Figure 1. The Superintendent shall be the main point of liaison between the Contractor and the CQA Engineer, as well as the Contractor and the Principal.

All design requests for information or clarifications should be submitted to the Designer by the Superintendent or the Principal for assessment.

Where a party/organisation is provided multiple roles within this structure, separate team resourcing shall be utilised and any communication from that party/organisation shall clearly identify which role is being implemented in providing such communication.

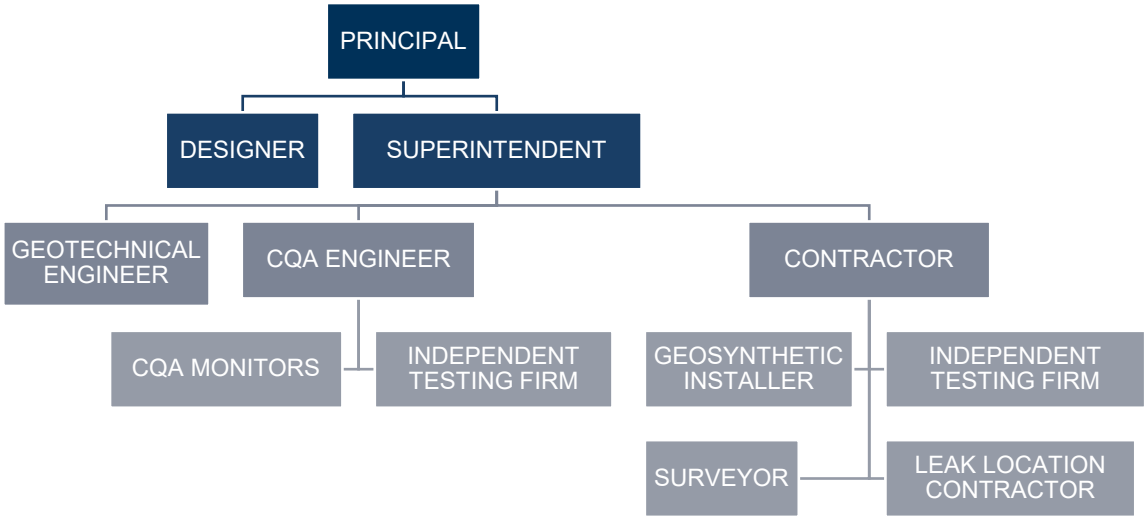


Figure 1 Lines of communication

1.5 Construction sequencing and scheduling

The Contractor shall be responsible for sequencing the installation of all materials during construction, including surveys, testing and field trials.

In general, construction installation sequencing shall proceed from higher elevations to lower elevations to prevent precipitation runoff from flowing into and/or below installed products.

Individual components shall not be covered with the subsequent component until the underlying component has been accepted by the Superintendent in accordance with this Technical Specification.

1.6 Submittals

The following pre-qualification submittals are required to be submitted by the Contractor at least 10 working days prior to construction for approval by the Superintendent.

1.6.1 Pre-qualification of the Geosynthetic Installer

Prior to construction, the Contractor shall provide a list documenting completed facilities for which the Geosynthetic Installer has completed the installation of a geosynthetic lining system similar to this Technical Specification. For each facility, the following information shall be provided:

– The name and purpose of the facility, its location, and the date of installation
– The name of the owner, project manager, designer, manufacturer, and fabricator (if any)
– If requested, the name and telephone number of a reference contact at the facility who can discuss the project
– The name and qualifications of the supervisor(s) of the installer's crew(s)
– The type(s) of seaming, patching, and tacking equipment
– Any available information on the performance of the geosynthetic lining system at the facility.

The Contractor shall also provide:

– Certification indicating an approval or licence from the proposed geosynthetic manufacturers for the Contractor to install the manufacturer's materials
– Certification that the Geosynthetic Installer's Field Crew Foreman has a minimum of 200 hectares of actual geosynthetic installation experience and a minimum of 100 hectares of supervisory experience for geosynthetic installation on a minimum of 10 different projects
– Certification that the Geosynthetic Installer's Seaming Foreman is an International Association of Geosynthetic Installer's Certified Welding Technician and has a minimum of 100 hectares of actual geosynthetic seaming experience and a minimum of 50 hectares of supervisory experience during the seaming of geosynthetic materials
– Certification that each individual on the Geosynthetic Installer's Seaming Crew has a minimum of 10 hectares of geosynthetic seaming experience and a minimum of 5 hectares of seaming experience with geosynthetics similar to this Technical Specification.

1.6.2 Pre-qualification of the Contractor's Independent Testing Firm

Prior to construction, the Contractor shall provide a listing of qualifications for the proposed Contractor's Independent Testing Firm(s) and its key personnel who shall perform the work described in this Technical Specification. The Contractor's Independent Testing Firm(s) shall be National Association Testing Authorities (NATA) accredited and proof of accreditation shall be maintained throughout the duration of the Works.

A listing of testing apparatus and testing standards typically performed by the testing firm shall be provided along with a letter stating that the testing firm is independent and has no financial interest in the Contractor, the Geosynthetic Installer or any of the manufacturers/suppliers that are providing materials for the Works.

1.6.3 Construction quality control plan

The Contractor shall prepare and implement a CQC Plan for the Works, and the plan shall address all quality considerations identified or outlined in this Technical Specification. The CQC plan shall incorporate, as necessary, field testing, and field verification, to demonstrate that all Works comply with this Technical Specification. The CQC plan shall also demonstrate how construction will occur and the methods by which the materials will be placed and tested to ensure compliance with this Technical Specification.

Works shall not commence until the CQC plan has been approved by the Superintendent.

The Principal may, at its discretion, audit the Contractor's implementation of the CQC plan. The Contractor shall co-operate with all such auditing.

1.7 Construction quality control testing

All construction quality control (CQC) testing shall be arranged by the Contractor and shall be carried out by the Contractor's Independent Testing Firm(s). The cost of CQC testing shall be borne by the Contractor. Unless noted otherwise, copies of all test results shall be sent to the Superintendent as soon as available but in any event within two days of becoming available and prior to the layer/material being covered. The minimum testing frequencies shall be as nominated within this Technical Specification.

At any stage throughout the Works, the Superintendent may arrange for independent testing and/or surveying to be carried out. If that testing reveals that any works are found to be noncompliant with the requirements of this Technical Specification and/or the Contract Drawings, the Contractor shall undertake rectification of the noncompliant items and conduct re-testing in accordance with this Technical Specification. All costs of undertaking such rectification work and re-testing shall be borne by the Contractor.

1.8 Construction quality assurance

A Construction Quality Assurance (CQA) Plan has been developed in conjunction with this Technical Specification and shall be implemented by the Principal to verify that the Works are undertaken in a manner that meets the requirements of the Contract Documents.

The Principal shall engage an independent organisation (the CQA Engineer), under contract to the Principal, who shall facilitate the requirements of the CQA Plan. This shall include independent CQA monitoring, observation, testing and documentation on behalf of the Principal.

The Contractor shall cooperate fully with the Superintendent and all representatives of the CQA Engineer during any independent CQA sampling, testing, and certification and shall ensure safe access to the Works for the purpose of monitoring, observation, and CQA implementation.

1.9 Work method statements

Prior to the commencement of each type of work, the Contractor shall submit to the Superintendent work method statements that detail how the work is to be carried out and the plant and equipment proposed.

The Contractor shall submit such work method statements to the Superintendent at least 5 working days prior to undertaking any work addressed by the work method statement.

The Superintendent may reject the submitted work method statement if, in the opinion of the Superintendent, the statement does not comply with the Technical Specification or any other Contract Documents provided to the Contractor prior to or during construction.

Where a work method statement is rejected, the Contractor shall revise and resubmit the statement. No work addressed by the work method statement shall be undertaken by the Contractor until the work method statement is approved by the Superintendent.

Acceptance by the Superintendent of a proposed work method statement in no way reduces the Contractor’s liability to achieve the requirements described in this Technical Specification.

Appendix A contains a schedule of activities for which the Contractor shall produce work method statements.

1.10 Construction survey requirements

Prior to commencing construction, the Contractor shall establish a survey grid over the Works footprint. The survey grid shall be a maximum 10 m spacing over the Works footprint, as well as any locations at which there is a change or break in grade and set out points identified on the Contract Drawings. The elevation of excavated surfaces and placed materials shall be recorded at these grid locations.

Survey data shall be provided to the Superintendent in graphical and tabular formats. All survey shall be to MGA and levels shall be based on Australian Height Datum (AHD).

Table 3 contains a schedule of survey requirements for the Works.

Table 3 Survey requirements

Component	Survey requirements
Bulk earthworks	Following completion of bulk earthworks, survey the elevation of the completed layer at all grid locations and at any changes in grade.
Liner extent	Following placement of the geosynthetic materials, survey the extent of the completed layer along the boundary and the alignment of the anchor trench.
Drainage aggregate layer	Following placement of the layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Furnace bottom ash layer	Following placement of the layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
PE pipework	Following placement of the PE pipework, survey the levels and alignments of the PE pipework along their full length and at any changes in grade.
Surface water drains	Following installation of the surface water drains, survey the levels and alignments of the surface water drains long their full length and at any changes in grade.

1.11 Witness and hold points

The following information applies to witness and hold points for the Works:

– A hold point is a defined position in the Works beyond which work shall not proceed without mandatory verification and acceptance by the Superintendent
– A witness point is a nominated position in the Works where the option of attendance may be exercised by the Superintendent, after notification of the requirement. The CQA Engineer shall be required to attend witness points.
– It shall be the Contractor's responsibility to ensure that all obligations are fulfilled in regards to the witness and hold points within the Contract
– The Contractor shall give the Superintendent a minimum 3 working days notice prior to the required inspection
– Where the witness or hold point relates to the condition of a surface or installed material, the Contractor shall verify that the completed surface has achieved full conformance with the Contract Documents
– Witness or hold points may be released for part of the Works Area only, as defined by the Superintendent, so that the Works can be completed in a sequenced manner. The Superintendent's approval of the completed items is required prior to the release of each witness or hold point.

Table 4 contains a list of activities to which witness and hold points apply.

Table 4 Witness and hold points

Item	Description	Witness	Hold
1	**Bulk earthworks**		
	Prior to placement of fill material, provision of submittals identified in Section 2.2.1		✓
	Steep slope inspection		✓
	Southern wall benching		✓
	Placement and testing	✓ (Part time CQA monitoring)	
	Proof rolling	✓ (Full time CQA monitoring)	
	Inspection of finished surface of each fill material		✓

Item	Description	Witness	Hold
	Following completion of earthworks, provision of submittals identified in 2.2.2		✓
2	**PE geomembrane**		
	Prior to installation of PE Geomembrane, provision of submittals identified in Section 3.2.1		✓
	Panel placement, seaming and field testing	✓ (Full time CQA monitoring)	
	Following installation of PE Geomembrane, provision of submittals identified in Section 3.2.2		✓
3	**Geosynthetic clay liner**		
	Prior to installation of GCL, provision of submittals identified in Section 4.2.1		✓
	Panel placement, seaming and field testing	✓ (Full time CQA monitoring)	
	Following installation of GCL, provision of submittals identified in Section 4.2.2		✓
4	**Geonet drainage geocomposite**		
	Prior to installation of geonet drainage geocomposite, provision of submittals identified in Section 5.2.1		✓
	Panel placement, seaming and field testing	✓ (Part time CQA monitoring)	
	Following installation of geonet drainage geocomposite, provision of submittals identified in Section 5.2.2		✓
5	**Geotextile**		
	Prior to installation of geotextile, provision of submittals identified in Section 6.2.1		✓
	Panel placement, seaming and field testing	✓ (Part time CQA monitoring)	
	Following installation of geotextile, provision of submittals identified in Section 6.2.2		✓
6	**PE pipework**		
	Prior to installation of PE pipe, provision of submittals identified in Section 8.2.1		✓
	Installation and jointing	✓ (Part time CQA monitoring)	
	Following installation of PE pipe, provision of submittals identified in Section 8.2.2		✓
7	**Drainage aggregate**		
	Prior to installation of drainage aggregate, provision of submittals identified in Section 9.2.1		✓
	Placement and testing	✓ (Part time CQA monitoring)	
	Following installation of drainage aggregate, provision of submittals identified in Section 9.2.2		✓
8	**Field trial**		
	Prior to field trial, provision of submittals identified in Section 11.2.1		✓
	Field trial	✓ (Full time CQA monitoring)	

Item	Description	Witness	Hold
	Following field trial, provision of submittals identified in Section 11.2.2		✓

1.12 Variations to the design

Any variations to the design documentation, specifically the Contract Drawings, Material Specification, Technical Specification and/or the CQA Plan require assessment and approval by the Designer.

1.13 Works as Executed Drawings

The Contractor shall provide one (1) set of Works as Executed Drawings, which shall include all corrections and as-constructed information done in a professional draftsman-like manner. All Works as Executed Drawings shall be certified by a Registered Surveyor.

The following Works as Executed Drawings shall be prepared as a minimum:

– Surface contours following bulk earthworks
– Surface contours of drainage aggregate layer
– Surface contours of furnace bottom ash layer
– Final alignments of PE pipework
– Final alignments of surface water drains
– Final extent of geosynthetic materials, including anchor trench alignment

All Works as Executed Drawings shall include test locations, showing as a minimum the approximate location, identification number, date sampled and type of testing completed.

1.14 Standards

1.14.1 Australian Standards

– 1141.11 Methods for Sampling and Testing Aggregates – Particle size distribution/dry sieve
– 1141.3.1 Methods for Sampling and Testing Aggregates – Sampling of aggregates and rock
– 1152 Specification for test sieves
– 1289 Methods of testing soils for engineering purposes
– 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
– 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
– 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
– 1289.3.6.2 Soil classification tests—Determination of the particle size distribution of a soil – Analysis by sieving in combination with hydrometer analysis (subsidiary method)
– 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
– 1289.3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil
– 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
– 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
– 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
– 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture

- 1289.6.7.1 Methods for Testing Soils for Engineering Purposes – Determination of the permeability of a soil
- 1289.6.7.2 Determination of the permeability of a soil - Falling head method for a remoulded specimen
- 1289.6.7.3 Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of permeability of a soil - Constant head method using a flexible wall permeameter
- 1463 Polyethylene Pipe Extrusion Compounds
- 1646 Elastomeric Seals for Water Works Purposes
- 1726 Geotechnical site investigations
- 2001.2.3 Methods of test for textiles - Physical tests - Determination of breaking force and extension of textile fabrics
- 2033 Installation of Polyethylene Pipe Systems
- 2698.2 Plastic Pipes and Fittings for Irrigation and Rural Applications Polyethylene Rural Pipes
- 2700 Colour Standards for General Purposes
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3704 Geosynthetics-Glossary of Terms
- 3705 Geotextiles-Identification, marking and general data
- 3706.1 Geotextiles - Methods of test - General requirements, sampling, conditioning, basic physical properties and statistical analysis
- 3706.2A Determination of tensile properties – Wide-strip method
- 3706.3 Determination of tearing strength - Trapezoidal method
- 3706.4 Determination of burst strength - California bearing ratio (CBR) - Plunger method
- 3706.4 Geotextiles - Methods of test - Determination of burst strength - California bearing ratio (CBR) - Plunger method
- 3706.7 Determination of pore-size distribution - Dry-sieving method
- 3706.9 Determination of permittivity, permeability and flow rate
- 3798 Guidelines on earthworks for commercial and residential developments
- 4129 Fittings for Polyethylene Pipes for Pressure Applications
- 4130 Polyethylene Pipes for Pressure Applications
- 4131 Polyethylene Compounds for Pressure Pipes and Fittings
- 4419 Soil for landscaping and garden use

1.14.2 American Society for Testing and Materials Standards

- D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- D1204 Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
- D123 Terminology Relating to Textiles
- D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1388 Test Methods for Stiffness of Fabrics
- D1505 Standard Test Method for Density of Plastics by the Density Gradient Technique
- D1603 Standard Test Method for Carbon Black in Olefin Plastics
- D3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Colorimetry
- D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- D4354 Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

- D4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- D4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water
- D4437 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4439 Standard Terminology for Geosynthetics
- D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4595 Tensile Properties of Geotextiles by the Wide Width Strip Method
- D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4716 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5262 Tension Creep Testing of Geosynthetics
- D5322 Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids
- D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
- D5514 Standard Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics
- D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
- D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- D5818 Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
- D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Colorimetry
- D5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners
- D5889 Standard Practice for Quality Control of Geosynthetic Clay Liners
- D5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembranes
- D6072 Standard Practice for Obtaining Samples of Geosynthetic Clay Liners
- D6102 Standard Guide for Installation of Geosynthetic Clay Liners
- D6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
- D6392 Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- D6395 Standard Practice for Non-destructive testing of Geomembrane Seams using Spark Test
- D6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
- D6693 Standard Test Method for Determining Tensile Properties of Non-Reinforced Polyethylene and Non-Reinforced Flexible Polypropylene Geomembranes
- D6767 Standard Test Method for Pore Size Characteristics of Geotextiles by Capillary Flow Test

- D6992 Test Method for Accelerated Tensile Creep and Creep Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- D7005 Determining The Bond Strength (Ply-Adhesion) of Composites
- D7179 Standard Test Method for Determining Geonet Bearing Force.
- D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
- D7466 Standard Test Method for Measuring Asperity Height of Textured Geomembranes
- D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- G22 Determining Resistance of Synthetic Polymer Materials to Bacteria

1.14.3 Geosynthetic Research Institute Standards

- GC8 Standard Guide for Determination of the Allowable Flow Rate of a Drainage Composite
- GCL3 Specification for Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners
- GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
- GM13 Standard Specification for Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM14 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
- GM17 Standard Specification for Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM19 Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
- GM20 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts
- GM29 Standard Practice for Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and/or Non-destructive Testing
- GM9 Standard Practice for Cold Weather Seaming of Geomembranes
- GN2 and GC13 Standard Guide for Jointing and Attaching Geonets and Drainage Composites.
- GT12(a) Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials
- GT13(a) Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

1.14.4 Water Services Association of Australia Standards

- WSA 02-2002 Sewerage Code of Australia
- WSA 03-2002 Water Supply Code of Australia.

2. Earthworks

2.1 General

This section contains the technical requirements for earthworks.

The Superintendent may reject any earthworks that do not meet or exceed the requirements of this section.

Any earthworks rejected by the Superintendent shall be remediated at the expense of the Contractor.

2.2 Submittals

2.2.1 Prior to placement of fill material

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of each type of fill material:

– Survey of the underlying surface in accordance with Section 1.10
– Work method statement(s) for the placement of the fill material, including testing and repair procedures (refer Appendix A).

2.2.2 Following completion of earthworks

The Contractor shall submit the following to the Superintendent for review and approval following completion of all earthworks (per layer and/or segment):

– As-built survey of the completed surface/s showing conforming layer thickness within the allowable tolerances
– CQC testing results/reports showing compliance with the requirements of this Technical Specification
– Defect and repairs log, showing details of all defects identified and any repairs completed.

2.3 Equipment

All earthworks shall be undertaken using conventional earthmoving equipment and methods typical to this type of project. Equipment shall be industry standard and operated in accordance with the equipment manufacturer's instructions.

Blasting is not permitted.

2.4 Quantities

The Contractor shall monitor all earthworks and shall be responsible for verifying the quantities of cut and fill available for constructing the Works.

Quantities of cut and fill provided in the Contract Documents are provided for bidding purposes only and do not account for shrinkage and swell or excess material.

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

2.5 Extent of disturbed areas

The Contractor shall confine machinery operations within the Works Area as shown on the Contract Drawings.

If directed by Superintendent, disturbed, compacted, or spoiled ground outside of the designated Works Area shall be cultivated and sown with an approved grass mix. The Contractor shall ensure that this operation is programmed to enable germination of seed prior to the Date of Practical Completion.

2.6 Lines and levels

All earthworks shall be to the lines and levels shown in the Contract Drawings.

Earthworks shall be trimmed to line and level by machine and/or hand as necessary to produce profiles to the tolerances required.

2.7 Excavation

Excavation shall consist of all excavation required to complete the Works unless separately designated.

Material that is unsuitable for use shall be excavated and disposed by the Contractor as directed by the Superintendent.

If excavated material is unsatisfactory for its specified use because of high moisture content, the Contractor may be directed by the Superintendent to either process the material to reduce the moisture content or to remove the material and replace it with suitable material.

Excavation slopes shall be finished in conformance with the lines and grades shown on the Contract Drawings or as re-determined by the Superintendent on the basis of site inspection and investigation during the works. All debris and loose material shall be removed.

The tops of excavation slopes and the end of excavations shall be rounded where shown on the Contract Drawings.

If the Contractor excavates beyond the slope line and the tolerance applicable, the Contractor shall request and the Superintendent may authorise a minor change in the general slope of the surface. This shall not be regarded as a redetermination of the final grades and levels. If the Contractor's request is denied, the Contractor shall submit details of the material and/or methods proposed to restore the specified slope and stability of the surface for approval.

2.8 Filling

2.8.1 General filling

Filling includes all operations associated with the preparation of the Works on which fill material is to be placed and the placing and compacting of approved fill material to the alignment, grading and dimensions shown on the Contract Drawings, including any pre-treatment such as breaking down, blending or drying out material containing excess moisture.

All fill shall be placed, spread, mixed, watered and compacted in accordance with the Technical Specification.

The ground surface prepared to receive fill shall be firm and unyielding. This shall be determined by undertaking compaction testing and roll testing.

Prior to filling, the ground surface shall be scarified, disked, or bladed until it is uniform and free from uneven features which may prevent uniform compaction. The scarified ground surface shall then be brought to appropriate moisture content, mixed as required and compacted. If the scarified zone is greater than 300 mm in depth, the excess shall be removed and placed in compacted lifts not greater than 200 mm compacted thickness, unless otherwise specified.

Unless otherwise specified, fill material shall be placed in thin lifts with a maximum compacted lift thickness of 200 mm. Each lift shall be spread evenly and thoroughly mixed to obtain a near uniform condition in each lift. In areas of excess lift thickness, regrading of the surface to the maximum lift thickness shall be completed prior to construction of additional lifts.

Handling and spreading of all fill material shall produce a gradation of the materials when compacted to comply with this Technical Specification.

All fill materials shall be placed in such a manner that the distribution and gradation of the materials throughout will be such that the fill will be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material within the zone.

Where work is interrupted by rain, fill operations shall not be resumed until observations and field tests by the Contractor indicate that the moisture content and density of the in-place fill materials and/or materials intended for placement are within the limits identified in this Technical Specification. This requirement does not preclude the Contractor from disking or aerating excessively wet areas to enhance drying.

2.8.2 Water conditioned ash filling

The contractor shall prepare a specific work method statement for the filling of water conditioned ash as part of the bulk earthworks (as shown on the Contract Drawings). This shall be in line with current operational methods and consider the following:

– Plant and equipment
– Pre-conditioning
– Lift thickness
– Moisture content
– Finishing for overlying material placement

The work method statement shall be reviewed and approved by the Superintendent in consultation with the Designer.

2.9 Inspection

The Designer or a suitably qualified and experienced geotechnical engineer shall regularly inspect excavation and filling works within critical areas such as the filter bag removal area, slip area, and any identified soft spots. This shall be undertaken to identify and specify if any additional stabilisation measures that are required.

2.10 Compaction

Unless stated otherwise, all fill shall be compacted to 98% SDD at a moisture content of -4 to +0% of optimum moisture content (OMC).

2.11 Proof rolling

Proof rolling shall be used for all final earthworks surfaces to assist in identifying soft spots and unsuitable material.

All final design subgrade/surfaces shall be proof rolled by a mechanical self-propelled smooth drum roller (or equivalent) in the presence of the Superintendent to assess the soundness and suitability.

Proof rolling shall be conducted upon the full width and length of all final earthworks surfaces. A final proof roll shall be conducted over the finished surface prior to acceptance.

To show conformance with the requirements of the Technical Specification, during proof rolling the surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability.

2.12 Tolerances

Unless specified otherwise, tolerances shall meet the acceptance criteria in Table 5.

The Contractor may excavate and re-compact the existing material if necessary to assist in achieving this tolerance.

Notwithstanding these allowable tolerances, the Contractor shall be responsible for meeting grading requirements across the surfaces of earthworks materials as shown on the Contract Drawings.

Plus (+) refers to the following:

– Elevation: Plus (+) is higher than design
– Layer thickness: Plus (+) is thicker than design
– Depth: Plus (+) is deeper than design
– Width: Plus (+) is wider than design.

Minus (-) refers to the following:

– Elevation: Minus (-) is lower than design
– Layer thickness: Minus (-) is thinner than design
– Depth: Minus (-) is shallower than design
– Width: Minus (-) is narrower than design.

Table 5 Tolerances

Element	Measurement	Acceptance criteria
General excavation	Elevation	±100 mm
Design surface/subgrade	Elevation	+0, -100 mm
Sidewalls: At the toe of the batter 2 m above toe of batter and higher Between toe of batter and 2 m above toe of batter	Elevation	 +0, -100 mm ± 100 mm pro rata basis
Embankments/bunds	Elevation	+100, -0 mm
All trenches	Depth Width	+100, -0 mm +100, -0 mm
Drainage aggregate layer	Layer thickness	+50, -0 mm
Furnace bottom ash layer	Layer thickness	+50, -0 mm

2.13 Anchoring of geosynthetics

The Contractor shall prepare a work method statement for the excavation and backfill of anchor trenches to submit to the Superintendent for review and approval prior to the Works, with consideration to the guidance below.

Anchor trench excavation, backfill, and compaction shall be completed to the line and grades shown on the Contract Drawings.

Anchor trenches shall be prepared with slightly rounded corners where the geosynthetics adjoin the trench so as to avoid sharp bends in the geosynthetic material. The base of the anchor trench must be a smooth uniform surface that is free of defects and loose material.

The geosynthetic layers shall be placed in the trench as per the Contract Drawings to ensure effective anchorage. Select fill material shall be used for backfilling the anchor trenches. Select fill material shall be placed in maximum 100 mm loose lifts if compacted with hand-operated compaction equipment, or maximum 200 mm loose lifts if compacted with a self-propelled compactor.

The Contractor shall repair or replace any geosynthetics damaged as a result of placement or compaction of backfill.

2.14 Defects and repairs

Compacted fill material with non-conforming CQC test results shall be remediated as Table 6. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

Material with non-conforming CQC test results after remedial work has been implemented (that is, tested for a second time) shall be removed and replaced.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

Table 6 Remedial actions for compacted fill

Category	Density ratio result	Density index result	Moisture result	Remedial action[1]
A	Non-conforming by less than 1%	Non-conforming by less than 3%	Conforming	Re-compact (maximum of three passes)
B	Non-conforming by 1% or more	Non-conforming by less than 5%	Conforming, but not more than 1.0% wet of OMC	Rip, re-water, re-compact and re-test
C	Non-conforming by 1% or more	N/A	Pass, but 1.0% or more wet of OMC	Rip, re-compact and re-test
D	Conforming	N/A	Non-conforming	Rip, re-water, re-compact and re-test
E	Non-conforming	Non-conforming by more than 5%	Non-conforming	Remove fill, replace, compact and re-test

2.15 Acceptance

The Contractor shall retain ownership and responsibility for the earthwork activities until final acceptance of earthworks by the Principal.

The earthworks shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– The Contractor has submitted the required as-built surveys of the completed earthworks showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
– CQC test results showing compliance with the requirements of this Technical Specification have been provided by the Contractor to the Superintendent and approved
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

[1] Should the Superintendent deem the depth of insufficiently compacted material to be greater than can be effectively compacted from the surface, material shall be removed to a depth at which compaction is satisfactory and replaced and compacted in layers

3. PE geomembrane

3.1 General

This section contains the technical requirements for (PE) polyethylene geomembrane.

The Superintendent may reject any PE geomembrane that does not meet or exceed the requirements of this section.

Any PE geomembrane rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

3.2 Submittals

3.2.1 Prior to installation of polyethylene geomembrane

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the PE geomembrane:

– Delivery, storage and handling log for all rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling
– Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation
– Work method statement for installation
– Survey of the underlying surface in accordance with Section 1.10.

3.2.2 Following installation of polyethylene geomembrane

The Contractor shall submit the following to the Superintendent for review and approval following installation of the PE geomembrane:

– Panel placement log, providing details on panel number and associated roll number, date and time placed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information
– Trial weld log, recording all trial welds and test results
– Field welding log providing details of all field welding undertaken, including:
    - Weld type
    - Weld ID number
    - ID numbers of panels to be joined
    - Name of welder
    - Details of equipment used
    - Ambient air temperature
    - Geomembrane surface temperature
    - Weld temperature
    - Any problems or issues arising during welding.
– Field sampling and testing results, including non-destructive and destructive tests
– Results of electrical leak location survey (refer Section 3.8)
– Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
– Defects and repairs log, showing details of all defects identified and repairs completed.

3.3 Preparation of receiving surface

Prior to placement of PE geomembrane, the underlying GCL shall be free of:

– Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the GCL
– Excessive wrinkles preventing intimate contact between the GCL and PE geomembrane
– Any panels that have hydrated prematurely without confinement
– Excessive bentonite powder and/or paste on the surface that may hinder welding

Placement of PE geomembrane shall proceed alongside the underlying GCL. The overlying PE geomembrane shall be placed immediately following acceptance of the GCL panels to protect the underlying GCL by the CQA Engineer.

The Superintendent may reject any underlying GCL or underlying foundation material which does not meet these requirements. Any GCL rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

3.4 Installation

3.4.1 General

The Contractor shall prepare a work method statement for installation of PE geomembrane (refer Appendix A), considering the guidance below. The work method statement shall be submitted to the Superintendent for review and comment prior to installation of the PE geomembrane on site.

3.4.2 Weather conditions

The Contractor shall consider the weather conditions daily to confirm they are suitable for placement of PE geomembrane.

PE geomembrane shall not be placed or seamed:

– If moisture prevents proper preparation, panel placement and/or panel seaming
– During precipitation, during hail, during periods of excessive fog, during periods of excessive dust, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water)
– During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations
– When sheet temperatures are lower than 0° or higher than 60° as measured by a calibrated infrared thermometer or surface thermocouple.

3.4.3 Traffic

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

No vehicle shall be allowed to travel directly on the PE geomembrane.

3.4.4 Placement

PE geomembrane shall be placed in accordance with the following:

– The PE geomembrane shall be placed and seamed in accordance with this Technical Specification, the Contract Drawings, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent

- Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects, including tears, abrasion, indentation, cracks, thin spots or any other faults or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected
- PE geomembrane shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards
- PE geomembrane shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base
- The arrangement of the PE geomembrane panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent
- Installation shall progress from the highest elevations to the lowest
- PE geomembrane rolls shall be placed in an orderly fashion which shall minimise or prevent surface water from flowing below previously installed PE geomembrane
- PE geomembrane shall not be allowed to 'bridge over' voids or low areas. The PE geomembrane shall be placed to allow intimate contact with the underlying layer
- PE geomembrane shall be installed without undergoing excessive buckling, wrinkling or tensioning
- PE geomembrane shall not be dragged across an unprepared surface. If the PE geomembrane is dragged across an unprepared surface, it shall be inspected for defects and repaired or rejected if necessary
- Where there is a geosynthetic layer below, the installation of the PE geomembrane shall be undertaken in a matter so as not to damage the underlying layer
- Sandbags or equivalent ballast shall be used as necessary to temporarily hold the PE geomembrane in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the PE geomembrane
- Only those PE geomembrane rolls which can be seamed or permanently anchored on at least two sides on the same day (including the longest edge) shall be placed on a daily basis. All other sides shall be temporarily anchored
- PE geomembrane installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 2.13. PE geomembrane panels shall be anchored as soon as possible. The Geosynthetic Installer shall program anchor trenches backfilling when the temperature is coolest to minimise effects of material expansion
- Personnel working on the PE geomembrane shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the PE geomembrane. PE geomembrane in heavy traffic areas shall be protected by a geosynthetic overlay
- PE geomembrane shall be cut from each roll with an approved hook blade knife with flat zones on each end
- PE geomembrane rolls shall be freely suspended during placement
- The method used to unroll the PE geomembrane shall not cause bridging, excessive wrinkles, scores, scratches and/or crimps
- Folds and wrinkles caused by PE geomembrane panel placement or thermal expansion shall be minimised
- After placement, the PE geomembrane shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing before the overlying cover material or geosynthetic is placed.

3.4.5 Seaming

PE geomembrane shall be seamed in accordance with the following guidance.

General

- The PE geomembrane shall be field seamed into a continuous sheet across the Works by using either dual hot wedge fusion welding or extrusion welding seams

– Dual hot wedge fusion welding shall be the preferred method of welding and shall be used for primary welds between adjacent PE geomembrane panels. Extrusion welding shall only be used for detailed work, repair work, or in areas inaccessible for dual hot wedge fusion welding (where approved by the Superintendent)
– Trial seams shall be completed each day as per Section 3.6
– All seams shall be ‘shingled’ down-slope to promote runoff (roof tile fashion)
– All field seaming operations shall be supervised by the Seaming Foreman and no field seams shall be made without the Seaming Foreman present
– Prior to welding, the prepared weld surfaces shall be free of dust, dirt, debris, markings foreign material and any other potential contaminants that would inhibit welding. Where contamination does occur, the prepared surfaces shall be thoroughly cleaned and the weld completed
– There shall be no free moisture in the weld area during welding. If free moisture is located in the weld area, mitigation measures during seaming shall be employed as approved by the Superintendent
– The Geosynthetic Installer shall have an independently calibrated handheld temperature measuring device to confirm the temperatures of each and every welding machine prior to the commencement of any test or field welds. All information regarding the results gained from the temperature device shall be recorded for each welding machine
– Any electric generators used in welding shall be placed on a smooth base such that no damage occurs to the underlying PE geomembrane
– Adjacent to anchor trenches, seaming shall extend up the panels a minimum of 300 mm past the crest of the anchor trench.

Weld locations

PE geomembrane panel placement shall take into consideration the site geometry including:

– Field seams shall be orientated parallel to the line of maximum slope
– For slopes (batters with a 10% grade or steeper), transverse (cross-slope) seams shall not be permitted
– No cross seams shall be allowed within 1,500 mm of the toe of any slope
– In corners and odd shaped geometric locations, the number and total length of field seams shall be minimised
– Seams shall not be located at low points
– All cross seams shall be offset at least 600 mm from the cross seam of the adjacent panel and be extrusion or wedge welded where they intersect
– All primary welds used to connect panel ends to sheets shall form T-joins (tees). These T-connections shall have a distance of at least 500 mm. The welding seams of the PE geomembrane cannot cross (no cruciform connections).

Dual hot wedge fusion welding

– The dual hot wedge fusion welding shall be conducted using the split head wedge fusion weld method, fusing the upper and lower overlapped PE geomembrane panels
– The welding equipment shall be capable of continuously monitoring and controlling the temperature in the zone of contact where the machine is actually fusing the PE geomembrane so as to ensure that changes to environmental conditions shall not adversely affect the integrity of the weld
– Seams shall have a finished overlap of a minimum of 150 mm for dual hot wedge fusion welding but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam
– The dual hot wedge fusion welding shall form two contact fusion areas of a minimum width of 15 mm and a 5 mm minimum wide void between each of the separate parallel weld zones.

Extrusion welding

- The extruder may be a combination sheet pre-heat and extruder type or a combination dynamic mixing assembly and extruder type
- The extrudate shall be manufactured from the same resin type used in the manufacture of the relevant PE geomembrane being welded. All physical properties shall be identical to those possessed by the raw PE geomembrane material. The Geosynthetic Installer shall provide certification from the manufacturer that the relevant PE geomembrane and extrudate produced for the Works have the same properties and are of the same resin for each batch
- During welding, the Geosynthetic Installer shall be responsible for regularly checking, calibrating and recording of:
  - Preheat air flow and temperature at the nozzle
  - Extrudate flow and temperature at the barrel outlet
- Seams shall have a finished overlap of a minimum of 75 mm for extrusion welding but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam
- The minimum width of the surface extruded bead shall be 30 mm
- Prior to welding, oxidation by-products shall be removed from the weld area by grinding or buffing. Grind marks shall not be deeper than 10% of the PE geomembrane thickness. Seam grinding shall be been completed less than one hour before seam welding. The end of welds more than five minutes old shall be ground to expose new material before restarting a weld
- Prior to welding, the extruder shall be purged until all the heat-degraded extrudate is removed
- Welding shall be undertaken in one direction only
- A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

3.5 Pipe boots

Pipe boots may be constructed in the factory or in the field in accordance with the detail shown on the Contract Drawings from relevant PE geomembrane conforming to this Technical Specification.

All pipe boot seams shall be spark tested with acceptable pipe boots showing no spark.

Alternative testing methods may be allowed at the discretion of the Superintendent.

3.6 Trial seams

- Trial seams shall be performed on fragment pieces of PE geomembrane to verify that seaming conditions are satisfactory and to supply test specimens for the CQA program.
- Trial seams shall be conducted at the beginning of each seaming period and at least once each four hours for each seaming apparatus used that day. Trail seams shall be repeated if any welding stoppage exceeds one hour and if weather conditions change. Trial seams shall be made under the identical conditions as the actual seams.
- Each seamer shall make at least one trial seam each day for each seam method for each seaming equipment apparatus to be used that day.
- Trial seams shall be a minimum of 1,350 mm by 300 mm with seam centred.
- The trial seam sample shall be cut into three subsamples (450 mm by 300 mm with seam centred).
- The two subsamples from each end shall immediately be tested onsite for peel and shear strength in accordance with GM19.
- If either specimen does not meet the acceptance criteria, the seamer and seaming apparatus and/or methods shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive trial seams are successful.
- The central portion of the trial seam sample shall be labelled and provided to the CQA Engineer for destructive testing at the CQA Engineer's Independent Testing Firm. A minimum one trial seam sample per day shall be subjected to destructive testing. The Superintendent may reduce the

frequency of trial seam destructive testing at the CQA Engineer's Independent Testing Firm, in consultation with the CQA Engineer, if the field tensiometer appears adequate for assuring trial seam quality.

– If a trial seam sample records a non-conforming result for a test conducted at the CQA Engineer's Independent Testing Firm, a destructive test seam sample shall be taken by the Contractor from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the CQA Engineer's Independent Testing Firm by the Contractor and, if they recording non-conforming test results, the length of seam represented by the test sample shall be rejected.
– The conditions of this section are considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam(s).

3.7 Field seam sampling and testing

3.7.1 General

Testing parameters, requirements and anticipated schedules shall be continuously reviewed by the Contractor to ensure that adequate personnel and proper equipment shall be available.

Field seam sampling and testing shall be performed after seaming to verify that the mechanical characteristics of the seams do not compromise the PE geomembrane integrity.

Test results shall be provided to the Superintendent in accordance with Section 1.7.

3.7.2 Destructive seam testing

Destructive seam samples shall be taken and tested in accordance with Table 7.

Repair patches shall be extrusion welded over the areas where destructive seam samples have been taken and shall be subjected to non-destructive testing.

The location of each destructive seam sample shall be up to the discretion of the Superintendent and CQA Engineer and designated on a copy of the panel placement drawing, along with the date and time of sampling and the sample number.

Destructive test samples shall be a minimum of 1350 mm by 300 mm with seam centred.

The destructive seam sample shall be cut into 3 subsamples (450 mm by 300 mm with seam centred).

The two subsamples from each end shall be taken and tested on-site for peel and shear strength.

If both on-site subsamples meet the acceptance criteria of Table 7, the central portion of the test sample shall be labelled and provided to the CQA Engineer for destructive testing at the CQA Engineer's Independent Testing Firm.

If either on-site or off-site test results do not meet the acceptance criteria listed in Table 7, the length of seam represented by the test sample shall be rejected.

Table 7 Destructive seam testing requirements

Test description	Test method	Minimum test frequency (2)	Acceptance criteria (3)
Peel strength (4)	ASTM D6392	1 test per 150 m (5) (or part thereof)	As per GM19

[2] A minimum of one series of destructive tests shall be performed each day that seaming is performed
[3] All destructive test results shall be based on Film-Tear Bond (FTB) criteria. All samples which produce seam failures shall be considered unacceptable
[4] Peel strength testing shall be performed on both Weld A and Weld B
[5] When ambient air temperatures during seaming operations are less than 10°C, testing frequency shall be increased to one test per 75 linear meters

Test description	Test method	Minimum test frequency (2)	Acceptance criteria (3)
Shear strength	ASTM D6392	1 test per 150 m (6) (or part thereof)	As per GM19

3.7.3 Non-destructive seam testing

All seams shall be non-destructively tested over the entire length of seam by at least one of the methods in Table 8. The tests shall be undertaken no earlier than one hour after welding. In addition to the above tests, the welds shall be visually inspected to assess the quality of the workmanship and the appearance of the welded seam.

Table 8 Non-destructive seam testing requirements

Test description	Test method	Minimum test frequency	Acceptance criteria
Vacuum box	ASTM D5641	All seams shall be tested by at least one of these three test methods as appropriate	No imperfections
Air pressure (7)	ASTM D5820		Refer Table 9
Spark test	ASTM D6365		No spark

Table 9 Air pressure test schedule

Geomembrane thickness	Minimum pressure	Maximum pressure	Maximum pressure differential (8)
2.0 mm	210 kPa	250 kPa	10 kPa

3.7.4 Non-conforming test results

If any test specimen does not meet the acceptance criteria listed, the test series shall be considered unacceptable and all material or length of seam represented by the test series shall be rejected. The Geosynthetic Installer may, at no additional compensation, take additional samples for quality control testing in an attempt to minimise the amount of material represented by the non-conforming test result.

In the event of discrepancies between the CQA Engineer's test results and the Contractor's test results, the Contractor shall be responsible for arranging a third independent testing firm to verify test results.

An acceptable length of seam shall be defined as a length of seam which lies between conforming destructive test locations and has passed non-destructive seam testing.

3.7.5 Field testing summary

The Geosynthetic Installer shall prepare a field testing summary for all installed PE geomembrane. For each PE geomembrane layer, a separate copy of the panel placement drawing shall be utilised for this summary and shall indicate the PE geomembrane layer represented. On each sheet, the following information shall be recorded:

– The location, date, sample number and test result (conforming/non-conforming) of each destructive test series
– The location, identification number and date of each non-destructive air pressure seam test including the length of the tested seam and the result of the test (conforming/non-conforming)

[6] When ambient air temperatures during seaming operations are less than 10°C, testing frequency shall be increased to one test per 75 linear meters
[7] All hypodermic needle punctures shall be repaired as per the requirements of this Specification
[8] Observe and record the pressure 5 min after the initial reading. If the loss of pressure exceeds that shown, or if the pressure does not stabilize, the faulty area should be located and repaired

– The location, date and lengths of non-destructive vacuum box testing performed on a daily basis and the result of the tests (conforming/non-conforming)
– The location, identification number and date of each non-destructive spark test including the length of the tested seam and the result of the test (conforming/non-conforming).

3.8 Electrical leak location survey

3.8.1 General

Following the installation of each PE geomembrane layer, the Leak Location Contractor engaged by the Contractor shall conduct an electrical leak location survey to detect leaks in the PE geomembrane. The survey shall be continuously witnessed by the CQA Engineer.

3.8.2 Preparation and support

The Contractor shall be responsible for preparing the survey area for the leak location survey. The Contractor shall be responsible for completing installation work around the edge of each PE geomembrane layer that provides electrical isolation of the PE geomembrane for the electrical leak location surveys. The Superintendent may provide further details on this procedure if requested.

The Contractor shall ensure the PE geomembrane surface is clean and dry prior to the survey.

3.8.3 Execution

The arc testing leak location survey shall be performed after the installation of each PE geomembrane layer in accordance with ASTM D7953.

The Leak Location Contractor shall be responsible for calibrating equipment utilised to achieve optimum data quality and sensitivity for the site conditions.

The survey works best when the geomembrane is in intimate contact with the subgrade. Wrinkles are an impediment to conducting a good survey and defects on wrinkles may not be detected. Therefore, it is usually in the interest of the project to conduct the survey when the liner system is cool and flat, such as in the morning or during the night.

Working on slopes can create safety hazards with slippery surfaces, and may require additional harnessing and slower production rates. The Leak Location Contractor shall account for this in their work method statement.

Leak locations shall be logged, visibly marked, and reported to the Contractor, CQA Engineer and Superintendent for repair.

3.8.4 Reporting

The Leak Location Contractor shall report the general results of the survey to the Contractor, CQA Engineer and Superintendent during the daily progress of the field work.

Prior to the demobilisation of the survey personnel from the site, the Leak Location Contractor shall submit a list of locations of the leaks detected to the Contractor, CQA Engineer and Superintendent.

The Leak Location Contractor shall submit a report documenting the field work and results of the surveys to the Contractor, CQA Engineer and Superintendent following completion of the field work.

3.8.5 Repairs

The Geosynthetic Installer shall be responsible for repairing any leaks found. Repairs shall be undertaken in accordance with Section 3.9.

After the leak is repaired, the Leak Location Contractor shall retest the area to ensure the leak was repaired and that there are no other leaks in the vicinity of the repair.

3.9 Defects and repairs

The Geosynthetic Installer shall be responsible for inspecting the placed PE geomembrane to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed PE geomembrane to identify any damage or faults in the material. Any areas of PE geomembrane damaged during installation shall be repaired by the Geosynthetic Installer. All repairs shall be verified by the Superintendent.

The Geosynthetic Installer shall prepare a work method statement for installation of PE geomembrane (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geomembrane to site.

The installation component of the work method statement shall include work methods for defects and repairs, developed in accordance with the guidance provided below:

– All repairs shall be undertaken in accordance shall be undertaken in accordance with this Technical Specification, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent. All repairs shall be verified by the Superintendent
– Patches and cap strips shall have rounded edges (minimum radius of 75 mm), shall be made of the same geomembrane and shall extend a minimum of 150 mm beyond the edge of defects. All patches shall be of the same compound and thickness as the PE geomembrane being patched over. Patches shall be seamed using extrusion (fusion) welding
– Punctures, pin holes, blisters, small tears and localised imperfections shall be repaired using a patch
– Large tears and lengths of seam shall be repaired using a cap strip. No reseaming over existing seams shall be permitted
– Tears which lie on slopes greater than 5% or which lie in areas of stress and have sharp ends shall have all sharp ends rounded prior to repair
– The PE geomembrane below large patches and cap strips shall be cut as necessary to prevent moisture or gas collection between sheets
– Excessive wrinkles which exist at the end of seaming operations and which may become creased during backfilling shall be cut and reseamed. Excessive wrinkles shall be defined as a wrinkle which at the time of covering, and in the opinion of the Superintendent, meets any of the following criteria:
    - Is nominally >200 mm in height
    - May fold during backfilling
    - May adversely impede the flow along the surface of the geomembrane
– ‘Fishmouths’ or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut ‘fishmouths’ or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 150 mm beyond the cut in all directions. All corners of the patch shall be rounded with a 25 mm minimum radius
– All repair seams shall be made in accordance with the requirements of Section 3.4.5
– Each repair shall be required to pass non-destructive tests (refer Section 3.7.3). Large cap strips may require destructive testing (refer Section 3.7.2), as directed by the Superintendent.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

3.10 Acceptance

The Contractor shall retain all ownership and responsibility for all PE geomembrane until final acceptance of all work under this Contract by the Principal.

PE geomembrane shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved

- Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
- The electrical leak location survey has been completed and all required repairs have been completed by the Contractor
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s.

4. Geosynthetic clay liner

4.1 General

This section contains the technical requirements for the geosynthetic clay liner (GCL)

The Superintendent may reject any GCL that does not meet or exceed the requirements of this section.

Any GCL rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

4.2 Submittals

4.2.1 Prior to installation of GCL

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of GCL:

– Delivery, storage and handling log for all rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling
– Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation
– Work method statement for installation
– Survey of the underlying surface in accordance with Section 1.10.

4.2.2 Following installation of GCL

The Contractor shall submit the following to the Superintendent for review and approval following installation of GCL:

– Panel placement and seaming log, providing details on panel number and associated roll number, date and time placed, date and time seamed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information
– Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
– Defect and repairs log, showing details of all defects identified and any repairs completed.

4.3 Preparation of receiving surface

Prior to placement of GCL, the receiving surface shall exhibit the following characteristics:

– The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
– The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required)
– The surface shall be free of debris (such as filter bags), roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials
– No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm
– The surface shall promote drainage and excessive water shall not be allowed to pond on the surface
– The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired

– All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material
– The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

The receiving surface shall be surveyed as per the requirements of Section 1.10.

Placement of GCL shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

4.4 Installation

4.4.1 General

The Contractor shall prepare a work method statement for s installation of GCL (refer Appendix A), considering the guidance below. The work method statement shall be submitted to the Superintendent for review and approval prior to installation of the GCL on site.

4.4.2 Weather conditions

The Contractor shall consider the weather conditions on a daily basis to confirm they are suitable for placement of GCL.

Liners shall not be placed or seamed:

– If moisture prevents proper preparation, panel placement and/or panel seaming
– During precipitation, during hail, during periods of excessive fog, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water) and/or under any other conditions which may cause premature hydration of the GCL
– During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations.

4.4.3 Traffic

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

No vehicle shall be allowed to traffic directly on the GCL.

4.4.4 Placement

GCL shall be placed in accordance with the following:

– The GCL shall be placed and seamed in accordance with this Technical Specification, the Contract Drawings, the approved work method statement, the manufacturer's instructions and ASTM D6102. Any contradictions shall be clarified with the Superintendent
– Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected
– The protective wrapping on the rolls shall be maintained at all times prior to installation
– GCL shall be protected at all times from damage due to exposure to sunlight, dirt, dust and other hazards
– GCL shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base
– The arrangement of the GCL panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent
– Installation shall progress from the highest elevations to the lowest

– GCL shall not be allowed to ‘bridge over’ voids or low areas. The GCL shall be placed to allow intimate contact with the underlying layer
– GCL shall be installed without undergoing excessive buckling, wrinkling or tensioning
– GCL shall not be dragged across an unprepared surface. If the liner is dragged across an unprepared surface, it shall be inspected by the Superintendent and/or CQA Engineer for defects and repaired or rejected if necessary
– Where there is a geosynthetic layer below, the installation of the GCL shall be undertaken in a matter so as not to damage the underlying layer
– Sandbags or equivalent ballast shall be used as necessary to temporarily hold the GCL in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the liner
– Care should be taken to avoid contaminating the upper surface of the GCL with bentonite powder from the within the liner
– GCL installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 2.13. GCL panels shall be anchored as soon as possible
– Personnel working on the GCL shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the liner. GCL in heavy traffic areas shall be protected by a geosynthetic overlay
– GCL rolls shall be freely suspended during placement
– The method used to unroll the GCL shall not cause bridging or excessive wrinkles
– After placement, the GCL shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing before the overlying cover material or geosynthetic is placed.

4.4.5 Seaming

GCL shall be seamed in accordance with the following:

– All seams shall be overlapped and sealed with bentonite paste
– All seams shall be ‘shingled’ down-slope to promote runoff (roof tile fashion)
– End seams shall be overlapped a minimum of 500 mm and side seams shall be overlapped a minimum of 300 mm
– For slopes (batters with a 10% grade or steeper), transverse (cross-slope) seams shall be minimised. If required, transverse seams shall be overlapped a minimum of 1,500 mm. Transverse overlaps shall be immediately anchored
– The overlap zone shall be kept clean and shall not be contaminated with loose soil or other debris. There shall be no folds or wrinkles in the overlap zone and no plant traffic or foot traffic shall occur over the finished overlap
– Bentonite paste shall be applied continuously across the overlap zone at a rate of 400 grams per metre
– Bentonite used for seaming shall comply with the relevant bentonite acceptance criteria for GCL in Appendix B.
– Care shall be undertaken to avoid contaminating the upper surface of the GCL with bentonite paste
– For coated GCL, additional measures such as geotextile strips and/or taping shall be implemented based on manufacturer’s instructions.

4.5 Protection and covering

The GCL shall be protected from damage and premature hydration due to precipitation, wind and other environmental conditions.

Covering and confinement activities shall be coordinated to ensure the following:

– On a daily basis, only those areas of GCL which can be covered to within 3 m of all edges shall be installed. All edges which are not completely covered shall be protected with anchored tarpaulins
– For GCL only, the overlying polyethylene geomembrane shall be placed immediately following placement and acceptance of the GCL panels
– The overlying confinement layer shall be placed as soon as practicable, in accordance with the GCL manufacturer's instructions or as approved by the Superintendent. Notwithstanding these requirements, the overlying confinement layer shall be placed no longer than 2 weeks following GCL placement.

If the placed GCL panels have hydrated prematurely without confinement, then the effected liner panels shall be removed and replaced by the Contractor at their own expense.

4.6 Pipe penetrations

The GCL shall be cut in a pie-shaped configuration at pipe penetrations.

A second GCL layer shall be installed over the first liner, made using a new piece of GCL of the same material type and thickness with a minimum 500 mm overlap beyond the penetration area in each direction.

Bentonite paste shall be applied across the overlap zone around the penetration area at a rate of 400 grams per metre. Bentonite used for repairs shall comply with the relevant bentonite acceptance criteria in Appendix B.

4.7 Defects and repairs

The Contractor shall be responsible for inspecting the placed GCL to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed GCL to identify any damage or faults in the material. Any areas of GCL damaged during installation shall be repaired in accordance with the manufacturer's instructions and the approved work method statement. All repairs shall be verified by the Superintendent.

Repairs shall be made using a new piece of GCL of the same material type and thickness with a minimum 500 mm overlap beyond the repair area in each direction.

Bentonite paste shall be applied across the overlap zone around the repair area at a rate of 400 grams per metre. Bentonite used for repairs shall comply with the relevant bentonite acceptance criteria in Appendix B.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

4.8 Acceptance

The Contractor shall retain all ownership and responsibility for all GCL until final acceptance of the GCL by the Principal.

The GCL shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

5. Geonet drainage geocomposite

5.1 General

This section contains the technical requirements for geonet drainage geocomposite.

The Superintendent may reject any geonet drainage geocomposite that does not meet or exceed the requirements of this section.

All geonet drainage geocomposite rejected by the Superintendent shall be removed from the site at the Contractor's expense.

5.2 Submittals

The Contractor shall be responsible for the submission of all submittals required for geonet drainage geocomposite by this Technical Specification.

5.2.1 Prior to installation of geonet drainage geocomposite

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the geonet drainage geocomposite:

– Delivery, storage and handling log for all rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling
– Proposed panel placement drawing, showing the location and reference number of all panels, expected seams, connections and penetrations, and panel dimensions and layout and the order of panel installation
– Work method statement for installation
– Survey of the underlying surface in accordance with Section 1.10.

5.2.2 Following installation of geonet drainage geocomposite

The Contractor shall submit the following to the Superintendent for review and approval following installation of the geonet drainage geocomposite:

– Panel placement and seaming log, providing details on date and time placed, date and time seamed, condition of receiving surface, weather conditions and precipitation events, quality assurance (QA) checks performed, and all other relevant information
– Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
– Defect and repairs log, showing details of all defects identified and any repairs completed.

5.3 Preparation of surface to receive geonet drainage geocomposite

Prior to placement of geonet drainage geocomposite, the underlying PE geomembrane shall be free of:

– Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the PE geomembrane
– Excessive wrinkles preventing intimate contact between the PE geomembrane and geonet drainage geocomposite

The overlying geonet drainage geocomposite shall only be placed following acceptance of the GCL panels to protect the underlying PE geomembrane by the CQA Engineer.

The Superintendent may reject any underlying PE geomembrane or underlying foundation material which does not meet these requirements. Any PE geomembrane rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

5.4 Installation

The Contractor shall prepare a work method statement for installation of geonet drainage geocomposite (refer Appendix A), considering the guidance below. The work method statement shall be submitted to the Superintendent for review and comment prior to installation of the geonet drainage geocomposite on site.

The Contractor shall undertake installation in accordance with the manufacturer's instructions, the approved work method statement, GRI-GN2 and GRI-GC13, this Technical Specification and the Contract Drawings. Any contradictions shall be clarified with the Superintendent.

The work method statement shall be developed based on the guidance provided below:

- Prior to incorporation into the works, each roll shall be inspected for damage and/or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected
- The protective wrapping on geonet drainage composite rolls shall be maintained at all times prior to installation
- The Contractor shall verify that the material is free from dust and dirt immediately prior to installation. Washing operations may be implemented at the discretion of the Superintendent
- Geonet drainage geocomposite shall not be placed or seamed:
    - If moisture prevents proper preparation, panel placement or panel seaming
    - During precipitation, during periods of fog, or in the presence of excess moisture (e.g. dew, ponded water)
    - During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations
- Geonet drainage geocomposite shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards
- Equipment used shall not damage the geonet drainage composite by handling, trafficking, leakage of hydrocarbons, or by other means
- No vehicle shall be allowed to travel directly on the geonet drainage geocomposite.
- Geonet drainage geocomposite shall not be allowed to 'bridge over' voids or low areas. The geonet drainage composite shall be placed to allow intimate contact with the underlying layer
- Geonet drainage geocomposite shall not be dragged across an unprepared surface. If the geonet drainage composite is dragged across an unprepared surface, it shall be inspected by the Superintendent and repaired or rejected if necessary
- Geonet drainage geocomposite rolls shall be freely suspended during placement
- The installation of the geonet drainage composite shall be undertaken in a manner so as not to damage the underlying layer
- Metallic ties shall not be used
- Geonet drainage geocomposite shall not be welded to the geomembrane
- The machine direction of materials shall be placed parallel to the slope
- Strands of one layer shall not penetrate the channels of another layer
- The geotextiles above and below the geonet drainage geocomposite shall be continuously inspected for broken needles remaining from needle-punching operations
- Sandbags or equivalent ballast shall be used as necessary to temporarily hold the geonet drainage composite in position under the foreseeable and reasonably expected wind conditions. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geonet drainage composite

– After placement, the geonet drainage geocomposite shall be free of irregular stressing, folds and wrinkles
– The geonet drainage geocomposite shall be covered after installation within a 10-day period.

5.5 Defects and repairs

All repairs shall be undertaken in accordance with the manufacturer's instructions and the approved work method statement. All repairs shall be verified by the Superintendent.

5.6 Acceptance

The Contractor shall retain all ownership and responsibility for all geonet drainage geocomposite until final acceptance of all work under this Contract by the Principal.

Geonet drainage geocomposite shall be accepted by the Principal when all of the following conditions are met:

– Installation is finished
– Adequacy of all field seams and repairs is verified by the Superintendent
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– Required submittals are provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

6. Geotextile

6.1 General

This section contains the technical requirements for geotextile.

The Superintendent may reject any geotextile that does not meet or exceed the requirements of this section.

Any geotextile rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

6.2 Submittals

6.2.1 Prior to installation of geotextile

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the geotextile:

– Delivery, storage and handling log for all rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling
– Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation
– Work method statement for installation
– Survey of the underlying surface in accordance with Section 1.10.

6.2.2 Following installation of geotextile

The Contractor shall submit the following to the Superintendent for review and approval following installation of the geotextile:

– Panel placement log, providing details on panel number and associated roll number, date and time placed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information
– Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
– Defects and repairs log, showing details of all defects identified and repairs completed.

6.3 Preparation of receiving surface

Prior to placement of geotextile, the receiving surface shall exhibit the following characteristics:

– The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
– The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required)
– The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials
– No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm
– The surface shall promote drainage and excessive water shall not be allowed to pond on the surface
– The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired

– All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material
– The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

Where geotextile is being placed over a geosynthetic material, the underlying geosynthetic shall be free of excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials.

The receiving surface shall be surveyed as per the requirements of Section 1.10.

Placement of geotextile shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

6.4 Installation

6.4.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of geotextile (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geotextile to site.

6.4.2 Weather conditions

The Contractor shall consider the weather conditions on a daily basis to confirm they are suitable for placement of geotextile.

Geotextile shall not be placed or seamed:

– If moisture prevents proper preparation, panel placement and/or panel seaming
– During precipitation, during hail, during periods of excessive fog, during periods of excessive dust, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water)
– During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations.

6.4.3 Traffic

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

No vehicle shall be allowed to travel directly on the geotextile.

6.4.4 Placement

Geotextile shall be placed in accordance with the following:

– The geotextile shall be placed and seamed in accordance with this Technical Specification, the Contract Drawings, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent
– Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects, including tears, abrasion, indentation, cracks, thin spots or any other faults or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected
– Geotextile shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards

- Geotextile shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base
- The arrangement of the geotextile panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent
- Installation shall progress from the highest elevations to the lowest
- Geotextile rolls shall be placed in an orderly fashion which shall minimise or prevent surface water from flowing below previously installed geotextile
- Geotextile shall not be allowed to 'bridge over' voids or low areas. The geotextile shall be placed to allow intimate contact with the underlying layer
- Geotextile shall be installed without undergoing excessive buckling, wrinkling or tensioning
- Geotextile shall not be dragged across an unprepared surface. If the geotextile is dragged across an unprepared surface, it shall be inspected for defects and repaired or rejected if necessary
- Where there is a geosynthetic layer below, the installation of the geotextile shall be undertaken in a matter so as not to damage the underlying layer
- Sandbags or equivalent ballast shall be used as necessary to hold the geotextile in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geotextile
- Only those geotextile rolls which can be seamed or permanently anchored on at least two sides on the same day shall be placed on a daily basis. All other sides shall be temporarily anchored
- Geotextile installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 2.13. Geotextile panels shall be anchored as soon as possible
- Personnel working on the geotextile shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the geotextile. Geotextile in heavy traffic areas shall be protected by a geosynthetic overlay
- Geotextile rolls shall be freely suspended during placement
- The method used to unroll the geotextile shall not cause bridging, excessive wrinkles, scores, scratches and/or crimps
- After placement, the geotextile shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing.

6.4.5 Seaming

Geotextile shall be seamed in accordance with the following:

- Geotextile seams shall be formed by overlapping the edges of the geotextile panels by a minimum of 200 mm and thermally bonding the seam or sewing the seam together with continuous stitches located a minimum of 100 mm from the overlapped edges. A two-thread, double-locked stitch shall be used. The proposed seaming method shall be in accordance with the manufacturer's instructions
- Equipment used for thermal bonding and/or sewing shall be inspected and approved by the Superintendent prior to use. If requested by the Superintendent, the Geosynthetic Installer shall prepare a trial seam for inspection and/or testing prior to approval
- The Contractor shall ensure that the seaming method does not result in damage to the underlying geosynthetics
- Sewing procedures shall conform to the manufacturer's instructions. Spot sewing shall not be allowed
- Thread used to sew panels of geotextile together shall be polymeric thread with physical and chemical-resistance properties that equal or exceed those of the geotextile. The thread colour shall contrast with the geotextile colour and shall be approved for use by the manufacturer
- Adhesive may be used to seam the geotextile subject to approval from the Superintendent. The adhesive shall be approved by the manufacturer for use in seaming their product. If requested by the Superintendent, the Geosynthetic Installer shall prepare a trial seam for inspection and/or testing prior to approval

– Seams shall provide seam strength which equals or exceeds 75% of parent material strength when tested in accordance with AS 3706.2 (parent material strength) and AS 3706.6 (seam strength). The Superintendent may organise independent testing of the completed seams to verify conformance with this requirement. The Geosynthetic Installer shall repair any locations where samples are taken in accordance with Section 6.5.

6.5 Defects and repairs

The Contractor shall be responsible for inspecting the placed geotextile to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed geotextile to identify any damage or faults in the material. Any areas of geotextile damaged during installation shall be repaired by the Contractor. All repairs shall be verified by the Superintendent.

Any geotextile that has been damaged (by tears, holes or otherwise) during installation shall be repaired by patching a new piece of geotextile of the same material type and thickness with a minimum 300 mm overlap beyond the repair area in each direction. Any soil or other foreign material that may have penetrated the damaged geotextile onto the surface of the underlying layer or within the underlying layer shall first be removed to the satisfaction of the Superintendent before any repair work is undertaken.

Seaming of geotextile repair patches shall be undertaken in accordance with Section 6.4.5.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

6.6 Acceptance

The Contractor shall retain all ownership and responsibility for all geotextile until final acceptance of all work under this Contract by the Principal.

Geotextile shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
– The Superintendent is satisfied that sufficient sandbags or equivalent ballast have been placed across the surface of any geotextile to be left exposed at the completion of the Works
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

7. Ash excavation and placement

7.1 General

This section contains the technical requirements for ash excavation and placement. This has been provided for the operational phase of the ash filling within the Stage 2B Cell, and hence other requirements outside of this section are not specifically relevant unless otherwise stated.

7.2 Submittals

Prior to ash placement, the Contractor shall submit a work method statement for ash excavation and placement with consideration to the requirements outlined in this Technical Specification.

7.3 Excavation

The Contractor shall excavate designated ash materials to achieve the final lines and levels as shown on the Contract Drawings.

All excavated ash material shall be transported as a priority to a nominated location as directed by Superintendent. All excavated ash materials will be immediately relocated to the nominated locations.

7.4 Placement

7.4.1 General

Only ash permitted under the Contract shall be placed within cells approved for disposal.

The amount of ash exposed during operations shall be minimised.

All ash batters shall be no steeper than 1 (vertical) in 3 (horizontal).

Ash placement shall be undertaken such that pre-capping contours are suitable for placement of the final capping layer. Placement is to ensure no accession of infiltration to groundwater and no groundwater accession to ash.

7.4.2 Protection of lining system

Ash shall be placed in near horizontal layers across the entire area of the cell in horizontal lifts over the entire footprint.

Placement of the ash against the basal and sidewall liner system shall be undertaken so as to avoid damage to the lining systems. Specifically, no compaction plant and equipment shall be allowed within 6 horizontal metres of the sidewall lining system at any time.

Ash placed against the sidewall shall be placed on existing ash and pushed against the sidewall. All pushing shall be towards the slope. No ash or other materials shall be pushed down the slope of the sidewall.

Any protective layers across the sidewall lining system shall be maintained through operations. Inspections of the protection layer shall be undertaken following any rainfall event and any scouring or other damage to the layer shall be rectified.

No traffic is permitted on the separation geotextile over the leachate collection system, with the first layer of ash to be end tipped form the previously placed ash layer.

7.4.3 Compaction and lift thickness

Compaction of the ash shall be undertaken to ensure a typical in-situ ash density of 1.2 tonnes per cubic metre. Based on the equipment utilised, the moisture condition and type of ash the maximum uncompacted ash layer shall be adjusted by the operator to ensure this requirement is met. Notwithstanding, all ash placed in the repository shall be spread in maximum uncompacted layers of 300 vertical millimetres (0.3 vertical metres) prior to compaction. The maximum depth of any ash lift across the cell shall not exceed 3 vertical metres.

In-situ compaction shall be confirmed by six monthly surveys of the previously filled areas as a minimum in line with the relevant consent, EPL or other operating conditions.

7.4.4 Initial lift requirements

The initial lift of ash shall be:

– Placed by tracked plant, such as a bulldozer, to avoid high point loads that could potentially damage the base liner
– A minimum of 1.5 metres
– Free from protruding objects that can pierce the liner
– Placed in a manner to ensure the lining systems remains fit for purpose.

As soon as is feasible, a working platform should be established with or on top of the first lift of ash, sufficient in size to allow for truck and plant manoeuvring.

7.4.5 Setback from key-in locations

Where an internal or perimeter bund requires later removal to facilitate extension of operations to new areas, ash (including any required cover) shall not be placed within 1.5 metres of the termination of the liner at the toe of the bund. This shall also consider operation of rain flaps or other control measures at these locations.

7.4.6 Leachate collection system

The operation depth of leachate in the cell shall be limited to no more than 300 mm.

7.5 Access ramp

To allow for access of plant and trucks into the active ash cell, at least during the initial stages, an access ramp shall be constructed across the perimeter bund. The location of the ramp shall be selected such that it can provide cell access for the longest possible period.

The gradient of the ramp shall be suitable for truck access, under consideration of vehicle traction under full load. If the required space and construction materials are available, it is advisable to construct the ramp with a shallow gradient to avoid regular disturbance of the ramp surface.

At the crest of the perimeter bund the depth of the ramp shall be no less than 1.5 metre to allow for future wear and consolidation of the ramp. This depth shall be maintained across any liner and leachate collection system areas.

During construction the access ramp, the inclusion of a geogrid layer compatible with the access ramp material (such as a Combigrid 30/30 or similar) shall be considered to assist with stability and provide for a reduction in point loads that could lead to liner damage.

With consideration of the direction of approaching and/or departing trucks, a sufficiently large turning area shall be allowed for to ensure trucks do not approach the ramp at an angle.

8. PE pipework

8.1 General

This section contains the technical requirements for polyethylene (PE) pipework and fittings.

The Superintendent may reject any PE pipework and fittings that does not meet or exceed the requirements of this section.

Any PE pipework and fittings rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.2 Submittals

8.2.1 Prior to installation of PE pipework

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the PE pipework:

– Delivery, storage and handling log for all PE pipework to be used in the Works, including delivery dockets, pipework identification, details of storage and handling
– Work method statement for installation.

8.2.2 Following installation of PE pipework

The Contractor shall submit the following to the Superintendent for review and approval following installation of the PE pipework:

– As-built survey of all pipework showing conforming lines and levels
– Defects and repairs log, showing details of all defects identified and repairs completed.

8.3 Installation

8.3.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE pipework and fittings (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE pipework to site.

The installation component of the work method statement shall be developed in accordance with the guidance provided below:

– The PE pipework and fittings shall be placed and seamed in accordance with this Technical Specification, the Contract Drawings, AS 2033, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent
– Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects. If damage or defects are identified, the PE pipework shall be inspected by the Superintendent and approved or rejected
– Perforations shall be drilled to the size, number and location indicated on the Contract Drawings. Perforated pipework shall be thoroughly cleaned of drilling wastes or other foreign matter and any hanging beads removed before installation
– PE pipework shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer
– PE pipework shall be placed on an even bed of supporting material in accordance with the Contract Drawings

– PE pipework shall lay free on the base with no induced strain. Where there is evidence of induced pipe strain, the Contractor shall be required to eliminate the strain. The Contractor shall also remove and replace any fitting, which induces a torque or strain to the pipe
– PE pipework shall be cut in a manner so as to ensure square ends. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow be obtained
– Pipe joints shall be butt-fusion welded in accordance with the manufacturer's instructions
– PE pipework and fittings shall be held firmly in position and protected from damage while drainage aggregate or other backfilling material is being placed
– All pipe and fittings shall be clean upon installation and kept so during the progress of the Works
– Any PE pipework that becomes either partially or fully clogged and/or damaged before final acceptance shall be cleaned/repaired to the satisfaction of the Superintendent, and/or replaced.

8.4 Defects and repairs

The Contractor shall be responsible for inspecting the placed PE pipework and fittings to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed PE pipework and fittings to identify any damage or faults in the material. Any areas of PE pipework damaged during installation shall be repaired by the Contractor in accordance with the manufacturer's instructions. All repairs shall be verified by the Superintendent.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

8.5 Acceptance

The Contractor shall retain all ownership and responsibility for all PE pipework and fittings until final acceptance of all work under this Contract by the Principal.

PE pipework and fittings shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– The Contractor has submitted the required as-built surveys of the completed PE pipework and fittings showing conformance with the Contract Drawings, and this has been approved by the Superintendent
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the installed PE pipework and fittings.

9. Drainage aggregate

9.1 General

This section contains the technical requirements for the drainage aggregate. The relevant requirements for the drainage aggregate in Section 2 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the drainage aggregate that do not meet or exceed the requirements of this section.

Any component of the drainage aggregate rejected by the Superintendent shall be remediated at the expense of the Contractor.

9.2 Submittals

9.2.1 Prior to placement of drainage aggregate

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the drainage aggregate:

– Survey of the underlying surface in accordance with Section 1.10.
– Work method statement for placement of the drainage aggregate, including testing and repair procedures (refer Appendix A).

9.2.2 Following placement of drainage aggregate

The Contractor shall submit the following to the Superintendent for review and approval following placement of drainage aggregate:

– As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
– CQC testing results/reports showing compliance with the requirements of this Technical Specification
– Defect and repairs log, showing details of all defects identified and any repairs completed.

9.3 Preparation of receiving surface

Prior to placement of drainage aggregate, the underlying geosynthetic shall be free of:

– Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
– Excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials.

The foundation material underlying the geosynthetic shall:

– Be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
– Be free of abrupt breaks, indentations and/or sudden changes in grade
– Promote drainage and excessive water shall not be allowed to pond on the surface of the geosynthetic.

Placement of drainage aggregate shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

9.4 Installation

The Contractor shall prepare a work method statement for placement of the drainage aggregate outlining the placement methodology, access and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to commencement of the required field trial.

A field trial shall be undertaken by the Contractor to verify the Contractor's proposed construction methodology for the drainage aggregate, in accordance with Section 11. The Contractor shall adjust the placement method as necessary based on the results of the field trial.

The work method statement and construction methodology for the drainage aggregate shall be developed in accordance with the guidance provided below:

– The drainage aggregate shall be placed with a uniform particle size distribution to prevent concentration of fines. This can be achieved through conditioning of the material prior to placement
– The drainage aggregate shall be constructed in one lift with a minimum thickness of 300 mm. Plant shall not be allowed to traffic the underlying surface unless a minimum 300 mm thick drainage aggregate layer is present. Drainage aggregate shall be placed in areas without placed drainage aggregate by unloading the material from a pad of previously placed drainage aggregate
– The maximum allowable ground pressure for plant trafficking the minimum 300 mm thick drainage aggregate layer is 35 kPa
– Plant exceeding the allowable ground pressure requirements shall be allowed providing they work from elevated pads with a minimum thickness from the underlying surface of 1 m. These elevated pads shall be removed following completion of drainage aggregate placement
– Aggregate shall be placed directly on the underlying geosynthetic rather than pushing in place to avoid the formation of excessive wrinkles or 'waves'
– Drainage aggregate shall be placed in a manner which does not result in excessive particle breakdown or crushing
– Drainage aggregate shall be placed carefully around any pipework to ensure the pipework has sufficient and uniform support
– No aggregate shall be placed in areas where the underlying geosynthetic is not in contact with the supporting subgrade
– Drainage aggregate shall not be placed closer than 2 m from the edge of geosynthetic panels where seaming of additional geosynthetics to the edge is yet to be performed. Temporary access across such edges shall be subject to approval by the Superintendent.

9.5 Construction quality control testing

The Contractor shall undertake CQC testing of the drainage aggregate in accordance with Table 10 as a minimum and the relevant requirements of Section 1.7. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer.

Table 10 Construction quality control testing – drainage aggregate

Property	Test method	Minimum test frequency
Particle size distribution	AS 1141.3.1, AS 1141.11.1	1 per 1,000 m^3

9.6 Tolerances

The Contractor shall place the drainage aggregate within the tolerances provided in Section 2.12.

9.7 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the aggregate to inspect underlying materials for damage. The Contractor shall repair any damage that occurs to the underlying materials as a consequence of the placement of drainage aggregate in accordance with this Technical Specification.

Any areas of placed drainage aggregate that do not conform to the required CQC testing criteria shall be repaired by the Contractor to the satisfaction of the Superintendent. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

9.8 Acceptance

The Contractor shall retain ownership and responsibility for the drainage aggregate until final acceptance of the drainage aggregate by the Principal.

The drainage aggregate shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– The Contractor has submitted the required as-built surveys of the completed drainage aggregate showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
– CQC test results showing compliance with the requirements of this Technical Specification have been provided by the Contractor to the Superintendent and approved
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

10. Furnace bottom ash

10.1 General

This section contains the technical requirements for the furnace bottom ash. The relevant requirements for the furnace bottom ash in Section 2 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the furnace bottom ash that do not meet or exceed the requirements of this section.

Any component of the furnace bottom ash rejected by the Superintendent shall be remediated at the expense of the Contractor.

10.2 Submittals

10.2.1 Prior to placement of furnace bottom ash

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the furnace bottom ash:

– Work method statement for placement of the furnace bottom ash, including testing and repair procedures (refer Appendix A).

10.2.2 Following placement of furnace bottom ash

The Contractor shall submit the following to the Superintendent for review and approval following placement of furnace bottom ash:

– As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
– CQC testing results/reports showing compliance with the requirements of this Technical Specification
– Defect and repairs log, showing details of all defects identified and any repairs completed.

10.3 Preparation of receiving surface

Prior to placement of furnace bottom ash, the underlying geosynthetic shall be free of:

– Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
– Excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials.

Placement of furnace bottom ash shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

10.4 Installation

The Contractor shall prepare a work method statement for placement of the furnace bottom ash outlining the placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to commencement of the field trial.

A field trial shall be undertaken by the Contractor to verify the Contractor's proposed construction methodology for the furnace bottom ash, in accordance with Section 11. The Contractor shall adjust the placement method as necessary based on the results of the field trial.

The work method statement and construction methodology for the furnace bottom ash shall be developed in accordance with the guidance provided below:

– The furnace bottom ash shall be placed using methods and equipment appropriate to maintain a relatively loose condition in all areas.
– The furnace bottom ash shall be placed with a uniform particle size distribution to prevent concentration of fines. This can be achieved through conditioning of the material prior to placement
– The furnace bottom ash shall be constructed in one lift with a minimum thickness of 300 mm. Plant shall not be allowed to traffic the underlying surface unless a minimum 300 mm thick furnace bottom ash layer is present. Furnace bottom ash shall be placed in areas without placed furnace bottom ash by unloading the material from a pad of previously placed furnace bottom ash
– The maximum allowable ground pressure for plant trafficking the minimum 300 mm thick furnace bottom ash layer is 35 kPa
– Plant exceeding the allowable ground pressure requirements shall be allowed providing they work from elevated pads with a minimum thickness from the underlying surface of 1 m. These elevated pads shall be removed following completion of furnace bottom ash placement
– Ash material shall be placed directly on the underlying geosynthetic rather than pushing in place to avoid the formation of excessive wrinkles or 'waves'
– Furnace bottom ash shall be placed in a manner which does not result in excessive particle breakdown or crushing
– Furnace bottom ash shall be placed carefully around any pipework to ensure the pipework has sufficient and uniform support
– No ash shall be placed in areas where the underlying geosynthetic is not in contact with the supporting subgrade
– Furnace bottom ash shall not be placed closer than 2 m from the edge of geosynthetic panels where seaming of additional geosynthetics to the edge is yet to be performed. Temporary access across such edges shall be subject to approval by the Superintendent.

10.5 Compaction

No addition compaction shall be conducted for the furnace bottom ash layer, except as occurs incidentally. Access ramps or tracks used for the placement of furnace bottom ash shall be sufficiently spread out to avoid concentrated zones of overcompaction.

10.6 Construction quality control testing

The Contractor shall undertake CQC testing of the furnace bottom ash in accordance with Table 11 as a minimum and the relevant requirements of Section 1.7. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer.

Table 11 Construction quality control testing – furnace bottom ash

Property	Test method	Minimum test frequency
Particle size distribution	AS 1141.3.1, AS 1141.11.1	1 per 1,000 m^3

10.7 Tolerances

The Contractor shall place the furnace bottom ash within the tolerances provided in Section 2.12.

10.8 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the ash to inspect underlying materials for damage. The Contractor shall repair any damage that occurs to the underlying materials as a consequence of the placement of furnace bottom ash in accordance with this Technical Specification.

Any areas of placed furnace bottom ash that do not conform to the required CQC testing criteria shall be repaired by the Contractor to the satisfaction of the Superintendent. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

10.9 Acceptance

The Contractor shall retain ownership and responsibility for the furnace bottom ash until final acceptance of the furnace bottom ash by the Principal.

The furnace bottom ash shall be accepted by the Principal when all of the following conditions are met:

– Required submittals are provided by the Contractor to the Superintendent and approved
– The Contractor has submitted the required as-built surveys of the completed furnace bottom ash showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
– CQC test results showing compliance with the requirements of this Technical Specification have been provided by the Contractor to the Superintendent and approved
– Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
– The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
– The Superintendent has inspected and approved the finished surface/s.

11. Field trial

11.1 General

This section contains the technical requirements for undertaking the field trial for the drainage aggregate and furnace bottom ash. The relevant requirements for the field trial in Section 2 shall be considered alongside guidance provided in this section.

All materials used for test sections shall be removed upon completion of the field trial and disposed of by the Contractor unless otherwise approved by the Superintendent.

11.2 Submittals

11.2.1 Prior to conducting the field trial

The Contractor shall submit the following to the Superintendent for review and approval prior to conducting the field trial:

– Work method statement for field trial methodology, including proposed location of the field trial
– Work method statement(s) for installation of the drainage aggregate and furnace bottom ash.

11.2.2 Following completion of the field trial

The Contractor shall submit the following to the Superintendent for review and approval following completion of the field trial:

– A report containing the methods, details and results of the field trial
– Updated work method statement(s) for installation of the drainage aggregate and furnace bottom ash based on the results of the field trail.

11.3 Method

The Contractor shall conduct a field trial of the drainage aggregate and furnace bottom ash for each source of drainage aggregate material, furnace bottom ash material and underlying liner arrangement. The purpose of the field trial is to evaluate the Contractor's proposed drainage aggregate and furnace bottom ash placement method and performance of the liner protection measures.

11.3.1 Proposed placement method

The Contractor shall submit a work method statement outlining the proposed placement method of the drainage aggregate and furnace bottom ash to the Superintendent prior to undertaking the field trial.

The work method statement shall include details of the following as a minimum:

– Method of transportation of drainage aggregate and furnace bottom ash to placement location
– Method of spreading drainage aggregate and furnace bottom ash
– Method of lift thickness control
– Details of plant and equipment to be used during placement, including calculation of ground pressure and proposed drainage aggregate and furnace bottom ash thickness limits during trafficking
– Details of temporary pads or access tracks for plant exceeding allowable ground pressure limits
– Approximate number of passes for each item of plant on the drainage aggregate and furnace bottom ash layers.

11.3.2 Field trial of placement method

The field trial shall be supervised by the following personnel as a minimum:

– Contractor
– Geosynthetic Installer
– Superintendent
– CQA Engineer.

The field trial may be constructed within the proposed layer area, or in an area approved by the Superintendent. The Contractor shall nominate the proposed location of the field trial for approval prior to undertaking the trial.

The field trial shall measure approximately 10 m by 20 m, unless otherwise approved by the Superintendent. Should the Superintendent approve construction of the field trial outside of the proposed drainage aggregate layer area, the Contractor shall construct the field trial on an area consistent with those represented on the Contract Drawings, and the areas of drainage aggregate and furnace bottom ash shall be constructed using the methods, materials and equipment to be used during construction of the permanent drainage aggregate and furnace bottom ash layers.

The complete underlying material profile shall be installed for the field trial to provide meaningful and complete results. The underlying materials for the field trial shall be installed as per the methods used to install the permanent underlying materials.

The drainage aggregate and furnace bottom ash shall be placed as per the work method statement outlined in Section 11.3.1. The field trial shall mimic the actual placement method and real-world conditions. Any variations from this work method statement shall result in a non-conforming field trial unless approved by the Superintendent.

The Superintendent may direct additional passes or turning manoeuvres to be performed at their discretion to fully test the effectiveness of the protection measures.

11.3.3 Exhumation and inspection of the underlying geosynthetics

Prior to removal of the drainage aggregate and furnace bottom ash, the layer thickness shall be recorded in order to compare the degree of damage to the thickness of the drainage aggregate and furnace bottom ash.

Following completion of the field trial, the underlying PE geomembrane shall be exposed.

Most of the material may be removed using an excavator; however, care shall be taken to avoid doing any further damage to the underlying geosynthetics. Within 100 mm of the PE geomembrane, the material shall be removed by hand excavation to avoid damage to the PE geomembrane.

Once the material has been removed, the PE geomembrane shall be inspected for damage. The PE geomembrane shall be inspected over the length of the field trial test area.

Damage to the PE geomembrane shall include any holes, creases, indentations or scratches. Undamaged geomembrane shall be unblemished.

The location of the damage shall be recorded and compared to the drainage aggregate and furnace bottom ash thickness at that point.

Where it is clear that there is no damage to any layers of the underlying geosynthetics as agreed with the Superintendent, the thickness of the drainage aggregate and furnace bottom ash and associated plant and equipment used at that point shall be recorded.

11.3.4 Reporting and update of the proposed placement method

The Contractor shall submit a report to the Superintendent outlining the major findings from the field trial. The Contractor shall update the proposed placement method to reflect the findings of the field trial.

The Superintendent shall review and approve the updated placement method prior to placement of the permanent drainage aggregate and furnace bottom ash layers. The report and updated placement method shall be provided to the Superintendent 10 working days prior to placement of the drainage aggregate and furnace bottom ash.

Appendices

Appendix A

Work method statements

Schedule of work method statements

Component	Work method statement requirements
General	The Contractor shall prepare the following general work method statements for review approval by the Superintendent: – Scheduling – Site access and traffic control – Survey control – Surface water management – Erosion and sediment control
Earthworks	The Contractor shall prepare an earthworks work method statement for review and approval by the Superintendent with consideration to the following: – Scheduling – Excavation – Filling – Stockpile management and control measures – Method of moisture conditioning, material placement and compaction for earthworks materials – Earthworks material layer thickness control and survey – Trimming and final surface preparation – Anchor trench excavation and backfilling – Defects and repairs – Quality control testing In addition, a specific work method statement shall be prepared for water conditioned ash placement.
Geotextile	The Contractor shall prepare a geotextile work method statement for review approval by the Superintendent with consideration to the following: Scheduling Storage and handling Surface preparation Panel placement Installation, ballast and protection Seams Defects and repairs Quality control testing
PE geomembrane	The Contractor shall prepare a PE geomembrane work method statement for review approval by the Superintendent with consideration to the following: – Scheduling – Storage and handling – Surface preparation – Panel placement – Installation, ballast and protection – Seams and welding – Defects and repairs – Quality control testing – Leak location survey
Geonet drainage composite	The Contractor shall prepare a geonet drainage composite work method statement for review approval by the Superintendent with consideration to the following: – Scheduling – Storage and handling – Surface preparation

Component	Work method statement requirements
	– Panel placement – Installation, ballast and protection – Seams – Defects and repairs – Quality control testing – Compression testing
Drainage aggregate	The Contractor shall prepare a drainage aggregate work method statement for review approval by the Superintendent with consideration to the following: – Scheduling – Method of material placement – Surface preparation – Material layer thickness control and survey – Trimming and final surface preparation – Defects and repairs – Quality control testing
PE pipework	The Contractor shall prepare a PE pipework work method statement for review approval by the Superintendent with consideration to the following: – Scheduling – Storage and handling – Installation and protection – Jointing – Defects and repairs – Quality control testing
Furnace bottom ash	The Contractor shall prepare a furnace bottom ash work method statement for review approval by the Superintendent with consideration to the following: – Scheduling – Method of material placement – Surface preparation – Material layer thickness control and survey – Trimming and final surface preparation – Defects and repairs
Field trials	The Contractor shall prepare a field trials work method statement for review approval by the Superintendent with consideration to the following: – Method of transportation of material to placement location – Details of plant and equipment to be used during placement – Method of spreading fill material – Method of lift thickness control – Approximate number of passes for each item of plant on the layer

Appendix B

Material Specification

Hydra Stream 3 Project – LNAR Stage 2B

Material Specification

EnergyAustralia Pty Ltd

19 July 2024

→ The Power of Commitment



Project name		Energy Australia - Hydra Stream 3 - Ash Repository Design Services					
Document title		Hydra Stream 3 Project – LNAR Stage 2B | Material Specification					
Project number		12610307					
File name		12610307-Mt Piper Ash Repository - Material Specification Stage 2B.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	S. Kerle R. Huynh	C. Nivison-Smith		A. Roberts		19/7/24

GHD Pty Ltd | ABN 39 008 488 373
Contact: Ryan Huynh, Senior Civil / Environmental Engineer | GHD
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmail@ghd.com | **ghd.com**

© GHD 2024
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Contents

1. Introduction **1**

1.1 General 1

1.2 Definitions 1

1.3 Drawing list 2

1.4 Lines of communication 3

1.5 Quality 3

1.5.1 Construction quality control 3

1.5.2 Construction quality assurance 3

1.5.3 Independent conformance testing 3

1.6 Witness and hold points 4

1.7 Variations to the design 5

1.8 Standards 5

1.8.1 Australian standards 5

1.8.2 American Society for Testing and Materials Standards 6

1.8.3 Geosynthetic Research Institute Standards 8

1.8.4 Water Services Association of Australia 8

2. Materials **9**

2.1 General 9

2.2 Unsuitable material 9

2.3 Select fill 9

2.3.1 Submittals prior to delivery of select fill material to site 9

2.3.2 Material 9

2.4 Furnace bottom ash 10

2.4.1 Submittals prior to stockpiling of furnace bottom ash 10

2.4.2 Material 10

2.5 PE geomembrane 11

2.5.1 Submittals prior to selection of the polyethylene geomembrane manufacturer 11

2.5.2 Submittals prior to delivery of polyethylene geomembrane to site 11

2.5.3 Manufacturer’s quality control 12

2.5.4 Manufacturer’s quality assurance 12

2.5.5 Material 12

2.5.6 Roll and sample identification 14

2.5.7 Delivery, storage, and handling 15

2.6 Geosynthetic clay liner 15

2.6.1 Submittals prior to selection of the geosynthetic clay liner manufacturer 15

2.6.2 Submittals prior to delivery of geosynthetic clay liner to site 16

2.6.3 Manufacturer’s quality control 16

2.6.4 Manufacturer’s quality assurance 16

2.6.5 Material 17

2.6.6 Roll and sample identification 18

2.6.7 Delivery, storage, and handling 18

2.7 Geonet drainage geocomposite 19

2.7.1 Submittals prior to selection of the geonet drainage geocomposite manufacturer 19

2.7.2 Submittals prior to delivery of geonet drainage geocomposite to site 19

2.7.3 Manufacturers quality control 20

2.7.4 Manufacturers quality assurance 20
2.7.5 Material 20
2.7.6 Roll and sample identification 21
2.7.7 Delivery, storage, and handling 21
2.8 Geotextile 21
2.8.1 Submittals prior to selection of the geotextile manufacturer 21
2.8.2 Submittals prior to delivery of geotextile to site 22
2.8.3 Manufacturer's quality control 22
2.8.4 Manufacturer's quality assurance 22
2.8.5 Material 23
2.8.6 Roll and sample identification 24
2.8.7 Delivery, storage, and handling 24
2.9 PE pipework 25
2.9.1 Submittals prior to delivery of PE pipework to site 25
2.9.2 Materials 25
2.9.3 Delivery, storage, and handling 25
2.10 Drainage aggregate 26
2.10.1 Submittals prior to delivery of drainage aggregate to site 26
2.10.2 Materials 26
2.11 Leachate sump pump and rising main 27
2.11.1 Submittals prior to delivery of leachate sump pump 27
2.11.2 Sump pump 27
2.11.3 Rising main 27

Table index

Table 1 Definitions 1
Table 2 Drawing list 2
Table 3 Independent sample size and frequency schedule 4
Table 4 Witness and hold points 5
Table 5 Acceptance criteria – Select fill 10
Table 6 Acceptance criteria – Furnace bottom ash 11
Table 7 Acceptance criteria – PE geomembrane 13
Table 8 Acceptance criteria – GCL 17
Table 9 Acceptance criteria – Geonet drainage geocomposite 20
Table 10 Acceptance criteria – Geotextile 23
Table 11 Acceptance criteria – Drainage aggregate 26

Figure index

Figure 1 Lines of communication 3

1. Introduction

1.1 General

This Material Specification contains the material requirements for the construction of the Stage 2B Cell (the Works) at the Mount Piper Power Station (MPPS) (the site) and must be read in conjunction with the other Contract Documents. This document contains the requirements for the supply and approval of the materials only; a separate Technical Specification has been developed for the installation specifications.

Where the Material Specification and any other Contract Documents do not agree, the Contractor shall seek clarification from the Superintendent.

1.2 Definitions

The Definitions described in the Contract Documents apply to this document. The following additional terms used in this Material Specification shall have the meanings ascribed to them below unless the context otherwise requires:

Table 1 Definitions

Term	Definition
Contract	The agreement between the Principal and Contractor
Contract Drawings	The construction drawings which form part of the Contract Documents
Contract Documents	The documents which form the Contract
Contractor	The person bound to execute the work under the Contract
Contractor's Independent Testing Firm	Independent testing firm(s) engaged by the Contractor to conduct construction quality control (CQC) testing
Construction Quality Assurance (CQA) Engineer	Suitably qualified professional responsible for administering the CQA requirements for the Works
Construction Quality Assurance (CQA) Engineer's Independent Testing Firm	Independent testing firm(s) engaged by the CQA Engineer to conduct CQA testing
Construction Quality Assurance (CQA) Plan	Plan forming part of the Contract Documents, describing the construction quality assurance requirements for the Works
Designer	GHD Pty Ltd
Excavated Natural Material (ENM)	As defined in the NSW EPA excavated natural material exemption 2014 (**http://www.epa.nsw.gov.au/resources/waste/rre14-excavated-natural-material.pdf**)
Field Crew Foreman	Foreman for the Geosynthetic Installer's field crew, as defined by the Contractor
Geosynthetic	Synthetic material (man-made plastic and fabric) used in geotechnical and construction applications
Geosynthetic Installer	Firm subcontracted by the Contractor to complete the installation of geosynthetic for the Works
Leak Location Contractor	Contractor engaged by the CQA Engineer to conduct leak location surveys throughout the Works
Material Specification	This document
Minimum Average Roll Value (MARV)	Calculated as per GRI White Paper #10 The Dual Roles for Using MARV (**http://www.geosynthetic-institute.org/papers/paper10.pdf**)
Maximum Average Roll Value (MaxARV)	Calculated as per GRI White Paper #10 The Dual Roles for Using MARV (**http://www.geosynthetic-institute.org/papers/paper10.pdf**)
Principal	As defined in the Conditions of Contract
Regulatory Authority	Authority responsible for licencing the Works

Term	Definition
Seaming Crew	Crew responsible for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor
Seaming Foreman	Foreman for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor
Superintendent	As defined in the Conditions of Contract
Technical Specification	Document which contains the technical requirements for procedures to be implemented for the construction for the Works, which form part of the Contract Documents
Virgin Excavated Natural Material (VENM)	Virgin excavated natural material. As defined in Schedule 1 of the *Protection of the Environment Operations Act 1997*
Work under the Contract	The work which the Contractor is or may be required to execute under the Contract and includes variations, remedial work, constructional plant and temporary works
Works	The whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract, which by the Contract is to be handed over to the Principal
Works Area	As shown on the Contract Drawings

1.3 Drawing list

This Material Specification shall be considered in conjunction with the Contract Drawings described in Table 2.

Table 2 Drawing list

Drawing no.	Drawing title	Revision
12610307-G101	Cover Sheet, Locality Plan and Drawing List	0
12610307-G102	Existing Site Plan	0
12610307-C101	Stage 2B South Early Works	0
12610307-C102	Stage 2B South Lining System	0
12610307-C103	Stage 2B South Leachate Collection System	0
12610307-C104	Stage 2B North Early Works	0
12610307-C105	Stage 2B North Lining System	0
12610307-C106	Stage 2B North Leachate Collection System	0
12610307-C107	Cut And Fill Plan	0
12610307-C109	Long Section	0
12610307-C110	Cross Sections	0
12610307-C111	Typical Sections And Details - Sheet 1 of 6	0
12610307-C112	Typical Sections and Details - Sheet 2 of 6	0
12610307-C113	Typical Sections and Details - Sheet 3 of 6	0
12610307-C114	Typical Sections and Details - Sheet 4 of 6	0
12610307-C115	Typical Sections and Details - Sheet 5 of 6	0
12610307-C116	Typical Sections and Details - Sheet 6 of 6	0
12610307-C117	Pumping Arrangement Plan	0

1.4 Lines of communication

The lines of communication for the Works are illustrated in Figure 1. The Superintendent shall be the main point of liaison between the Contractor and the CQA Engineer, as well as the Contractor and the Principal.

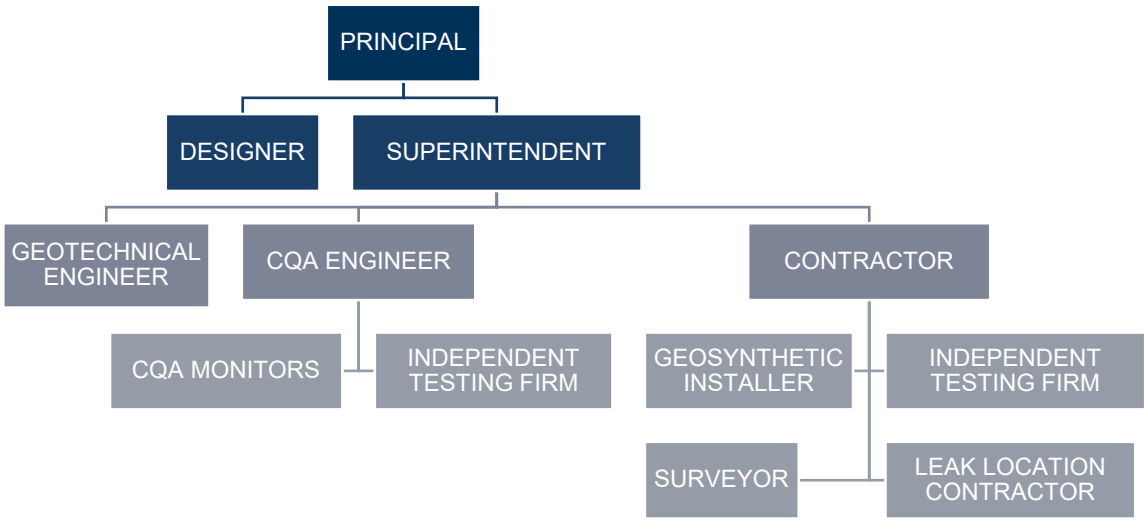


Figure 1 Lines of communication

1.5 Quality

1.5.1 Construction quality control

All construction quality control (CQC) testing shall be arranged by the Contractor and shall be carried out by the Contractor's Independent Testing Firm. The cost of CQC testing shall be borne by the Contractor. Unless noted otherwise, copies of all test results shall be sent to the Superintendent as soon as available but in any event within two days of becoming available. The minimum testing frequencies shall be as nominated within this Material Specification.

At any stage throughout the Works, the Superintendent may arrange for independent testing and/or surveying to be carried out. If that testing reveals that any works are found to be not compliant with the requirements of this Material Specification and the Contract Drawings, the Contractor shall undertake rectification of the non-compliant items and conduct re-testing in accordance with this Material Specification. All costs of undertaking such rectification work and re-testing shall be borne by the Contractor.

1.5.2 Construction quality assurance

A Construction Quality Assurance (CQA) Plan has been developed in conjunction with this Material Specification and shall be implemented by the Principal to verify that the Works are undertaken in a manner that meets the requirements of the Contract Documents.

The Principal shall engage an independent organisation (the CQA Engineer), under contract to the Principal, who shall facilitate the requirements of the CQA Plan. This shall include independent CQA monitoring, observation, testing and documentation on behalf of the Principal.

The Contractor shall cooperate fully with the Superintendent and all representatives of the CQA Engineer during any independent CQA sampling, testing, and certification and shall ensure, at all times, safe access to the Works for the purpose of monitoring, observation, and CQA implementation.

1.5.3 Independent conformance testing

The CQA Engineer shall arrange for independent conformance testing of the materials used in the Works, in accordance with the CQA Plan, to assure conformance with this Material Specification. Samples shall be collected

at locations designated by the CQA Engineer and all independent conformance sampling shall be witnessed by the CQA Engineer.

The sample frequency shall be in accordance with Table 3. The table also identifies the indicative sample size. The sample sizes shall be confirmed by the CQA Engineer prior to construction. Sampling shall include the first and last roll. The specified frequency assumes all rolls are from a single manufacturing run. If rolls are from different manufacturing runs, then the frequency shall be applied to each manufacturing run. The test frequency for all rolls where, in the opinion of the CQA Engineer, the manufacturing run cannot be identified shall be every roll for all test types. Samples shall not be taken from the outer wrap of the roll.

Table 3 Independent sample size and frequency schedule

Material	Indicative size	Frequency
Geonet drainage geocomposite	1 metre by roll width	1 per 1,250 m^2, including the first and last roll (based on production order) – minimum of two tests
Geosynthetic clay liner	1 metre by roll width	1 per 1,250 m^2, including the first and last roll (based on production order) – minimum of two samples
Polyethylene geomembrane	1 metre by roll width	1 per 5,000 m^2, including the first and last roll (based on production order) – minimum of two samples
Geotextile	1 metre by roll width	1 per 5,000 m^2, including the first and last roll (based on production order) – minimum of two tests

As a minimum, a period of 10 weeks shall be allowed for from the completion of on-site sampling of all geosynthetic materials on-site to the receipt of independent conformance testing results and subsequent approval/rejection of the materials for use. This shall be confirmed by the CQA Engineer prior to construction.

If a sample records a non-conforming test result, it may be re-tested. If it passes this retest, both results shall be provided in the laboratory report from the relevant independent testing firm. If the retest produces a non-conforming test result, the Contractor shall remove and replace all rolls between the sampled roll and the nearest conforming rolls either side (based on the production order of the rolls). The Contractor may, by testing and verification of these intermediate rolls, reduce the range of rolls to be removed in this way. Such additional testing shall be for the full range of specified tests, not just the test or property which yielded a failure.

In the event of discrepancies between the CQA Engineer's test results and the Contractor's test results, the Contractor shall be responsible for arranging a third independent testing firm to verify the test results.

Any replacement material shall receive the independent conformance testing in accordance with the CQA Plan.

1.6 Witness and hold points

The following information applies to witness and hold points for the Works:

– A hold point is a defined position in the Works beyond which work shall not proceed without mandatory verification and acceptance by the Superintendent
– A witness point is a nominated position in the Works where the option of attendance may be exercised by the Superintendent, after notification of the requirement
– It shall be the Contractor's responsibility to ensure that all obligations are fulfilled in regard to the witness and hold points within the Contract
– The Contractor shall give the Superintendent a minimum 2 days notice prior to the required inspection
– Witness or hold points may be released for part of the Works Area only, as defined by the Superintendent, so that the Works can be completed in a sequenced manner. The Superintendent's approval of the completed items is required prior to the release of each witness or hold point.

Table 4 contains a list of activities to which witness and hold points apply.

Table 4 Witness and hold points

Item	Description	Witness	Hold
1	**Select fill**		
	Prior to delivery of select fill material to site, provision of submittals identified in Section 2.3.1		✓
2	**Furnace bottom ash**		
	Prior to stockpiling of furnace bottom ash, provision of submittals identified in Section 2.4.1		✓
3	**PE geomembrane**		
	Prior to selection of the PE Geomembrane manufacturer, provision of submittals identified in Section 2.5.1		✓
	Prior to delivery of PE Geomembrane to site, provision of submittals identified in Section 2.5.2		✓
4	**Geosynthetic clay liner**		
	Prior to selection of the GCL manufacturer, provision of submittals identified in Section 2.6.1		✓
	Prior to delivery of GCL to site, provision of submittals identified in Section 2.6.2		✓
5	**Geonet drainage geocomposite**		
	Prior to delivery of geonet drainage geocomposite to site, provision of submittals identified in Section 2.7.1		✓
	Prior to installation of geonet drainage geocomposite, provision of submittals identified in Section 2.7.2		✓
6	**Geotextile**		
	Prior to selection of geotextile manufacturer, provision of submittals identified in Section 2.8.1		✓
	Prior to delivery of geotextile to site, provision of submittals identified in Section 2.8.2		✓
7	**PE pipework**		
	Prior to delivery of PE pipework to site, provision of submittals identified in Section 2.9.1		✓
8	**Drainage aggregate**		
	Prior to delivery of drainage aggregate to site, provision of submittals identified in Section 2.10.1		✓

1.7 Variations to the design

Any variations to the design documentation, specifically the Contract Drawings, Material Specification, Technical Specification and/or the CQA Plan require assessment and approval by the Designer.

1.8 Standards

1.8.1 Australian standards

– 1141.11 Methods for Sampling and Testing Aggregates – Particle size distribution/dry sieve
– 1141.3.1 Methods for Sampling and Testing Aggregates – Sampling of aggregates and rock
– 1152 Specification for test sieves
– 1289 Methods of testing soils for engineering purposes
– 1289.2.1.1 Determination of the moisture content of a soil - oven drying method

- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.2 Soil classification tests—Determination of the particle size distribution of a soil – Analysis by sieving in combination with hydrometer analysis (subsidiary method)
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of Emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.1 Methods for Testing Soils for Engineering Purposes – Determination of the permeability of a soil
- 1289.6.7.2 Determination of the permeability of a soil - Falling head method for a remoulded specimen
- 1289.6.7.3 Determination of the permeability of a soil - Constant head method using a flexible wall permeameter
- 1463 Polyethylene Pipe Extrusion Compounds
- 1646 Elastomeric Seals for Water Works Purposes
- 1726 Geotechnical site investigations
- 2001.2.3 Methods of test for textiles - Physical tests - Determination of breaking force and extension of textile fabrics
- 2033 Installation of Polyethylene Pipe Systems
- 2698.2 Plastic Pipes and Fittings for Irrigation and Rural Applications Polyethylene Rural Pipes
- 2700 Colour Standards for General Purposes
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3704 Geosynthetics-Glossary of Terms
- 3705 Geotextiles-Identification, marking and general data
- 3706.1 Geotextiles - Methods of test - General requirements, sampling, conditioning, basic physical properties and statistical analysis
- 3706.2A Determination of tensile properties – Wide-strip method
- 3706.3 Determination of tearing strength - Trapezoidal method
- 3706.4 Geotextiles - Methods of test - Determination of burst strength - California bearing ratio (CBR) - Plunger method
- 3706.7 Determination of pore-size distribution - Dry-sieving method
- 3706.9 Determination of permittivity, permeability and flow rate
- 3798 Guidelines on earthworks for commercial and residential developments
- 4129 Fittings for Polyethylene Pipes for Pressure Applications
- 4130 Polyethylene Pipes for Pressure Applications
- 4131 Polyethylene Compounds for Pressure Pipes and Fittings
- 4419 Soil for landscaping and garden use.

1.8.2 American Society for Testing and Materials Standards

- D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting

- D1204 Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
- D123 Terminology Relating to Textiles
- D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1388 Test Methods for Stiffness of Fabrics
- D1505 Standard Test Method for Density of Plastics by the Density Gradient Technique
- D1603 Standard Test Method for Carbon Black in Olefin Plastics
- D3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Colorimetry
- D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
- D4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing
- D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- D4437 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4439 Standard Terminology for Geosynthetics
- D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4595 Tensile Properties of Geotextiles by the Wide Width Strip Method
- D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4716 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5262 Tension Creep Testing of Geosynthetics
- D5322 Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids
- D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
- D5514 Standard Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics
- D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
- D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- D5818 Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
- D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Colorimetry
- D5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners
- D5889 Standard Practice for Quality Control of Geosynthetic Clay Liners
- D5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembranes
- D6072 Standard Practice for Obtaining Samples of Geosynthetic Clay Liners
- D6102 Standard Guide for Installation of Geosynthetic Clay Liners

- D6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
- D6392 Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- D6395 Standard Practice for Non-destructive testing of Geomembrane Seams using Spark Test
- D6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners
- D6693 Standard Test Method for Determining Tensile Properties of Non-Reinforced Polyethylene and Non-Reinforced Flexible Polypropylene Geomembranes
- D6767 Standard Test Method for Pore Size Characteristics of Geotextiles by Capillary Flow Test
- D6992 Test Method for Accelerated Tensile Creep and Creep Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- D7005 Determining The Bond Strength (Ply-Adhesion) of Composites
- D7179 Standard Test Method for Determining Geonet Bearing Force.
- D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
- D7466 Standard Test Method for Measuring Asperity Height of Textured Geomembranes
- D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- G22 Determining Resistance of Synthetic Polymer Materials to Bacteria

1.8.3 Geosynthetic Research Institute Standards

- GC8 Standard Guide for Determination of the Allowable Flow Rate of a Drainage Composite
- GCL3 Specification for Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners
- GM9 Standard Practice for Cold Weather Seaming of Geomembranes
- GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
- GM13 Standard Specification for Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM14 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
- GM17 Standard Specification for Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM19 Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
- GM20 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts
- GM29 Standard Practice for Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and/or Non-destructive Testing
- GN2 and GC13 Standard Guide for Jointing and Attaching Geonets and Drainage Composites.
- GT12(a) Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials
- GT13(a) Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

1.8.4 Water Services Association of Australia

- WSA 02-2002 Sewerage Code of Australia
- WSA 03-2002 Water Supply Code of Australia.

2. Materials

2.1 General

This section contains the requirements for acceptance of each material. The requirements are included in the individual sections of this Material Specification.

The Contractor shall be responsible for the co-ordinating, delivery, approval, storage, preparation, handling of all materials.

The Contractor is responsible for ensuring its program allows time for material testing, assessment, and approval.

If materials proposed for use in the Works are damaged while under the Contractor's care, the Contractor is responsible for replacing the materials at no expense to the Principal.

Importation of materials from off-site shall comply with the approved truck volumes under Mount Piper Power Station Development Consent (80-10060) and shall be in accordance with the MPPS Operational Environmental Management Plan (OEMP).

2.2 Unsuitable material

All soil/earthen material types shall not contain any of the following:

– Organic soils, such as topsoils, severely root-affected subsoils and peat
– Materials contaminated through past site usage which may contain toxic substances or soluble compounds harmful to water supply or agriculture
– Materials containing substances that can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture
– Silts or materials that have the deleterious engineering properties of silt
– Materials containing fire ant infestation/s
– Fill that contains wood, metal, plastic, boulders or other deleterious material
– Actual or potential acid sulphate soils (ASS)
– High plasticity clays
– Material susceptible to combustion.

2.3 Select fill

2.3.1 Submittals prior to delivery of select fill material to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of each type of fill material to site (per material source):

– Material source
– Certification that the material is VENM or ENM
– Pre-qualification test results/reports demonstrating that the material complies with the relevant material property requirements of this Material Specification
– Estimated quantity of material which is represented by the pre-qualification test results/reports.

2.3.2 Material

Select fill material shall:

– Be selectively sourced material from on-site or imported from an approved source.
– Imported material shall be classed as VENM or ENM

– Not contain any unsuitable materials identified in Section 2.2 unless approved by the Superintendent
– Be well graded in accordance with AS 1726
– Comply with the acceptance criteria specified in Table 5.

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 5 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 5 Acceptance criteria – Select fill

Property	Test method	Acceptance criteria	Minimum test frequency
Particle size distribution: - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	 100% > 15%	1 per 5,000 m^3, minimum 3 tests per source
Atterberg limits: - Plasticity index - Liquid limit	AS 1289.3.1.1, 3.2.1 & 3.3.1	 8 – 35 ≤ 50	1 per 5,000 m^3, minimum 3 tests per source
Emerson class	AS 1289.3.8.1	> 3	1 per 5,000 m^3, minimum 3 tests per source
% Organic content	AS 1289.4.1.1	< 5%	1 per 5,000 m^3, minimum 3 tests per source

2.4 Furnace bottom ash

2.4.1 Submittals prior to stockpiling of furnace bottom ash

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of each type of fill material to site (per material source):

– Material source.
– Pre-qualification test results/reports demonstrating that the material complies with the relevant material property requirements of this Material Specification.
– Estimated quantity of material which is represented by the pre-qualification test results/reports.

2.4.2 Material

The FBA shall:

– Be ash produced by the MPPS
– Be free of organic matter or detritus materials
– Not contain components that could pose harm to the other materials
– Comply with the acceptance criteria specified in Table 6.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 6 showing that the proposed material meets the requirements of this table.

Table 6 Acceptance criteria – Furnace bottom ash

Property	Test method	Acceptance criteria	Minimum testing frequency	Notes
Permeability	AS1289.6.7.1 Prepare specimen by light tamping (to ~90% SMDD) under moist conditions	1 x 10^{-6} m/s	1 per 1,000m^3, minimum 3 tests per source	Constant head test. Test after sample pre-treated as per RMS T102 (3 cycles)
Grading	AS 1141.11 / 12	min 100% < 19mm max 35% < 75µm	1 per 1,000m^3, minimum 3 tests per source	Test after sample pre-treated as per RM St102 (3 cycles)
Atterberg Limits	AS 1289.3.1.1 / 3.2.1 / 3.3.1	Non-plastic	1 per 1,000m^3, minimum 3 tests per source	
Shear strength	AS 1289.6.2.2	Shear strength, equivalent to that of a drained friction angle of 30 degrees	1 per 3,000m^3, minimum 3 tests per source	Test pressures 25, 50, 100, 200, 400 kPa. Test after sample pre-treated as per RM St102 (3 cycles)

2.5 PE geomembrane

2.5.1 Submittals prior to selection of the polyethylene geomembrane manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a PE geomembrane manufacturer (per manufacturer and product):

– Product manufacturer
– Product name
– Material data sheet showing the material properties of the proposed PE geomembrane
– A list documenting no less than 10 completed facilities totalling a minimum of 50 hectares for which the manufacturer has manufactured PE geomembrane similar to this Material Specification. For each facility the following information shall be provided:
  - Name and purpose of the facility
  - The location and date of installation
  - The name of the owner, the project manager, designer, fabricator (if any), and the installer
  - If requested, the name and telephone number of the contact at the facility who can discuss the project
  - The PE geomembrane type, thickness, and total square metres of the installation surface.
– Documentation indicating that the polymer supplier has previously produced a minimum of 1,000 tonne of polymer of the same composition as that proposed for use in the manufacture of the PE geomembrane for the Works
– Manufacturer's quality control and assurance procedures.

2.5.2 Submittals prior to delivery of polyethylene geomembrane to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of PE geomembrane to site (per PE geomembrane product):

– Manufacturer's certificate of compliance outlining conformance with the requirements of this Material Specification
– Manufacturer's quality control and assurance test results

– Certification that the PE geomembrane supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If the PE geomembrane is not manufactured from consecutive lots, the resin manufacturer shall provide certification of quality and consistency of the resin characteristics
– Statement on the origin of the resin, its identification (type and lot number), resin supplier's name and production plant, resin brand name and type, and the maximum amount of recycling polymer material added to the raw resin
– Copies of quality control certificates issued by the resin supplier which shall include testing conducted to verify conformance with Table 10
– Certifications that the PE geomembrane and extrudate produced for the Works have the same properties and are of the same resin
– Complete description of the manufacturer's shipping, handling and storage procedures
– Manufacturer's installation procedures and requirements
– Work method statement for PE geomembrane delivery, storage and handling. This shall include proposed handling equipment and restraining methods, and other information that shall promote proper use.

2.5.3 Manufacturer's quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all PE geomembrane for the Works.

Manufacturer's quality control submissions shall include:

– Date of manufacture
– Lot number, roll number, length and width
– Manufacturer quality control documentation for the particular lot of resin used in the production of the rolls delivered
– Cross-referencing list delineating the corresponding resin used in the production of the rolls delivered
– Quality control program laboratory-certified reports
– The manufacturer's approved quality assurance stamp and the technician's signature.

The frequency of sampling and testing shall be in accordance with Table 10.

The Superintendent may reject any PE geomembrane rolls that have not been sampled and/or tested in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.5.4 Manufacturer's quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all PE geomembrane for the Works.

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

The Superintendent may reject any PE geomembrane rolls that have not been sampled and/or tested in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.5.5 Material

The PE geomembrane shall:

– Be manufactured of new, first-quality resin and shall be compounded and continuously manufactured specifically for the Works. All rolls delivered to site shall be consecutive from the same batch/lot unless

otherwise approved. The resin manufacturer shall certify each batch for the acceptance criteria listed in Table 7

– Comply with the acceptance criteria specified in Table 7
– Not contain more than 1 percent non-volatile pigment or fillers other than carbon black
– Not be factory seamed.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 7 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots.

If required by the Superintendent, a sample of the PE geomembrane shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 7 Acceptance criteria – PE geomembrane

Property	Test method	Acceptance criteria		Minimum testing frequency
		2 mm LLDPE (Smooth)	2 mm LLDPE (Single sided textured)	
Resin [1]				
Density (max.)	ASTM D1505 or D792 (method B)	0.926 g/cm^3	0.926 g/cm^3	per resin lot
Melt index (max.) [2]	ASTM D1238	1.0 g/10 min	1.0 g/10 min	per resin lot
Sheet				
Thickness (min. average)	ASTM D5199 (smooth) ASTM D5994 (textured)	2.0 mm	1.9 mm	every roll
Thickness (min.) - Lowest individual of 8 of 10 readings - Lowest individual of 10 readings	ASTM D5199 (smooth) ASTM D5994 (textured)	 - 1.8 mm	 1.8 mm 1.7 mm	every roll
Asperity height (min. average) [3]	ASTM D7466	-	0.4 mm	every 2nd roll
Density (max.)	ASTM D1505 or D792 (method B)	0.939 g/cm^3	0.939 g/cm^3	90,000 kg
Tensile properties (min. average) [4] - break strength - break elongation	ASTM D6693	 53 N/mm 800%	 21 N/mm 250%	9,000 kg
2% modulus (max.)	ASTM D5323	414 MPa	414 MPa	per each formulation
Tear resistance (min. average)	ASTM D1004	200 N	200 N	20,000 kg
Puncture resistance (min. average)	ASTM D4833	500 N	400 N	20,000 kg

[1] Base resin density without carbon black or additives added
[2] Conducted at 190°C with 2.16 kg mass applied
[3] Alternate the measurement side for double sided textured sheet
[4] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of five test specimens each direction:
- LLDPE break elongation is calculated using a gage length of 50 mm at 50 mm/min

Property	Test method	Acceptance criteria		Minimum testing frequency
		2 mm LLDPE (Smooth)	2 mm LLDPE (Single sided textured)	
Axi-symmetric break resistance (min.)	ASTM D5617	30%	30%	per each formulation
Carbon black content (range)	ASTM D4218 [5]	2 to 3%	2 to 3%	20,000 kg
Carbon black dispersion (category) [6]	ASTM D5596	Cat 1 or 2 only	Cat 1 or 2 only	20,000 kg
Oxidative induction time (OIT) (min. average) [7] - standard OIT AND - high pressure OIT	 ASTM D3895 ASTM D5885	 100 min 400 min	 100 min 400 min	90,000 kg
Oven aging at 85°C (min. average) - standard OIT AND - high pressure OIT	ASTM D5721 ASTM D3895 ASTM D5885	 35% retained at 90 days 60% retained at 90 days	 35% retained at 90 days 60% retained at 90 days	per each formulation
UV resistance (min. average) [8] - high pressure OIT [9]	ASTM D7238 ASTM D5885	35% retained after 1600 hours	35% retained after 1600 hours	per each formulation

2.5.6 Roll and sample identification

All PE geomembrane rolls and samples shall be identified in accordance with ASTM D4873.

Each roll or panel shall carry a label which identifies, as a minimum:

– Product name, grade and name of manufacturer
– Date of manufacture, batch number
– Material thickness
– Roll number
– Roll length
– Roll weight
– Roll width
– Handling guidelines
– Reference numbers to raw material batch and laboratory certified reports
– The manufacturer's approved quality assurance stamp and the technician's signature.

The Superintendent may reject any PE geomembrane rolls or samples that have not been identified in accordance with this section.

[5] Other methods such as ASTM D1603 (tube furnace) or ASTM D6370 (TGA) are acceptable if an appropriate correlation to ASTM D4218 (muffle furnace) can be established
[6] Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 10 in categories 1 or 2 only, none in category 3

[7] Samples to be evaluated at 30 and 60 days to compare with the 90 day response
[8] The condition of the test should be 20 hour UV cycle at 75ºC followed by 4 hour condensation at 60ºC
[9] UV resistance is based on percent retained value regardless of the original high pressure OIT value

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.5.7 Delivery, storage, and handling

The Contractor shall prepare a work method statement for delivery, storage, handling of PE geomembrane. The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE geomembrane to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

– Delivery, storage and handling of all PE geomembrane rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum
– Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls
– Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling
– Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals
– PE geomembrane roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls
– Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement
– The Contractor shall inspect all PE geomembrane rolls for defects and damage upon delivery.

The Superintendent may reject any PE geomembrane rolls that have not been delivered, stored, or handled in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.6 Geosynthetic clay liner

2.6.1 Submittals prior to selection of the geosynthetic clay liner manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a GCL manufacturer (per manufacturer and product):

– Product manufacturer
– Product name
– Material data sheet showing the material properties of the proposed GCL
– A list documenting at least 10 completed facilities totalling a minimum of 50 hectares for which the manufacturer has manufactured GCL similar to this Material Specification. For each facility the following information shall be provided:
    - Name and purpose of the facility, its location and the date of installation
    - The name of the owner, the project manager, designer, fabricator (if any), and the installer
    - If requested, the name and telephone number of a reference contact at the facility who can discuss the
    - project
    - The GCL type and total square metres of the installation surface

– Manufacturer’s quality control and assurance procedures (including the geotextile components).

2.6.2 Submittals prior to delivery of geosynthetic clay liner to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of GCL to site (per GCL product):

– Manufacturer’s certificate of compliance stating conformance with the requirements of this Material Specification
– Manufacturer’s quality control and assurance test results
– Certification that the GCL supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If the GCL is not manufactured from consecutive lots, the manufacturer shall provide certification of quality and consistency of the product characteristics
– Statement on the origin of the bentonite, bentonite supplier’s name and production plant, and bentonite brand name and type
– Copies of quality control certificates issued by the bentonite supplier to verify conformance with Table 8
– Manufacturer’s certification (per 50 tonnes of product) that the bentonite form is natural sodium bentonite powder[10]
– Complete description of the manufacturer’s shipping, handling and storage procedures
– Manufacturer’s installation procedures and requirements
– Work method statement for GCL delivery, storage and handling.

2.6.3 Manufacturer’s quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all GCL for the Works.

Manufacturer’s quality control submissions shall include:

– Date of manufacture
– Lot number, roll number, length and width
– Bentonite manufacturer quality control documentation for the particular lot of clay used in the production of the rolls delivered
– Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered
– Cross-referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered
– Quality control program laboratory-certified reports
– The manufacturer’s approved quality assurance stamp and the technician’s signature.

The frequency of sampling and testing shall be in accordance with Table 8.

The Superintendent may reject any GCL rolls that have not been sampled and/or tested in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.6.4 Manufacturer’s quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all GCL for the Works.

[10] Bentonite powder consisting of > 80 wt% sodium as activated bentonite may be used with approval from the Superintendent. Approval shall be sought prior to construction and prior to selection of GCL manufacturer

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

The Superintendent may reject any GCL rolls that have not been sampled and/or tested in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.6.5 Material

The GCL shall:

– Be new, first quality products manufactured for the Works
– Be a proprietary product comprising a layer of natural sodium bentonite powder [11] of uniform thickness and consistency, reinforced by stitch-bonding or needle-punching to fully integrate the cover and carrier geotextile/s and constrained by thermally locking. All rolls delivered to site shall be consecutive from the same batch/lot unless otherwise approved.
– Certified as needle-free by the manufacturer
– Comply with the acceptance criteria specified in Table 8.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 8 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots. In addition to this, manufacturer's certification (per 50 tonnes of product) that the bentonite form is natural sodium bentonite powder shall be provided for all the GCL rolls supplied.

If required by the Superintendent, a sample of the GCL shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 8 Acceptance criteria – GCL

Property	Test method	Acceptance criteria	Minimum testing frequency
Bentonite clay			
Bentonite clay – particle size (min.)	AS 1289.3.6.2	80% passing 75 micron sieve (powdered)	every 50 tonnes
Bentonite clay – free swell index (min.)	ASTM D5890	24 mL/2g or $cm^3/2g$	every 50 tonnes
Bentonite clay – fluid loss (max.)	ASTM D5891	18 mL	every 50 tonnes
Bentonite clay – montmorillonite content (min.)	CSIRO x-ray diffraction	70%	every 50 tonnes
Bentonite clay – carbonate content (max.)	CSIRO x-ray diffraction	2 wt%	every 50 tonnes
Bentonite clay – cation exchange capacity (min.)	Methylene blue method	70 meq/100g or cmol/kg	every 50 tonnes
Geotextile			
Cover geotextile - mass (MARV) Non-woven	AS 3706.1	200 g/m^2	every 20,000 m^2
Carrier geotextile - mass (MARV) Non-woven AND woven	AS 3706.1	200/100 g/m^2	every 20,000 m^2

[11] Bentonite powder consisting of > 80 wt% sodium as activated bentonite may be used with approval from the Superintendent. Approval shall be sought prior to selection of GCL manufacturer

Property	Test method	Acceptance criteria	Minimum testing frequency
Durability of geotextile and reinforcing yarns (min.) [12]	Section 5.6.2 of GRI-GCL3	65%	yearly
Geosynthetic clay liner			
GCL mass per unit area @ 0% moisture (MARV) [13]	ASTM D5993	4,100 g/m^2	every 4,000 m^2
Bentonite clay mass per unit area @ 0% moisture (MARV) [4]	ASTM D5993	3,700 g/m^2	every 4,000 m^2
Bentonite clay moisture content (max.)	ASTM D5993	35%	every 4,000 m^2
Strip tensile strength (MARV) Machine direction	 ASTM D6768	 10 kN/m	 every 20,000 m^2
Peel strength (MARV)	ASTM D6496	360 N/m	every 4,000 m^2
Hydraulic conductivity (max.)	ASTM D5887	5 x 10^{-11} m/s	every 25,000 m^2

2.6.6 Roll and sample identification

All GCL rolls and samples shall be identified in accordance with ASTM D4873.

Each roll or panel shall carry a label which identifies, as a minimum:

– Product name, grade and name of manufacturer
– Date of manufacture, batch number
– Roll number
– Roll length
– Roll weight
– Roll width
– Handling guidelines
– Reference numbers to raw material batch and laboratory certified reports
– The manufacturer's approved quality assurance stamp and the technician's signature.

The Superintendent may reject any GCL rolls or samples that have not been identified in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.6.7 Delivery, storage, and handling

The Contractor shall prepare a work method statement for delivery, storage, handling of GCL The work method statement shall be submitted to the Superintendent for review and approval prior to delivery of the GCL to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

– Delivery, storage and handling of all GCL rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D5888 as a minimum
– Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls
– Rolls shall be wrapped with weather and moisture-proof wrapping to prevent any contact with water prior to installation. In the event that it is suspected that roll/s may have come into contact with water, the Superintendent shall inspect the moisture content of the bentonite of the effected roll/s and reject the roll/s if

[12] Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days
[13] Mass of the GCL and bentonite clay shall be measured after oven drying per the stated test method

they are damaged beyond use. All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor

- Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling
- Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals
- GCL roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls
- Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement
- The Contractor shall inspect all GCL rolls for defects and damage upon delivery.

The Superintendent may reject any GCL rolls that have not been delivered, stored or handled in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.7 Geonet drainage geocomposite

2.7.1 Submittals prior to selection of the geonet drainage geocomposite manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a geonet drainage geocomposite manufacturer (per manufacturer and product):

- Product manufacturer
- Product name
- Material data sheet showing the material properties of the proposed geonet drainage geocomposite
- Manufacturer’s quality control and assurance procedures.

2.7.2 Submittals prior to delivery of geonet drainage geocomposite to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of geonet drainage geocomposite to site:

- Manufacturer’s certificate of compliance outlining conformance with the requirements of this Material Specification
- Manufacturer’s quality control and assurance test results
- Certification that the geonet drainage geocomposite supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If geonet drainage geocomposite is not manufactured from consecutive lots, the manufacturer shall provide certification of quality and consistency of the product characteristics
- Complete description of the manufacturer’s shipping, handling, and storage procedures
- Manufacturer’s installation procedures and requirements
- Work method statement for geotextile delivery, storage and handling. This shall include proposed handling equipment and restraining methods, and other information that shall promote proper use

2.7.3 Manufacturers quality control

The manufacturer shall follow a quality control program throughout the manufacturing of all geonet drainage geocomposite approved by the Superintendent.

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

The Superintendent may reject any geonet drainage geocomposite rolls that have not been sampled and/or tested in accordance with this section.

All geonet drainage geocomposite rolls rejected by the Superintendent shall be removed from the site at the Contractors expense.

2.7.4 Manufacturers quality assurance

The manufacturer shall follow a QA program throughout the manufacturing of all geonet drainage geocomposite approved by the Superintendent.

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

The Superintendent may reject any geonet drainage geocomposite rolls that have not been sampled and/or tested in accordance with this section.

All geonet drainage geocomposite rolls rejected by the Superintendent shall be removed from the site at the Contractors expense.

2.7.5 Material

All geonet drainage geocomposite shall be new, first quality products manufactured for the Works. All rolls delivered to site shall be consecutive from the same batch/lot unless otherwise approved.

The geotextile component shall be a non-woven, needle-punched, polypropylene geotextile factory bonded to the geonet. The bonding shall be uniform across the full extent of the geonet with no unbonded areas except for edges and overlaps.

The maximum unbounded area at edges and overlaps shall be 300mm from the edge of the geonet.

The geonet resin shall be new, first quality, compounded polyethylene resin.

Geonet drainage geocomposite shall meet or exceed the acceptance criteria specified in Table 9.

Table 9 Acceptance criteria – Geonet drainage geocomposite

Property (qualifier)	Test Method (ASTM)	Acceptance criteria		Minimum Testing Frequency
		Seepage control layer	Leachate drainage layer	
Geonet (before lamination)				
Thickness at 200 kPa (min.)	D5199	7.6 mm	7.6 mm	every 5,000 m^2
Density [14] (min.)	D1505 or D792	0.95 g/cm^3	0.95 g/cm^3	every 5,000 m^2
Carbon black content (range)	D1603 or D4218	1.5 to 3.0%	1.5 to 3.0%	every 5,000 m^2
Tensile strength (min. ave.)	D7179	13.1 kN/m	13.1 kN/m	every 10,000 m^2
Compressive strength (MARV)	D6364	830 kPa	830 kPa	every 10,000 m^2
Transmissivity [15] (MARV)	D4716	7 x 10^{-4} m^2/s	1.5 x 10^{-2} m^2/s	every 50,000 m^2
Geotextile (before lamination)				

[14] density of the formulated material
[15] tested between rigid end platens at a hydraulic gradient of 0.1; a pressure of 480 kPa, and at a seating dwell time of 15 min

Property (qualifier)	Test Method (ASTM)	Acceptance criteria		Minimum Testing Frequency
		Seepage control layer	Leachate drainage layer	
Mass per unit area (MARV)	D5261	270 g/m^2	270 g/m^2	every 10,000 m^2
Grab tensile strength (MARV)	D4632	900 N	900 N	every 10,000 m^2
Grab elongation (MARV)	D4632	50%	50%	every 10,000 m^2
CBR puncture strength (MARV)	D6241	2,000 N	2,000 N	every 10,000 m^2
Trapezoidal tear strength (MARV)	D4533	350 N	350 N	every 10,000 m^2
Permittivity (MARV)	D4491	0.5 s^{-1}	0.5 s^{-1}	every 50,000 m^2
Apparent opening size (MARV)	D4751	250 µm	250 µm	every 50,000 m^2
UV stability (typical) [16]	D4355	50%	50%	per formulation
Geonet drainage geocomposite				
Configuration (top to bottom)		Geotextile - geonet - geotextile	Geotextile - geonet - geotextile	
Ply adhesion (min. ave.)	D7005	170 N/m	170 N/m	every 5,000 m^2
Transmissivity [17] (MARV)	D4716	8 x 10^{-4} m^2/s	2 x 10^{-3} m^2/s	every 50,000 m^2

2.7.6 Roll and sample identification

All geonet drainage geocomposite rolls and samples shall be identified in accordance with ASTM D4873.

The Superintendent may reject any geonet drainage geocomposite roll or sample that has not been identified in accordance with this section.

Any geonet drainage geocomposite roll or sample rejected by the Superintendent shall be removed from the site at the Contractors expense.

2.7.7 Delivery, storage, and handling

The delivery, storage, and handling of all geonet drainage geocomposite rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum.

The Contractor shall inspect all geonet drainage geocomposite rolls for defects and damage upon delivery.

The Superintendent may reject any geonet drainage geocomposite roll or sample that has not been stored or handled in accordance with this section.

Any geonet drainage geocomposite roll or sample rejected by the Superintendent shall be removed from the site at the Contractors expense.

2.8 Geotextile

2.8.1 Submittals prior to selection of the geotextile manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a geotextile manufacturer (per manufacturer and product):

– Product manufacturer
– Product name

[16] strength retained after 500 hours
[17] tested between rigid end platens at a hydraulic gradient of 0.1; a pressure of 480 kPa, and at a seating dwell time of 15 min

– Material data sheet showing the material properties of the proposed geotextile
– Manufacturer's quality control and assurance procedures.

2.8.2 Submittals prior to delivery of geotextile to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of geotextile to site (per geotextile product):

– Manufacturer's certificate of compliance outlining conformance with the requirements of this Material Specification
– Manufacturer's quality control and assurance test results
– Certification that the geotextile supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If geotextile is not manufactured from consecutive lots, the manufacturer shall provide certification of quality and consistency of the product characteristics
– Statement on the origin and identification of the fibres and polymers, including the supplier's name and production plant
– Complete description of the manufacturer's shipping, handling, and storage procedures
– Manufacturer's installation procedures and requirements
– Work method statement for geotextile delivery, storage and handling. This shall include proposed handling equipment and restraining methods, and other information that shall promote proper use

2.8.3 Manufacturer's quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all geotextile for the Works.

Manufacturer's quality control submissions shall include:

– Date of manufacture
– Lot number, roll number, length and width
– Polymer quality control documentation used in the production of the rolls delivered
– Fibre quality control documentation used in the production of the rolls delivered
– Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered
– Quality control program laboratory-certified reports
– The manufacturer's approved quality assurance stamp and the technician's signature.

The frequency of sampling and testing shall be in accordance with Table 10.

The Superintendent may reject any geotextile rolls that have not been sampled and/or tested in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.8.4 Manufacturer's quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all geotextile for the Works.

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

The Superintendent may reject any geotextile rolls that have not been sampled and/or tested in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.8.5 Material

The geotextile shall:

– Be manufactured of new, first-quality products manufactured for the Works. All rolls delivered to site shall be consecutive from the same batch/lot unless otherwise approved
– Certified as needle-free by the manufacturer
– Comply with the acceptance criteria specified in Table 10.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 10 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots.

If required by the Superintendent, a sample of the geotextile shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 10 Acceptance criteria – Geotextile

Property	Test method	Acceptance criteria			Minimum testing frequency
		Separation geotextile	Protection geotextile	Sacrificial geotextile	
Woven/Non-woven	-	Non-woven	NOT USED	Non-woven	-
Polymer	-	Polypropylene	NOT USED	Polypropylene	-
Formation	-	Needle punched	NOT USED	Needle punched	-
Mass per unit area (MARV)	AS 3706.1	-	NOT USED	-	every 2,500 m^2
Grab tensile strength (MARV)	AS 3706.2b	1,100 N	NOT USED	1,100 N	every 5,000 m^2
Grab elongation (MARV)	AS 3706.2b	50%	NOT USED	50%	every 5,000 m^2
Trapezoidal tear strength (MARV)	AS 3706.3	400 N	NOT USED	400 N	every 5,000 m^2
CBR burst strength (MARV)	AS 3706.4	2,250 N	NOT USED	2,250 N	every 5,000 m^2
Permittivity (MARV)	AS 3706.9	0.5 s^{-1}	NOT USED	0.5 s^{-1}	every 5,000 m^2
Pore size (MaxARV)	ASTM D6767	220 µm	NOT USED	220 µm	every 5,000 m^2
UV stability (typical) [18]	ASTM D4355	50%	NOT USED	50%	per each formulation

[18] Strength retained after 500 hours

2.8.6 Roll and sample identification

All geotextile rolls and samples shall be identified in accordance with AS 3705.

Each roll or panel shall carry a label which identifies, as a minimum:

– Product name, grade and name of manufacturer
– Date of manufacture, batch number
– Material thickness
– Roll number
– Roll length
– Roll weight
– Roll width
– Handling guidelines
– Reference numbers to raw material batch and laboratory certified reports
– The manufacturer's approved quality assurance stamp and the technician's signature.

The Superintendent may reject any geotextile rolls or samples that have not been identified in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.8.7 Delivery, storage, and handling

The Contractor shall prepare a work method statement for delivery, storage, handling of geotextile. The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geotextile to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

– Delivery, storage and handling of all geotextile rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum
– Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls
– Rolls shall be wrapped with weather and moisture-proof wrapping to prevent any contact with water prior to installation. In the event that it is suspected that roll/s may have come into contact with water, the Superintendent shall inspect the moisture content of the effected roll/s and reject the roll/s if they are damaged beyond use. All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor
– Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling
– Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals
– Geotextile roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls
– Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement
– The Contractor shall inspect all geotextile rolls for defects and damage upon delivery.

The Superintendent may reject any geotextile rolls that have not been delivered, stored, or handled in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.9 PE pipework

2.9.1 Submittals prior to delivery of PE pipework to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of PE pipework to site (per PE pipework product):

– Product manufacturer
– Product name
– Manufacturer's certificate of compliance outlining conformance with the requirements of this Material Specification
– Manufacturer's quality control and assurance procedures
– Manufacturer's quality control and assurance test results
– Complete description of the manufacturer's shipping, handling and storage procedures
– Manufacturer's installation procedures and requirements
– Work method statement for PE pipework delivery, storage and handling. This shall include proposed handling equipment and restraining methods, and other information that shall promote proper use.

2.9.2 Materials

The materials used for the PE pipework and fittings shall be in accordance with the Contract Drawings.

If required by the Superintendent, a sample of the PE pipework shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

2.9.3 Delivery, storage, and handling

The Contractor shall prepare a work method statement for delivery, storage and handling of PE pipework and fittings. The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE pipework to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

– Delivery, storage and handling of all PE pipework and fittings shall be undertaken in accordance with the manufacturer's instructions
– PE pipework shall be delivered to site, handled and stored in such a manner that no damage occurs to the PE pipework
– PE pipework shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from chemicals, excessive heat, UV radiation, vandalism and animals
– The Contractor shall inspect all PE pipework and fittings for defects and damage upon delivery.

The Superintendent may reject any PE pipework and fittings that have not been delivered, stored or handled in accordance with this section.

All PE pipework and fittings rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

2.10 Drainage aggregate

2.10.1 Submittals prior to delivery of drainage aggregate to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of the drainage aggregate to site (per material source):

– Material source
– Certification that the material is VENM or ENM
– Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Material Specification
– Estimated quantity of material which is represented by the pre-qualification test results/reports
– Information on the parent geology of the material.

2.10.2 Materials

Drainage aggregate shall:

– Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM
– Not contain any unsuitable materials identified in Section 2.2 unless approved by the Superintendent
– Be rounded to sub-rounded
– Be clean, hard, sound and durable material that will maintain the required performance under the maximum loads likely to be imposed on it in service
– Be non-reactive in mildly acidic conditions
– Have a calcium carbonate content of less than 8.5% by mass
– Have an effective angle of internal friction of greater than 35 degrees
– Be relatively uniform in grain size
– Comply with the acceptance criteria specified in Table 11.

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 11 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

The Superintendent may organise independent testing of the material to verify conformance with the requirements of this section.

Table 11 Acceptance criteria – Drainage aggregate

Property	Test method	Acceptance criteria	Minimum test frequency
Constant head permeability	AS 1289.6.7.1[19]	> 10^{-3} m/s	1 per 10,000 m^3, minimum 3 tests per source
Particle size distribution: - Passing 40 mm - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	 100% ≤ 10% ≤ 3%	1 per 1,000 m^3, minimum 3 tests per source

[19] The intrinsic permeability of the testing apparatus shall be established prior to testing the drainage aggregate and reported with the test results to verify the testing apparatus is suitable for this test

2.11 Leachate sump pump and rising main

2.11.1 Submittals prior to delivery of leachate sump pump

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of the leachate sump pump to site.

– Pump data sheet including pump curve.
– Pipe submittals as outlined in Section 2.9.

2.11.2 Sump pump

The Contractor shall supply a submersible borehole pump that is suitable for submergence up to 20 m. The pump shall be readily serviceable with spares and consumables available from Australian suppliers. The pump shall be constructed of stainless-steel Grade 316. The pump must be able to pass sand and abrasives without damage.

The pump shall be compatible with the nominated leachate collection sump and extraction riser (refer to Drawing C113). The pump shall fit within the leachate extraction riser pipe (DN450 PE100 SDR11). The Contractor shall supply the required equipment as specified by the pump manufacturer required for the operation of the pump.

The Contractor will also supply any equipment required for the necessary access of the pump. This includes:

– SS316 lifting chain.
– Securing hook for chain.
– 100 m of cable.
– IP65 junction box or better.

The nominated pump will operate at a duty point of approximately 5.1 L/s at 13.4 m head. The duty point is to be within 50% to 120% of best efficiency point (BEP) (AS-04-2005 SW Part 1 P & D) of the selected pump.

An external ultrasonic flow meter is to be provided on the rising main within 2 m of the pump / rising main connection.

The pump shall be installed with on-board float switches to allow for automatic pump operation. The Contractor shall determine the cut-off and cut-in point with consultation from the pump supplier and the Superintendent. If on-board switches cannot be provided, then a low-level switch shall be provided in conjunction with the supplied flowmeter for pump cut-off purposes.

2.11.3 Rising main

The leachate rising main shall be DN75 PE100 SDR13.6 pipe meeting relevant Australian Standards. The transfer pipeline shall be located above ground as shown in the Drawings.

Appropriate signage shall be provided to install along the rising main alignment to indicate the rising main is conveying leachate.

The highest elevation adjacent to the ponds shall act as a discharge point. At this discharge point, a suitably sized tee-connection with a combination air valve and three separate flange offtakes for each pond shall be installed, each with a manual valve. These offtakes shall require a larger pipe size (such as DN200, subject to confirmation with the Superintendent) to drain to each pond.

ghd.com

→ The Power of Commitment

Appendix E

Appointment of expert

Department of Planning and Environment

Our ref: MP09_0186-PA-16

Ben Eastwood
NSW Environment Leader
EnergyAustralia NSW Pty Ltd
350 Boulder Road
Portland, NSW, 2847

29/09/2023

Subject: Mount Piper Power Station – Ash Placement - Emplacement Design Expert

Dear Mr. Eastwood

I refer to your request seeking the Planning Secretary's approval of David Gamble to provide advice on the design of the ash placement areas to ensure structural stability as required under Schedule 2, Condition B14 of the Project Approval for Mount Piper Power Station – Ash Placement (MP09_0186).

The Department has reviewed the nomination and information you have provided and is satisfied that David Gamble of GHD is suitably qualified and experienced.

Accordingly, I can advise that the Planning Secretary approves the appointment of David Gamble to design ash emplacement areas and ensure structural stability.

If you wish to discuss the matter further, please contact Wayne Jones on (02) 6575 3406.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments
As nominee of the Planning Secretary