

**3C WASTE LIMITED
(FCC ENVIRONMENT LIMITED)**



SUPPLEMENTAL
CONSTRUCTION OF 2025 PERMANENT CAPPING
AT LLANDDULAS LANDFILL SITE

Document Reference: WR8063/04 Rev 1
March 2025



Project Quality Assurance

Report Ref : WR8063/04 Rev 1

Report Date : March 2025

Prepared for : FCC Environment Limited
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White Rose Way
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Rev	Date Issued	Amendment Details	Author	Reviewer
0	March 2025	Issue to FCC for Approval	SS	AK
1	24/04/2025	Updated Feedback - NRW	SS	AK

Purpose

This Supplemental Document was prepared for the construction of 2025 permanent capping at Llanddulas Landfill Site for 3C Waste Limited who are the permit holders for the site but are a subsidiary of FCC Environment Limited and shall be referenced here on in as FCC.

Sirius Environmental Limited (Sirius) accepts no responsibility or liability for any use that is made of this document other than by the Client, FCC Environment Limited, for the purposes for which it was originally commissioned and prepared.

To be read in conjunction with the approved Specification WR7712/01A and CQA Plan WR7712/02A.

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1 GENERAL REQUIREMENTS

1.1 Introduction

FCC Environment (UK) Limited (FCC) are seeking to install a permanent capping system on an area at Llanddulas Landfill Site. The site address is:

Llanddulas Landfill Site,
Abergele Road,
Llanddulas,
Conwy,
LL22 8HP

Sirius Environmental Limited (Sirius) has prepared a detailed Specification for the construction of 2025 Capping. FCC shall appoint a third party independent Construction Quality Assurance (CQA) consultant to provide supervision for the duration of the capping works on FCC's behalf. A representative of the CQA Engineer, the CQA Inspector, shall supervise the construction works and shall advise the Contractor with regard to the onsite and offsite testing requirements.

The Construction Quality Assurance (CQA) Plan and Engineering Specification for the capping works which are to be undertaken have been prepared in accordance with the Environmental Permit for the site.

This document, when read in conjunction with the approved Specification WR7712/01A and CQA Plan ref: WR7712/02A details the requirements for the installation (Contractor) and quality control procedures (CQA Inspector) of the capping system undertaken. Quality control procedures followed during the capping works by the CQA Inspector, will demonstrate that the works have been undertaken in accordance with the approved Specification and CQA plan WR7712/01A and WR7712/02A. Previously approved drawings attached to Specification WR7712/01A (in Appendix 7) are superseded by drawings attached to this supplemental document **WR8063/04**.

Definitions, Facilities and construction requirements are outlined in Section 1 of the approved specification WR7712/01A.

Note: Any reference to a PPC (Pollution Prevention and Control) Permit in the approved specification and CQA Plan should now be read as a reference to the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016), which reflect the current regulatory framework for environmental permitting in England and Wales.

1.2 Project Team

The project team shall comprise:

Waste Management Operator/Employer	<i>FCC Environment (UK) Limited</i>
Designer	<i>Sirius Environmental Limited</i>
Main Contractor	<i>Jones Bros Civil Engineering (Ruthin) Limited</i>
CQA	<i>Sirius Environmental Limited</i>
Principal Designer	<i>Sirius Environmental Limited</i>

1.3 Regulations and Site Safety

The works come under the Construction (Design and Management) Regulations of 2015 and the Main Contractor shall also be appointed as the Principal Contractor.

The Contractor shall comply with the safety requirements set out in the following documents:

- FCC - Health and Safety Policy;
- FCC - Site User Safety Instructions;
- FCC - General Policy Statement for Contractors Conditions of Contract and Safety Rules;
- FCC - Health & Safety Site Plan.

A copy of these documents is available for inspection at the landfill site office. The Contractor shall adhere to the site Health and Safety Rules and the DSEAR Regulations dated 2002. The Contractor's performance with respect to these rules shall be reviewed at each progress meeting. Health and Safety requirements are outlined in Section 2 of the approved Specification WR7712/1A.

2 SCOPE OF THE CONSTRUCTION WORKS

2.1 General Description

The design concepts for the capping construction were developed to accord with the Permit for the site, associated pre-operation conditions and the approved CQA Plan/Specification WR7712/01A & 02A. The position of the proposed development, in relation to the landfill area, is shown on Drawing WR8063/01/01.

For the capping lining system, a 1mm thick (LLDPE) Geomembrane is proposed which will tie into the previous cap areas, shown on Drawing WR8063/01/01. The Construction details for the capping works are shown on Drawing WR8063/01/02. The 25m testing grid is shown on Drawing WR8063/01/03. Services overlay are shown on Drawing WR8063/01/04.

The capping works shall generally involve:

Capping System: 1mm thick (LLDPE) Geomembrane

- Trimming / regrading of existing waste surface as required;
- Placement and trimming of a 300mm thick regulating layer to achieve the formation levels for the liner;
- Placement of a Lower Protector Geotextile (if required) over the regulated surface;
- Installation of a fully welded, 1mm thick, double textured Linear Low Density Polyethylene (LLDPE) geomembrane liner;
- Installation of a Protector Geotextile / Drainage Geocomposite over the LLDPE capping geomembrane;
- Tie-in to existing capping systems and basal lining system;
- Sealing of the capping system around protuberances;
- Installation of 1,200mm of restoration soils above the protector geotextile / drainage geocomposite; and
- Installation of SW deflection bunds, pipes and ditches.

The Employer and the Designer will liaise to confirm whether a protector geotextile or a drainage geocomposite will be utilised in the capping works, or whether both will be included across different areas of the cap. The choice between these materials will be dependent on

the results of the interface testing, and whether they demonstrate that the stability of the capping slopes is likely to be maintained using the proposed products.

2.2 Principal Quantities

Previously approved principal quantities attached to the Specification WR7712/1 (in Appendix 2) are superseded by principal quantities attached to this supplemental document **WR8063/04**.

The principal quantities for the works are given in Appendix 2.

2.3 Testing and Construction Requirements

All information relating to testing and construction requirements are found in the approved Specification WR7712/1A and CQA Plan WR7712/2A.

Approved Testing and Construction Requirements

Earthworks Requirements	Section 4 - WR7712/1	Appendix 6
Geomembrane	Section 5 - WR7712/1	Appendix 6
Restoration Soils	Section 8 - WR7712/1	Appendix 6

2.4 Stability Risk Assessment

The areas of proposed capping are compliant with parameters explored in the approved WR7712/01A Specification and Veneer assessment. Specific veneer assessment for the proposed area 2025 shows acceptable factors of safety, and attached in Appendix 3 of this supplemental document.

Interface testing shall be conducted during the works.

2.5 CQA Proformas

Previously approved CQA Proformas attached to CQA Plan WR7712/2A (in Appendix 2) are superseded by CQA Proformas attached to this supplemental document **WR8063/04**.

The CQA Proformas for the these works are found in Appendix 4.

**3C WASTE LIMITED
(FCC ENVIRONMENT LIMITED)**



**DESIGNER RISK ASSESSMENT
FOR 2025 PERMANENT CAPPING
AT LLANDDULAS LANDFILL SITE**

Document Reference: WR8063_3
March 2025



Project Quality Assurance

Report Reference : WR8063_3

Report Date : March 2025

Prepared for : FCC Environment Limited
3 Sidings Court
White Rose Way
Doncaster
Yorkshire
DN4 5NU

Issued by : Sirius Environmental Limited
4245 Park Approach
Thorpe Park
Leeds
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Rev	Date Issued	Amendment Details	Author	Reviewer
	March 2025	FCC for approval	SS	AK

Purpose

This document was prepared as the Designer's Risk Assessment (DRA) for the Construction of an area of permanent capping at Llanddulas Landfill Site for 3C Waste Limited, who are the permit holders for the site, but are a subsidiary company of FCC Environment (UK) Limited, and will be referred to as FCC Environment (UK) Limited from here on in.

Sirius Environmental Limited (Sirius) accepts no responsibility or liability for any use that is made of this document other than by the Client, FCC Environment (UK) Limited (FCC), for the purposes for which it was originally commissioned and prepared.

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1. PROJECT DESCRIPTION

- 1.1.1 The proposed works and Construction Quality Assurance requirements are included with Documents Ref: WR8063_1 (Engineering Specification) and WR8063_2 (CQA Plan).

2. MAINTENANCE AND USAGE NOTES

- 2.1.1 The following notes are provided for the end-user, who should be aware of the following hazards when operating or maintaining the completed facility:

- (i) Following placement of the first 500mm of soils or when subsequent soils are placed, the surface should be scarified to allow the binding together of the upper and lower soils layers;
- (ii) Prior to the placement of the upper soils the surface of the lower 500mm of soils should be checked on a regular basis to ensure voids or gullies do not appear due to water erosion;
- (iii) Following the capping works, large plant shall not traffic the area unless necessary. Any necessary plant movement on the restored soils layer must undertaken with care to ensure that the underlying capping is not damaged by plant movements. Any channels of erosion should be identified by the site operator and trafficking in these areas should be assessed;
- (iv) 4 x 4 vehicle movements shall be kept to a minimum immediately after hydroseeding to ensure damage to the establishing vegetation is minimised, to avoid stability issues;
- (v) The free edge of the geocomposite drainage layer should always be maintained to prevent water build up in the drainage system; and
- (vi) Ditches on site shall be maintained to ensure that surface water drains away from the capping area.

3. DESIGN RISKS

- 3.1.1 Design risks, mitigation measures and residual risks are identified on the following risk assessments. The Contractor's attention is drawn to the specific construction hazards identified for which residual risks are considered to be moderate or high. The Contractor is expected to undertake an assessment of risk and to develop specific method statements to reduce the risks to an acceptable level.

	Design Risk Assessment			Sheet Number: 1 of 4		
				Job Number: WR8063_3		
				Date: March 2025		

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
General excavations, deep excavations and excavations from stockpiles	Risk to personnel and plant from excavation collapse	Construction Personnel	H	M	H	Regularly inspect excavations as work proceeds to identify potential failure areas	M	L	M	Contractor to provide details of working methods in construction phase health and safety plan, including assessment of ground stability for earthworks plant, and details of all restrictions to be imposed
	Excavated slopes to be battered back at appropriate angle/gradient					M	L	M		
	Organise excavation work such that plant is located on stable ground					M	L	M		
	Restrict access to excavations (both above and below the working face)					M	L	M		
Excavations within landfill waste	Risk to personnel from contact with waste, leachate, etc	Construction personnel	M	L	H	Check extent and location of excavations (with regard to existing cell works). Remove leachate from excavations on regular basis. Monitor for presence of landfill gas. Implement strict hygiene rules	L	L	L	Contractor to provide details in construction phase health and safety plan. Movements on and around waste to be restricted to absolute minimum. Maintain good personal hygiene. Wear gloves.
	Risk to personnel from landfill gas	Construction and landfill personnel	H	H	H		M	L	M	Refer to landfill safe working practices. Requirement for 'hot works' permit. No smoking on site. H ₂ S issues to be highlighted. All H ₂ S wells and chambers to be clearly marked by Employer prior to mobilisation of Contractor. Evacuation strategy to be included in construction phase health and safety plan.
Exposure of buried asbestos during regrade of capping areas/construction of cell tie-in	Risk of inhalation of airborne fibres	Construction personnel	H	L	M	Stop works and isolate area. Request inspection of excavation by the Employer's staff if any suspect materials are encountered. General restriction of access for non-essential personnel	H	L	M	Contractor to develop safe working methods to isolate any asbestos if encountered. If encountered, licensed specialist contractor to be appointed by contractor. ASB5 notification to be raised for HSE.
Working adjacent to excavations	Objects falling onto personnel and plant operating below	Construction personnel	H	M	M	Access to excavations, and edge of excavations, to be restricted	M	L	M	Contractor to provide details of restrictions
Water	Potential flooding of excavation due to intense rainfall combined with extensive catchment area	Construction personnel	L	M	M	Drainage ditches or sumps to be excavated to allow water to be diverted from, and removed from excavation	L	L	L	Weather reports to be monitored. Temporary drainage measures to be detailed in construction phase health and safety plan
	Surface water lagoons located within the landfill site	Construction and site personnel	M	L	L	Lagoons are fenced. Contractor to liaise with the Employer's over pumping arrangements	L	L	L	Access within fenced areas to be restricted to essential personnel, no lone working in these areas.

	Design Risk Assessment		Sheet Number: 2 of 4	
			Job Number:	WR8063_3
			Date:	March 2025

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
Groundwater	Instability/accumulation of groundwater/soft ground	Construction personnel	M	L	M	Pedestrian access to area to be restricted to essential personnel.	L	L	L	Groundwater control system has been incorporated into the design.
Fire	Caused by oxygen drawn into waste mass	Construction and site personnel	H	L	M	Close liaison with LFG contractor (Infinis) during construction works with regard to disconnection/reconnection of gas wells, and relocation of collection pipework, to prevent oxygen being drawn into the waste mass during the capping works.	L	L	L	
Working on or adjacent to soft ground	Subsidence of plant and machinery	Construction personnel	M	M	M	Review existing soils data. Monitor condition of soils as work proceeds	M	L	M	Contractor to develop working methods to cater for working over and adjacent to soft ground
Loading of excavation materials	Risk to personnel in vicinity of vehicles	Construction personnel	M	M	M	Drivers to position vehicles in safe locations	L	L	L	Contractor to provide details of loading arrangements in construction phase health and safety plan
						Access to loading area to be restricted	L	M	L	Contractor to provide details of restriction arrangements in construction phase health and safety plan
Working at heights	Fall into excavations	Construction personnel	H	M	H	Excavation depths and gradients to be minimised	M	L	M	Contractor to provide details of measures to be imposed, including barriers to be erected around excavations and restricted access provisions.
	Objects falling onto personnel below	Construction personnel	H	M	H	Access to excavations to be restricted	M	L	M	
Transportation of materials on site	Risk of vehicle collisions	Construction personnel	M	L	M	Access/egress arrangements to each works area to be self-explanatory	L	L	L	Contractor to provide details of access/egress arrangements, including signage, in construction phase health and safety plan
Working on steep slopes	Materials falling onto personnel and/or plant	Construction personnel	H	M	H	Restoration soils will not be constructed at angles steeper than 1:2.5 (across full height on the slope). Geosynthetic rolls are to be stored at the base of the slope or at the flat area at the top of the slope.	H	M	M	Contractor to develop safe working method for materials handling
	Vehicles overturning	Construction personnel	H	M	H	Contractor to avoid vehicular access routes at crests of slopes where possible. Edge protection to be provided as necessary.	M	L	M	Materials to be placed from base of slopes where possible. If placed from top of slopes, stop boards or other protective measures must be used.

	Design Risk Assessment			Sheet Number: 3 of 5	
				Job Number:	WR8063_3
				Date:	March 2025

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
Installation of geosynthetic materials	Personnel falling down slope	Construction personnel	H	M	H	Access to be restricted to essential personnel	L	L	L	Contractor to provide suitable edge protection, instruction, and if appropriate, fall arrest systems
	Risk to personnel from manual handling	Construction personnel	M	L	M	Use standard manual handling techniques. Consider wind conditions prior to placement	L	L	L	Contractor to provide manual handling details in construction phase health and safety plan. Use of mechanised handling in preference to manual handling.
	Risk to personnel during lifting operations	Construction personnel	M	L	M	Organise lifting operations to minimise conflict with groundworkers	L	L	L	Contractor to provide lifting details in construction phase health and safety plan
	Risk to personnel access over installed geosynthetic materials	Construction personnel	M	L	M	Provide safe means of access over geosynthetic	L	L	L	Contractor to provide safe access details in construction phase health and safety plan
	Risk of gas explosion/burns	Construction personnel	H	M	H	Installation contractor to demonstrate competence. Installation staff to be suitably qualified. No spark testing to be undertaken – vacuum box testing only of extrusion welds. DSEAR zoning to be applied. Gas monitors to be provided.	M	L	M	DSEAR zoning drawing to be obtained from Employer on mobilisation to site. Gas risk to be included in site induction [procedures.
Site traffic/traffic management	Cuts from knives used in installation	Construction personnel	M	M	M	Risk assessment and method statement to be provided. Use of retractable blades. Use of appropriate gloves.	L	L	L	Rotation of personnel to avoid fatigue. New blades to allow frequent replacement due to blunting
	Risk to personnel from moving plant and machinery	Construction and landfill personnel	M	L	M	Contractor to ensure that consideration has been given to vehicular and pedestrian traffic management	L	L	L	Separate pedestrian and vehicular access routes. Contractor to provide traffic management arrangements in construction phase health and safety plan. The Employer's site rules to be included within induction process and enforced.
Deliveries	Risk of injury during unloading and handling	Construction personnel, delivery drivers	M	L	M	Contractor to ensure that all suppliers and subcontractor material deliveries are properly coordinated and due regard is given to the restriction of routes, programming and sizing of delivery vehicles.	M	L	L	Contractor to provide details in construction phase health and safety plan
Existing services	Risk to personnel from landfill gas mains, leachate pipes, compressed air lines and associated power cables	Construction personnel	M	M	H	Banksman to be employed when operating in close proximity to leachate and has wells or pipes. Contractor to ensure that all persons affected by existing services are aware of those services and take all necessary precautions to protect themselves and the services.	M	L	M	Contractor to identify services on site at commencement of construction works. Contractor to provide details of investigative procedures, e.g. CAT scanning Services drawing to be obtained from Employer on mobilisation to site.

	Design Risk Assessment			Sheet Number: 4 of 4		
				Job Number: WR8063_3		
				Date: March 2025		

Subject	Hazards	Persons at Risk	Initial			Mitigation Measures	Residual			Action
			Severity	Likelihood	Risk		Severity	Likelihood	Risk	
	Risk to personnel from hidden services	Construction personnel	M	L	M	Contractor to ensure that all persons undertaking works likely to affect any hidden services are aware of their possible presence and take all necessary precautions to protect themselves and the services	M	L	L	Contractor to identify KNOWN services on site at commencement of construction works. Details of 'safe dig' procedures to be provided in construction phase health and safety plan.
	Risk of damage to services	Construction personnel	M	L	M	Contractor to ensure adequate support is provided to services exposed during excavations Contractor to check adequacy of goal posts with regard to overhead power cables and routing of plant and vehicles	L	L	L	Contractor to provide details in construction phase health and safety plan, and in traffic management plan

FCC ENVIRONMENT

PROJECT ACTIVITY SCHEDULE

ACTIVITY	LANDFILL
SUB-ACTIVITY	Permanent Capping
CONTRACTOR	Jones Bros
SITE NAME	Llanddulas
PROJECT NAME	2025 Capping Works
PROJECT CODE	WR8063
PROJECT AX CODE	SK37-IN-009632
FCC NEC SUPERVISOR	Adrian Curt
FCC NEC QUANTITY SURVEYOR	
SITE START DATE	TBC
SITE WORKS DURATION	TBC
PROJECT STATUS	Draft
Capping Area Delivered	24,091m2

Signed Agreement:

Date: XX/XX/XXXX

Contractor

FCC PS

FCC QS

Description of Works

General:-

Haul distances will be measured from the centre of the supply area to the centre of the final capped area.

Scope of Works:-

Trimming / regrading of existing waste surface as required;
Placement and trimming of a 300mm thick regulating layer to achieve the formation levels for the liner;
Placement of a Lower Protector Geotextile (if required) over the regulated surface;
Installation of a fully welded, 1mm thick, double textured Linear Low Density Polyethylene (LLDPE) geomembrane liner;
Installation of a Protector Geotextile / Drainage Geocomposite over the LLDPE capping geomembrane;
Tie-in to existing capping systems and basal lining system;
Sealing of the capping system around protuberances;
Installation of 1,200mm of restoration soils above the protector geotextile / drainage geocomposite and
Installation of SW defelction bunds, pipes and ditches

Extra-ordinary Works

WR8063		
1. General Items	-	
2.Strip Existing Materials	-	
3.Capping Systems	-	
4.Subsoil	-	
5.Peat	-	
6.Top Soil	-	
7. Drainage	-	
Project Total	£	-
Project Insurance	£	-
Project Total inc Discount	£	-

FCC ENVIRONMENT
LANDFILL Capping

				JONES BROS Quants 1	Meas Unit 1	SIRIUS Quants 2	Meas Unit 2	Unit Rate	Total Cost £
1	General Items								
	1	Site Establishment & General Attendance			Sum				-
	2	Weekly Site Running Costs			Sum				-
	3	Project Testing as per Testing schedule			Sum				-
	4								-
	5								-
								Total	-
2	Strip Existing Materials / Waste								
	1	Excavate							
		1 Soil							
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3				-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		2 Cap (Clay / Mineral)							
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3				-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		3 Cap (Synthetic & Geotextile)							
		1 0 Haul			m2				-
		2 Not exceeding 250m Haul			m2				-
		3 More Than 250m Haul ne 500m haul			m2				-
		4 More Than 500m Haul ne 1000m haul			m2				-
		5 More than 1000m haul (per 500m)			m2				-
		4 Stabilisation Layer							
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3				-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		5 Excavation of Waste							
		1 0 Haul			m3	6267			-
		2 Not exceeding 100m Haul			m3				-
		3 More Than 100m Haul ne 500m haul			m3				-
		4 More than 500m Haul (per 500m)			m3				-
	2	Fill							
		1 Excavate From on site / Imported.			m3				-
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3				-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		2 Spread level & compact			m3	5807			-
		3 Trim surface to level			m2	24091			-
								Total	-
3	Capping Systems								
	1	Stabilisation Layer (300mm thick)							
		1 Excavate From on site.							-
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3	7227			-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		2 Spread level & Compact			m3	7227			-
		3 Trim Surface			m2	24091			-
	2	Capping Layer							
		1 Clay / Mineral (1m thick)							-
		1 Excavate							-
		1 0 Haul			m3				-
		2 Not exceeding 250m Haul			m3				-
		3 More Than 250m Haul ne 500m haul			m3				-
		4 More Than 500m Haul ne 1000m haul			m3				-
		5 More than 1000m haul (per 500m)			m3				-
		2 Spread level & Compact			m3				-
		3 Trim Surface			m2				-
		4 E.O for watering clay to achieve moisture levels (for			m3				-
		2 Membrane & Synthetic							-
		1 LLDPE			m2	24091			-
		2 HDPE			m2				-
		3 GCL			m2				-
		4 Geotextile							-
		1 3kn 300g/m +/-10% Tolerance			m2				-
		2 4kn 400g/m +/-10% Tolerance			m2	15087			-
		3 5kn 500g/m +/-10% Tolerance			m2				-
		5 Drainage Geocomposite							-
		1 4kn 400g/m +/-10% Tolerance			m2	9004			-
		2 5kn 500g/m +/-10% Tolerance			m2				-
	3	Intrusions							
		1 355mm or less internal dia			no.				-
		2 360mm to 525mm Internal dia			no.	37		Mat Type	-
		3 530mm to 1000mm Internal dia			no.				-
		4 Over 1005mm internal dia			no.				-
	4	Connect to existing							
		1 Anchor Trenches							-
		2 Connect to existing LLDPE / HDPE				37			-
		3 Connect to existing Clay / Mineral				689			-
		4 Connect to existing GCL							-
	5	Infrastructure							
		1 Rainflap 300mm Pipe			m				-
		2 Sandbags - Standard			m				-
		3 Sandbags - Bulk Bags (1ton)			m				-
		4 Sandbag Headwall			m				-
								Total	-

FCC ENVIRONMENT
LANDFILL Capping

			JONES BROS Quants 1	Meas Unit 1	SIRIUS Quants 2	Meas Unit 2	Unit Rate	Total Cost £
4	Subsoil (Above liner Subsurface Layer)							
	1	Excavate From on site / Imported.						
		1 0 Haul		m3				-
		2 Not exceeding 250m Haul		m3	28909			-
		3 More Than 250m Haul ne 500m haul		m3				-
		4 More Than 500m Haul ne 1000m haul		m3				-
		5 More than 1000m haul (per 500m)		m3				-
	2	Spread level & Com less than 1m deep 1m deep and above		m3	28909			-
	3	Trim Surface		m2	24091			-
							Total	-
5	Peat							
	1	Excavate From on site / Imported.						
		1 0 Haul						-
		2 Not exceeding 250m Haul						-
		3 More Than 250m Haul ne 500m haul						-
		4 More Than 500m Haul ne 1000m haul						-
		5 More than 1000m haul (per 500m)						-
	2	Spread level & Compact						-
	3	Trim Surface						-
							Total	-
6	Topsoil (Layer)							
	1	Excavate From on site / Imported.						
		1 0 Haul		m3				-
		2 Not exceeding 250m Haul		m3				-
		3 More Than 250m Haul ne 500m haul		m3				-
		4 More Than 500m Haul ne 1000m haul		m3				-
		5 More than 1000m haul (per 500m)		m3				-
	2	Spread level & Compact		m3				-
	3	Trim Surface		m2				-
							Total	-
7	Drainage							
	1	Piped work (100mm bedding, twice pipe dia cover, three times 100mm ID ne 1.5m average depth inc stone backfill 160mm ditto 300mm ditto		m m m	8			- - -
	2	Fittings						-
		1 Bends		no.				-
		2 Junctions		no.				-
		3 Valves		no.				-
		4 Others		no.				-
	3	Ditches (x-section area)						-
		1 ne 2m2/m						-
		1 0m - 50m		m				-
		2 50m - 250m		m				-
		3 250m - 500m		m	279			-
		4 500m - 750m		m				-
		5 750m - 1000m		m				-
		6 Over 1000m		m				-
		2 over 2m2 ne 4m2/m						-
		1 0m - 50m		m				-
		2 50m - 250m		m				-
		3 250m - 500m		m				-
		4 500m - 750m		m				-
		5 750m - 1000m		m				-
		6 Over 1000m		m				-
	4	Deflection Bunds						-
		1 500mm high with a 500mm wide crest		m	532			-
							Total	-

Material	Test	Rate (£)	Quantity	Cost
Clay	Plasticity Index			£ -
	Particle Density			£ -
	Core Cutter Density			£ -
	Moisture Content			£ -
	Triaxial Permeability (fixed rate)			£ -
	PSD by Hydrometer			£ -
	Wet Sieve PSD			£ -
	Dry Density / Moisture Content (2.5kg)			£ -
	Dry Density / Moisture Content (4.5kg)			£ -
				£ -
Leachate Drainage Blanket	10% Fines			£ -
	Wet Sieve Analysis			£ -
	Dry Sieve Analysis			£ -
	Permeability			£ -
GCL				
	Swell Index / Free Swell			£ -
	Montmorillonite Content			£ -
	Bentonite Mass/Unit Area			£ -
	Mass per Unit Area of GCL			£ -
	Moisture Content of Clay			£ -
	Peel Strength			£ -
	CBR Puncture Resistance			£ -
Geomembrane	GCL Grab Strength			£ -
	Carbon Black Content			£ -
	Carbon Black Dispersion			£ -
	Density			£ -
	Dimensional Stability			£ -
	Melt Flow Index			£ -
	Thickness			£ -
	Puncture Resistance			£ -
	Tear Resistance			£ -
	Textured Asperity Height			£ -
	Notched Constant Load Test - limited to 500hrs			£ -
	Oxidative Induction Time			£ -
	UV Resistance			£ -
	Destructive Weld/ Seam Testing			£ -
Geotextile				
	Tensile Properties			£ -
	Thickness			£ -
	Puncture Resistance			£ -
	Tear Resistance			£ -
	Apparent Opening Size			£ -
	Drop Cone Test			£ -
	Grab Breaking Strength			£ -
	Mass/Unit Area			£ -
Interface Testing	Cylinder Load Test			£ -
Engineered Fill testing	Capping interface testing			£ -
	PSD			£ -
	Materials Classification			£ -
	Core Cutter Density			£ -
	Particle Density			£ -

Total £0.00
Total plus Fee

Contract Risk Register

Site	Llanddulas
Project Title	2025 Capping Works
Project Number	WR8063
Contractor	Jones Bros

Risk Number	Risk Detail	Risk Owner	Likelihood	Severity	Provisional sum
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Signed for and on behalf FCC & Contractor

Contractor		Date	
FCC NEC Project Manager		Date	



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

1 in 2.9 13.5m High GDL

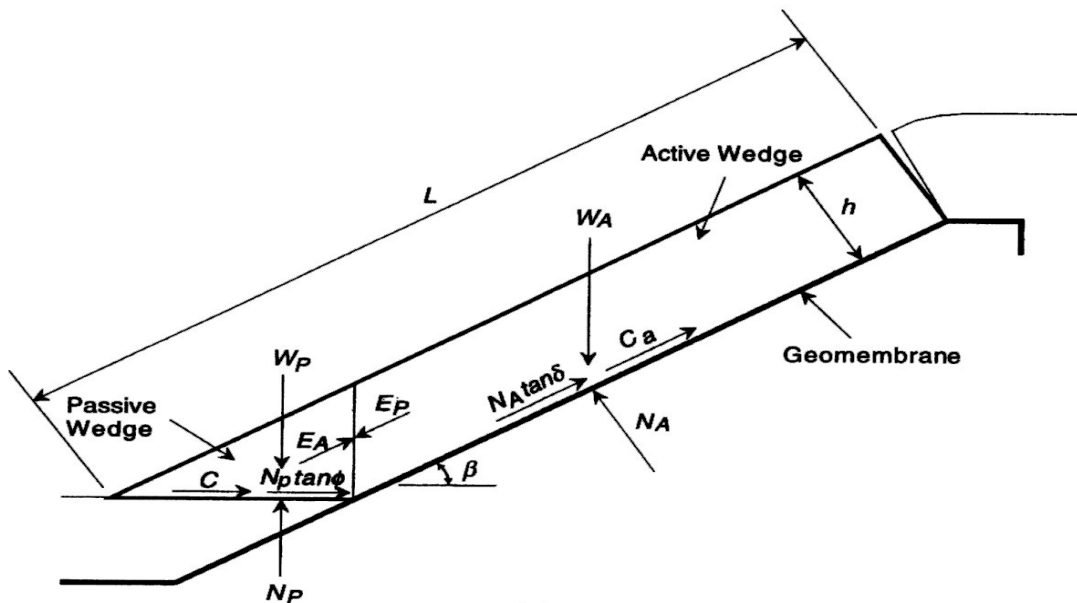
Checked: A Kirk

Date: 31/03/2025

Reviewed: A Kirk

Capping system stability PSR = 0.0

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.20	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geocomposite friction angle, d1	26	Deg.
Cover soil/Geocomposite cohesion intercept, a1	3	kPa
Geocomposite/Geomembrane friction angle, d2	22	Deg.
Geocomposite/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, δ_3	25	Deg.
Geomembrane/Blinding layer, α_3	2	kPa

Parallel submergence ratio, PSR 0.0

Geosynthetic tensile strengths:

Geocomposite	12	kN/m
Geomembrane	11	kN/m



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

Reviewed: A Kirk

1 in 2.9 13.5m High GDL

Date: 31/03/2025

1. Stability of Cover Soils

Calculated Parameters

Length of slope, L	44.403	m
Thickness of water, h_w	0.000	m
Weight of active wedge, W_A	914.361	kN
Weight of passive wedge, W_P	44.745	kN
Pore pressure perp. to slope, U_n	0.000	kN
Pore pressure in interwedge surface, U_h	0.000	kN
Force normal to active wedge, N_A	871.077	kN
Vert pp on passive wedge, U_v	0.000	kN
a	264.836	
b	-611.656	
c	79.118	

Factor of Safety against cover soils sliding

2.17

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	266.504	kN
Shear strength at lower interface	413.563	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	12	kN

Factor of Safety against rupture

No Tension

(ii) Geomembrane

Shear strength at upper surface	413.563	kN
Mobilised shear stress at upper interface	266.504	kN
Shear strength at lower interface	514.873	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture

No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

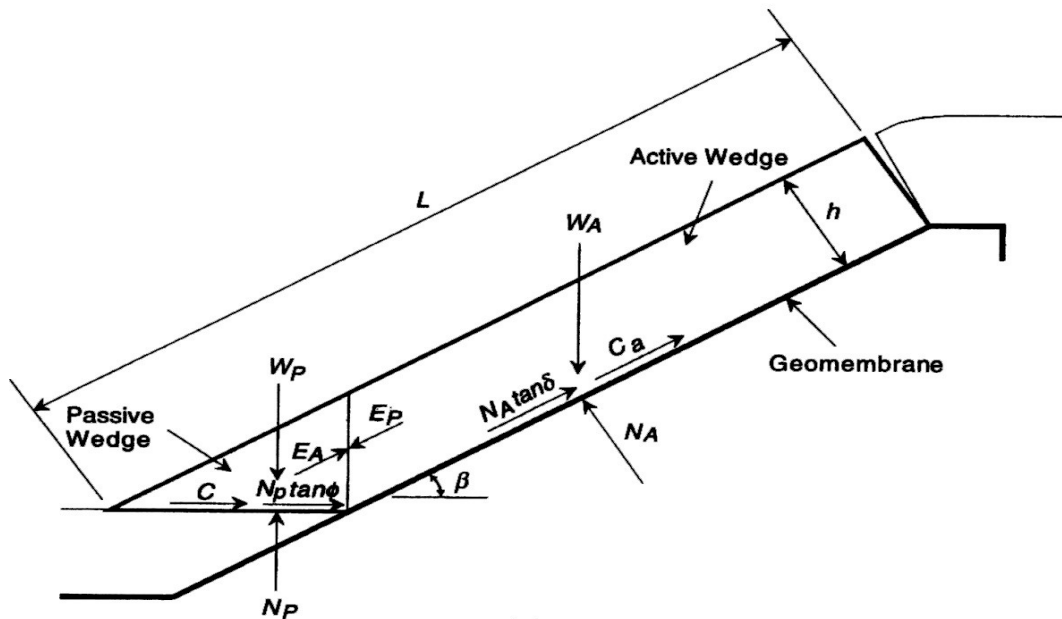
Reviewed: A Kirk

1 in 2.9 13.5m High GDL

Date: 31/03/2025

Capping system stability PSR = 0.25

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geocomposite friction angle, d1	26	Deg.
Cover soil/Geocomposite cohesion intercept, a1	3	kPa
Geocomposite/Geomembrane friction angle, d2	22	Deg.
Geocomposite/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	25	Deg.
Geomembrane/Blinding layer, a3	2	kPa
Parallel submergence ratio, PSR	0.25	
Geosynthetic tensile strengths:		
Geocomposite	12	kN/m
Geomembrane	11	kN/m



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

Reviewed: A Kirk

1 in 2.9 13.5m High GDL

Date: 31/03/2025

1. Stability of Cover Soils

Calculated Parameters

Length of slope, L	44.403	m
Thickness of water, h_w	0.300	m
Weight of active wedge, W_A	940.692	kN
Weight of passive wedge, W_P	45.056	kN
Pore pressure perp. to slope, U_n	125.423	kN
Pore pressure in interwedge surface, U_h	0.450	kN
Force normal to active wedge, N_A	770.875	kN
Vert pp on passive wedge, U_V	1.410	kN
a	272.504	
b	-565.659	
c	72.189	

Factor of Safety against cover soils sliding 1.94

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	304.889	kN
Shear strength at lower interface	423.818	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	12	kN

Factor of Safety against rupture No Tension

(ii) Geomembrane

Shear strength at upper surface	423.818	kN
Mobilised shear stress at upper interface	304.889	kN
Shear strength at lower interface	526.708	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

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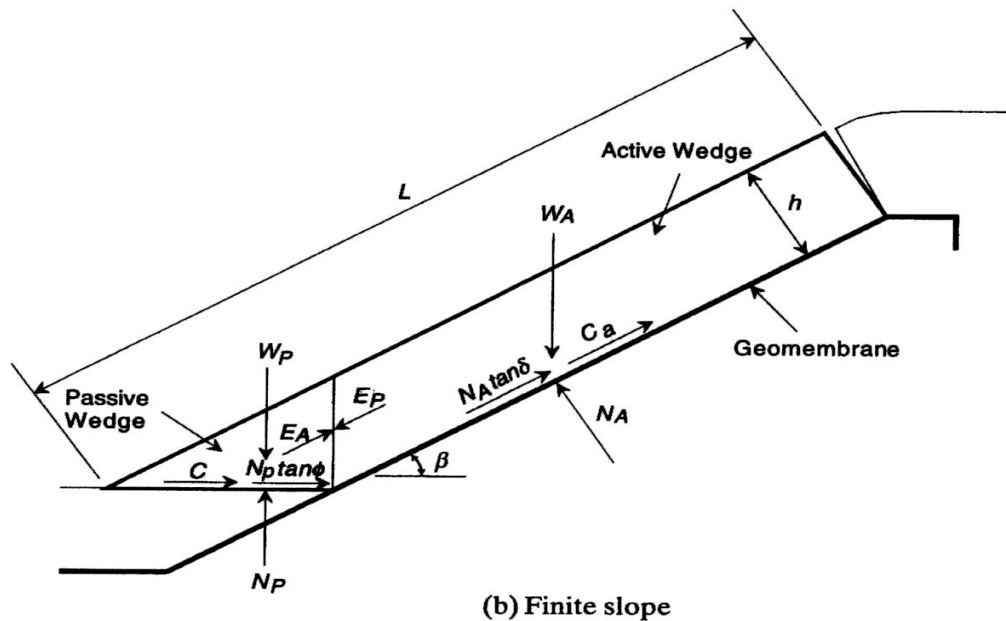
Reviewed: A Kirk

1 in 2.9 13.5m High GDL

Date: 31/03/2025

Capping system stability PSR = 0.5

Geometry:



Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geocomposite friction angle, d1	26	Deg.
Cover soil/Geocomposite cohesion intercept, a1	3	kPa
Geocomposite/Geomembrane friction angle, d2	22	Deg.
Geocomposite/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	25	Deg.
Geomembrane/Blinding layer, a3	2	kPa
Parallel submergence ratio, PSR	0.5	
Geosynthetic tensile strengths:		
Geocomposite	12	kN/m
Geomembrane	11	kN/m



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

Reviewed: A Kirk

1 in 2.9 13.5m High GDL

Date: 31/03/2025

1. Stability of Cover Soils

Calculated Parameters

Length of slope, L	44.403	m
Thickness of water, h_w	0.600	m
Weight of active wedge, W_A	966.402	kN
Weight of passive wedge, W_P	45.988	kN
Pore pressure perp. to slope, U_n	247.886	kN
Pore pressure in interwedge surface, U_h	1.800	kN
Force normal to active wedge, N_A	673.315	kN
Vert pp on passive wedge, U_V	5.640	kN
a	280.076	
b	-519.717	
c	65.443	

Factor of Safety against cover soils sliding

1.72

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	350.985	kN
Shear strength at lower interface	434.072	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	12	kN

Factor of Safety against rupture

No Tension

(ii) Geomembrane

Shear strength at upper surface	434.072	kN
Mobilised shear stress at upper interface	350.985	kN
Shear strength at lower interface	538.543	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture

No Tension



PROJECT Llanddulas Perm Capping 2025

1 in 2.9 13.5m High GDL

Job No. WR8063

Made By: S Saad

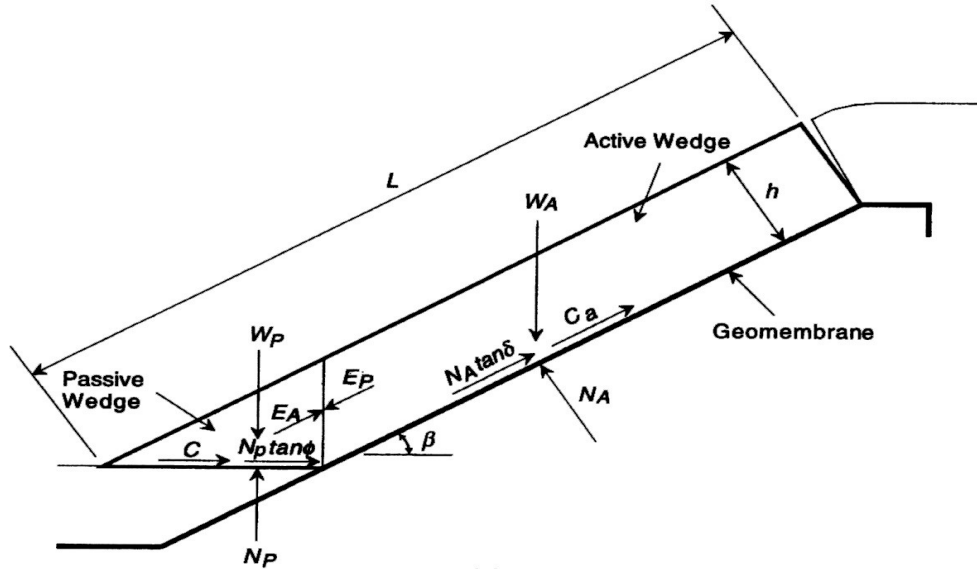
Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

Capping system stability PSR : 1.0

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geocomposite friction angle, d1	26	Deg.
Cover soil/Geocomposite cohesion intercept, a1	3	kPa
Geocomposite/Geomembrane friction angle, d2	22	Deg.
Geocomposite/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	25	Deg.
Geomembrane/Blinding layer, a3	2	kPa
Parallel submergence ratio, PSR	1.0	
Geosynthetic tensile strengths:		
Geocomposite	12	kN/m
Geomembrane	11	kN/m



PROJECT Llanddulas Perm Capping 2025

1 in 2.9 13.5m High GDL

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

1. Stability of Cover Soils

Calculated Parameters

Length of slope, L	44.403	m
Thickness of water, h_w	1.200	m
Weight of active wedge, W_A	1015.957	kN
Weight of passive wedge, W_P	49.717	kN
Pore pressure perp. to slope, U_n	483.931	kN
Pore pressure in interwedge surface, U_h	7.200	kN
Force normal to active wedge, N_A	486.120	kN
Vert pp on passive wedge, U_V	22.561	kN
a	294.928	
b	-427.993	
c	52.499	

Factor of Safety against cover soils sliding 1.32

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	477.518	kN
Shear strength at lower interface	454.581	kN
Tension developed in the GT	22.937	kN
Tensile strength of the GT	12	kN

Factor of Safety against rupture 0.52

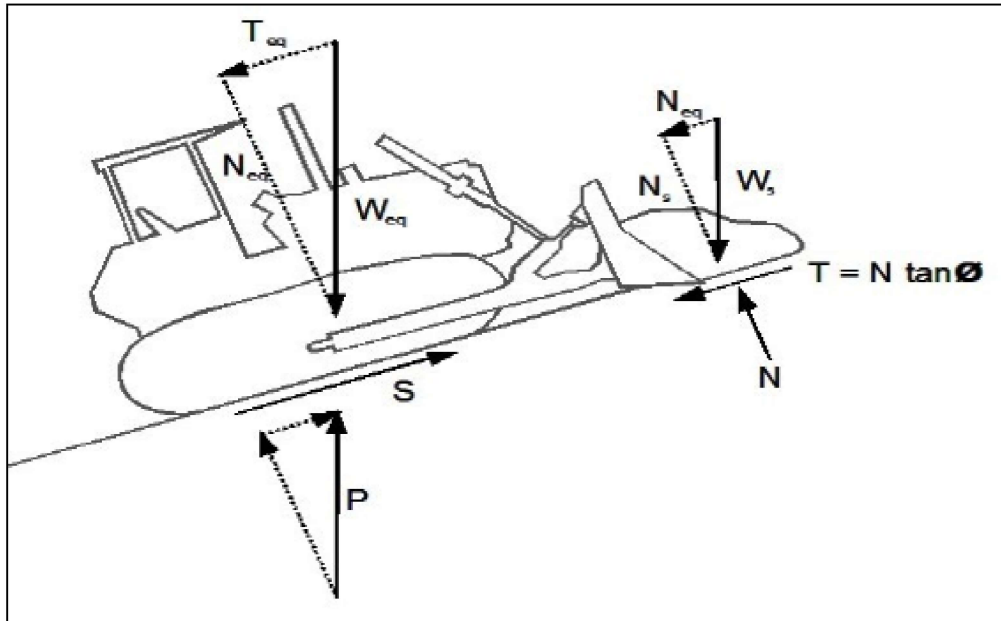
(ii) Geomembrane

Shear strength at upper surface	454.581	kN
Mobilised shear stress at upper interface	454.581	kN
Shear strength at lower interface	562.214	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture No Tension

Capping system stability: Effect of plant loading

Geometry:



Input Parameters

Cover soils unit weight (dry), g_{dry}
 Cover soil internal shear strength, ϕ
 Cover soil cohesion, c
 Thickness of cover soil, h
 Height of slope, H
 Slope angle, β

18	kN/m ³
25	Deg.
5	kPa
1.2	m
13.5	m
17.7	Deg.

Geosynthetic interface shear strengths:

Cover soil/Geocomposite friction angle, $d1$
 Cover soil/Geocomposite cohesion intercept, $a1$
 Geocomposite/Geomembrane friction angle, $d2$
 Geocomposite/Geomembrane cohesion intercept, $a2$
 Geomembrane/Blinding layer, $d3$
 Geomembrane/Blinding layer, $a3$

26	Deg.
3	kPa
22	Deg.
1	kPa
25	Deg.
2	kPa



PROJECT Llanddulas Perm Capping 2025

1 in 2.9 13.5m High GDL

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

I (Influence Factor)

Wb (Bulldozer Weight)

w (Track Length)

b (Track Width)

Force per unit area

Equivalent Force/ unit width

acceleration of plant

acceleration due to gravity

Dynamic Force per unit width

Effective Equipment Force normal to failure Plane

Cohesive Force Along Failure plane of Passive Wedge

Geosynthetic tensile strengths:

Geocomposite

Geomembrane

1		
230	kN	
3.2	m	
0.91	m	
45	kPa	
144	kN/m	
2	m/s ²	
9.81	m/s ²	
29.3578		
137.1833		
19.7347		
12	kN/m	
11	kN/m	

1. Stability of Cover Soil

Calculated Parameters

Length of slope, L	44.403	m
Weight of active wedge, W _A	914.361	kN
Weight of passive wedge, W _P	44.745	kN
Pore pressure perp. to slope, U _n	0.000	
Pore pressure in interwedge surface, U _h	0.000	
Force normal to active wedge, N _A	871.077	kN
a	334.512	
b	-685.766	
c	70.144	

Factor of Safety against cover soil sliding

1.94

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	298.059	kN
Shear strength at lower interface	413.563	kN
Tension developed in the Geotextile	0.000	kN
Tensile strength of the Geotextile	20	kN

Factor of Safety against rupture

No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

Shear strength at upper surface 413.563 kN

Mobilised shear stress at upper interface 298.059 kN

Shear strength at lower interface 514.873 kN

Tension developed in the Geomembrane 0.000 kN

Tensile strength of the Geomembrane 12 kN

Factor of Safety against rupture

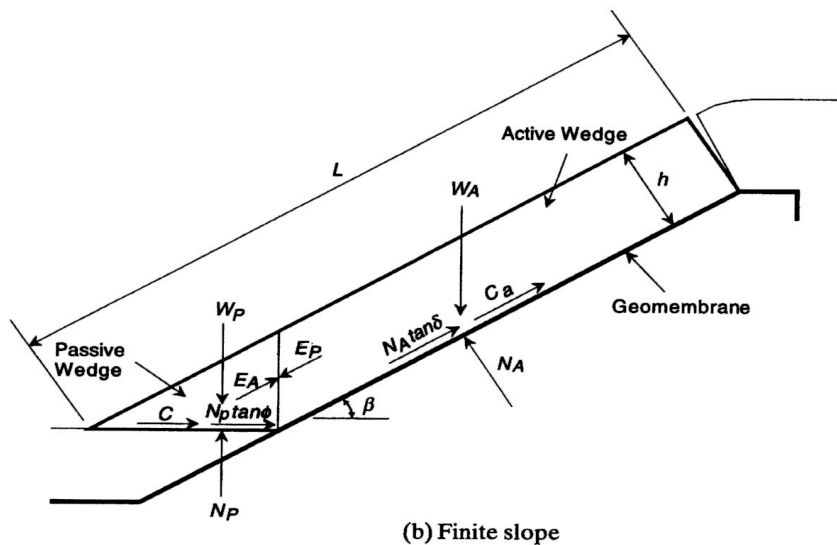
No Tension

Capping system stability: Effect of gas pressure

Aim: To assess the stability of the drainage material and integrity of the geosynthetic lining system

Approach: Use the approach proposed by Koerner & Daniels, 1997.

Geometry:



Input Parameters

Cover soil unit weight, γ	18	kN/m ³
Cover soil internal shear strength, ϕ	25	Deg.
Cover soil cohesion, c	5	kPa
Thickness of cover soil, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.

N.B. Consider only interface at base of geosynthetics on which gas pressure acts.

Geosynthetic interface shear strengths:

Geomembrane/Blinding layer, δ_3	25	Deg.
Geomembrane/Blinding layer, α_3	2	kPa

Gas pressure	5.0	kPa
--------------	-----	-----

Ignores strength of geosynthetic layers

**PROJECT Llanddulas Perm Capping 2025****1 in 2.9 13.5m High GDL**

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

1. Stability of Cover Soil**Calculated Parameters**

Length of slope, L	44.403	m
Weight of active wedge, W_A	914.361	kN
Weight of passive wedge, W_p	44.745	kN
Pore pressure perp. to slope, U_n	0.000	
Pore pressure in interwedge surface, U_h	0.000	
Force normal to active wedge, N_A	871.077	kN
Force normal to active wedge from gas pressure, N_G	222.02	kN
a	264.836	
b	-433.214	
c	43.193	

Factor of Safety against geomembrane sliding**1.53**



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

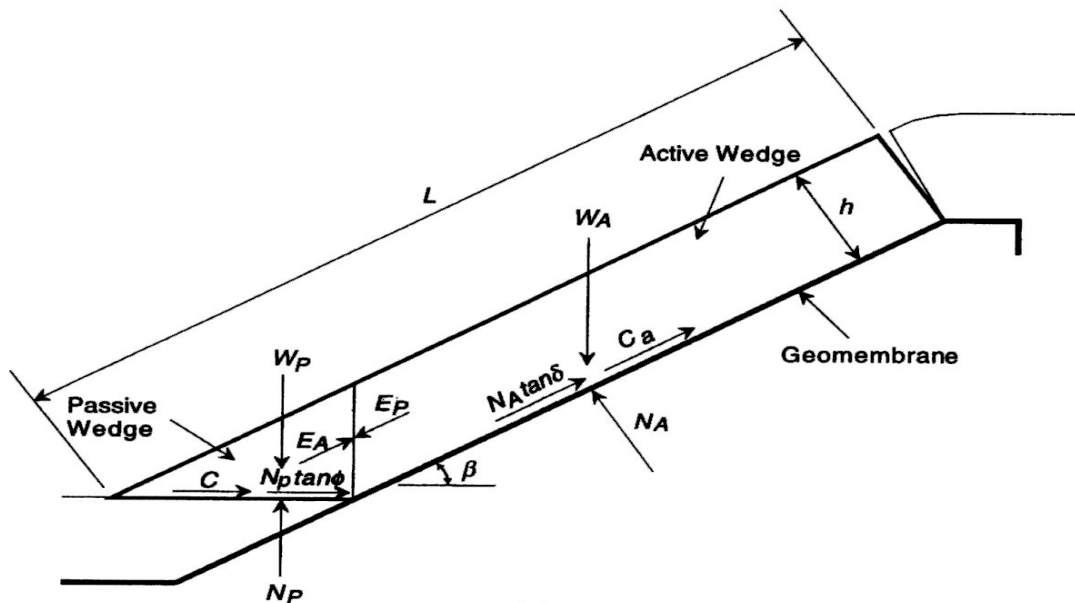
Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

Capping system stability PSR = 0.0

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.20	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geotextile friction angle, d1	28	Deg.
Cover soil/Geotextile cohesion intercept, a1	3	kPa
Geotextile/Geomembrane friction angle, d2	22	Deg.
Geotextile/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, δ_3	22	Deg.
Geomembrane/Blinding layer, α_3	1	kPa

Parallel submergence ratio, PSR 0.0

Geosynthetic tensile strengths:

Geotextile	15	kN/m
Geomembrane	11	kN/m



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

1. Stability of Cover Soils

Calculated Parameters

Length of slope, L	44.403	m
Thickness of water, h_w	0.000	m
Weight of active wedge, W_A	914.361	kN
Weight of passive wedge, W_P	44.745	kN
Pore pressure perp. to slope, U_n	0.000	kN
Pore pressure in interwedge surface, U_h	0.000	kN
Force normal to active wedge, N_A	871.077	kN
Vert pp on passive wedge, U_v	0.000	kN
a	264.836	
b	-648.150	
c	84.549	

Factor of Safety against cover soils sliding 2.31

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	268.084	kN
Shear strength at lower interface	413.563	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	15	kN

Factor of Safety against rupture No Tension

(ii) Geomembrane

Shear strength at upper surface	413.563	kN
Mobilised shear stress at upper interface	268.084	kN
Shear strength at lower interface	413.563	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

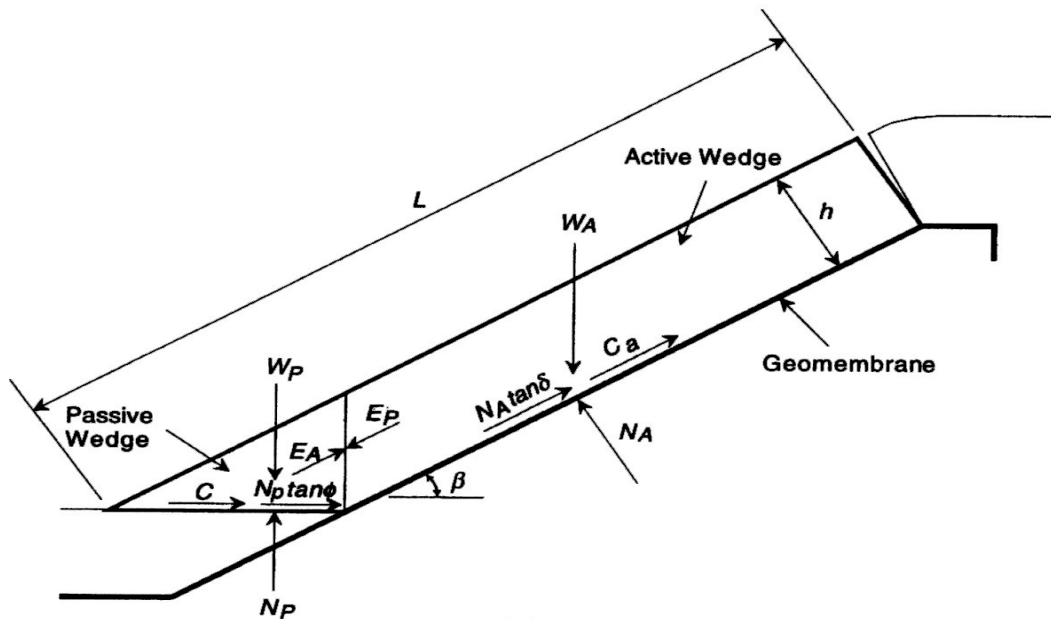
Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

Capping system stability PSR 0.25

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geotextile friction angle, d1	28	Deg.
Cover soil/Geotextile cohesion intercept, a1	3	kPa
Geotextile/Geomembrane friction angle, d2	22	Deg.
Geotextile/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	22	Deg.
Geomembrane/Blinding layer, a3	1	kPa
Parallel submergence ratio, PSR	0.25	
Geosynthetic tensile strengths:		
Geotextile	15	kN/m
Geomembrane	11	kN/m

**PROJECT Llanddulas Perm Capping 2025****1 in 2.9 13.5m High GTX**

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

1. Stability of Cover Soils**Calculated Parameters**

Length of slope, L	44.403	m
Thickness of water, h_w	0.300	m
Weight of active wedge, W_A	940.692	kN
Weight of passive wedge, W_P	45.056	kN
Pore pressure perp. to slope, U_n	125.423	kN
Pore pressure in interwedge surface, U_h	0.450	kN
Force normal to active wedge, N_A	770.875	kN
Vert pp on passive wedge, U_V	1.410	kN
a	272.504	
b	-597.955	
c	76.996	

Factor of Safety against cover soils sliding 2.06**2. Integrity of Geosynthetics****(i) Geotextile**

Mobilised shear stress at upper interface	307.511	kN
Shear strength at lower interface	423.818	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	15	kN

Factor of Safety against rupture No Tension**(ii) Geomembrane**

Shear strength at upper surface	423.818	kN
Mobilised shear stress at upper interface	307.511	kN
Shear strength at lower interface	423.818	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

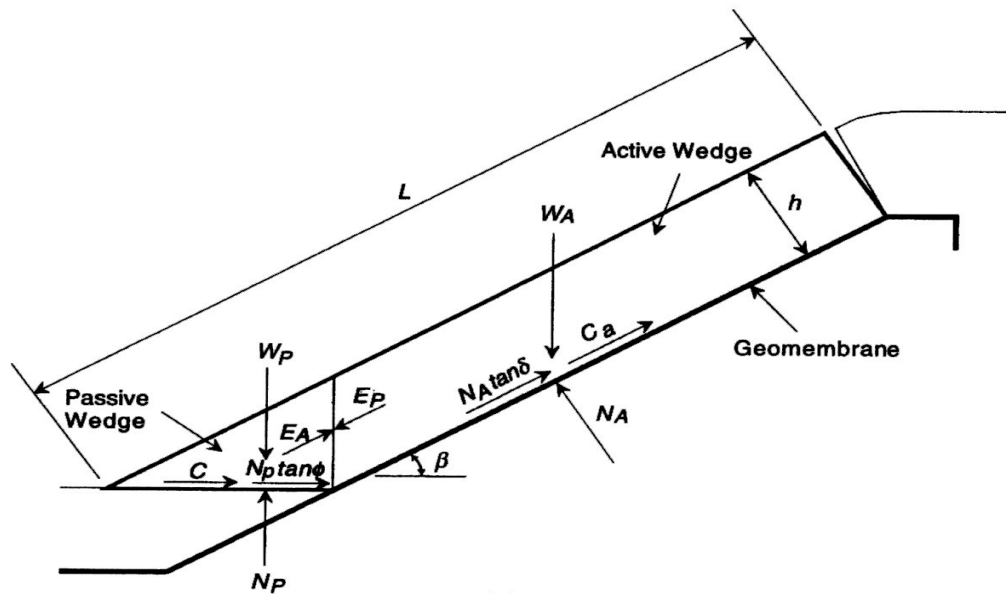
Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

Capping system stability PSR = 0.5

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geotextile friction angle, d1	28	Deg.
Cover soil/Geotextile cohesion intercept, a1	3	kPa
Geotextile/Geomembrane friction angle, d2	22	Deg.
Geotextile/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	22	Deg.
Geomembrane/Blinding layer, a3	1	kPa
Parallel submergence ratio, PSR	0.5	
Geosynthetic tensile strengths:		
Geotextile	15	kN/m
Geomembrane	11	kN/m

**PROJECT Llanddulas Perm Capping 2025**

Job No. WR8063

Made By: S Saad

Checked: A Kirk

Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

1. Stability of Cover Soils**Calculated Parameters**

Length of slope, L	44.403	m
Thickness of water, h_w	0.600	m
Weight of active wedge, W_A	966.402	kN
Weight of passive wedge, W_P	45.988	kN
Pore pressure perp. to slope, U_n	247.886	kN
Pore pressure in interwedge surface, U_h	1.800	kN
Force normal to active wedge, N_A	673.315	kN
Vert pp on passive wedge, U_V	5.640	kN
a	280.076	
b	-547.925	
c	69.641	

Factor of Safety against cover soils sliding**1.82****2. Integrity of Geosynthetics****(i) Geotextile**

Mobilised shear stress at upper interface	355.016	kN
Shear strength at lower interface	434.072	kN
Tension developed in the GT	0.000	kN
Tensile strength of the GT	15	kN

Factor of Safety against rupture**No Tension****(ii) Geomembrane**

Shear strength at upper surface	434.072	kN
Mobilised shear stress at upper interface	355.016	kN
Shear strength at lower interface	434.072	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture**No Tension**



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Checked: A Kirk

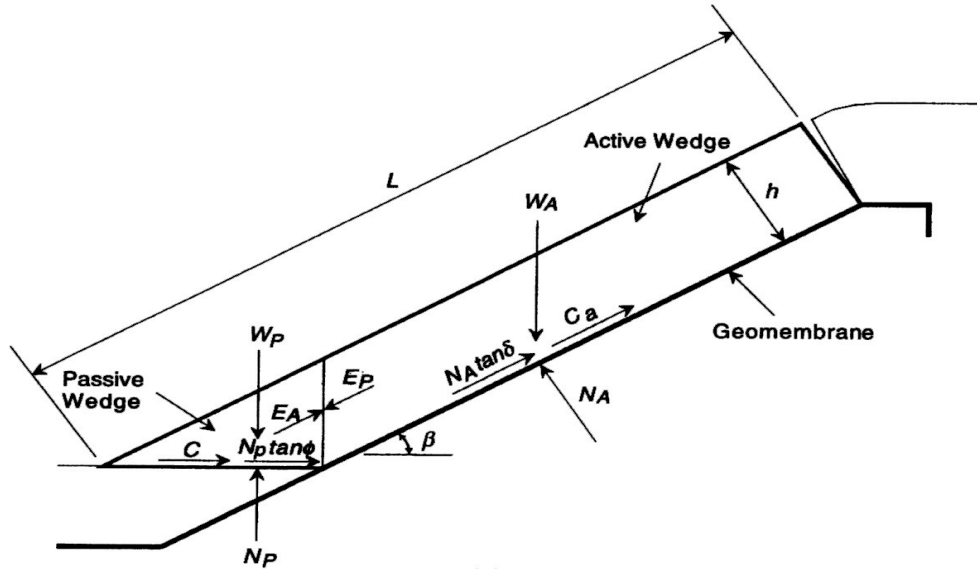
Reviewed: A Kirk

1 in 2.9 13.5m High GTX

Date: 31/03/2025

Capping system stability PSR : 1.0

Geometry:



(b) Finite slope

Input Parameters

Cover soils unit weight (dry), γ_{dry}	18	kN/m ³
Cover soils unit weight (saturated), γ_{sat}	20	kN/m ³
Cover soils internal shear strength, ϕ	25	Deg.
Cover soils cohesion, c	5	kPa
Thickness of cover soils, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.
Geosynthetic interface shear strengths:		
Cover soil/Geotextile friction angle, d1	28	Deg.
Cover soil/Geotextile cohesion intercept, a1	3	kPa
Geotextile/Geomembrane friction angle, d2	22	Deg.
Geotextile/Geomembrane cohesion intercept, a2	1	kPa
Geomembrane/Blinding layer, d3	22	Deg.
Geomembrane/Blinding layer, a3	1	kPa
Parallel submergence ratio, PSR	1.0	
Geosynthetic tensile strengths:		
Geotextile	15	kN/m
Geomembrane	11	kN/m

**PROJECT Llanddulas Perm Capping 2025****1 in 2.9 13.5m High GTX**

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

1. Stability of Cover Soils**Calculated Parameters**

Length of slope, L	44.403	m
Thickness of water, h_w	1.200	m
Weight of active wedge, W_A	1015.957	kN
Weight of passive wedge, W_P	49.717	kN
Pore pressure perp. to slope, U_n	483.931	kN
Pore pressure in interwedge surface, U_h	7.200	kN
Force normal to active wedge, N_A	486.120	kN
Vert pp on passive wedge, U_V	22.561	kN
a	294.928	
b	-448.359	
c	55.530	

Factor of Safety against cover soils sliding 1.38**2. Integrity of Geosynthetics****(i) Geotextile**

Mobilised shear stress at upper interface	486.208	kN
Shear strength at lower interface	454.581	kN
Tension developed in the GT	31.627	kN
Tensile strength of the GT	15	kN

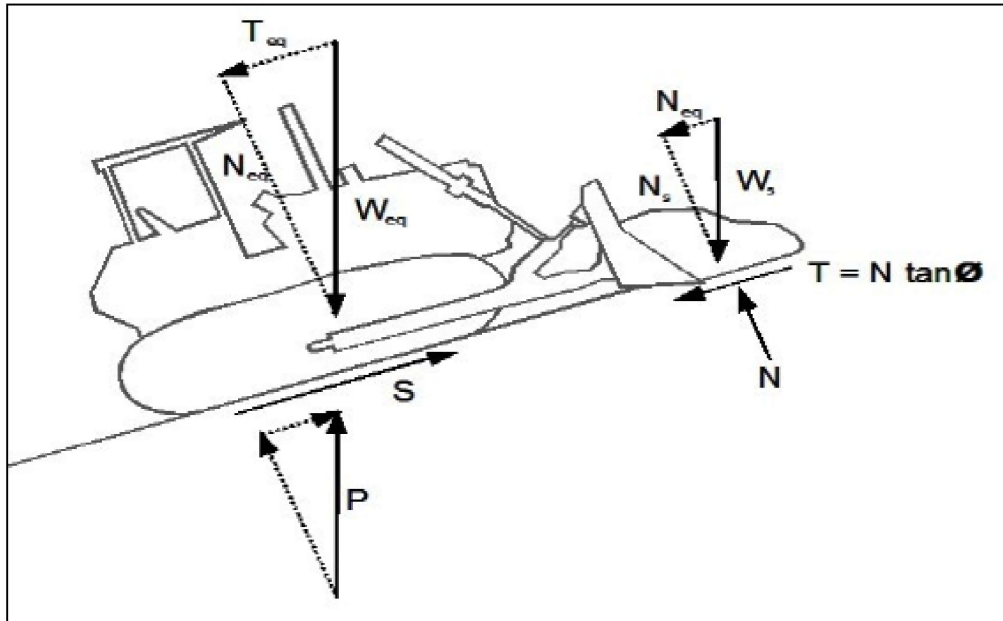
Factor of Safety against rupture 0.47**(ii) Geomembrane**

Shear strength at upper surface	454.581	kN
Mobilised shear stress at upper interface	454.581	kN
Shear strength at lower interface	454.581	kN
Tension developed in the GM	0.000	kN
Tensile strength of the GM	11	kN

Factor of Safety against rupture No Tension

Capping system stability: Effect of plant loading

Geometry:



Input Parameters

Cover soils unit weight (dry), g_{dry}
 Cover soil internal shear strength, ϕ
 Cover soil cohesion, c
 Thickness of cover soil, h
 Height of slope, H
 Slope angle, β

18	kN/m ³
25	Deg.
5	kPa
1.2	m
13.5	m
17.7	Deg.

Geosynthetic interface shear strengths:

Cover soil/Geotextile friction angle, $d1$
 Cover soil/Geotextile cohesion intercept, $a1$
 Geotextile/Geomembrane friction angle, $d2$
 Geotextile/Geomembrane cohesion intercept, $a2$
 Geomembrane/Blinding layer, $d3$
 Geomembrane/Blinding layer, $a3$

28	Deg.
3	kPa
22	Deg.
1	kPa
22	Deg.
1	kPa



PROJECT Llanddulas Perm Capping 2025

1 in 2.9 13.5m High GTX

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

I (Influence Factor)

Wb (Bulldozer Weight)

w (Track Length)

b (Track Width)

Force per unit area

Equivalent Force/ unit width

acceleration of plant

acceleration due to gravity

Dynamic Force per unit width

Effective Equipment Force normal to failure Plane

Cohesive Force Along Failure plane of Passive Wedge

Geosynthetic tensile strengths:

Geotextile

Geomembrane

1		
230	kN	
3.2	m	
0.91	m	
45	kPa	
144	kN/m	
2	m/s ²	
9.81	m/s ²	
29.3578		
137.1833		
19.7347		
15	kN/m	
11	kN/m	

1. Stability of Cover Soil

Calculated Parameters

Length of slope, L	44.403	m
Weight of active wedge, W _A	914.361	kN
Weight of passive wedge, W _P	44.745	kN
Pore pressure perp. to slope, U _n	0.000	
Pore pressure in interwedge surface, U _h	0.000	
Force normal to active wedge, N _A	871.077	kN
a	334.512	
b	-728.007	
c	76.430	

Factor of Safety against cover soil sliding

2.07

2. Integrity of Geosynthetics

(i) Geotextile

Mobilised shear stress at upper interface	299.670	kN
Shear strength at lower interface	413.563	kN
Tension developed in the Geotextile	0.000	kN
Tensile strength of the Geotextile	20	kN

Factor of Safety against rupture

No Tension



PROJECT Llanddulas Perm Capping 2025

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

Reviewed: A Kirk

Shear strength at upper surface 413.563 kN

Mobilised shear stress at upper interface 299.670 kN

Shear strength at lower interface 413.563 kN

Tension developed in the Geomembrane 0.000 kN

Tensile strength of the Geomembrane 12 kN

Factor of Safety against rupture

No Tension



PROJECT Llanddulas Perm Capping 2025

1 in 2.9 13.5m High GTX

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

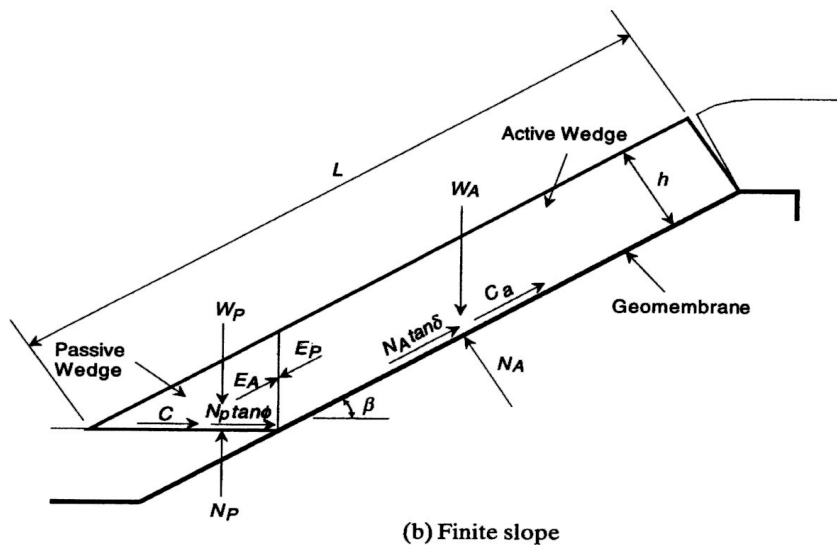
Reviewed: A Kirk

Capping system stability: Effect of gas pressure

Aim: To assess the stability of the drainage material and integrity of the geosynthetic lining system

Approach: Use the approach proposed by Koerner & Daniels, 1997.

Geometry:



Input Parameters

Cover soil unit weight, γ	18	kN/m ³
Cover soil internal shear strength, ϕ	25	Deg.
Cover soil cohesion, c	5	kPa
Thickness of cover soil, h	1.2	m
Height of slope, H	13.5	m
Slope angle, β	17.7	Deg.

N.B. Consider only interface at base of geosynthetics on which gas pressure acts.

Geosynthetic interface shear strengths:

Geomembrane/Blinding layer, δ_3	22	Deg.
Geomembrane/Blinding layer, α_3	1	kPa

Gas pressure	5.0	kPa
--------------	-----	-----

Ignores strength of geosynthetic layers

**PROJECT Llanddulas Perm Capping 2025****1 in 2.9 13.5m High GTX**

Job No. WR8063

Made By: S Saad

Date: 31/03/2025

Checked: A Kirk

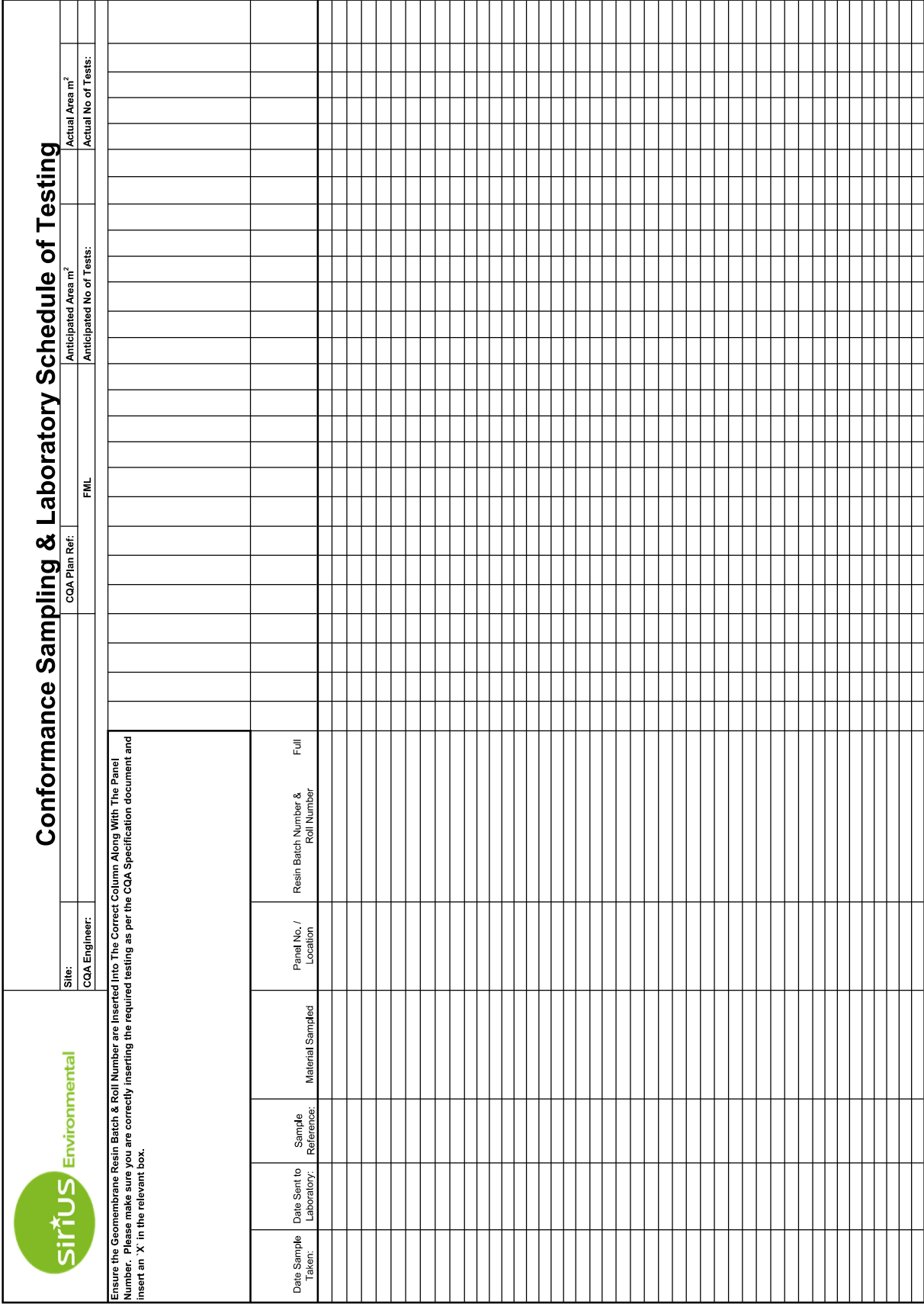
Reviewed: A Kirk

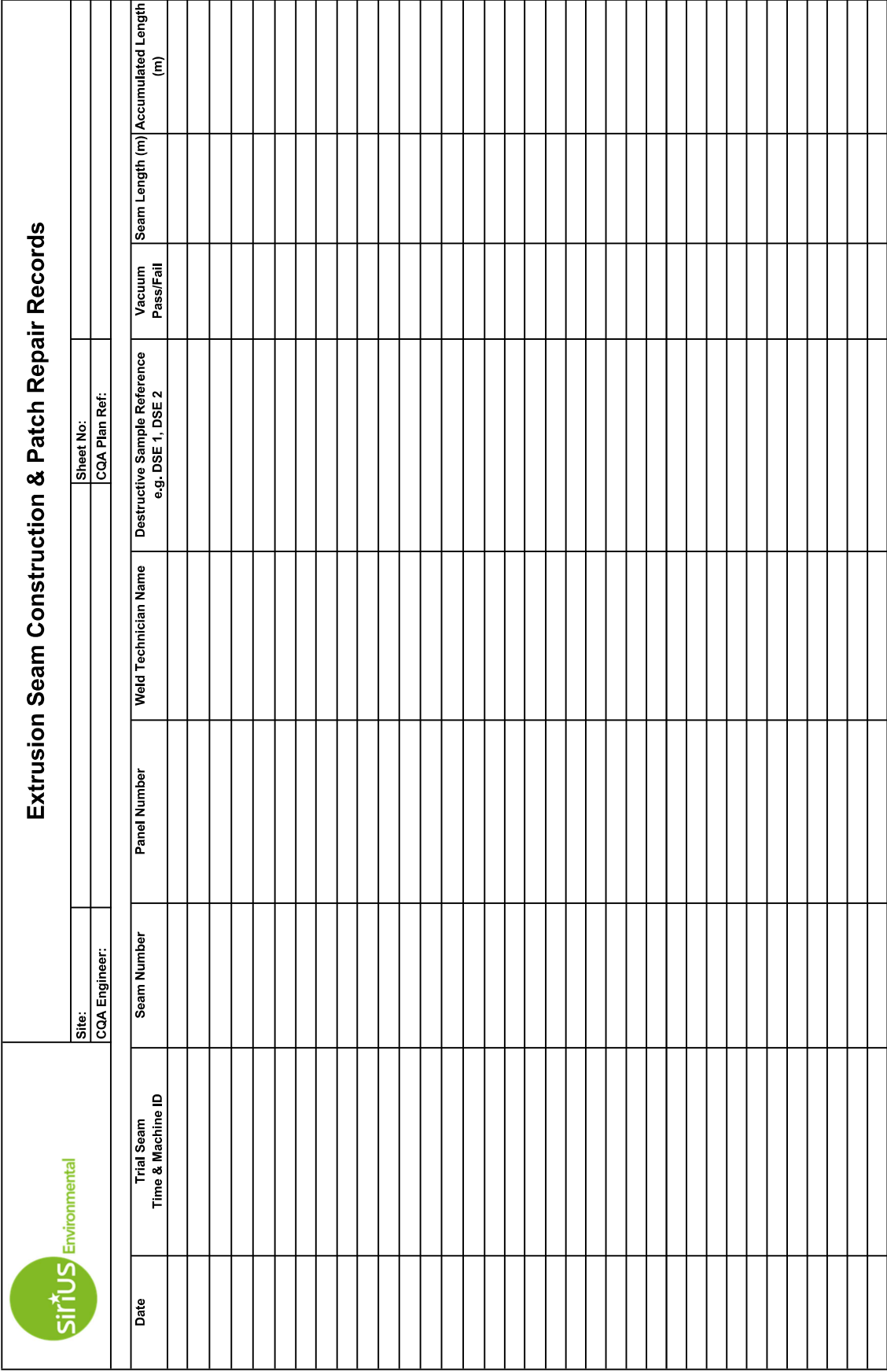
1. Stability of Cover Soil**Calculated Parameters**

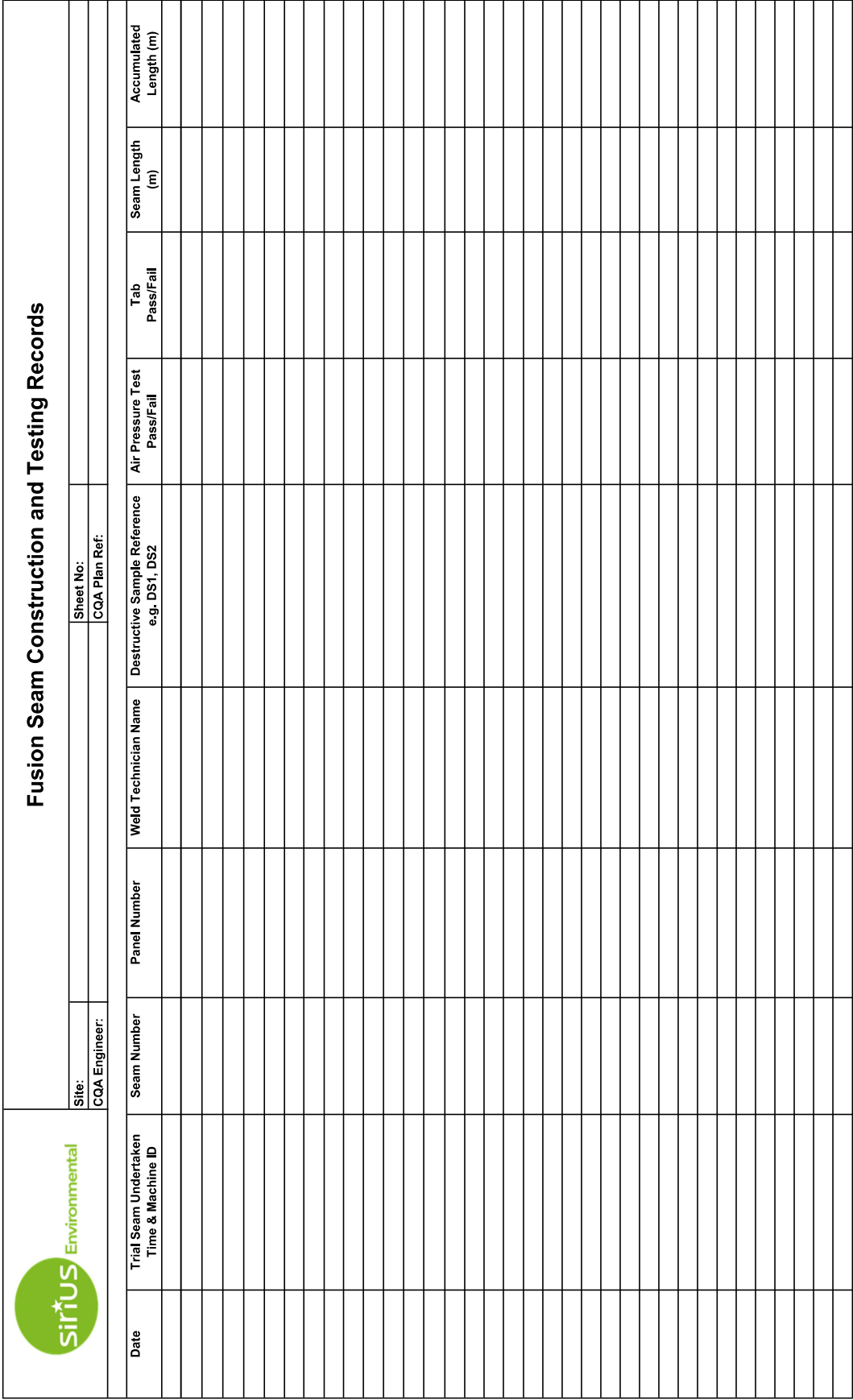
Length of slope, L	44.403	m
Weight of active wedge, W_A	914.361	kN
Weight of passive wedge, W_p	44.745	kN
Pore pressure perp. to slope, U_n	0.000	
Pore pressure in interwedge surface, U_h	0.000	
Force normal to active wedge, N_A	871.077	kN
Force normal to active wedge from gas pressure, N_G	222.02	kN
a	264.836	
b	-352.402	
c	37.320	

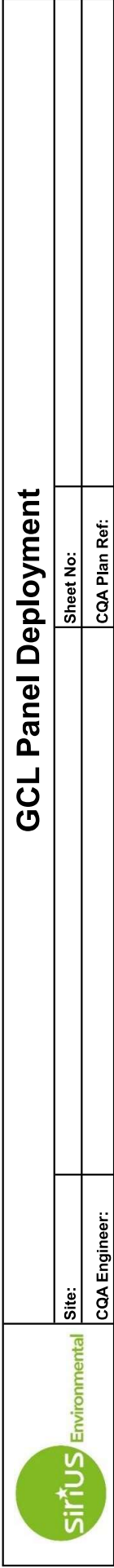
Factor of Safety against geomembrane sliding**1.21**

[illegible]





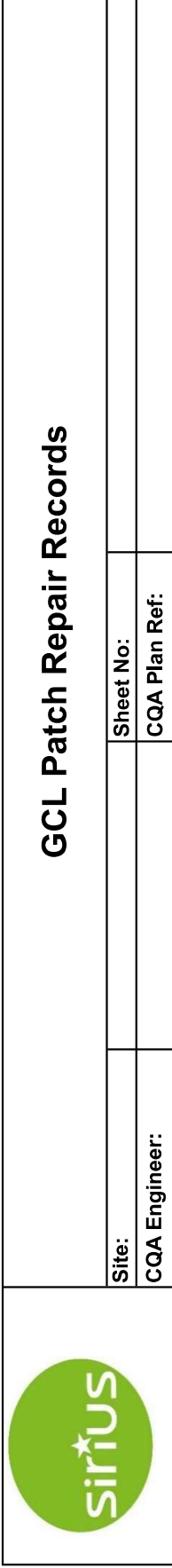




	GCL Panel Deployment	
	Site:	Sheet No:
	CQA Engineer:	CQA Plan Ref:

	GCL Panel Deployment	
	Site:	Sheet No:
	CQA Engineer:	CQA Plan Ref:

[illegible]



	GCL Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

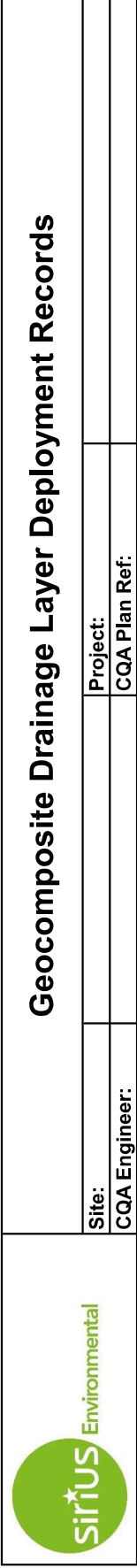
	GCL Patch Repair Records		
	Site:	Sheet No:	
	CQA Engineer:	CQA Plan Ref:	

	GCL Patch Repair Records		
	Site:	Sheet No:	
	CQA Engineer:	CQA Plan Ref:	

	GCL Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

	GCL Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

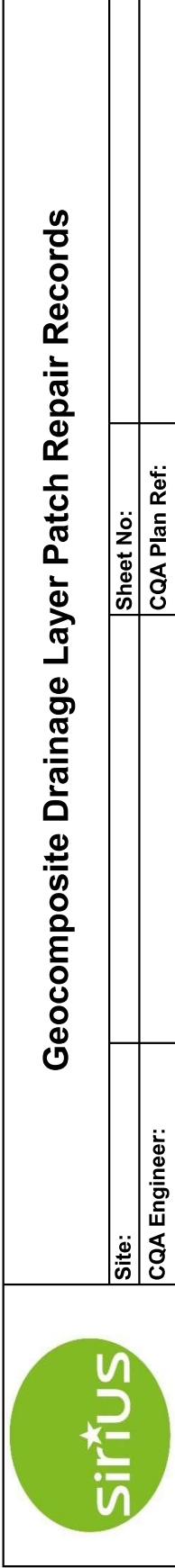
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	Geocomposite Drainage Layer Deployment Records	
	Site:	Project:
	CQA Engineer:	CQA Plan Ref:

	Geocomposite Drainage Layer Deployment Records	
	Site:	Project:
	CQA Engineer:	CQA Plan Ref:

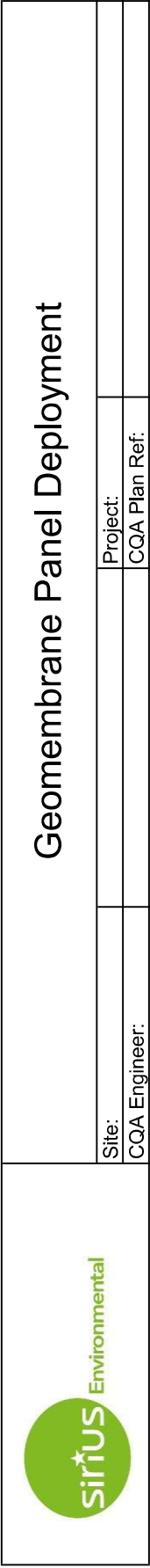
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	Geocomposite Drainage Layer Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

	Geocomposite Drainage Layer Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

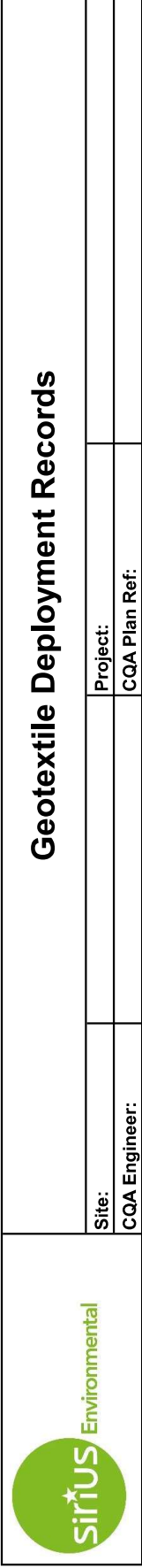
[illegible]



	Geomembrane Panel Deployment		
	Site:		Project:
	CQA Engineer:		CQA Plan Ref:

	Geomembrane Panel Deployment		
	Site:		Project:
	CQA Engineer:		CQA Plan Ref:

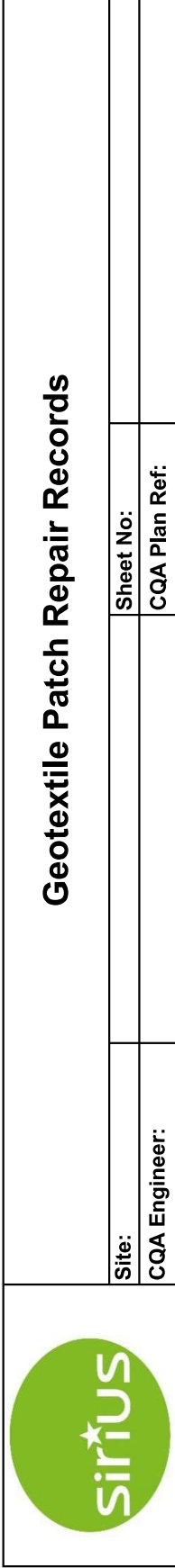
[illegible]



	Geotextile Deployment Records		
	Site:	Project:	
	CQA Engineer:	CQA Plan Ref:	

	Geotextile Deployment Records		
	Site:	Project:	
	CQA Engineer:	CQA Plan Ref:	

[illegible]



	Geotextile Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

	Geotextile Patch Repair Records			
	Site:		Sheet No:	
	CQA Engineer:		CQA Plan Ref:	

[illegible]

[illegible]



GCL Materials Received

Site:		Sheet No:	
CQA Engineer:		CQA Plan Ref:	

[illegible]



Materials Received

Site:		Sheet No:	
CQA Engineer:		CQA Plan Ref:	

[illegible]



Daily Site Record Sheet

Date:		Site:	
Weather:		CQA Plan Ref:	

Visitors to Site:			
List of Plant	Hours of Operation	Comments	

Prepared by:		Signed:	
--------------	--	---------	--



Surface Acceptance Certificate

Site:		Sheet No:	
CQA Engineer:		CQA Plan Ref:	

Area of Subgrade under consideration:	Surface of Regulating Layer
---------------------------------------	-----------------------------

I the undersigned, a duly appointed representative of Sirius Environmental Limited, have visually observed the subgrade described above and confirm the subgrade is an acceptable surface upon which to install

This certification is based on observation of the surface of the subgrade only. No subterranean inspections or tests have been performed by Sirius Environmental Limited, and Sirius Environmental Limited makes no representations or warranties regarding the conditions which may exist below the surface of the subgrade.

Sirius Environmental Representative:	
Name:	Signature:
Date:	Position:

From: [Bennion, Christopher](#)
To: [Roberts, Anthony](#)
Cc: [Curt, Adrian](#); [Andrew Kirk](#)
Subject: RE: Llanddulas Capping 2022-2023
Date: 31 January 2023 10:05:42
Attachments: [image002.png](#)
[image003.png](#)
[image004.png](#)
[image005.png](#)
[image006.png](#)
[image007.png](#)

Hi Tony

Many thanks for this, will keep you posted

Cheers

Chris Bennion - Site Business Manager

Mobile: +447720 669229 | **Email:** Chris.Bennion@fccenvironment.co.uk

FCC Environment | Gowry | Ince Lane | Wimbolds Trafford | Chester | Cheshire | CH2 4JP |
<http://www.fccenvironment.co.uk/>



From: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>
Sent: 31 January 2023 10:03
To: Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>
Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Andrew Kirk <andrew.kirk@thesiriusgroup.com>
Subject: Re: Llanddulas Capping 2022-2023

Hi Chris,

I have assessed the CQA report and the engineering specification report and can confirm both are satisfactory to NRW.

Once you have a definite date for works to commence, please can you contact me 4 weeks in advance so we can arrange pre-capping site meeting to go through issues in more detail.

Best wishes

Tony

Tony Roberts
Cyfoeth Naturiol Cymru / Natural Resources Wales
Senior Officer/SMNR and SynBiogas Programme Project Manager

Waste and Industry Regulation Team, Maes Y Fynnon,
Bangor. LL57 2DW

Ffôn/Tel: 03000 653752

Ffôn symudol / Mobile: 07468 742602

E-Bost/E-mail

Anthony.Roberts@naturalresourceswales.gov.uk

From: Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>

Sent: 06 January 2023 08:38

To: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>

Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Andrew Kirk <andrew.kirk@thesiriusgroup.com>

Subject: RE: Llanddulas Capping 2022-2023

Thanks Tony, appreciated

Chris Bennion - Site Business Manager

Mobile: +447720 669229 | **Email:** Chris.Bennion@fccenvironment.co.uk

FCC Environment | Gowry | Ince Lane | Wimbolds Trafford | Chester | Cheshire | CH2 4JP |

<http://www.fccenvironment.co.uk/>



From: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>

Sent: 06 January 2023 08:38

To: Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>

Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Andrew Kirk <andrew.kirk@thesiriusgroup.com>

Subject: Re: Llanddulas Capping 2022-2023

Hi Chris,

Thanks for the update and timeline. I will progress this ASAP and get back to you well before the deadline.

Cheers

Tony

Tony Roberts
Cyfoeth Naturiol Cymru / Natural Resources Wales
Senior Officer/SMNR and SynBiogas Programme Project Manager
Waste and Industry Regulation Team, Maes Y Fynnon,
Bangor. LL57 2DW
Ffôn/Tel: 03000 653752
Ffôn symudol / Mobile: 07468 742602

E-Bost/E-mail

Anthony.Roberts@naturalresourceswales.gov.uk

From: Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>
Sent: 04 January 2023 14:18
To: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>
Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Andrew Kirk <andrew.kirk@thesiriusgroup.com>
Subject: RE: Llanddulas Capping 2022-2023

Hi Tony

Been speaking to Adrian (engineering manager) today.
If we have enough soils to complete this capping it might be started in summer 2023
So, if possible could you have a look at the CQA plan for us by around March 2023 please?

Regards

Chris Bennion - Site Business Manager
Mobile: +447720 669229 | **Email:** Chris.Bennion@fccenvironment.co.uk
FCC Environment | Gowry | Ince Lane | Wimbolds Trafford | Chester | Cheshire | CH2 4JP |
<http://www.fccenvironment.co.uk/>



From: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>
Sent: 13 October 2022 09:14
To: Andrew Kirk <andrew.kirk@thesiriusgroup.com>
Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>; Porter, Anthony <Anthony.Porter@fccenvironment.co.uk>; Andrew Coxon <andrew.coxon@thesiriusgroup.com>; Ian York <ian.york@thesiriusgroup.com>; Leon Tinkley <Leon.Tinkley@thesiriusgroup.com>
Subject: Re: Llanddulas Capping 2022-2023

Thanks Andrew.

Tony

Tony Roberts

Cyfoeth Naturiol Cymru / Natural Resources Wales
Senior Officer/SMNR and SynBiogas Programme Project Manager
Waste and Industry Regulation Team, Maes Y Fynnon,
Bangor. LL57 2DW

Ffôn/Tel: 03000 653752

Ffôn symudol / Mobile: 07468 742602

E-Bost/E-mail

Anthony.Roberts@naturalresourceswales.gov.uk

From: Andrew Kirk <Andrew.Kirk@thesiriusgroup.com>

Sent: 13 October 2022 09:09

To: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>

Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>; Ant Porter <anthony.porter@fccenvironment.co.uk>; Andrew Coxon <Andrew.Coxon@thesiriusgroup.com>; Ian York <Ian.York@thesiriusgroup.com>; Leon Tinkley <Leon.Tinkley@thesiriusgroup.com>

Subject: Re: Llanddulas Capping 2022-2023

Anthony

It won't be until 2023 so no massive rush.

Thanks



Andrew Kirk | Design Director | Environmental

M [07702 892 395](tel:07702892395)

T [0113 264 9960](tel:01132649960)

W www.thesiriusgroup.com

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From: Roberts, Anthony <Anthony.Roberts@cyfoethnaturiolcymru.gov.uk>

Sent: Wednesday, October 12, 2022 12:18:45 PM

To: Andrew Kirk <Andrew.Kirk@thesiriusgroup.com>

Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>; Ant Porter <anthony.porter@fccenvironment.co.uk>; Andrew Coxon <Andrew.Coxon@thesiriusgroup.com>; Ian York <Ian.York@thesiriusgroup.com>; Leon Tinkley <Leon.Tinkley@thesiriusgroup.com>

Subject: Re: Llanddulas Capping 2022-2023

Good Morning Andrew,

Thank you for the submission of the documents relating to the proposed capping works at Llanddulas landfill.

I intend to review the proposals for construction shortly and will respond as soon as possible.

Do you have any closer approximations to when the work might be undertaken?

Please note:

You state that you require that 'The Environment Agency Reviews' please can you ensure that any further correspondence refers to Natural Resources Wales (NRW), as we are the regulatory body for this site.

Best wishes

Tony

Tony Roberts

Cyfoeth Naturiol Cymru / Natural Resources Wales
Senior Officer/SMNR and SynBiogas Programme Project Manager
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Sent: 29 September 2022 08:27
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Cc: Curt, Adrian <adrian.curt@fccenvironment.co.uk>; Bennion, Christopher <Chris.Bennion@fccenvironment.co.uk>; Ant Porter <anthony.porter@fccenvironment.co.uk>; Andrew Coxon <Andrew.Coxon@thesiriusgroup.com>; Ian York <Ian.York@thesiriusgroup.com>; Leon Tinkley <Leon.Tinkley@thesiriusgroup.com>
Subject: Llanddulas Capping 2022-2023

Dear Anthony

As is required in the Llanddulas Landfill PPC Permit we write to inform you of FCC's intent to construction the final capping at Llanddulas, this may be done in a few phases over the next year or so.

On behalf of FCC, Sirius request that the Environment Agency reviews the proposals for construction, and confirms in writing that the proposals are acceptable.

Should you have any queries or concerns with the above, or any questions relating to the attached, please feel free to contact the undersigned.

Please could you also confirm if you require a hard copy of the report for your records and that this has downloaded OK.

 [WR7712 Llanddulas Permanent Capping 2022 COA Plan Rev1.pdf](#)

 [WR7712 Llanddulas Permanent Capping 2022 Specification Rev1.pdf](#)

Regards



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**3C WASTE LIMITED
(FCC ENVIRONMENT LIMITED)**



**SPECIFICATION FOR 2022 PERMANENT CAPPING
AT LLANDDULAS LANDFILL SITE**

Document Reference: WR7712_1A Rev1
September 2022



Project Quality Assurance

Report Reference : WR7712_1A Rev1

Report Date : September 2022

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Rev	Date Issued	Amendment Details	Author	Reviewer
1	27/09/2022	Addition of Geotextile option into the design, amendments to slope stability section and interface testing requirements	JC	AK

Purpose

This document was prepared as a Specification for the Construction of an area of Permanent Capping at Llanddulas Landfill Site for 3C Waste Limited, who are the permit holders for the site, but are a subsidiary company of FCC Environment (UK) Limited and will be referred to as FCC Environment (UK) Limited from here on in.

Sirius Environmental Limited (Sirius) accepts no responsibility or liability for any use that is made of this document other than by the Client, FCC Environment (UK) Limited (FCC), for the purposes for which it was originally commissioned and prepared.

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1 GENERAL REQUIREMENTS

1.1 Introduction

FCC Environment (UK) Limited (FCC) are seeking to install a permanent capping system on an area at Llanddulas Landfill Site. Llanddulas Landfill Site is located immediately to the south of the village of Llanddulas, between Abergale and Colwyn Bay at National Grid reference SH 901 777. The site currently operates under an Environmental Permit Ref: BU0800IZ. The site address is:

Llanddulas Landfill Site,
Abergele Road,
Llanddulas,
Conwy,
LL22 8HP

Sirius Environmental Limited (Sirius) has prepared a detailed Specification for the construction of the 2022 Permanent Capping. FCC will appoint a third party independent Construction Quality Assurance (CQA) consultant to provide supervision for the duration of the capping construction on FCC's behalf. A representative of the CQA Engineer, the CQA Inspector, shall supervise the construction works and shall advise the Contractor with regard to the onsite and offsite testing requirements.

The Construction Quality Assurance Plan and Engineering Specification for the capping construction works to be undertaken have been prepared in accordance with the Environmental Permit, BU0800IZ.

This document, when read in conjunction with the CQA Plan ref: WR7712_2A details the requirements for the installation of the capping system undertaken by the Contractor, and the quality control procedures that will be followed during the capping works by the CQA Inspector to demonstrate that the works have been undertaken in accordance with the Specification. This document also details requirements for each element of the construction which should be read in conjunction with the construction drawings.

1.2 Project Team

The project team will comprise:

Waste Management Operator/Employer – FCC Environment (UK) Limited

Designer – Sirius Environmental Limited

Main Contractor – TBC

CQA – Sirius Environmental Limited

Principal Designer – Sirius Environmental Limited

1.3 Facilities

1.3.1 Contractor's Compound

The location and layout of the Contractor's compound shall be agreed with FCC prior to commencement of any works on site. The Contractor shall submit their proposals to FCC for mess facilities, plant standing, and maintenance areas. The Contractor shall site their plant standing, maintenance and refuelling areas so that no pollution will occur. 110% secondary containment bunding shall be used for fuel/oil storage tanks where appropriate. The Contractor shall also take into account the storage and mess requirements of their sub-contractors, if appropriate.

No lodgings or caravans will be allowed on site.

The Contractor shall ensure that adequate provision is made within the compound area for parking of all the plant, equipment and any private vehicles owned by operatives/subcontractors and visitors. Parking will not be permitted in any other areas of the landfill site.

The Contractor shall be responsible for the security of the works, all the Contractor's offices, plant, materials, services and machinery.

1.3.2 Contractor's Offices and Welfare Facilities

The Contractor shall be responsible for the provision and maintenance of welfare facilities for themselves and any sub-contractors. These facilities shall be as prescribed in the Working Rule agreement published by the Civil Engineering Construction Conciliation Board for Great Britain. The sanitary accommodation and disposal arrangements shall comply with the requirements of the local Environmental Health Authority. The Contractor's personnel shall not be permitted access to FCC's mess, shower and toilet facilities.

1.3.3 Fuel and Oil Installations

The Contractor's fuel and oil installations within the site shall only be provided at locations approved by FCC, such approval is not to be unreasonably withheld or delayed.

All fuel and oil installations provided by the Contractor shall be contained within an impermeable bund capable of containing 110% of the tank capacity in the event of a spillage; 'self-bunded' items will be permitted, subject to the Contractor being able to substantiate their efficacy.

The Contractor shall designate an area within his compound for carrying out plant maintenance and repairs. The Contractor shall ensure that all routine maintenance and repairs take place within this area. Any fuel or oil spillages will be remediated and a safe and controlled manner by the Contractor and at their expense.

1.3.4 Facilities for CQA Inspector (If required)

Where required, the Contractor shall provide, service and maintain one high-security steel ISO container, or as otherwise provided for, for the sole use of the CQA Inspector within the agreed location of his compound, subject to the approval of the CQA Inspector, which shall not be unreasonably delayed or withheld. The Contractor shall ensure that the container is provided with power supply, sufficient electricity power sockets, electric lighting and space heating, such that it will be ready for use by the CQA Inspector on the first day that CQA work is required. The Contractor shall be responsible for the maintenance of these facilities throughout the duration of the works.

All keys for the CQA Inspector's facilities shall be handed to the CQA Inspector.

1.4 Landfill Gas and Leachate Management Systems

FCC has installed landfill gas and leachate management systems across the Site, including areas within and adjacent to the works. FCC shall inform the Contractor which systems are to remain undisturbed during the period of the works, and which can be, or have been, decommissioned.

Should the Contractor subsequently damage or disturb any operational system, they shall immediately inform the CQA Inspector and FCC. Only if required by FCC, the Contractor shall carry out such reasonable remedial measures as are deemed necessary by FCC to reinstate any damaged or disturbed system to the same condition as immediately prior to

commencement of the works, otherwise FCC shall provide for the remediation to be completed within a timescale to be agreed with the Contractor.

1.5 PPC Permit

The area of the works is encompassed by the existing Pollution Prevention and Control (PPC) Permit for the current landfill operations. The Contractor shall not directly or indirectly compromise FCC's ability to carry out its operations in accordance with the PPC Permit, a copy of which shall be provided by FCC on request.

2 CONSTRUCTION REQUIREMENTS

2.1 Regulations and Site Safety

The works come under the Construction (Design and Management) Regulations of 2015 and the Main Contractor will also be appointed as the Principal Contractor.

The Contractor shall comply with the safety requirements set out in the following documents:

- FCC - Health and Safety Policy;
- FCC - Site User Safety Instructions;
- FCC - General Policy Statement for Contractors Conditions of Contract and Safety Rules; and
- FCC - Health & Safety Site Plan.

A copy of these documents is available for inspection at the landfill site office.

The Contractor shall adhere to the site Health and Safety Rules and the DSEAR Regulations dated 2002. The Contractor's performance with respect to these rules will be reviewed at each progress meeting.

2.2 CDM Area

The extent and location of the CDM area shall be agreed with FCC prior to any works commencing on-site, and 'works' shall include the delivery of any plant, equipment, materials and/or accommodation.

The agreed area shall be demarcated on site and once demarcated, the Principal Contractor shall ensure that the requirements of the CDM Regulations 2015 are adhered to at all times within it.

2.3 Method Statements and Risk Assessments

The Sirius Design Risk Assessment is enclosed in Appendix 1.

The Contractor shall submit to FCC for the approval, prior to commencement of the works, method statements and risk assessments detailing the proposals for all the works to be undertaken.

2.4 Substances Hazardous to Health

A substance hazardous to health shall only be used or generated in or about the works where specified in the Contract or with the consent of the CQA Inspector.

Where any substance hazardous to health is so used or generated during the works the Contractor shall provide the CQA Inspector with:

- A copy of the assessment of the risks created by the use of that substance; and
- Details of the measures to be taken to prevent or adequately control the exposure of the persons working with or those who may be affected by the substance.

The information required in the above shall be provided to FCC at least 14 days prior to the use of or incorporation into the works of substances hazardous to health or where appropriate at the commencement of the works where this is less than 14 days.

The Contractor shall advise FCC of the information, instruction, training and supervision to be provided for the Contractor's personnel and any other person likely to enter the area in which the hazard exists. The Contractor is to ensure that provision is made for monitoring health.

Where the measures referred to necessitate the use of protective clothing or other safety apparatus the Contractor shall:

- Provide FCC and their staff with sufficient and suitable items of protective clothing and safety apparatus if not previously supplied;
- Arrange for the proper storage, maintenance and regular testing and replacement of the items provided to the Employer and their staff; and
- Arrange for appropriate training or instruction for FCC and their staff in the use of such items.

2.5 Noise

The Contractor shall comply with any site specific noise limits and the following specific requirements:

- No work other than the operation of plant and equipment for the control of the groundwater shall take place outside the permitted hours except in case of emergency. FCC shall be informed of any such emergency immediately.
- All mobile plant, equipment and vehicles under the control of the Contractor, his sub-Contractors and suppliers, and in use or calling at the site, shall be fitted with appropriate silencing equipment and shall be maintained to manufacturers' standards.

2.6 Naked Flames and Smoking

Naked flames are prohibited within the working area on site at all times. Smoking will only be permitted in areas approved by FCC.

The Contractor shall obtain a permit to work from FCC for any 'hot works'. The works are to be carried out away from the landfill area and at a location agreed with FCC.

2.7 Mobile Plant

All Contractor's and subcontractors' vehicles (plant and operatives vehicles) shall be fitted with flashing amber beacons for vehicle awareness. Green flashing beacons to indicate that seat belts are in operation shall also be fitted to all construction plant. These beacons shall be located in a visually prominent position and shall be used whenever vehicles are on site. No Contractor's or subcontractors' vehicles will be allowed on site without the use of a flashing amber beacon.

All mobile plant shall be assessed for restricted rear view vision and action agreed, dependant upon the outcome of this assessment, which may result in suitable equipment being fitted in order to minimise the potential risk to within acceptable limits.

2.8 Dust Nuisance

The Contractor shall take all necessary steps to eliminate the generation of dust nuisance during the works.

Existing highways, site and access roads used by the vehicles and plant of the Contractor or of their sub-contractors or suppliers of materials, shall be kept clean and clear of all dust and mud dropped by the vehicles in any form. All dust and mud from the works spreading onto highways, site and access roads shall be immediately cleared by the Contractor by use of mechanical plant to the approval of FCC.

Compliance with this clause shall not relieve the Contractor of any responsibility for complying with the requirements of any Highway Authority in respect of keeping roads clean.

2.9 Communication Systems

The Contractor shall obtain the approval of FCC prior to the commissioning of any communication equipment and, following approval, shall ensure that it does not interfere with any existing systems on the site.

2.10 Access

The general arrangement of the site is shown on the respective site layout drawings. The only entrances to the works for the use of the Contractor are via the main site entrance, no other site entrances are to be used unless stated in the Specification. Areas for site offices, welfare facilities and plant standing areas will be arranged with FCC.

The main access road is to be kept clear at all times, as it will be used primarily by FCC's operations traffic. The Contractor will need to make provision for providing suitable access within the site, in particular between borrow areas, stockpile areas and the Contractors compound.

The Contractor must not use the access roads used by FCC for access into active cells unless given prior permission of FCC. Alternative access roads must be used or constructed, the locations of which shall be agreed with FCC prior to work commencing.

The Contractor shall carry out jointly with FCC a condition survey of the access roads made available under the Contract prior to the commencement of any works. The Contractor shall repair and make good any damage to FCC's landfill access roads which occur as a result of the Contractor's activities.

The Contractor's vehicles must give way to landfill traffic and not impede the movement of the traffic involved in landfill operations.

The specified speed limits within the landfill site shall be observed at all times. Non-compliance may result in the exclusion of any offender from the site.

Appropriate signage must be displayed to warn traffic of slow moving plant, particularly if the haul road access crosses the main access road.

All vehicles leaving the site must be free from mud and debris. The Contractor will be responsible and will pay for the removal of debris and any damages arising from mud and debris that leaves the site as a consequence of the works.

2.11 Permitted Hours of Working

The permitted hours of working are to be agreed with FCC at the pre-start meeting.

Monday to Friday - 07.00 - 18.00

Saturday - 07.00 - 14.00

Working on Sundays and Bank Holidays will not be allowed unless approved beforehand by FCC.

2.12 Control of Surface Water

The Contractor shall carry out all necessary operations for the control of standing water, or surface water run-off, within the CDM area to enable the construction of the works, and by doing so shall prevent damage to the works, the site, or adjoining properties. Where these actions include measures to prevent the in-flow of water from the site, these works shall be approved by FCC before commencement.

Any water shall only be discharged outside the CDM area and/or off-site following the receipt of approval by FCC.

2.13 Control of Leachate

The Contractor shall carry out all necessary operations for the control of leachate, within the CDM area to enable the construction of the works, and by doing so shall prevent damage to the works, the site, or adjoining properties. Where these actions include measures to prevent the in-flow of leachate from the site, these works shall be approved by FCC before commencement.

Any leachate collected shall only be discharged outside the CDM area and/or off-site following the receipt of approval by FCC.

2.14 Disposal of Exhumed Waste

In the event that it is necessary to excavate waste in order to achieve any element or elements of this Specification, the excavated waste will be disposed of in the operational area of the landfill, or as otherwise directed by FCC.

2.15 Protection of Boreholes

The Contractor shall locate and adequately protect existing deep ground water and landfill gas monitoring boreholes within the works area from damage during the works. The locations of the boreholes are to be confirmed with FCC.

2.16 Inclement Weather

No materials shall be placed or compacted during inclement weather conditions, if in the opinion of the CQA Inspector, trafficking over compacted or uncompacted material would prove detrimental to the construction. Any such trafficking damage caused by the Contractor shall be repaired in accordance with the Contract at the Contractor's expense. Inclement weather conditions may include, rain, snow, freezing conditions or excessive heat as indicated by the CQA Inspector.

Following wet weather conditions, any standing water on the surface of the construction must be removed at the Contractor's expense. If instructed by the CQA Inspector, the Contractor shall remove any material rendered unsuitable by wetting at the Contractor's expense. Earthworks placement operations following inclement weather conditions shall not proceed without the prior approval of the CQA Inspector.

Any frozen material shall be allowed to thaw before use. Previously compacted material that has become frozen shall be removed from the works and stockpiled until suitable for reuse.

2.17 Tolerance limits

Tolerance limits for the work shall be as follows:

- i) Positions in plan shall be within 50 mm of the true positions shown on or calculated from the drawings.
- ii) Levels shall be + 50mm of the required elevation shown on or calculated from the drawings; and

- iii) All other survey control and tolerance information is available in the FCC Good Practice Guide 6.0.

2.18 Confidentiality

The whole of the Tender Documents and all information provided by FCC for the purpose of or in connection with the Contract shall be dealt with by the Contractor as confidential to them and not be disclosed by them other than to their employees, sub-contractors or agents as appropriate for the sole purpose of the Contract.

The Contractor shall not, except with the prior consent in writing of FCC:

- i) Publish or advertise or permit to be published or advertised any photograph, drawing or written matter concerning the Contract or the works.
- ii) Use or permit the use of the name of FCC in any publication or advertisement.
- iii) Place any advertisement on any part of the works.

The Contractor shall refer all press representatives to FCC. Photographs for publication shall not be made of any part of the works without the prior written authorisation of FCC. Such authorisation if granted shall be in the form of itemised approvals for each exposure concerned.

3 SCOPE OF THE CONSTRUCTION WORKS

3.1 General Description

The design concepts for the capping construction were developed to accord with the Permit for the site and associated pre-operational conditions.

The position of the proposed development on site in relation to previously capped areas is shown on Drawing WR7712/06/01, along with the locations of tie-ins to existing basal lining and capping systems. Construction details for the capping works are shown on Drawing WR7712/06/02.

Construction of the capping system will involve:

- Trimming / regrading of existing waste surface as required;
- Placement and trimming of a 300mm thick regulating layer to achieve the formation levels for the liner;
- Placement of a Lower Protector Geotextile (if required) over the regulated surface;
- Installation of a fully welded, 1mm thick, double textured Linear Low Density Polyethylene (LLDPE) geomembrane liner;
- Installation of a Protector Geotextile / Drainage Geocomposite over the LLDPE capping geomembrane;
- Tie-in to existing capping systems and basal lining system;
- Sealing of the capping system around protuberances; and
- Installation of 1,200mm of restoration soils above the protector geotextile / drainage geocomposite.

The Employer and the Designer will liaise to confirm whether a protector geotextile or a drainage geocomposite will be utilised in the capping works, or whether both will be included across different areas of the cap. The choice between these materials will be dependent on the results of the interface testing, and whether they demonstrate that the stability of the capping slopes is likely to be maintained using the proposed products. The veneer calculations for stability and the required interface testing are described in Section 3.2 below.

3.2 Slope Stability

Slope Veneer Calculations have been carried out on the steepest slope within the capping area. These calculations are included in Appendix 3. The steepest slope in the capping area has a gradient of approximately 1 in 2.6 and is 11m High.

If a protector geotextile is utilised in the capping system, the Factor of Safety (FoS) for the steepest slope within the capping system at a Parallel Submergence Ratio (PSR) of 1.0 is $FoS = 1.32$. This represents the FoS when the soils are fully saturated. The FoS of 1.32 is higher than the minimum required $FoS = 1.3$ and therefore shows that the capping slope will remain stable. In order to achieve this FoS, the interface shear strength parameters used for the cover soil to geotextile interface (as shown in the calculations in Appendix 3) were set at: cohesion intercept = 4kPa, friction angle = 25° . The interface testing (as specified below) carried out between the selected geotextile product and the proposed restoration soils must show that these values can be achieved. If these values cannot be achieved and updated slope veneer calculations (with the parameters from the testing results) indicates that the $FoS = 1.3$ will not be achieved for the slope at a PSR of 1.0, then a drainage geocomposite will be required on the steepest slopes in the capping area.

If a drainage geocomposite is utilised in the capping system, the Factor of Safety (FoS) for the steepest slope within the capping system at a PSR of 0.5 is $FoS = 1.35$. This represents the FoS when the lower half of the soils is saturated. The Factor of Safety (FoS) at a PSR of 1.0 is $FoS = 1.03$. Normal Practice when a geocomposite drainage layer (GDL) is utilised in the capping system is that a minimum FoS of 1.3 is required at a PSR of 0.5. With the utilisation of a GDL, the PSR of 1.0 should never be achieved, therefore the calculated factor of safety of $FoS = 1.35$ (which is above the minimum required $FoS = 1.3$) at a PSR of 0.5 is sufficient for this design proposal and shows that stability of the capping slopes is likely to be maintained when a drainage geocomposite is utilised. In order to achieve this FoS, the interface shear strength parameters used for the cover soil to geocomposite interface (as shown in the calculations in Appendix 3) were set at: cohesion intercept = 2kPa, friction angle = 25° . It is anticipated that these values will be achieved for the geocomposite to soils interface, however interface testing (as specified below) is still required for this interface to verify that this is the case.

Interface testing is required to be carried out to confirm that the interface parameters used in the slope stability calculations are appropriate, utilising the products proposed to be used in the works. The slope stability calculations shall be updated according to the interface testing

results, to confirm that the parameters used are achievable / the stability of the capping slopes will be maintained.

The following interfaces shall be tested:

- Drainage Geocomposite to Restoration Soils (2 tests); and
- Protector Geotextile to Drainage Geocomposite (2 tests).

The interface testing requirements are set out in Appendix 6.

All interface testing results and the updated slope stability calculations shall be presented in the CQA Validation Report, with a summary detailing the significance of the results.

If the topographic survey of the capping area undertaken by the Contractor (see Section 3.4) shows that the waste slopes are significantly different from those shown on the Drawings, then further slope veneer calculations shall be undertaken by the Sirius designer to confirm that the stability of the capping slopes will be maintained.

3.3 Principal Quantities

The principal quantities for the works are given in Appendix 2.

3.4 Survey Information

The Contractor shall undertake surveys in accordance with the FCC Good Practice Guide (included in Appendix 4). An initial survey of the capping area shall be taken on a 10m grid spacing, or a 5m grid spacing on slopes and at breaks of slopes. This survey shall be compared to existing surveys, and once approved by FCC, the Contractor's survey will form the 'original ground level survey' (OGL) from which the measurement of the works shall be undertaken. Further surveys will be required as follows:

- i) Formation levels / top of waste;
- ii) Location of existing lining systems for tie in, annotate survey to show where existing cap new cap welded to existing and where new cap has been placed in anchor trench;
- iii) Top of regulating layer surface;
- iv) Regulating layer isopachyte using surveyed trial pit depth verification;
- v) Lower Protector Geotextile panel layout (if relevant);

- vi) Geomembrane panel layout;
- vii) Protector Geotextile panel layout (if required);
- viii) Drainage Geocomposite panel layout (if required);
- ix) Top of restoration soils; and
- x) Restoration soils isopachyte using surveyed trial pits for depth verification.

3.5 Daily Journal

The Contractor will be required to keep a detailed daily journal recording the information detailed below. The Contractor will give FCC reasonable access to the daily journal which will, if necessary, be made available to FCC, Natural Resources Wales (NRW) or any other Authority during and after completion of the Works if required. The Contractor will forward copies of the daily journals on a weekly basis to the FCC.

This information shall be recorded in an acceptable form of daily journal which shall include the following:

- date of shift;
- names of personnel in attendance during the shift;
- weather conditions, including ambient temperature;
- type of plant used; plant breakdowns and hours;
- approximate totals of earthworks carried out including identification of source and destination;
- removal of foreign matter and oversize material;
- depth of regulating layer and restoration soils layer;
- approximate totals for amount of geosynthetic materials deployed, seamed, bonded, tested and repaired including width of each panel installed;
- summary of field and laboratory testing carried out;
- sample type and material taken for particular testing;
- delays;
- additional works, reasons and reference;
- deliveries;

- details of meetings and other correspondence;
- details of remedial works; and
- any other relevant information.

4 EARTHWORKS REQUIREMENTS

4.1 General

This section outlines the requirements for excavation and placing the engineered fill materials.

The compaction of engineered fill materials shall be carried out in accordance with the Highways Agency “Manual of Contract Documents for Highway Works (MCDHW) – Volume 1 Specification for Highway Works” Series 600 Earthworks (2016), published by HMSO except as amended hereunder. The Contractor shall employ only that plant and those working methods that are suited to the materials to be handled and traversed. They shall be responsible for maintaining the nature of the suitable material so that when it is placed and compacted it remains in accordance with the Contract. Suitability shall be determined in accordance with the definitions below.

The Contractor shall submit their proposals to FCC and the CQA Inspector regarding the extent and management of the excavations, stockpiling and filling of materials before starting works. Excavations shall not proceed without the prior approval of FCC.

The Contractor shall not remove any materials from the site unless approved by FCC.

After completion of the works, the Contractor is required to re-grade any stockpiles and surrounding areas where deemed necessary. This shall be carried out to the satisfaction of the CQA Inspector and FCC.

4.2 Definitions

The following definitions shall apply to the Specification and CQA Plan wherever reference is made to the defined engineered fill material:

- “Suitable fill material” shall comprise all that is acceptable in accordance with MCDHW;
- “Unsuitable material” shall mean material other than suitable materials and shall include:
 - Peat, material from swamps marshes and bogs;
 - Logs, stumps and perishable material;
 - Material in a frozen condition;

- Material susceptible to spontaneous combustion; and
- Any commercial or domestic waste.
- “rock” shall be deemed to mean hard material which, in the opinion of the Project Manager, necessitates for its loosening or removal the use of special machinery designed for rock cutting, but shall exclude any material that can be removed by normal excavating machinery and which, in any case, has a volume not exceeding 1 cubic metre or 0.25 cubic metres where the net width of the excavation is less than 2 metres.

4.3 Waste Surface Preparation

The Contractor shall undertake a topographical survey of the area to be capped in order to establish any requirement for re-grading of slopes as indicated by the slope stability analysis within Appendix 3. This survey shall be carried out at a maximum of 28 days prior to the commencement of the capping works. The OGL survey is to be supplied to the Sirius designer to check accuracy against the Stability Risk Assessment / Veneer Calculations.

Upon completion of landfilling, the surface of the waste shall have been temporarily covered with a layer of soils. Prior to installing the capping system the surface of the waste may be required to be re-graded in order to ensure that the waste slopes are consistent with the slope stability analysis, and to remove any undulations and any unsuitable waste materials, which, in the opinion of the CQA Inspector, may affect the performance of the cap. The re-graded surface of the waste shall be tracked following trimming / re-grading to minimise future differential settlement.

The Contractor shall supply FCC with a method statement for the regrading works and liaise closely with site management to ensure the works do not affect the existing operations or contravene the site Permit requirements.

As part of the preparation, some waste may be exposed. The Contractor shall ensure that during the re-grading works the area exposed at any one time shall not exceed 1,000m², in order to minimise the emission of landfill gas, control odours and nuisance from litter, vermin, birds and insects.

If at the end of the day it is not possible to install the geomembrane or lower protector geotextile (see Chapter 6) over the working area, the Contractor shall place a minimum of 300mm of the waste regulating layer over the exposed waste.

If unusual or hazardous waste is encountered during the re-grading process, the Contractor

shall not excavate these materials until they have been categorised and handling precautions confirmed with FCC.

All large articles of waste encountered during the re-grading process, such as crates, barrels, or other materials that may degrade and collapse at some time in the future, shall be crushed, broken up or flattened, and subsequently buried such that they are covered to a depth of not less than 1m below the surface of the waste.

In the event of perched leachate being encountered locally saturating the waste surface, the saturated material shall be excavated and replaced with granular drainage material. The granular material shall comprise inert crushed rock or gravel. The leachate shall be allowed to flow via a granular filled trench down the waste slope, to a more permeable waste, to facilitate the drainage of the leachate within the waste mass. All excavated waste material which cannot be locally re-graded shall be disposed of in the active area of the landfill.

Upon completion of the re-grading works the Contractor shall seek approval from the CQA Inspector as to the adequacy of the prepared surface to receive the waste regulating layer and to confirm that the slope gradients meet the requirements of the slope stability analysis within Appendix 3.

4.4 Waste Regulating Layer

A minimum 300mm thick layer of clayey or other suitable material with a maximum clod / particle size of 125mm shall form the waste regulating layer above the waste and shall be installed over the final waste level to provide an even surface upon which to place the capping system.

Where the waste regulating layer is to be placed in contact with the existing regulating layer, the existing regulating layer is to be cut at a 1:2 or a reasonable angle. This is required so that when placement of the new regulating layer is undertaken, compactive effort can be utilised on both the new and the edge of the old to ensure the old and the new regulating layer form a single homogenous mass and firm surface for the installation of the geomembrane or lower protector geotextile.

1 sample will be taken per 2500m³ of material used for the regulating layer and tested for Particle Size Distribution (PSD) in accordance with BS1377 1990 Part 2 Clauses 9.2 and 9.4. The PSD results shall be used to classify the material in accordance with MCDHW 2016 and to determine the compaction methodology from SHW in accordance with Table 1.

Should the regulating layer consist of cohesive material, hand shear vane (HSV) tests shall be undertaken on a 25m alphanumeric grid basis to demonstrate a required undrained shear strength of 50kN. Any areas that fail to meet the required strength shall be removed and re-laid by the Contractor to the satisfaction of the CQA Inspector.

If the regulating layer is non cohesive the hand shear vane requirements do not apply.

The surface of the waste regulating layer to receive the geomembrane cap shall be smooth and free from debris, roots, angular or sharp rocks and any other deleterious materials that may cause damage to the capping system. Any such deleterious material shall be removed from the surface and any resulting depression repaired to the CQA Inspector's satisfaction.

The surface shall be rolled and compacted such that it provides a firm formation sufficient to permit the movement of vehicles and welding equipment over the surface without causing rutting or other deleterious effects. The surface shall have no sudden sharp or abrupt changes in grade, and shall be free from areas excessively softened by high water content. A continuous fall shall be maintained towards the low lying area of the restored surface, with no areas of ponding or backfalls on the surface.

If an adequate regulating layer surface cannot be achieved due to an excessive amount of particles above 50mm, the Contractor may include a lower protector geotextile as described in the relevant section of this document.

Trial holes or marker tubes are to be located on a 25m grid to ascertain that adequate depth of regulating layer has been placed in accordance with this Specification.

4.5 Regulating Layer Testing Requirements

The maximum particle size for the upper surface of the regulating layer in direct contact with the overlying geomembrane or lower protector geotextile shall be 25mm except for isolated particles with a maximum size of 50mm in any dimension based upon a visual assessment at the point of placement in the Works and provided the isolated particles are dispersed within a finer matrix.

Testing shall be carried out on the regulating layer in accordance with Table 1.

Table 1. Regulating Layer Testing Requirements

Parameter	Test Method (BS 1377:1990:)	Acceptance Criteria	Testing Frequency
Cohesive Fill:			
In-situ Shear Strength (Hand Shear Vane)	Part 9 Test 4.4 On Site Testing	>50 kPa	1 per 25m Grid per layer
Particle Size Distribution	Part 2 Clauses 9.2 and 9.4	To Determine Classification for Placement and Compaction	1 per 2,500m ³
Thickness	Manual	>300mm	1 per 25m Grid
Non Cohesive Fill:			
Particle Size Distribution	Part 2 Clauses 9.2 and 9.4	To Determine Classification for Placement and Compaction	1 per 2,500m ³
Thickness	Manual	>300mm	1 per 25m Grid

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all the required tests.

4.6 As-Built Drawings

A survey of the top of regulating layer will be carried out. This drawing will be supplied to the CQA Inspector.

5 GEOMEMBRANE LINER

5.1 General

The approved surface of the regulating layer shall be covered with a welded, double textured, 1mm thick LLDPE geomembrane. The geomembrane shall be supplied in accordance with the following specifications and installed in accordance with the construction details shown on Drawing WR7712/06/02.

The Contractor shall be required to undertake the following:

- Supply and install a welded, textured, 1mm thick LLDPE geomembrane on the approved surface of the regulating layer or lower protector geotextile;
- Tie the geomembrane into existing capping and basal lining systems previously installed at the site; and
- Provide all material quality control certificates and other information described below.

5.2 Contractor's Experience

The liner installation Contractor or sub-contractor shall have considerable experience of installing geomembrane of the type specified for the works. The Contractor shall submit to FCC a summary of the experience of the proposed liner installation Contractor with the specified materials including an estimate of the total area installed by them in the United Kingdom over the past 3 years.

5.3 Geomembrane Material

The geomembrane will consist of double textured 1.0mm thick LLDPE produced from new resins and containing no fillers, plasticisers or additives of any kind with the exception of carbon black. The surface shall be unlaminated and free from blemishes, abrasions or other surface imperfections.

The geomembrane will conform to the parameters established as given in Table 2 below.

Table 2: Geomembrane Specification and Conformance Testing

Parameter	Test Method	Test Frequency	Requirement (Textured LLDPE)
Thickness	ASTM D5994	5,000 m ²	1.0mm (nom -5%) 1.0mm (-10%, 8 out of 10) 1.0mm (-15% lowest value)
Density	ASTM D1505A	5,000 m ²	<0.939 g/ml
Carbon Black Content	ASTM D1603	5,000 m ²	2% to 3%
Carbon Black Dispersion	ASTM D5596	5,000 m ²	9 of 10 in cat 1 or 2 1 of 10 in cat 3
Texture Asperity Height (min.ave.)	GRI GM12	5,000 m ²	>0.40mm
Tensile Strength: At Yield (min.ave) At Break (min ave) Elongation at Yield (min ave.) Elongation at Break (min ave.)	ASTM D6693 Type IV	5,000 m ²	- 11N/mm - 250%
Puncture Resistance (min ave.)	ASTM D4833	5,000 m ²	200 N
Tear Resistance (min ave.)	ASTM D1004	5,000 m ²	100 N
Oxidation Induction Time (OIT) Standard OIT or High Pressure OIT	ASTM D3895 ASTM D5885	10,000 m ² Per Source	100 minutes (min. ave.) 400 minutes (min. ave.)

5.4 Delivery, Handling and Storage

The geomembrane will be delivered to site in rolls equipped with slings and loaded in such a way as to facilitate the unloading and handling of each roll without damaging it. Upon delivery the CQA Inspector will inspect each roll for damage, and any defects or damaged areas will be recorded. Any rolls that are deemed by the CQA Inspector to be too badly damaged to be included in the works will be segregated from the rest of the material and removed from the works.

Each roll will be clearly labelled with the manufacturers' name, the product name and type, the batch and roll number, and the roll length, width, weight, and date of manufacture.

A crane or other suitable lifting equipment will be used to off-load the rolls to the storage area. Rolls will only be lifted by the supplied slings or core bars. The material is not to be handled with the tines of a forklift machine, the bucket of an excavator, or any similar equipment under any circumstances.

The storage area for the geomembrane will be agreed with FCC and prepared to the satisfaction of the Contractor prior to delivery of the material to site. The storage area will be large enough to accommodate the rolls of geomembrane flat to the ground. It will be flat, clean, dry, and free from rocks or other obstacles and it will be located out of the way of the way of moving plant. The rolls of geomembrane will not be stacked more than 3 high with nothing stacked above the geomembrane.

The Contractor shall provide adequate and acceptable measures for protecting the material at all stages of the work, from all sources of potential damage such as sharp objects, boulders, cobbles etc, including weather conditions, until completion of the contract.

Any damaged or defective rolls are to be marked and segregated by the Contractor for further investigation.

5.5 Manufacturer's Quality Control

The Contractor will supply a quality control certificate for each roll of material delivered to site and each batch of resin used in production of the geomembrane. The certificates will be supplied prior to delivery of the material to site and will contain quality control data in accordance with the test methods and requirements given in Table 2 above. CE Declaration certificates are also to be included when the material is delivered.

The certificates will include:

- i) The manufacturer's name;
- ii) Product name and type;
- iii) Date of manufacture;
- iv) Batch number and roll number; and
- v) Values for those parameters listed in Table 2.

5.6 Conformance Testing

As soon as practicable after the delivery of the geomembrane rolls to site, the Contractor shall select, cut and label samples 1m long across the entire width of the selected rolls for conformance testing as directed by the CQA Inspector. Prior to taking the conformance sample the Contractor shall remove and discard the first 1m (outside) of the roll. Sets of samples shall be taken at the frequencies set out in Table 2.

The Contractor shall submit the samples for conformance testing to an independent laboratory having UKAS accreditation for each test being carried out. A copy of the results of the testing are to be forwarded to the CQA Inspector.

If testing shows that the geomembrane does not meet any one of the minimum requirements of Table 2, then this may be cause for rejection of the material from that roll.

The CQA Inspector may at their discretion accept material from elsewhere on that roll if the Contractor can demonstrate, through further laboratory testing (at their expense) at a geosynthetic testing laboratory approved by the CQA Inspector, that this material does meet the acceptance criteria contained in Table 2.

5.7 Surface Preparation Prior to Geomembrane Deployment

The geomembrane will be deployed directly onto the prepared surface of the regulating layer. The surface will be clean, smooth rolled, and free from loose material, ponded water, desiccation cracks, soft spots or any other surface defects. There are to be no sharp angles in the subgrade.

The maximum particle size for the upper surface of the regulating layer in direct contact with the overlying geomembrane shall be 10mm except for isolated particles with a maximum size of 25mm in any dimension based upon a visual assessment at the point of placement in the Works and provided the isolated particles are dispersed within a finer matrix.

The CQA Inspector will inspect and approve the surface prior to deployment of the geomembrane. Geomembrane will not be installed at any location without the approval of the surface at that location. Should any area fail to meet the required standard for geomembrane deployment the Contractor will remediate the area to the CQA Inspector's satisfaction. The methodology for the remediation of the failed surface will be discussed and agreed with the CQA Inspector prior to remedial works taking place.

Approval of the surface may be withdrawn if the surface should deteriorate prior to deployment of the geomembrane. Approval will then be withheld until the surface has been remediated to the CQA Inspector's satisfaction.

5.8 Deployment of Geomembrane

Prior to the commencement of installation, the Contractor will submit an accurate sketch or drawing to the satisfaction of the CQA Inspector, showing the proposed rolls, panel layout, and overlaps for the geomembrane. The sketch or drawing should show the Contractor's proposed start point and proposed direction of working. Any alterations from this proposed layout will not proceed without prior consent from the CQA Inspector.

The CQA Inspector will record each panel deployed and maintain a record of the date and location of installation. Each panel will be observed for defects and a record will be kept to ensure that all defects are properly repaired. All geomembrane panels will be arranged so that seams are aligned in the direction of maximum slope, wherever practicable, in accordance with accepted good practice.

The Contractor will ensure that:

- No damage is caused to the geomembrane by the tools, plant or equipment during deployment, no welding generators are to be placed directly upon the geomembrane;
- The geomembrane will remain clean and free from any contamination;
- Personnel working on the geomembrane will not smoke, wear shoes likely to cause damage, or engage in any other activity that could damage the geomembrane;
- The method of deployment will be such as to minimise stresses or strain on the geomembrane and will not cause damage to the underlying regulating layer;
- The geomembrane will be in intimate contact with the underlying surface without bridging over hollows or humps;
- The method of deployment will prevent wrinkles and creases in the geomembrane;
- No vehicles will track directly over the geomembrane;
- Surface water will be prevented from infiltrating beneath the deployed geomembrane;
- No geomembrane will be deployed during periods of rain, snow, or wind likely to cause damage to the geomembrane; and

- Geomembrane installation testing will be carried out in accordance with Table 3 below.

The geomembrane shall be secured in anchor trenches and welded to the geomembrane of existing capping systems as shown in Drawing WR7712/06/02 where required.

5.9 Seaming Procedures

Only suitably qualified (Level 1 certification) and experienced personnel will carry out the deployment and welding of the geomembrane liner. The welding operators and installation staff should hold a current third party certificate for installation and welding of flexible lining systems to a recognised standard (e.g. the British Geomembrane Association (BGA) or Thermal Welding Institute (TWI/CSWIP) third party accreditation schemes).

The Contractor will only construct field seams on each working day after trial seams have been carried out on that day to the satisfaction of the CQA Inspector. The general seaming procedure will be such that:

- The welding equipment does not damage the geomembrane;
- All surfaces of the geomembrane to be seamed are clean, dry and free from dust, dirt, debris and foreign material of any kind prior to seaming;
- Twin track fusion welding will be the preferred welding method, extrusion welding will only be used with the permission of the CQA Inspector;
- Where seam overlap grinding is necessary it shall not remove more than 10% of the nominal geomembrane thickness and does not extend more than 12mm on either side of any proposed extrusion seam. Grinding will not take place more than one hour prior to seaming;
- Temporary heat bonding of adjacent panels, or any pre-heating during seaming, will not cause any damage or overheating to the geomembrane. The use of adhesives shall not be permitted;
- Where a seam runs into an anchor trench the weld will extend to the back edge of the trench. Any seam defects falling within the anchor trench will be repaired in accordance with the Specification;
- Seams will be aligned so as to minimise the number of wrinkles and "fishmouths". Any wrinkles / fishmouths that cannot be eliminated by pulling the sheet will be cut along their ridge, overlapped and extrusion welded. Where the overlap does not

meet the requirements of the Specification it will be patched in accordance with the Specification; and

- Seaming will not take place:
 - During any period of rain or snow unless the CQA Inspector is satisfied that measures have been implemented to allow the seam to be made on dry geomembrane materials;
 - At ambient temperatures lower than 5°C or higher than 35°C, unless approved by the CQA Inspector, during periods of high relative humidity or wind speed;
 - Over frozen or saturated ground;
 - Over ponded water;
 - During periods of darkness unless approved by the CQA Inspector and subject to the Contractor providing adequate lighting.

If the Contractor wishes to carry out welding at ambient temperatures below 5°C or above 35°C, they shall demonstrate by trial seaming that the seam is equivalent to those produced under approved conditions and that the overall quality of the geomembrane is not adversely affected.

5.9.1 Trial Seams

The Contractor will perform trial seams with each seaming machine and operator at least at the start of each shift and following any period of machine shutdown greater than 1 hour or change of operator in the presence of the CQA Inspector and in accordance with the requirements of Table 3 below. In addition, trial seams should also be carried out where weather conditions have changed such that there will be an effect on the welding efficiency of the machinery, and if there is any doubt about the effectiveness of the welding equipment.

The trial seams will be at least 3m long for both extrusion seams and fusion seams. On completion of the trial seam, the Contractor shall cut a total of six 25mm wide field tabs normal to the seam at 15mm centres and subject the tabs to field destructive testing. Three specimens shall be tested in peel mode and three in shear mode.

If a trial seam fails field destructive testing as specified above then the entire operation will be repeated. The seaming machine and the operator will not be allowed to perform field seaming until the deficiencies are corrected and both machine and operator have achieved passing trial seams. The parameters for the seam testing are shown in Table 3.

If any of the additional specimens fail, the welding equipment shall be inspected and a report made of any defects and the corrective action taken. Welding may continue after two further consecutive full trial seams are achieved without failure.

Should three test welds fail in any 24-hour period, two samples will be sent to an independent laboratory for testing. If the test results indicate failure the machine shall be returned for repair. If the test results indicate a pass the equipment may be used subsequent to two further consecutive full trial seams being achieved without failure. The equipment should not be used until the test results are known. If the equipment fails five times in any 48-hour period it shall be returned for repair with a record kept of the service.

The CQA Inspector will verify that trial seaming is performed at the appropriate intervals and that passing results are achieved prior to any production seaming by the apparatus/seamer. The CQA Inspector will observe the field testing of each trial seam and will maintain a log of all trial seam data.

Table 3: Geomembrane Installation Testing

Parameter	Test Method	Test Frequency	Requirement
			Textured
Start Up Test Weld			
Welding Equipment and Operative	Visual and peel and shear using appropriate equipment	Daily at the start of works and after 1 hr stoppages and after any significant changes in welding conditions	Test fails outside welded area
Non-Destructive Weld Testing			
Dual Track Welds (Fusion welds)	Air Pressure Test	Continuous – every weld	Inflate to 2 bar and maintain pressure over 5 minutes
Extrusion Welds	Vacuum Box	Continuous – every weld	No bubbles witnessed
Destructive Weld Testing LLDPE			
On-site	Peel and shear using appropriate equipment	Every weld or a minimum of every 4 hours	Failure to be outside weld
Off-site - Seam peel strength and bonded seam strength Shear Elongation and Peel Separation	ASTM D6392 GRI GM19	1 per 200m of seam or If less than 200m of seam is deployed in a single day there is still the requirement to take a minimum of one per day.	Fusion Weld: Shear Test > 10.5 N/mm Peel Test > 8.8 N/mm Extrusion Weld: Shear Test > 10.5 N/mm Peel Test > 7.6 N/mm Fusion Weld: Shear Elongation > 50% Peel Separation < 25% Extrusion Weld: Shear Elongation > 50% Peel Separation < 25%
QA Inspection			
Visual Inspection of Geomembrane	For tears, holes, scratches, cuts etc.	Every roll	No defects

5.9.2 Seaming Methodology

The panels will be deployed in accordance with a method statement and proposed panel layout drawing issued by the Contractor prior to commencement of the works; the method statement and proposed layout will be submitted for approval to the CQA Inspector.

5.9.2.1 Fusion Welding

Wherever possible the seams in the geomembrane will be fusion welded with a double seam.

Fusion welded seams will be formed by working in one direction only.

5.9.2.2 Extrusion Welding

Extrusion seaming will only be used with the approval of the CQA Inspector where double seam welding is not practicable.

The width of extrusion seams will not be less than 30mm. Prior to forming an extrusion seam adjacent panels will be temporarily secured by heat bonding and the seam surfaces scarified by grinding to provide a key and to remove surface oxidation.

The extrudate material used for extrusion welding shall be identical in composition to that of the geomembrane and supplied by the geomembrane supplier.

The extruder will be purged prior to the commencement of any extrusion seaming or after any stoppage in seaming until all heat degraded extrudate has been removed from the barrel.

The CQA Inspector will utilise a seam numbering system that is a combination of the panel numbers being joined. For example, the seam joining panels No 1 and 2 would be seam No 1/2. The CQA Inspector will maintain a log of seaming data for each seam including the source roll for each panel, date, identification of the seamer and machine, ambient and machine temperatures. All seams will be observed for visual integrity and any defects will be logged to verify that they are properly repaired and tested.

5.10 Sampling and Testing

Sampling and testing shall be carried out in accordance with the requirements of Table 3.

5.10.1 Qualitative Destructive Testing

The Contractor will take a tab sample from each completed seam. The tabs will be nominally 25mm wide and at least 105mm long with all tabs being tested for peel and shear failure. The seam will be deemed to have passed qualitative destructive testing if the failure occurs solely in the geomembrane and does not enter the seam. The seam will be deemed to have

failed qualitative destructive testing if any of the failure enters the seam. Geomembrane Weld Failure Codes are presented in Appendix 5.

If the tab sample fails field qualitative destructive testing the Contractor will carry out all of the following actions:

- The welding equipment will be taken out of service until it has passed a trial seam;
- Additional tabs will be taken at 3m intervals each side of the failed tab for qualitative destructive testing;
- Further tabs will be taken until the failed part of the seam can be identified between two successful tabs; and
- The failed seam will then be reconstructed in accordance with the Specification. The CQA Inspector may direct the taking of additional tab samples and qualitative destructive testing at any location along the length of the seam.

5.10.2 Quantitative Destructive Testing

The Contractor will recover samples for quantitative destructive testing at a frequency of one sample from a minimum of every **200m of welding or one sample per day per machine**, whichever is the least, at locations as directed by the CQA Inspector. The Contractor shall submit the samples for conformance testing and will send a copy of the results of the testing to the CQA Inspector. This shall not relieve the Contractor from any of his obligations under the Contract.

Each sample will be at least 0.3 metres wide by 1.2 metres long with the seam centred lengthways. One 25mm wide tab will be cut from each end of the sample. The remaining sample will be cut into two parts with one additional 25mm wide tab being cut from each of the two parts. The tabs will be tested in the field for failure in peel and shear in accordance with the Specification.

The two sample parts shall be distributed as follows:

- i) one part measuring 300mm x 300mm, to the Contractor; and
- ii) one part measuring 300mm x 300mm, to the CQA Inspector.

The Contractor shall forward the sample to the testing laboratory for quantitative destructive testing in accordance with ASTM D6392. This testing shall involve peel mode and shear mode tests from tabs taken alternately throughout the sample. Copies of the results of the

testing will be forwarded to the Contractor but this shall not relieve them of any of their obligations under the Contract.

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

- i) Failure occurs solely on the parent material and does not enter the seam;
- ii) The peel and shear strength exceeds these requirements specified in Table 3 for four of the five samples, where the fifth tab fails to meet the requirements above then its peel and shear strength must exceed 80% of the requirements specified in Table 3; and
- iii) For Peel Separation and Shear Elongation all 5 samples must meet the minimum requirements specified in Table 3.

If there is a failure the Contractor shall extract an additional test sample from a seam produced on the same day by the same item of seaming equipment and / or operator, at a location to be agreed with the CQA Inspector, to confirm that the failure was an isolated occurrence. If this sample fails destructive testing, all seams produced by the particular item of equipment will not be approved.

In the event of a failed destructive test the Contractor may do either of the following:

- i) Replace or cap the entire seam length i.e. remove the seam and re-seam;
- ii) Extract further samples for destructive testing a minimum of 3m in both directions (if applicable) from the location of the failed test. If these samples pass destructive testing, the seam shall be reconstructed between these locations by capping in accordance with the Specification. If any of these samples fail destructive testing, all seams produced by the particular item of equipment will not be approved.

5.10.3 Non-Destructive Seam Testing

The Contractor shall carry out a risk assessment and submit method statements for their proposed method of carrying out non-destructive testing of extrusion welded seams. The Contractor shall undertake vacuum box testing of extrusion welded seams. The testing method for fusion seams is Air Pressure Testing. All seams shall be non-destructively tested by the Contractor in the presence of the CQA Inspector.

The CQA Inspector will verify that the procedures outlined for non-destructive testing are adhered to by the Contractor. The CQA Inspector will record the date and time, identification

of the person performing the test, pressure values and the pass/fail conditions for all seams. The CQA Inspector will verify that all failed conditions are properly remediated and retested, and verify that all data is complete.

5.10.3.1 Air Pressure Testing

All fusion seams shall be air pressure tested. The air channel formed between the twin welds shall be sealed at both ends and an inlet valve and pressure gauge fitted to one end. The channel shall then be pressurised to a maximum pressure of 2.0 bar and a minimum pressure of 1.8 bar. Following removal of the pressure source, the pressure shall be allowed to equalise for two minutes to allow for the stabilisation of the temperature effects. The change in pressure shall then be recorded over the next five minute period. If the pressure decreases by more than 0.2 bar over the 5 minute period then the fusion seam will be deemed to have failed the test.

Upon completion of the air pressure test, the channel shall be deflated from the opposite end to which the pressure source was applied to confirm that the full length of seam had been pressurised.

If a seam fails the air pressure test, or indicates a blockage in the channel, the test length shall be incrementally reduced until the failure area has been clearly identified. In the case of identifiable points of failure, the seam shall be repaired using an extrusion weld and the test repeated. If specific points of failure cannot be identified to the satisfaction of the CQA Inspector then the whole seam shall be repaired in accordance with the requirements of the Specification.

5.10.3.2 Vacuum Box Testing

Extrusion seams shall be tested over their entire length using the purpose made equipment which produces a vacuum over the tested area. A detergent water solution shall be applied to the full test area prior to the application of the test equipment. Upon application of the vacuum, bubbling of the solution should indicate the location of a leak in the seam. The vacuum shall be applied for a period of not less than 10 seconds. The location of any leaks shall be marked in an indelible manner and then the seam repaired in accordance with the Specification.

5.10.4 Defect Repair

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

- Point defects;
 - a) The area will be prepared by grinding and an extra layer of extrudate applied.
- Large faults;
 - a) The faulted area will be cut back to remove all imperfections and will be overlain with a single piece of compatible geomembrane to give a minimum overlap of 100mm in all directions. The area will then be prepared and seamed in accordance with this Specification.
- Seam faults;
 - a) Faulted extrusion seams will be overlain with a single piece of compatible geomembrane with a minimum overlap of 100 mm in all directions to form a cap strip. The repair may then be completed as for large faults; and
 - b) Faulted fusion seams will be cut back to remove the upper flap, prepared by grinding and extruded in accordance with this Specification.

The CQA Inspector will log each defect requiring repair with a unique code and then, using the same code, verify that each defect is properly repaired and tested. Non-destructive testing of all repairs will be observed by the CQA Inspector.

5.10.5 Testing Review

The CQA Inspector will review all destructive and non-destructive testing data, including a walkover prior to the placement of the covering layer and record that all testing has been completed to their satisfaction.

5.11 Temporary Surcharge

The Contractor shall be responsible for providing adequate temporary loading and/or anchoring measures (e.g. in the form of durable sandbags or similar weights without sharp edges and not likely to damage the geomembrane) on the geomembrane immediately after deployment to protect the geomembrane from damage by the wind or to prevent slippage during the works. These measures shall remain in place until the overlying layers are placed

over the geomembrane, unless otherwise directed by the CQA Inspector. On steep embankments, suspension of sandbags or other weights by ropes may be required.

5.12 Tie-in to Existing Basal Lining System

The geomembrane shall be tied-in to the existing basal lining system in the locations shown on Drawing WR7712/06/01, and in accordance with the construction detail shown on Drawing WR7712/06/02. The existing geotextile in these locations shall be cut back to expose the existing geomembrane, then the new geomembrane shall be extrusion welded to the existing geomembrane. The tie-in will be observed and recorded by the CQA Inspector to confirm that a satisfactory seal is achieved. The new geomembrane shall be secured in the existing anchor trench with the existing geomembrane. After the geomembrane has been placed, the trench shall be backfilled using suitable material and plant to the satisfaction of the CQA Inspector.

5.13 Tie-in to Existing Capping Geomembrane

The geomembrane shall be tied-in to the existing geomembrane liner of permanent capping systems in the locations shown on Drawing WR7712/06/01. The geomembrane shall overlap the existing geomembrane by a minimum of 100mm, as shown in the construction detail on Drawing WR7712/06/02. The tie-ins will be, where possible, fusion welded and will be observed and recorded by the CQA Inspector to confirm that a satisfactory seal is achieved. Where fusion welding is not reasonably practicable, extrusion welding may be used, and will be observed and recorded by the CQA Inspector to confirm that a satisfactory seal is achieved. The construction detail for tie-ins to existing temporary capping systems has also been included in Drawing WR7712/06/02, in case there are areas where this type of tie-in are required.

5.14 Protuberances

The Contractor shall ensure that all protuberances in the cap are installed as shown in the construction detail on Drawing WR7712/06/02.

Where leachate / gas wells or HDPE pipework are required to pass through the cap, the area around the penetration will be sealed with a 150mm wide, 500mm deep ring of hydrated bentonite powder/granules. The CQA Inspector shall inspect each seal for integrity.

Protuberances will be extended to pass through the restoration soils, and installed inside oversized pipework where they pass through the geosynthetic layers and restoration soils.

To comply with the DSEAR requirements the Contractor shall form and install a geomembrane boot detail with a minimum distance of 2.2m from the outside of the pipe boot, as shown in the construction detail on Drawing WR7712/06/02.

6 PROTECTOR GEOTEXTILE

6.1 General

Where agreed between the Employer and the Designer based on the results of the interface testing, the welded LLDPE geomembrane shall be covered with a Protector Geotextile. The geotextile shall be supplied in accordance with the parameters given in Table 4 and the procedures and CQA requirements described below. The Contractor will be required to:

- Supply and install a protector geotextile on the geomembrane surface;
- Tie the geotextile into the existing capping systems previously installed at the site; and
- Provide all material quality control certificates and other information described below.

6.2 Geotextile Materials

The geotextile material shall be a non-woven, needle punched geotextile, chemically resistant to the landfill environment. Conformance testing shall be carried out in line with the manufacturers' specified values for the properties set out in Table 4 below. The Contractor shall provide a schedule of results to show that the minimum requirements can be met by typical material of the type to be used, prior to installation on-site.

6.3 Manufacturer's Quality Control

Quality control certificates will be supplied to cover each roll of material delivered to site. The certificates will be supplied prior to delivery of the material to site and will contain quality control data typically according to the requirements of Table 4.

CE Declaration certificates are also to be included when the material is delivered.

Quality Control Certificates will be provided prior to installation and for inclusion in the CQA Validation Report as follows:

- A specification for the geotextile which includes all properties contained in Table 4 measured using the appropriate test methods;
- Written certification that minimum values given in Table 4 are guaranteed by the Manufacturer; and
- Written confirmation that testing to detect needle fragments and removal of needle fragments prior to delivery of the product has taken place.

Table 4: Protector Geotextile Specification and Conformance Testing

Physical Properties:				
Polymer type:	Prime quality polypropylene fibre (UV stabilised) with no post-consumer fibres			
Fabric construction:	Nonwoven fabric manufactured from mechanically entangled fibre			
	Approved test method	Units	Typical Mean value	Tolerance
Thickness @ 2kPa:	EN ISO 9863-1	mm	3.0	-20%
Mechanical Properties:				
Static puncture strength (CBR)	EN ISO 12236	kN	4	-10%
Tensile strength (md/cmd)	EN ISO 10319	kN/m	25/25	-10%
Tensile extension (md/cmd)	EN ISO 10319	%	50/50	+/- 20%
Dynamic Perforation Resistance	EN ISO 13433	mm	5	+ 3 mm
Durability (according to annex B: EN 13253)*:				
	Approved Test Method	Requirement		Tolerance
Resistance to weathering @ 50MJ/m ² radiant exposure ¹	EN 12224	Retained Strength		80%
Resistance to Oxidation (100 years)	EN ISO 13438**	Retained Strength 56 days		50%
Resistance to liquids	EN 14030	Retained Strength		50%
1. 1-4 months UV exposure depending on location/season				
* Durability test data can be supplied by the manufacturer – test frequency must not exceed 5 years.				
** Manufacturer may use alternative means of assessing oxidation to achieve 100 years.				
At least 1 conformance sample per batch of geotextile incorporated within the works				

6.4 Delivery, Handling and Storage

The material will be delivered, handled and stored in accordance with the manufacturer's recommendations and should be delivered and stored in tight wrappings in order to offer protector from ultraviolet degradation. Each roll of geotextile delivered to site will be identified with:

- Manufacturer's name, address and telephone number;
- CE mark with accrediting body's number;
- Product identification and polymer type;
- Geotextile batch and roll number;
- Roll length and width in metres;
- Roll weight in kilograms; and
- Polymer type.

Lifting and transportation of the geotextile materials shall be by appropriate machinery with the use of slings and core bars. The material is not to be handled with the tines of a forklift machine, the bucket of an excavator, or any similar equipment under any circumstances.

The Contractor shall provide adequate and acceptable measures for protecting the material at all stages of the work, from all sources of potential damage such as sharp objects, boulders, cobbles etc, including weather conditions and will be located out of the way of the way of moving plant. The rolls of geotextile will not be stacked more than 3 high with nothing stacked above them. All product rolls must be kept in the appropriate packaging until such time that they are required for installation.

Any damaged material will be excluded from the works.

6.5 Manufacturer's Quality Control

Quality control certificates will be supplied to cover each roll of material delivered to site. The certificates will be supplied prior to delivery of the material to site and will contain quality control data typically according to the requirements of Table 4.

CE Declaration certificates are also to be included when the material is delivered.

Quality Control Certificates will be provided prior to installation and for inclusion in the CQA Validation Report as follows:

- A specification for the geotextile which includes all properties contained in Table 4 measured using the appropriate test methods;
- Written certification that minimum values given in Table 4 are guaranteed by the Manufacturer; and
- Written confirmation that testing to detect needle fragments and removal of needle fragments prior to delivery of the product has taken place.

6.6 Geotextile Conformance Sampling

As soon as practicable after the delivery of the geotextile rolls to site, the Contractor shall cut and label samples 1m long across the entire width of selected rolls for conformance testing as directed by the CQA Inspector. Prior to taking the conformance sample the Contractor shall remove and discard the first 1m (outside) of the roll.

One set of samples per 2,500m² (minimum) shall be passed to the CQA Inspector for physical conformance testing as detailed in Table 4, and one set of samples per 5,000m² (minimum) for mechanical conformance testing as detailed in Table 4.

The Contractor shall submit the samples for conformance testing to an independent geosynthetic testing laboratory having UKAS Accreditation for each test being carried out.

If testing shows that the geotextile does not meet any one of the minimum requirements listed in Table 4, then this may be cause for rejection of the material from that roll. Any repairs, replacement or other works occasioned by the failure of the geotextile to meet the minimum requirements listed in Table 4 shall be carried out at the Contractor's expense. The CQA Inspector may at his discretion accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing (at his expense) at a geosynthetic laboratory approved by the CQA Inspector that this material does meet the acceptance criteria contained in Table 4.

6.7 Installation

The CQA Inspector will assign panel identification codes and maintain a record of panel/roll correspondence and the date and location of installation. Each panel will be observed for defects and a record will be kept to ensure that all defects are properly repaired and tested.

Geotextile panels will be placed directly over and in intimate contact with the geomembrane. The minimum panel overlap across slopes shall be 300mm and down slopes the minimum panel overlap shall be 500mm (or in accordance with the manufacturer's recommendations). The minimum panel overlaps on slopes will be as shown in Figure 1 below.

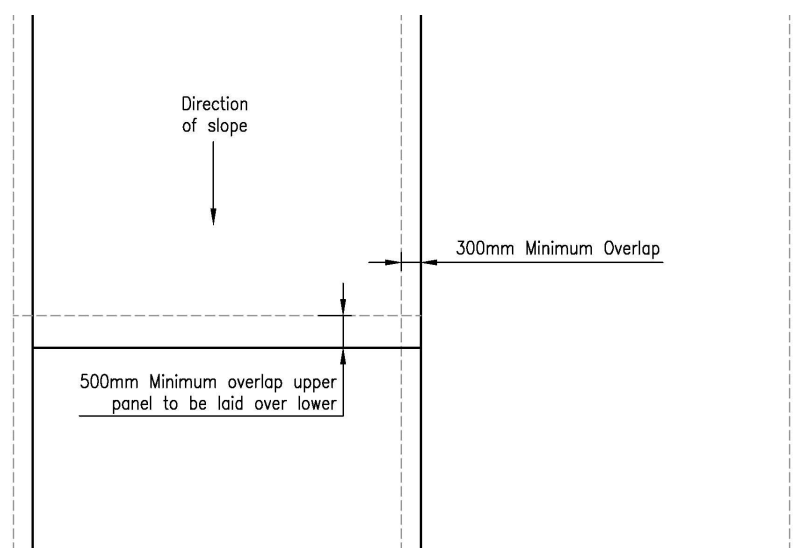


Figure 1. Protector Geotextile Minimum Panel Overlaps

Where possible panels should be deployed so that seams are aligned parallel to the line of maximum slope.

Geotextile panels shall be joined by heat bonding using methods to be approved in advance by the CQA Inspector.

Tie-ins and anchorage methods for the geotextile are to be agreed with the designers if it is determined that a lower protector geotextile is required.

In windy conditions and at the end of the working day, all exposed edges of the geotextile should be weighted down, the geotextile should be held down using sandbags or similar weights that will not damage the material. The CQA Inspector shall visually check for such damage.

All geotextile sheets will be visually inspected for damage and imperfections after deployment and any repairs required will be undertaken.

Furthermore, the Contractor shall ensure that:

- Equipment, plant and tools used shall not damage the geotextile by handling, trafficking, leakage of hydrocarbons or by other means;
- Personnel working on the geotextile shall not smoke, wear shoes likely to cause damage, or otherwise engage in any activity that could damage the geotextile;
- The method of placement shall be in such a manner as to avoid stresses and strains likely to cause damage to the geotextile and underlying layers;
- The geotextile shall be in continuous contact with the surface on which it is placed without stretching or bridging over humps and hollows;
- The method of deployment shall minimise wrinkles;
- Deployment shall not take place during periods of precipitation or in the presence of excessive moisture (fog, rain, snow, and heavy dew) or in the presence wind likely to cause damage;
- Geotextile shall not be placed over areas of ponded water; and
- Construction plant shall not traverse over any area of geotextile until sufficient depth of cover has been placed above the overlying geomembrane in accordance with the Contract.

6.8 Tie-in to Existing Geosynthetic Capping System

The geotextile shall be tied-in to the existing drainage geocomposite of completed permanent capping systems in the locations shown on Drawing WR7785/06/01, and according to the construction detail on Drawing WR7785/06/02. The geotextile shall overlap the existing geocomposite by a minimum of 300mm. The geotextile shall be heat bonded to the existing geocomposite and the tie-ins shall be observed and recorded by the CQA Inspector to confirm that a satisfactory seal is achieved.

6.9 Tie-in to Existing Basal Lining System

At the tie-in of the proposed capping system with the existing basal lining system (as demarcated on Drawing WR7712/06/01), if a protector geotextile is utilised, then the geotextile shall be placed in the existing anchor trench which is shown on the construction detail on Drawing WR7712/06/02, with the existing geomembrane and the capping geomembrane.

6.10 Inspection and Approval

The installed geotextile shall be subject to inspection and approval by the CQA Inspector. Approval shall be made on the basis of the following:

- i) The geotextile has been installed in accordance with this Specification;
- ii) A visual inspection has been undertaken to confirm that all stones, sandbags or any other potentially deleterious materials have been removed from the surface of the geotextile, that there are no visible surface defects and no folds or excessive undulations, and that the appropriate overlap between adjacent panels has been achieved; and
- iii) All necessary repairs have been made.

Where the geotextile has not been approved the Contractor shall discuss and agree appropriate remedial measures with the CQA Inspector. These measures may include the complete removal and replacement of a panel or undertaking remedial works.

6.11 Repairs

Any faulted areas on the geotextile shall be overlain with a single piece of compatible geotextile. The patch shall have a minimum overlap of 500mm in all directions that is to be secured to the underlying textile utilising the agreed method.

6.12 Interface Testing

Interface testing to determine interface shear strengths between the protector geotextile and restoration soils shall be carried out at an independent geosynthetic testing laboratory with UKAS accreditation to the specifications in Appendix 6. Further details of the interface testing requirements are set out in Section 3.2 of this Specification.

6.13 Lower Protector Geotextile

If, in the opinion of the CQA Inspector, the regulating layer is unsuitable for the placement of the geomembrane, the Contractor may place a lower protector geotextile beneath the geomembrane. The lower protector geotextile shall conform to the same specifications and be subject to the same installation and CQA requirements as described in this Chapter and the CQA Plan. The lower protector geotextile shall only be required in areas of below specification subgrade where larger particles are present on the surface and the LLDPE needs additional protection, however, consideration should be given to anchorage of such materials on perimeter slopes and the designers should be consulted once areas are identified, prior to covering with the geomembrane to ensure specific edge details are fit for purpose.

If a lower protector geotextile is utilised, the surface of the regulating layer shall still be rolled and compacted so that the surface is as flat and smooth as possible, with any excessively sharp / angular protruding stones being removed.

The CQA Inspector shall retain the right to refuse approval of the regulating layer if, in their opinion, it does not form a suitable surface even with the placement of a lower geotextile.

7 DRAINAGE GEOCOMPOSITE

7.1 General

Where agreed between the Employer and the Designer based on the results of the interface testing, the welded LLDPE geomembrane shall be covered with a Drainage Geocomposite. The drainage geocomposite shall be supplied in accordance with the parameters given in Table 5 below and installed in accordance with the drawings, and the procedures and CQA requirements described below. The Contractor will be required to:

- Supply and install a Drainage Geocomposite on the geomembrane surface;
- Tie the geocomposite drainage layer into the existing capping systems previously installed at the site; and
- Provide all material quality control certificates and other information described below.

7.2 Geocomposite Materials

The geocomposite material shall meet the requirements of Table 5 below and conformance testing shall be carried out in line with the manufacturers' specified values for the properties set out in Table 5 below. The Contractor shall provide a schedule of results to show that the minimum requirements can be met by typical material of the type to be used, prior to installation on-site.

Table 5: Drainage Geocomposite Specification and Conformance Testing

Physical Properties:					
Polymer type:	Prime quality polypropylene fibre (UV stabilised) with no post-consumer fibres				
Fabric construction:	Nonwoven fabric manufactured from mechanically entangled fibre				
	Approved test method	Units	Required value	Tolerance	Testing Frequency
Mechanical Properties:					
Static puncture strength (CBR)	EN ISO 12236	kN	4	-10%	1/6000m ²
Tensile strength (md/cmd)	EN ISO 10319	kN/m	25/25	-10%	1/6000m ²
Tensile extension (md/cmd)	EN ISO 10319	%	80/80	+/- 20%	1/6000m ²
Dynamic Perforation Resistance	EN ISO 13433	mm	5	+ 3mm	1/6000m ²
Drainage Properties:					
In Plane Water Flow @ H.G. 1.0 and 100kPa with soft foam platens to simulate soil action. Hard/soft foam platens are acceptable. Test is to be performed in the long direction or the long and cross direction, depending on whether band drains or a cuspatd core is used.	BS EN ISO 12958	l/m/s	0.1*		1/6000m ²
Durability (according to annex B: EN 13253)**:					
	Approved test method	Requirement		Tolerance	
Resistance to weathering @ 50MJ/m ² radiant exposure ¹	EN 12224	Retained Strength		80%	
Resistance to Oxidation (100 years)	EN ISO 13438***	Retained Strength 56 days		50%	
Resistance to liquids	EN 14030	Retained Strength		50%	
1. 1-4 months UV exposure depending on location/season					
* Values to be achieved regardless of any manufacturer's tolerances.					
** Durability test data can be supplied by the manufacturer – test frequency must not exceed 5 years.					
*** Manufacturer may use alternative means of assessing oxidation to achieve 100 years.					

7.3 Delivery, Handling and Storage

The material will be delivered, handled and stored in accordance with this Specification and should be delivered and stored in tight wrappings in order to offer protector from ultra violet degradation. Each roll of geocomposite delivered to site will be identified with:

- Manufacturer's name, address and telephone number;
- CE mark with accrediting body's number;
- Product identification and polymer type;
- Geocomposite batch and roll number;
- Roll length and width in metres;
- Roll weight in kilograms; and
- Polymer type.

Lifting and transportation of the geocomposite materials shall be by appropriate machinery with the use of slings and core bars. The material is not to be handled with the tines of a forklift machine, the bucket of an excavator, or any similar equipment under any circumstances.

The Contractor shall provide adequate and acceptable measures for protecting the material at all stages of the work, from all sources of potential damage such as sharp objects, boulders, cobbles etc, including weather conditions and will be located out of the way of the way of moving plant. The rolls of geocomposite will not be stacked more than 3 high with nothing stacked above them. All product rolls must be kept in the appropriate packaging until such time that they are required for Installation.

Any damaged material will be excluded from the works.

7.4 Manufacturers Quality Control

Quality control certificates will be supplied to cover each roll of material delivered to site. The certificates will be supplied prior to delivery of the material to site and will contain quality control data typically according to the requirements of Table 5.

CE Declaration certificates are also to be included when the material is delivered.

Quality Control Certificates will be provided prior to installation and for inclusion in the CQA Validation Report as follows:

- A specification for the geocomposite which includes all properties contained in Table 5 measured using the appropriate test methods;
- Written certification that minimum values given in Table 5 are guaranteed by the Manufacturer; and
- Written confirmation that testing to detect needle fragments and removal of needle fragments prior to delivery of the product has taken place.

7.5 Geocomposite Conformance Sampling

As soon as practicable after the delivery of the geocomposite rolls to site, the Contractor shall cut and label samples 1m long across the entire width of selected rolls for retention and/or conformance testing as directed by the CQA Inspector.

One set of samples per 6,000m² (at least one per batch) shall be passed to the CQA Inspector for mechanical and drainage properties conformance testing, as detailed in Table 5. All testing is to be carried out at an independent geosynthetic testing laboratory with UKAS accreditation for each test being carried out.

If testing shows that the geocomposite does not meet any one of the minimum requirements listed in Table 5, then this may be cause for rejection of the material from that roll. Any repairs, replacement or other works occasioned by the failure of the geocomposite to meet the minimum requirements listed in Table 5 shall be carried out at the Contractor's expense.

The CQA Inspector may at his discretion accept material from elsewhere on that roll if the Contractor can demonstrate through further laboratory testing (at their expense) at a geosynthetic laboratory approved by the CQA Inspector that this material does meet the acceptance criteria contained in Table 5.

7.6 Installation

The CQA Inspector will assign panel identification codes and maintain a record of panel/roll correspondence and the date and location of installation. Each panel will be observed for defects and a record will be kept to ensure that all defects are properly repaired and tested.

Geocomposite panels will be placed directly over and in intimate contact with the geomembrane. If a geocomposite with longitudinal band drains is used, the CQA Inspector shall ensure that panels are orientated so that the band drains flow down the slope.

The minimum panel overlap across slopes shall be 300mm and down slopes the minimum panel overlap shall be 500mm (or in accordance with the manufacturer's recommendations). This arrangement is shown on Figure 1 below.

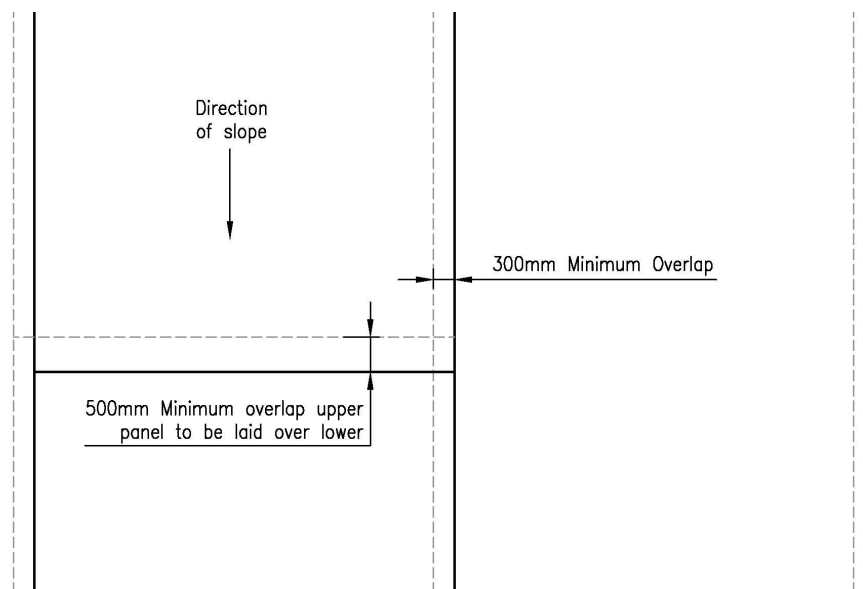


Figure 2. Drainage Geocomposite Minimum Panel Overlaps

Where possible panels should be deployed so that seams are aligned parallel to the line of maximum slope.

Geocomposite panels shall be joined by either heat bonding or by sewing using methods to be approved in advance by the CQA Inspector.

Adjacent to the tie-in of the proposed capping system with the existing basal lining system (as demarcated on Drawing WR7712/06/01), if a drainage geocomposite is utilised, the geocomposite shall be exposed at the ground surface to allow the water to flow freely from the capping slope, as shown in the construction detail on Drawing WR7712/06/02.

Furthermore the Contractor shall ensure that:

- Equipment, plant and tools used shall not damage the geocomposite by handling, trafficking, leakage of hydrocarbons or by other means;
- Personnel working on the geocomposite shall not smoke, wear shoes likely to cause damage, or otherwise engage in any activity that could damage the geocomposite or underlying geomembrane;

- The method of placement shall be in such a manner as to avoid stresses and strains likely to cause damage to the geocomposite and underlying layers;
- The geocomposite shall be in continuous contact with the surface on which it is placed without stretching or bridging over humps and hollows;
- The method of deployment shall minimise wrinkles;
- Only geocomposite to be used on the same working day shall be removed from the store;
- Deployment shall not take place during periods of precipitation or in the presence of excessive moisture (fog, rain, snow, and heavy dew) or in the presence wind likely to cause damage;
- Geocomposite shall not be placed over areas of ponded water;
- Direct contact with the geocomposite is to be minimised; and
- Construction plant shall not traverse over any area of geocomposite until sufficient depth of cover has been placed over it in accordance with the Contract.

In windy conditions and at the end of the working day, all exposed edges of the geocomposite should be weighted down, the geocomposite should be held down using sandbags or similar weights that will not damage the material. The CQA Inspector shall visually check for such damage.

All geocomposite sheets will be visually inspected for damage and imperfections after deployment and any repairs required will be undertaken.

7.7 Tie-in to Existing Capping System

The geocomposite shall be tied-in to the existing geocomposite of completed permanent capping systems in the locations shown on Drawing WR7712/06/02. The geocomposite shall overlap the existing geocomposite by a minimum of 300mm. The geocomposite shall be heat bonded to the existing geocomposite and the tie-ins shall be observed and recorded by the CQA Inspector to confirm that a satisfactory seal is achieved. The construction detail for tie-ins to existing temporary capping systems has also been included in Drawing WR7712/06/02, in case there are areas where this type of tie-in are required.

7.8 Protuberances

The Contractor shall ensure that the drainage geocomposite is installed around protuberances in the capping system as shown in the construction detail on Drawing WR7712/06/02.

7.9 Inspection and Approval

The installed geocomposite shall be subject to the inspection and approval by the CQA Inspector. Approval shall be made on the basis of the following:

- i) The geocomposite has been installed in accordance with this Specification;
- ii) A visual inspection has been undertaken to confirm that all stones, sandbags or any other potentially deleterious materials have been removed from the surface of the geocomposite, that there are no visible surface defects and no folds or excessive undulations;
- iii) That the appropriate overlap between adjacent panels has been achieved; and
- iv) All necessary repairs have been made.

Where the geocomposite has not been approved the Contractor shall discuss and agree appropriate remedial measures with the CQA Inspector. These measures may include the complete removal and replacement of a panel or undertaking remedial works.

7.10 Repairs

Any faulted areas on the geocomposite shall be overlain with a single piece of compatible geocomposite. The patch shall have a minimum overlap of 500mm in all directions that is to be secured to the underlying geocomposite utilising the agreed method (heat bonding, sewing or similar approved).

7.11 Interface Testing

Interface testing to determine interface shear strengths between the drainage geocomposite and restoration soils shall be carried out at an independent geosynthetic testing laboratory with UKAS accreditation to the specifications in Appendix 6. Further details of the interface testing requirements are set out in Section 3.2 of this Specification.

8 RESTORATION SOILS

8.1 General

After placement of the protector geotextile / drainage geocomposite, restoration materials will be placed to a minimum final depth of 1,200mm perpendicular to the slope. The first 500mm of soils shall be subject to CQA supervision with the remainder placed either as part of these works or by top up material at a later date depending on material availability. If the final 700mm of soils are placed at a later date, the site manager will be responsible for recording and reporting relevant data of soils to Natural Resources Wales on commencement and placement of the final 700mm of top up soils. FCC are to agree a procedure with Natural Resources Wales prior to commencing any top up works.

The material to be used for the restoration layer shall be sourced from on site or imported as directed by FCC. The material shall be free from any unsuitable material, or any other deleterious materials / objects that may potentially cause damage to the capping system.

Unsuitable material shall include:

- i) Material in a frozen condition or susceptible to spontaneous combustion;
- ii) Any industrial, commercial or domestic waste;
- iii) Any excessively wet material which does not provide a firm surface sufficient to permit the movement of plant or vehicles without causing excessive rutting ; and/or
- iv) Any material greater than 125mm in any dimension in the first 500mm of the restoration soils above the protector geotextile / drainage geocomposite and in the remaining soils any material greater than 200mm in any dimension.

The Contractor shall excavate and handle the material from onsite locations in such a manner that the nature and consistency of the material is not adversely affected. Where more than one type of material is encountered the Contractor shall, wherever practicable, excavate in such a manner that the materials can be separated. The materials will be rejected for use if it contains material that the CQA Inspector believes will potentially damage the geomembrane and / or protector geotextile / drainage geocomposite layers.

8.2 Placement

The restoration soils shall be placed as soon as practicable after the protector geotextile / drainage geocomposite has been placed. The restoration soils shall be spread in layers to

the required thickness to form a smooth even profile without undulations, hollows or depressions.

The Contractor shall undertake the placement of the restoration soils in a careful and systematic manner that does not affect the integrity of or cause damage or displacement to the capping system. The method employed should prevent the formation of any wrinkles and creases and/or any “folding over” in the capping system.

Under no circumstances other than for the safety of the Works shall plant be driven directly on the capping system. A minimum thickness of 500mm of material shall be placed at any location over the capping system before any of the Contractor’s tracked plant is allowed to traverse over the capping area. A minimum thickness of 1,000mm of material at any location shall be maintained between the capping system and wheeled haulage vehicles.

The Contractor’s placement method shall ensure that no lateral stresses are induced in the underlying layers of the capping system. In general, the methods employed shall comprise the following:

- i) Placing restoration soils working upslope;
- ii) Tipping of fresh material on previously placed material;
- iii) Casting material by 360° excavator (using a bucket without teeth);
- iv) Pushing of material up and over the face of the tipped load allowing it to fall vertically onto the underlying layers; and
- v) Preloading of the underlying layers with discrete mounds of material, to prevent the generation of excessive wrinkles or folds, and infilling between mounds.

The Contractor shall control the depth of restoration soils placement by using free standing profile boards or travellers. The Contractor shall ensure that the bases of the profile boards or travellers are flat and of such construction that they do not cause damage to the underlying geosynthetic capping system.

Any damage or disturbance to the capping system during the placement of the soils shall be repaired by the Contractor in accordance with the Contract.

The restoration soils shall not be compacted except by the passage of construction plant. The final surface of the soils shall be graded to achieve the required levels and profile and shall be free from any bumps and hollows, to the satisfaction of FCC.

The CQA Inspector shall carry out trial pitting on a 25m grid to verify that an adequate depth of restoration soils has been placed in accordance with Table 6 below. Trial pitting logs and the trial pitting grid layout shall be included in the CQA Validation Report.

The CQA Inspector shall also carry out a visual inspection of the restoration soils to ensure that the particle size requirements set out in Table 6 are met. Any particles that are too large shall be removed from the restoration soils.

Table 6. Restoration Soils Testing Requirements

Parameter	Test Method	Acceptance Criteria	Testing Frequency
Particle Size	Visual	Any material greater than 125mm in any dimension in the first 500mm of the restoration soils above the Protector Geotextile / Drainage Geocomposite and in the remaining soils any material greater than 200 mm in any dimension	Continuous Monitoring During Restoration Soils Placement
Thickness*1	Manual	>500mm or >1,200mm (dependent on thickness placed)	1 per 25m Grid

1. Trial pitting for soils thickness checking shall be carried out before the survey of the top of the restoration soils.

8.3 Protuberances

During placement of the restoration soils around any protuberance the Contractor shall batter back the soils to allow for future installation of any headworks by the Employer, unless otherwise directed by the CQA Inspector or FCC. A stockpile of restoration soils shall be left adjacent to each protuberance to allow backfilling at a later date.

The Contractor shall take all reasonable precautions against causing damage or disturbance to protuberances and any associated installations; and, at the start of the Contract the Contractor shall inspect the condition and alignment of these with the Supervisor. A similar inspection shall be carried out following the completion of the work around each protuberance. Should the Contractor cause any damage or disturbance he shall immediately carry out remedial works in accordance with the Contract.

APPENDIX 1
DESIGNER'S RISK ASSESSMENT

APPENDIX 2
PRINCIPAL QUANTITIES

APPENDIX 3
SLOPE STABILITY ANALYSIS

APPENDIX 4

FCC GOOD PRACTICE GUIDE VERSION 6.0

APPENDIX 5

GEOMEMBRANE WELD FAILURE CODES

APPENDIX 6

INTERFACE TESTING REQUIREMENTS

DRAWINGS

**3C WASTE LIMITED
(FCC ENVIRONMENT LIMITED)**



**CQA PLAN FOR 2022 PERMANENT CAPPING
AT LLANDDULAS LANDFILL SITE**

Document Reference: WR7712_2A Rev1
September 2022



Project Quality Assurance

Report : WR7712_2A Rev1
Reference
Report Date : September 2022

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Rev	Date Issued	Amendment Details	Author	Reviewer
1	27/09/2022	Addition of Geotextile option into the design	JC	AK

Purpose

This document was prepared as a Construction Quality Assurance (CQA) Plan for the Construction of an area of Permanent Capping at Llanddulas Landfill Site for 3C Waste Limited, who are the permit holders for the site, but are a subsidiary company of FCC Environment (UK) Limited and will be referred to as FCC Environment (UK) Limited from here on in.

Sirius Environmental Limited (Sirius) accepts no responsibility or liability for any use that is made of this document other than by the Client, FCC Environment (UK) Limited (FCC), for the purposes for which it was originally commissioned and prepared.

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Appendix 1 CQA Proformas

1 SCOPE OF THE CONSTRUCTION WORKS

1.1 General Description

The design concepts for the capping construction were developed to accord with the Permit for the site and associated pre-operational conditions.

The position of the proposed development on site in relation to previously capped areas is shown on Drawing WR7712/06/01, along with the locations of tie-ins to existing basal lining and capping systems. Construction details for the capping works are shown on Drawing WR7712/06/02.

Construction of the capping system will involve:

- Trimming / regrading of existing waste surface as required;
- Placement and trimming of a 300mm thick regulating layer to achieve the formation levels for the liner;
- Placement of a Lower Protector Geotextile (if required) over the regulated surface;
- Installation of a fully welded, 1mm thick, double textured Linear Low Density Polyethylene (LLDPE) geomembrane liner;
- Installation of a Protector Geotextile / Drainage Geocomposite over the LLDPE capping geomembrane;
- Tie-in to existing capping systems and basal lining system;
- Sealing of the capping system around protuberances; and
- Installation of 1,200mm of restoration soils above the protector geotextile / drainage geocomposite.

The Employer and the Designer will liaise to confirm whether a protector geotextile or a drainage geocomposite will be utilised in the capping works, or whether both will be included across different areas of the cap. The choice between these materials will be dependent on the results of the interface testing, and whether they demonstrate that the stability of the capping slopes is likely to be maintained using the proposed products. The veneer calculations for stability and the required interface testing are described in Section 3.2 of the Specification.

2 CQA SUPERVISION

2.1 General

The CQA Project Team will comprise the following:

The CQA Engineer - Will be office based and responsible for the following:

- Administration of the CQA program;
- Attendance at selected progress or liaison meetings and is the key contact with regulatory officers; and
- Production of the CQA Validation Report.

The CQA Inspector – The representative of the CQA Engineer located full time at the site during works requiring CQA supervision and responsible for the following:

- The on-site representative of the CQA Engineer;
- To be fully familiar with all CQA requirements for the project;
- Attendance at all CQA-related meetings (e.g. Pre-construction and Progress);
- Preparation, or overseeing the ongoing preparation of the as-built drawings;
- Assigning locations for testing and sampling;
- Keeping daily reports and records;
- Reporting to the CQA Engineer any relevant observations;
- Overseeing the collection and shipping of all samples for laboratory testing;
- Reviewing the results of laboratory testing and making appropriate recommendations;
- Reporting any unresolved deviations from this CQA Plan to the CQA Engineer;
- Provision of all records and relevant data to the CQA Engineer for the preparation of the final validation report, which will be submitted to Natural Resources Wales (NRW) for approval upon completion of the works;
- Noting and bringing to the attention of the Contractor any on-site activities that could result in damage to the liner system; and
- Verification that the works carried out are constructed in accordance with all requirements of the Specification and CQA Plan.

Staff undertaking the roles of the CQA Engineer and the CQA Inspector should have relevant experience in landfill construction and earthworks control or be supervised by experienced staff until relevant experience is obtained. The CVs of the CQA Project Team shall be supplied to NRW prior to commencement of the works. Should changes to CQA personnel be required, NRW shall be immediately notified and the respective CV shall be issued.

2.2 Definitions

For the sake of clarification the following definitions are given:

Construction Quality Assurance (CQA)

- Means a planned and systematic pattern of all means and actions designed to provide confidence that items or services meet contractual and regulatory requirements and shall perform satisfactory in service.

Construction Quality Assurance refers to means and actions employed by the Supervisor, to assure conformity of the preparation, production and installation of this CQA Plan, the Contract Drawings, and Specification. CQA is provided by Sirius.

Construction Quality Control (CQC):

- Means “those actions that provide a means to measure and regulate the characteristics of an item or service to contractual requirements”.

Construction Quality Control refers to those actions taken by Manufacturers, Installers, Contractors, or the Employer to ensure that the materials and the workmanship meet the requirements of the Contract Drawings and Specification.

Employer:

Means “the person or persons, firm or company or other body whom own and have responsibility for the facility”. For the works undertaken at Llanddulas Landfill Site, the Employer is FCC Environment (UK) Limited. The Employer has entered into a contract with a Contractor for the execution of the works detailed in the Specification and Contract Drawings. Personal representatives or other parties, e.g. the Supervisor, may represent the Employer on site.

Contractor:

Means 'the person or persons, firm, company or other body to whom the contract has been awarded by the Employer, and includes the Contractor's personal representatives or other parties, e.g. Sub-contractors, Manufacturers.

The Contractor shall undertake the execution of the works under the terms of the Contract.

Specification:

Means, 'that part of the Contract entered into between the Employer and the Contractor, which sets out the Employer's detailed requirements as to how the works should be constructed, tested, measured and quality assured'.

This CQA Plan is to be read in conjunction with the Specification Ref: WR7712_1A which is included with in the Design Pack.

2.3 Design Changes

Any design changes required to ensure the suitability of the construction works shall be referred to Sirius prior to discussions with NRW for approval.

2.4 Daily Meetings

Meetings will be held daily between the CQA Inspector and the Contractor's representative, the purpose of which is to:

- Review the work activities and locations for that day;
- Note the Contractor's installation personnel and plant for the day/shift;
- Review the previous days progress;
- Review the work schedule;
- Discuss any interfacing with other contractors and/or site operations; and
- Discuss/highlight any problems and identify solutions.

2.5 Site Visits

It is anticipated that from time to time NRW will visit the site to review the works. During these visits the CQA Inspector shall make available all test results and daily records up to that date for inspection by NRW.

Any problem encountered during construction should be discussed with NRW upon their arrival to site prior to any subsequent site walkover. The CQA Inspector shall discuss the problems encountered any discuss any proposed remediation methods.

2.6 CQA Requirements

The CQA requirements associated with each component of the works are detailed in the individual sections below.

2.7 CQA Proformas

All proformas in Appendix 1 are to be completed during the works to record the specific elements, these are all to be completed and submitted as part of the CQA Validation Report.

3 EARTHWORKS REQUIREMENTS

3.1 CQA Requirements

The works shall be carried out using Construction Quality Assurance (CQA) procedures developed for the works and which form part of this CQA Plan. The CQA Inspector shall observe, record and oversee the works as required to complete the CQA programme.

The CQA procedures include for checking of various parts of the works in a systematic way and include, but are not limited to consideration of the following elements.

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor for the installation of the waste regulation layer;
- Ensure that all material within the working area deemed unsuitable in accordance with the Specification is removed to an area agreed with FCC's Site Manager;
- Provide approval as to the adequacy of the prepared waste surface prior to installation of the waste regulating layer;
- Ensure that only suitable soils as defined in the Specification are used as engineered fill and regulating layer;
- Ensure the waste regulating layer is tied-in to existing waste regulating layers in accordance with the Specification and the construction details on the drawings;
- Ensure that the materials used for regulating layer are classified using Particle Size Distribution (PSD) testing, in accordance with the Specification;
- Ensure that if non-cohesive material forms the waste regulating layer adequate compaction has been applied in accordance with the Specification;
- Monitor the placement and compaction of the fill materials, ensuring that the works are carried out in accordance with the Specification and the required depth is placed;
- Ensure that the immediate surface upon which the geomembrane is to be installed is smooth and free of all rocks, stones, roots, sharp objects, or debris of any kinds;
- Ensure that the surface of the regulating / bedding layer provides a firm foundation for the geomembrane with no sudden, sharp, or abrupt changes in grade, and no standing water or excessive moisture;

- Confirm whether a lower protector geotextile is required beneath the geomembrane liner;
- Ensure that all areas of non-compliance are remediated in accordance with the Specification;
- Take photographs during the construction;
- Ensure that surveys / trial pit checks are undertaken in accordance with the Specification to confirm that the requisite levels and layer thicknesses have been achieved;
- Physically verify the undrained shear strength of cohesive materials on a 25m grid using a calibrated hand shear vane to ensure a minimum in-situ undrained shear strength of 50 kPa has been achieved; and
- Provide written certification to the Contractor that the surface on which the geomembrane liner is to be installed is acceptable prior to installation, and that the slope gradients meet the requirements of the slope stability analysis included within the Specification. Written certification may be withdrawn in the event of surface deterioration by any cause and only re-issued by the CQA Inspector upon remedial works being compliant with the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all required tests.

The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

4 GEOMEMBRANE LINER

4.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor detailing their proposed deployment and seaming techniques;
- Assess and approve, with respect to the requirements set out in the Specification, the proposed panel layout for the geomembrane to be submitted by the Contractor. The drawing should show the Contractor's proposed start point and direction of working, and the panels should be arranged so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), wherever practicable, in accordance with accepted good practice. The panel layout should seek to minimise the number of required overlapped seams;
- Ensure that the materials are delivered, handled and stored in accordance with the Specification;
- Ensure all welders hold and can produce current third party certification for welding and installation to the standard indicated in the Specification, prior to any welding taking place;
- Make a visual inspection of each roll as it is unloaded to identify any damage and record the relevant information for each roll;
- Assess all manufacturers' quality control certificates prior to installation to confirm that the material meets the requirements of the Specification prior to installation;
- Identify rolls from which conformance samples of the geomembrane are to be taken for laboratory conformance testing in accordance with the Specification;
- Assess the results of conformance tests to ensure compliance with the Specification. Should any materials fail to meet the requirements of the Specification, the CQA Inspector shall reject the failed roll and schedule further testing in accordance with the Specification;
- Inspect the subgrade and lower protector geotextile (if required) and verify that it is in full accordance with the Specification. This includes taking measurements using appropriate equipment on areas where an adverse change of gradient is suspected;

- Ensure that the immediate surface upon which the geomembrane is to be installed is generally smooth and free of deleterious materials which may damage the geomembrane;
- Provide written certification to the Contractor that the surface on which the geomembrane is to be installed is acceptable prior to installation. *Note the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being complaint with the Specification;*
- Witness all panel deployment ensuring compliance with the Specification;
- Witness all trial seaming ensuring compliance with the Specification;
- Witness all seam constructions to ensure compliance with the Specification verifying that all surfaces are completely clean, dry and free from imperfections and the correct overlap has been achieved;
- Witness all seam constructions to ensure that welding speeds and temperatures used in successful trial welds are the same used in field seaming;
- Ensure non-destructive testing is carried out in accordance with the Specification;
- Ensure that all defects / repairs and patch works are identified on the geomembrane and witness that they are repaired in accordance with the Specification;
- Ensure qualitative destructive testing is carried out in accordance with the requirements of the Specification;
- Instruct the Contractor as to the location of destructive test samples to be taken at the frequency detailed in the Specification;
- Ensure samples are sent to a laboratory accredited for all tests required within the Specification and that sub-samples are retained on site;
- Review the results of destructive testing to ensure that the testing has been undertaken in accordance with, and met, the Specification required values;
- Ensure that a defect free tie-in with the existing geomembrane is constructed;
- Ensure that geomembrane and seam construction continues to the back of the anchor trenches;
- Ensure that all protuberances are sealed around in accordance with the Specification and the construction detail on the relevant drawing; and

- Ensure that on completion of the geomembrane installation the Contractor produces a fully referenced as-built panel layout plan including all the detail listed within the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all required tests.

The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

5 PROTECTOR GEOTEXTILE

5.1 CQA Requirements

A lower protector geotextile may be required, if one is utilised this section will apply to the lower and upper geotextiles.

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor detailing their proposed deployment and seaming techniques;
- Ensure that the requirements for the protector geotextile product to be used within the works are in accordance with the requirements of the Specification;
- Ensure that the materials are delivered, handled and stored in accordance with the Specification;
- Make a visual inspection of each roll as it is unloaded to identify any damage and record the relevant information for each roll;
- Assess all protector geotextile manufacturers' quality control certificates to confirm that the protector geotextile meets the requirements of the Specification prior to installation;
- Assess and approve, with respect to the requirements set out in the Specification, the proposed panel layout for the protector geotextile to be submitted by the Contractor. The methodology shall show the Contractor's proposed start point and direction of working. The panels shall be arranged so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), wherever practicable, in accordance with accepted good practice. The panel layout shall seek to minimise the number of required heat bonded seams;
- Identify rolls from which conformance samples of the protector geotextile are to be taken for laboratory conformance testing in accordance with the Specification;
- Assess the results of conformance tests to ensure compliance with the Specification. Should any materials fail to meet the requirements of the Specification, the CQA Inspector shall reject the failed roll and schedule further testing in accordance with the Specification;
- Provide written certification to the Contractor that the surface on which the protector geotextile is to be installed is acceptable prior to installation. *Note the CQA Inspector*

may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being compliant with the Specification;

- Witness all panel deployment ensuring compliance with the Specification;
- Witness all seam constructions to ensure compliance with the Specification;
- Ensure that all defects are identified on the protector geotextile and witness that they are repaired in accordance with the Specification;
- Ensure that a defect free tie-in with the existing drainage geocomposite in adjacent capping areas is constructed;
- Ensure that protector geotextile and seam construction continues to the back of anchor trenches (if applicable);
- Ensure that protector geotextile is installed in accordance with the construction details on the drawings and the Specification at the location of leachate and gas wells;
- Provide written certification to FCC of areas approved to be covered with geomembrane; and
- Ensure that on completion of the protector geotextile installation the Contractor produces a fully referenced as-built panel layout plan including all the detail listed within the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all required tests.

The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

6 DRAINAGE GEOCOMPOSITE

6.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor detailing their proposed deployment and seaming techniques;
- Ensure minimum testing requirements for the geocomposite product to be used within the works are in accordance with the requirements of the Specification;
- Ensure that the materials are delivered, handled and stored in accordance with the Specification;
- Make a visual inspection of each roll as it is unloaded to identify any damage and record the relevant information for each roll;
- Assess all geocomposite product manufacturers' quality control certificates to confirm that the geocomposite product meets the requirements of the Specification prior to installation;
- Assess and approve, with respect to the requirements set out in the Specification, the proposed panel layout for the geocomposite to be submitted by the Contractor. The methodology shall show the Contractor's proposed start point and direction of working. The panels shall be arranged so that seams are aligned parallel to the line of maximum slope (i.e. normal to contours), wherever practicable, in accordance with accepted good practice. The panel layout shall seek to minimise the number of required heat bonded seams;
- Identify rolls from which conformance samples of the geocomposite are to be taken for laboratory conformance testing in accordance with the Specification;
- Assess the results of conformance tests to ensure compliance with the Specification. Should any materials fail to meet the requirements of the Specification, the CQA Inspector shall reject the failed roll and schedule further testing in accordance with the Specification;
- Provide written certification to the Contractor that the surface on which the geocomposite is to be installed is acceptable prior to installation. *xNote the CQA Inspector may withdraw the certificate should the surface deteriorate for any cause prior to installation and only reissue upon remediation works being compliant with the Specification;*

- Witness all panel deployment ensuring compliance with the Specification;
- Ensure that if a geocomposite with longitudinal band drains is used, the panels are orientated so that the primary band drains flow down the slope;
- Witness all seam constructions ensuring compliance with the Specification;
- Ensure that all defects are identified on the geocomposite and witness that they are repaired in accordance with the Specification;
- Ensure that a defect free tie-in with the existing geocomposite in adjacent capping areas is constructed;
- Ensure that the geocomposite is exposed with an open edge adjacent to the tie-in of the capping system to the existing basal lining system, and that seam construction continues to the open edge;
- Ensure that geocomposite is installed in accordance with the details on the drawings and the Specification at the location of leachate and gas wells;
- Provide written certification to the Contractor of areas approved to be covered with restoration soils; and
- Ensure that on completion of the geocomposite installation the Contractor produces a fully referenced as-built panel layout plan including all the detail listed within the Specification.

All laboratory testing will be undertaken by UKAS Accredited Laboratories, with accreditation for all required tests.

The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

7 RESTORATION SOILS

7.1 CQA Requirements

The CQA Inspector shall:

- Assess the method statement submitted by the Contractor for the installation of the restoration soils;
- Ensure that all material within the working area deemed unsuitable in accordance with the Specification is removed to an area agreed with FCC's Site Manager;
- Ensure that only suitable soils are used where required as restoration soils, this shall include checking that the particle size requirements set out in the Specification are met;
- Ensure that a minimum thickness of 1,000mm is maintained between wheeled plant and the drainage geocomposite or a minimum thickness of 500mm is maintained between tracked plant and the drainage geocomposite;
- Monitor the placement and compaction of the first 500mm of restoration soil, ensuring that the works are carried out in accordance with the Specification;
- Ensure that all areas of non-compliance are remediated in accordance with the Specification;
- Take photographs during the construction; and
- Ensure that surveys are undertaken in accordance with the Specification to confirm that the requisite levels and layer thicknesses have been achieved, soil depths are to be checked with trial pits.

The CQA Inspector shall fully document each item above and the documentation shall be presented in the CQA Validation Report.

8 CQA VALIDATION REPORT

Upon completion of the or capping works the CQA Inspector will prepare a Validation Report summarising the works undertaken and including all CQA documentation prepared. As a minimum this shall include:

- Description of the works;
- Completed summary sheets detailing the installation of each element of the works;
- Contractor's and manufacturer's documentation;
- Test (laboratory & field) reports, failing results / tests will also be presented (e.g. failing trail welds or air pressure tests) and correlated to the subsequent remedial works and / or re-testing;
- Interface testing results and updated slope stability calculations;
- All references to final levels in metres above ordnance datum;
- Details of all materials and equipment used;
- As-built drawings (Topographic and Panel Layout) which should include;
 - Title of Project, contract, element of works;
 - Drawing version number, with details of revision history;
 - Scale (Scale at size to be printed, eg 1:500 at A1);
 - Details of the Survey Grid (eg. OSGB36, or local grid);
 - Locations of control stations / levels, benchmarks, etc. (permanent and temporary);
 - North arrow;
 - Grid intersections; and
 - Distinguish between surveys done at different times and dates.
- Photographic record of the construction;
- Daily diaries; and
- Description of non-conformances and the subsequent remediation.

Pro-Forma sheets for the onsite completion by the CQA Inspector are in Appendix 1.

The above report will confirm that the works have been carried out in accordance with the Specification as incorporated in this Construction Quality Assurance Plan. The report will be certified by the CQA Engineer.

APPENDIX 1
CQA PROFORMAS

LGG 115 SHEAR BOX TEST CHECK LIST

Client:

Questions	Client to Confirm	Guidance
Interface	Geomembrane / Restoration Soils	Interface 1 Vs. interface 2
Shear Box	Yes	Large Shear Box (300 mm * 300 mm), direct shear
Method	LGG 155	ASTM D5321 – 08 and/or BS EN ISO 12957 – 1 and/or LGG 115
Test Frequency	1 (LGG 115 Route E)	Minimum 1 per 10,000 m ² , need multiple to calculate the standard deviation
Normal Stress, Pressure (kPa)	20, 50, 100 kPa	20, 50, 100 kPa 50, 150, 300 kPa
Shearing Rate (mm/min)	1mm/min	Typically, 1 mm/min, clays to be run slower, 0.1 mm/min
Dry Density	To be Determined	To be determined by compaction trial with 2.5 kg rammer
Consolidation	1 hours	For submerged interfaces, 1 hour or 24 hours for soils
Test Saturation	Submerged	Dry, as received or submerged
Sequence of Material in Situ	Geomembrane / Restoration Soils	The order of material when put in the ground
Thickness of Soil	100mm	Minimum of 50 mm, typically 100 mm to be ran in the Shear Box
Moisture Content	As received	Tested as received; we can calculate a range of moisture content for each soil
Interfaces Spacing	1mm	Typically, 0.5 – 1 mm
Interface Orientation	Machine Direction	Machine Direction or Cross Direction or both
Photographs	Yes	Before & After tests
Factor of Safety	1.3	Ratio e.g. 1.4
Slope Angle	17.7	Eg 20 degrees
Category of Soil	Soils to be Characterised	How were the design interface shear parameters obtained, we can characterise the soils
Material ID	Geomembrane / Restoration Soils	Technical data sheet, date of manufacture, roll number
Category of GCL's and Geocomposites		Yes/No
Are they derived from published sources of generic values for the geosynthetics e.g. NRW report TR1?		NO
Are they derived from unpublished generic values for the geosynthetics in the designer's database?		NO
Are they derived from test values in the particular manufacturer's database for similar geosynthetics?		NO
Are they based on test values from previous works on the site for similar geosynthetics from a different manufacturer?		NO
Are they based on test values (at least 4 sets) from previous works on the site for the particular geosynthetics from the same manufacturers?		YES
Soil Characteristics		Client or LAB to Confirm
The particle size distribution (d ₈₅)		LAB
The allowable range of the protector density		LAB
Cohesion of the soil		LAB
Soil conditions		LAB
Allowable range of moisture content		LAB
Liquid and plastic limits		LAB

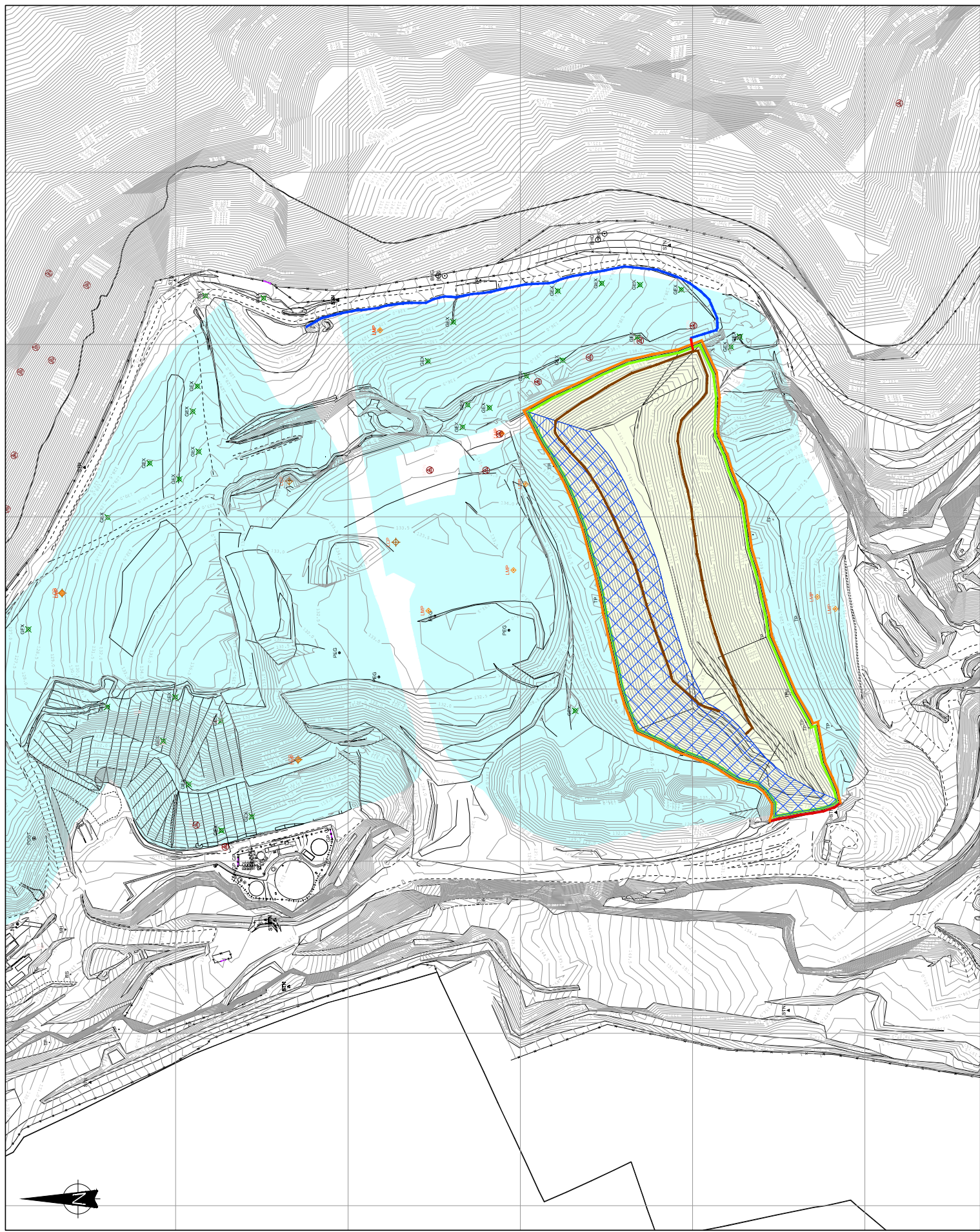
LGG 115 SHEAR BOX TEST CHECK LIST

Client:

LGG 115 SHEAR BOX TEST CHECK LIST

Client:

Questions	Client to Confirm	Guidance
Interface	Site Sampled Geocomposite / Restoration Soils	Interface 1 Vs. interface 2
Shear Box	Yes	Large Shear Box (300 mm * 300 mm), direct shear
Method	LGG 115	BS EN ISO 12957 – 1 and/or LGG 115
Test Frequency	1 (LGG 115 Route E)	Minimum 1 per 10,000 m ² , need multiple to calculate the standard deviation
Normal Stress, Pressure (kPa)	20, 50, 100 kPa	20, 50, 100 kPa 50, 150, 300 kPa
Shearing Rate (mm/min)	1mm/min	Typically, 1 mm/min, clays to be run slower, 0.1 mm/min
Dry Density	To be Determined	To be determined by compaction trial with 2.5 kg rammer
Consolidation	1 hour	For submerged interfaces, 1 hour or 24 hours for soils
Test Saturation	Submerged	Dry, as received or submerged
Sequence of Material in Situ	Geocomposite Restoration Soils	The order of material when put in the ground
Thickness of Soil	100mm	Minimum of 50 mm, typically 100 mm to be ran in the Shear Box
Moisture Content	As received	Tested as received; we can calculate a range of moisture content for each soil
Interfaces Spacing	1mm	Typically, 0.5 – 1 mm
Interface Orientation	Machine Direction	Machine Direction or Cross Direction or both
Photographs	Yes	Before & After tests
Factor of Safety	1.3	Ratio e.g. 1.4
Slope Angle	17.7 degrees	Eg 20 degrees
Category of Soil	Soils to be Characterised	How were the design interface shear parameters obtained, we can characterise the soils
Material ID	Chosen Geocomposite Product (sample taken from site) / Site Derived Restoration Soils	Technical data sheet, date of manufacture, roll number
Category of GCLs and Geocomposites		Yes/No
Are they derived from published sources of generic values for the geosynthetics e.g. NRW report TR1?		No
Are they derived from unpublished generic values for the geosynthetics in the designer's database?		Yes
Are they derived from test values in the particular manufacturer's database for similar geosynthetics?		No
Are they based on test values from previous works on the site for similar geosynthetics from a different manufacturer?		No
Are they based on test values (at least 4 sets) from previous works on the site for the particular geosynthetics from the same manufacturers?		No
Soil Characteristics		Client or Laboratory to Confirm
The particle size distribution (d ₈₅)		Laboratory
The allowable range of the protector density		Laboratory
Cohesion of the soil		Laboratory
Soil conditions		Laboratory
Allowable range of moisture content		Laboratory
Liquid and plastic limits		Laboratory



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NOTES

1. ALL DIMENSIONS IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM.
2. DO NOT SCALE FROM THIS DRAWING.
3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF THE CLIENT PRIOR TO COMMENCEMENT OF CONSTRUCTION WORKS COMMENCING.

KEY

- SITE SURVEY
- PROPOSED CAPPING AREA
- AREA REQUIRING A DECOMPOSITE DRAINAGE LAYER
- EXISTING GEOMEMBRANE CAPPING
- TIE INTO EXISTING SIDEWALL
- TIE INTO EXISTING GEOMEMBRANE
- PROPOSED SURFACE WATER DEFLECTION BUND
- PROPOSED DRAINAGE DITCH
- PROPOSED CULVERT

REV	DESCRIPTION	DATE	BY

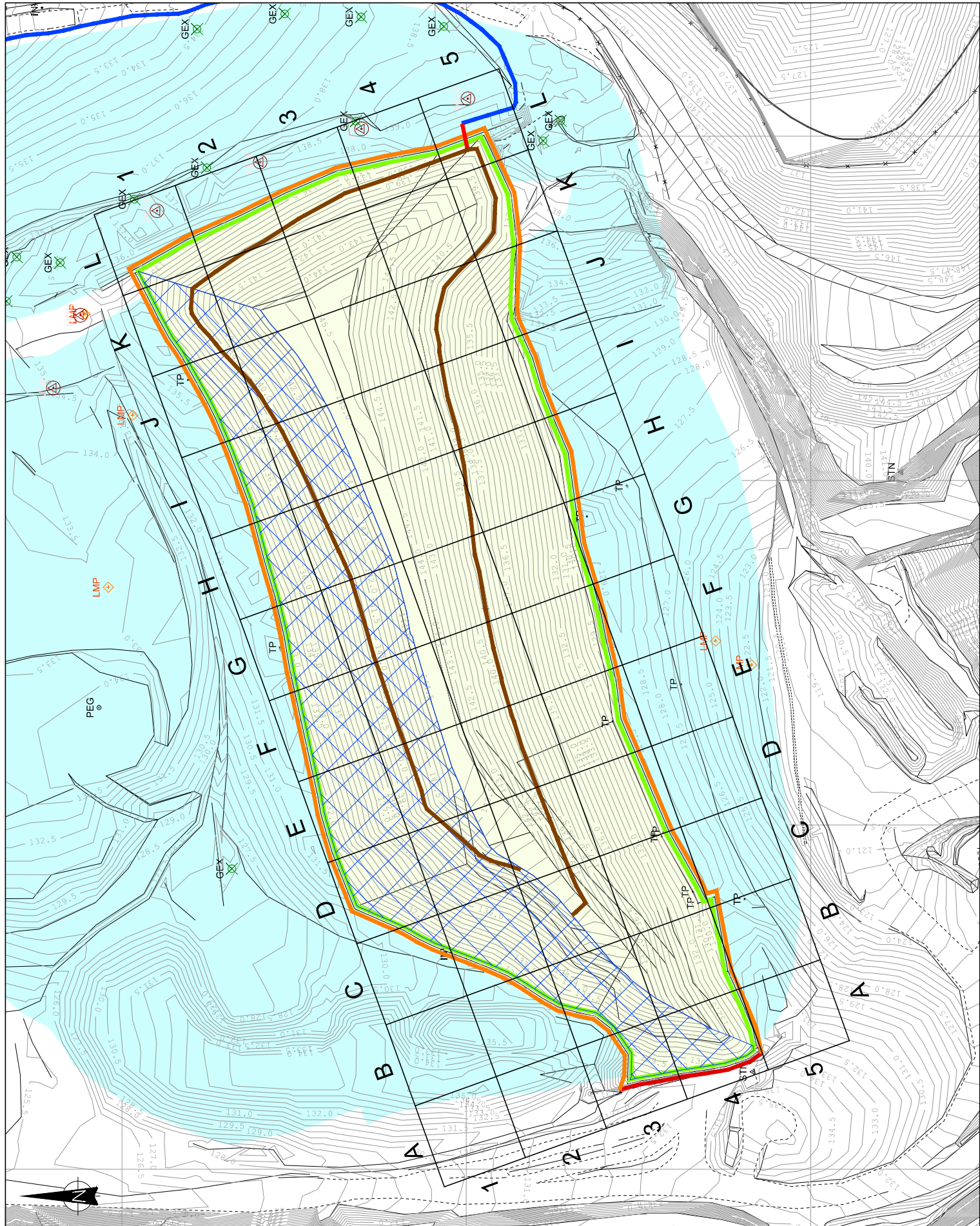


4201 Park Approach, Thompson Park, Llanddulas, LL25 0ES, 01753 545 0800

LLANDDULAS LFS
Remaining Site Capping Works

General Arrangement

PROJECT	DATE	PROJECT	DATE
M/C	26/03/2025	A/K	26/03/2025
SCALE	1:1000	ATL	WR8063/01/01





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- NOTES**
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 3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING ARE TO BE BROUGHT TO THE ATTENTION OF THE CLIENT PRIOR TO CONSTRUCTION WORKS COMMENCING.

- KEY**
- SITE SURVEY
 - PROPOSED CAPPING AREA
 - EXISTING GEOMEMBRANE CAPPING
 - PROPOSED SURFACE WATER DEFLECTION BUND
 - PROPOSED DRAINAGE DITCH
 - PROPOSED CULVERT

REV	DESCRIPTION	DATE	BY



JOB TITLE	
LLANDUDULAS LFS Remaining Site Capping Works	
DRAWING TITLE	
Services Overlay	
PROJECT	DATE
M/C	26/03/2025
DESIGN	A/K
SCALE	1:500
FILE	ATL
REVISION	WR0603/01/04
NUMBER	0