BAILLIE GREENER GRID PARK

DRAINAGE IMPACT ASSESSMENT

STATKRAFT UK LIMITED

NOVEMBER 2021

Prepared by
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Document Control

	Date	Version	Role		Print Name	Signature
Author	29/09/2021	1-0	Senior Hydrologist (Arcus)	BA hons MCIWEM	Reagan Duff	
Check & Review	30/09/2021	1-0	Operational Director (Arcus)	BSc hons, Registered EIA Practitioner	Stuart Davidson	

Revisions

	Date	Version	Role		Print Name	Signature
Author	30/09/2021	1-1	Senior Hydrologist (Arcus)	BA hons MCIWEM	Reagan Duff	
Issued	30/09/2021	1-1	Senior Planning Consultant (Arcus)	MA MSc MRTPI	Martin Gillespie	
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Issued	19/11/2021	2-0	Senior Planning Consultant (Arcus)	MA MSc MRTPI	Martin Gillespie	

1 INTRODUCTION

1.1 Background

This Drainage Impact Assessment ('DIA') has been produced in support of a planning application for the construction of a Greener Grid Park ('the Development') on land within the existing Baillie Wind Farm, southwest of Thurso ('the Site').

The DIA has been prepared by Arcus Consultancy Services Ltd ('Arcus'), on behalf of Statkraft UK LTD ('the Applicant') to satisfy the following requirements:

- Scottish Government, Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems[1];
- Scottish Government, Planning Advice Note 79: Planning Advice Note 79: Water and Drainage[2];
- Scottish Environmental Protection Agency (SEPA), Technical Flood Risk Guidance for Stakeholders[3];
- Scottish Water, Sewers for Scotland 4th Edition[4];
- CIRIA, The SuDS Manual (C753)[5];
- Highland Council ('HC'), Sustainable Design Guide[6]; and
- HC, Flood Risk and Drainage Impact Supplementary Guidance[7].

The Site Layout Plan can be found in Appendix A of this report.

1.2 Site Context

The Site comprises an area of approximately 1.99 hectares (ha) and is located approximately 1 kilometre (km) northeast of Shebster, 3.6 km southeast of Lower Dounreay and 8.6 km southwest of Thurso, centred on National Grid Reference (NGR) of E 302340, N 965060 as shown in Appendix A.

The Site is greenfield within the consented planning application boundary for an existing, operational wind farm.

Ordnance Survey (OS) Terrain 5 data indicates Site elevations are in the range of 101 to 109 metres (m) Above Ordnance Datum ('AOD'), with site topography falling from a high point in the north west to a low point in the south.

Infiltration testing has been carried out at the Site by Blake Geoservices Ltd in August 2021. The test pits indicated that underlying strata comprises rockhead to 1.1m below ground level (bgl), underlain by clay and gravel based sands and siltstone, with some boulders encountered. The infiltration testing technical note and logs can be found in Appendix B.

[1] Scottish Government, Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems (2001). [Online]. Available at: https://www.gov.scot/publications/pan-61-sustainable-urban-drainage-systems/ (Accessed 30/09/2021)

[2] Scottish Government, Planning Advice note 79: Water and Drainage (2006). [Online]. Available at: https://www.gov.scot/publications/planning-advice-note-pan-79-water-drainage/ (Accessed 30/09/2021)
[3] SEPA, Technical Flood Risk Guidance for Stakeholders (2019). [Online]. Available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/ (Accessed 30/09/2021)
[4] Scottish Water, Sewers for Scotland (2018). [Online]. Available at: https://www.scottishwater.co.uk/-/media/ScottishWater/Document-Hub/Business-and-Developers/Connecting-to-our-network/All-connections-information/SewersForScotlandv4.pdf (Accessed 30/09/2021)
[5] CIRIA, The SuDS Manual (C753) (2015). [Online]. Available at: https://www.ciria.org/AsiCommon/Controls/BSA/Downloader.aspx (Accessed 30/09/2021)
[6] Highland Council, Sustainable Design Guide (2013). [Online]. Available at: https://www.highland.gov.uk/download/downloads/id/3019/highland_council_sustainable_design_guide.pdf (Accessed 30/09/2021)
[7]Highland Council, Flood Risk and Drainage Impact supplementary Guidance (2013). [Online]. Available at: https://www.highland.gov.uk/downloads/file/2954/flood_risk_and_drainage_impact_assessment_supplementary_guidance (Accessed 30/09/2021)

1.3 Development Infrastructure

The Site Layout (as shown in Appendix A) will create a total impermeable area of 0.503 ha; detailed further in Table 1.

The proposed access tracks will comprise of permeable materials (e.g., Type 2 aggregate) and will be free draining and are therefore excluded from the total impermeable areas.

Table 1: Proposed Impermeable Areas

Hardstanding Infrastructure	**Total Area of Hardstanding (m^2)**
60 no. battery units (each 12.9m x 2.44m x 2.59m)	1857.6
2 no. synchronous compensators building (each 38.6 x 20.7m x 10.0m envelope)	1598
2 no. water cooler pump skid (each 6.35m x 2.05m x 2.6m)	26
6 no. switchgear containers (each 12.2m x 2.44m 3.0m)	178.6
6 no. inverter units (6.1m x 2.44m x 2.59m)	89.3
1 no. welfare facility (12.9m x 3.45m x 2.59m)	44.5
1 no. SHETL distribution container (12.19m x 3.45m x 2.59m)	44.5
1 no. Statkraft distribution container (12.19m x 3.45m x 2.59m)	44.5
2 no. synchronous compensator HV control and protection (each 12.19m x 3.45m x 2.59m)	89
2 no. LV electrical house (each 12.19m x 3.45m x 2.59m)	89
1 no. synchronous compensator comms house (12.19m x 2.44m x 2.59m)	29.7
1 no. BESS Comms House (12.19m x 2.44m x 2.59m)	29.7
1 no 275kV AIS & transformer (36.8m x 18.6m x 7.05m)	684.5
2 no. 2500kVA 690V transformers (each 4.0m x 4.0m x 2.9m)	16
6 no. 1000kVA 400V BoP auxiliary transformers (each 3.0m x 3.0m x 2.14m	54
2 no. lube oil pump skid (each 2.15 x 1.1m x 1.1m)	4.7
6 no. air blast coolers (each 9.6m x 2.4m x 2.5m)	138.2
1 no. backup diesel generator (5.1m x 2.07m x 1.6m)	10.6
Total Hardstanding (m^2):	**5028.4**
Total Hardstanding (ha):	**0.503**

2 SURFACE WATER DISCHARGE RATES

2.1 Surface Water Discharge Options

In accordance with the SuDS Manual and Sewers for Scotland, an evaluation has been undertaken to determine the most appropriate option to dispose of surface water from the Development.

The Development will be predominantly unoccupied with ad hoc maintenance visits and will therefore have no demand for water reuse onsite.

Infiltration testing has been carried out at the Site in August 2021, with two test pits excavated as detailed in Appendix B. The infiltration test results outline that the underlying strata comprises 'clayey' to 'very clayey' strata underlain by rockhead prohibitive infiltration and as such soakaways at the Site will not be feasible.

Managed discharge to a watercourse will be the most appropriate option to dispose of surface water from the Development accordance with the SuDS Manual and Sewers for Scotland, with information within Table 2 summarising the appropriate discharge method along with rationale.

Table 2: Surface Water Discharge Methods

Disposal route	Feasible?	Reason
Re-use onsite	✘	Site will be unmanned with infrequent maintenance visits, therefore no demand for water re-use.
Infiltrate to ground	✘	Infiltration testing has been carried out at the Site with no positive infiltration rate obtained, as shown in Appendix B.
Discharge to watercourse	✓	In accordance with the drainage hierarchy surface water will be discharged to a nearby watercourse.
Discharge to surface water sewer	✘	Surface water to discharge into nearby watercourse.
Discharge to combined sewer	✘	Surface water to discharge into nearby watercourse.

2.2 Greenfield Run-off Rates

Greenfield runoff rates for the 0.503 ha of impermeable area, outlined in Table 1 and shown in Appendix A, have been calculated using the Interim Code of Practice for SuDS (ICP SuDS) method[8] via Micro Drainage Software with rates shown in Table 3 and Appendix C.

The application of this approach leads to the runoff from the Site to be attenuated and discharged to the greenfield runoff rate of 4 l/s in up to the 200-year return period, with appropriate climate change allowances.

Table 3: Site Runoff Flow Rates (taken from Micro Drainage)

Return Period	Q (l/s)
Q_{BAR}	4.0
1	3.4
30	7.5
100	9.8
200	11.1

2.3 Return Period and Climate Change Allowance

In accordance with Map 1 of SEPA's climate change allowances[9] a 35 % allowance has been incorporated into the drainage design ('+35 % CC').

In accordance with Paragraph 2.7.1.4 of the Suds Manual and Sewers for Scotland 4th Edition, any on site storage attenuation features will be assessed with flooding and

[8] National SuDS Working Group, Interim Code of Practice for Sustainable Drainage Systems (2004). [Online]. Available at: https://www.susdrain.org/files/resources/other-guidance/nswg_icop_for_suds_0704.pdf (Accessed 30/09/2021)
[9] SEPA, Climate Change Allowances for Flood Risk Assessment in Land Use Planning (2019). [Online]. Available at: https://www.sepa.org.uk/media/426913/lups_cc1.pdf (Accessed 30/09/2021)

surcharging prevented in up to a 1:30 (+35 % CC) year event and flooding prevented in up to a 1:200-year (+35 % CC) event.

In accordance with Paragraph 2.6.1 and 2.6.8 of the SuDS Manual and Sewers for Scotland 4th Edition and acknowledging the electrically sensitive nature of the onsite infrastructure, it is required that the Site is assessed in up the 1:200-year (+35% CC) return period run-off volumes.

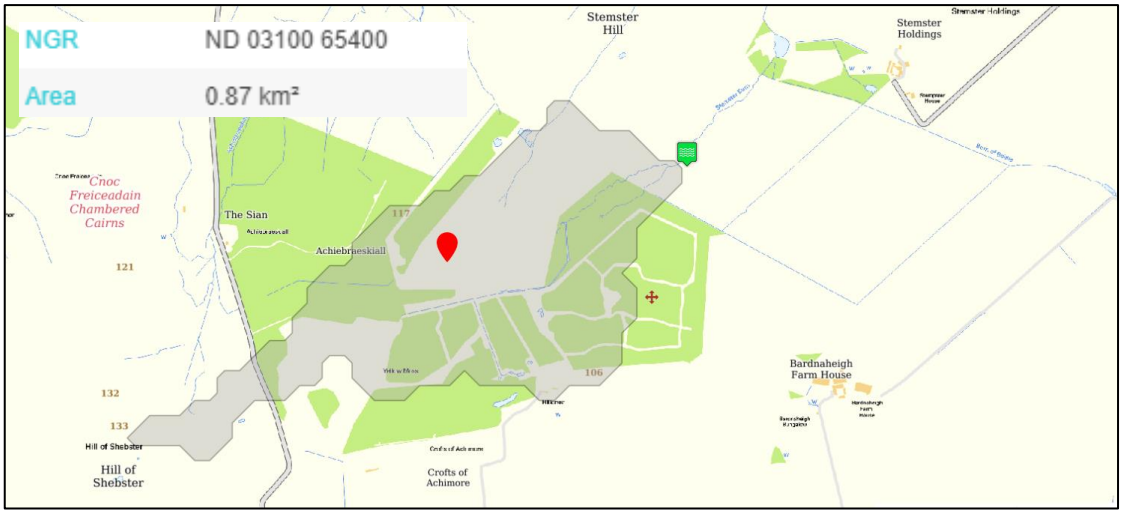
2.4 Discharge to Watercourse

As detailed in Section 2.1 the SuDS hierarchy has been consulted, with discharge to a nearby watercourse deemed the practicable form of drainage at the Site.

OS mapping indicates there is an open land drain located approximately 80 m south of the Site, which is approximately 600 m in length before culverting beneath an access track associated with the existing Wind Farm. The open land drain discharges into Shebster Burn approximately 700 m downstream of the Site, which ultimately discharges into Forss Water.

The UK CEH (FEH) web map[10] indicates that the watercourse is served by a catchment of 0.87 km², as shown in Plate 1.

Plate 1: Receiving Watercourse Catchment Extents



3 SURFACE WATER DRAINAGE DESIGN

The measures outlined in the following Sections will be implemented by the Applicant's Contractor to ensure that greenfield runoff rates are maintained during the construction and operational phases of the Development. Should the drainage measures or locations differ to what is outlined within this document, then the final detailed drainage design will be provided by the Contractor, and submitted to the Council, prior to construction.

3.1 Proposed Surface Water Drainage Scheme

The impermeable areas within the Development will be connected to a attenuation pond to the south of the Site via a piped filter drain system, as shown in Appendix D. The pond will enable surface water to be intercepted in accordance with existing topography and flow routes from north to south.

[10] UK Centre for Ecology and Hydrology, Flood Estimation Handbook. [Online]. Available at: https://fehweb.ceh.ac.uk/GB/map (Accessed 30/09/2021)

The outfall to the open land drain is located within the extents of the existing land ownership and no third party access agreements are required for the route to the discharge point.

The outflow of the pond to the nearest watercourse will be controlled by a Hydro-Brake (or other flow control device) and discharge to the watercourse to the south at 4 l/s.

In order to provide the Site with suitable attenuation of surface water in relation to the storage structure requirements (see Section 2.3) and acknowledging the nature of the Development, the pond will comprise of the approximate dimensions in accordance with the SuDS Manual:

- Base area: 212 m²;
- Total area: 469 m²;
- Depth: 1.0 m; and
- Side slope: 1 in 4.

The 'worst-case' scenario event in up to a 1:200-year (+35 % CC) event is shown in Plate 3, with the designed pond able to attenuate surface water flows without surcharge.

Details of critical events by return period can be found in Appendix E.

Plate 2: Network 1:200-Year (+CC) Critical Storm Event (Taken from Micro Drainage)

Storm Event	Rain (mm/hr)	Time to Vol Peak (mins)	Max Water Level (m)	Max Depth (m)	Flooded Volume (m³)	Max Control (l/s)	Discharge Volume (m³)	Σ Max Outflow (l/s)	Maximum Volume (m³)	Status
720 min Winter	9.298	686	100.999	0.999	0.0	4.0	469.7	4.0	331.4	Flood Risk

The designed pond has a drain down time of less than 48 hours in accordance with Section 6.23 of the HC Flood Risk and Drainage Impact Supplementary Guidance.

In accordance with Section 6.24 of the HC Flood Risk and Drainage Impact Supplementary Guidance long sections and cross sections of the proposed pond are shown in Appendix E.

A layout plan of the proposed surface water network can be found in Appendix D.

3.2 Exceedance Design

Section 6.20 of the HC Flood Risk and Drainage Impact Supplementary Guidance requires that surface water is contained within the Site for the 1:200-year event and exceedance routes are assessed.

As detailed in Section 3.1 the proposed pond will attenuate surface water for the 1:200-year (+35%) event with no overtopping and therefore will not result in exceedance flows and surface water will be managed onsite.

3.3 Water Quality

The Development will involve the construction and operation of a Greener Grid Park involving less than 300 traffic movements per day. Table 26.2 *Pollution hazard indices for different land use classifications* of the SuDS Manual identifies that the Development has a Pollution Hazard Level of Low, taken from the 'Low Traffic Roads e.g. residential roads and general access roads, < 300 traffic movements/day' scenario.

Table 5 outlines that the Development includes land uses which have the following Simple Index Approach (SIA) indices.

Table 5: Pollution Hazard Indices for Land Use Classifications

Land use	Pollution Level Hazard	Total Suspended Solids (TSS)	Metals	Hydrocarbons

Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4

A SIA has been developed on behalf of the Construction Industry Research and Information Association (CIRIA) to support the implementation of the water quality management design methods set out in the SuDS Manual, with appropriate cross referencing to the relevant 'Design Conditions' in the tool.

The Development has been categorised as 'Commercial/Industrial roofing: Low potential for metal leaching' within the SIA tool.

The permeable / porous roads will be sufficient to effectively mitigate any suspended solids, metals and hydrocarbons held within surface water at the Development prior to discharging into the receiving watercourse under expected conditions i.e. in the absence of large hydrocarbon spills.

The SIA outputs appended to this report, and as shown in Table 4, demonstrate that the combined Pollution Mitigation Indices for the run-off area are met by the installation of a pond.

Table 4: SIA outputs for Low Pollution Hazard Level scenario

	Total Suspended Solids	**Metals**	**Hydrocarbons**
Pollution Hazard Indices	0.5	0.4	0.5
Pond or Wetland	0.7	0.7	0.5

The outputs of the SIA tool indicate that the SuDS network has the required treatment potential in relation to the potential pollution hazard of the Development in the absence of significant spillages of hydrocarbons or other pollutants.

3.4 Construction Phase

The nature of hydrological incidents that could result from construction activities will be mitigated through the implementation of construction phase SuDS and the application of industry good practice as per CIRIA Guidance (C741)[11].

To prevent any sediment increase in associated runoff during the construction phase SuDS measures (e.g. spill kits, bunds, drip trays, plant nappies, designated refuelling points, emergency response plans) will effectively prevent sediment entering surrounding watercourses.

The implementation of such construction phase SuDS is to be confirmed with the Council prior to the construction phase.

[11] The Construction Industry Research and information Association (CIRIA), (2015), Environmental Good Practice on Site Guide (C741), CIRIA: London.

4 FOUL WATER DRAINAGE

The Development will be unmanned throughout the operational phase, excluding ad hoc maintenance visits, and will therefore not require a main connected foul water drainage solution.

The onsite welfare facility will have 'porta-loo' facilities which will comprise of waste being stored, managed and carried offsite by a licensed waste management courier.

During the construction phase a temporary a 'porta-loo' facility will be onsite, with waste being stored, managed and carried offsite by a licensed waste management courier.

5 LONG TERM MANAGEMENT AND TIMESCALES

5.1 Long Term Management

It will be the responsibility of the Applicant's Contractor to maintain effective drainage measures and rectify drainage measures that are not functioning adequately. This will be reviewed throughout construction and post-construction. The Contractor will also have responsibility for reporting on the functionality of drainage measures during regular Safety, Health and Environmental Quality meetings.

Where hardstanding areas will remain through the lifetime of the Development, the SuDS measures serving these areas will also remain in place and will be checked on a regular basis by visiting maintenance staff who will follow the proposed management and maintenance programme. Should drainage measures require dredging or unblocking, this will be undertaken as soon as practicable by a local contractor.

Appendix F outlines the management and maintenance programmes for the pond.

5.2 Timescales

Drainage measures outlined within this report should be implemented as soon as practical by the Applicant's Contractor but as a minimum before the construction of any impermeable surfaces which are proposed to drain into the approved drainage system.

Measures such as drainage pipes should be installed at the same time as the excavations, or as soon as practicable thereafter.

6 COMPLIANCE

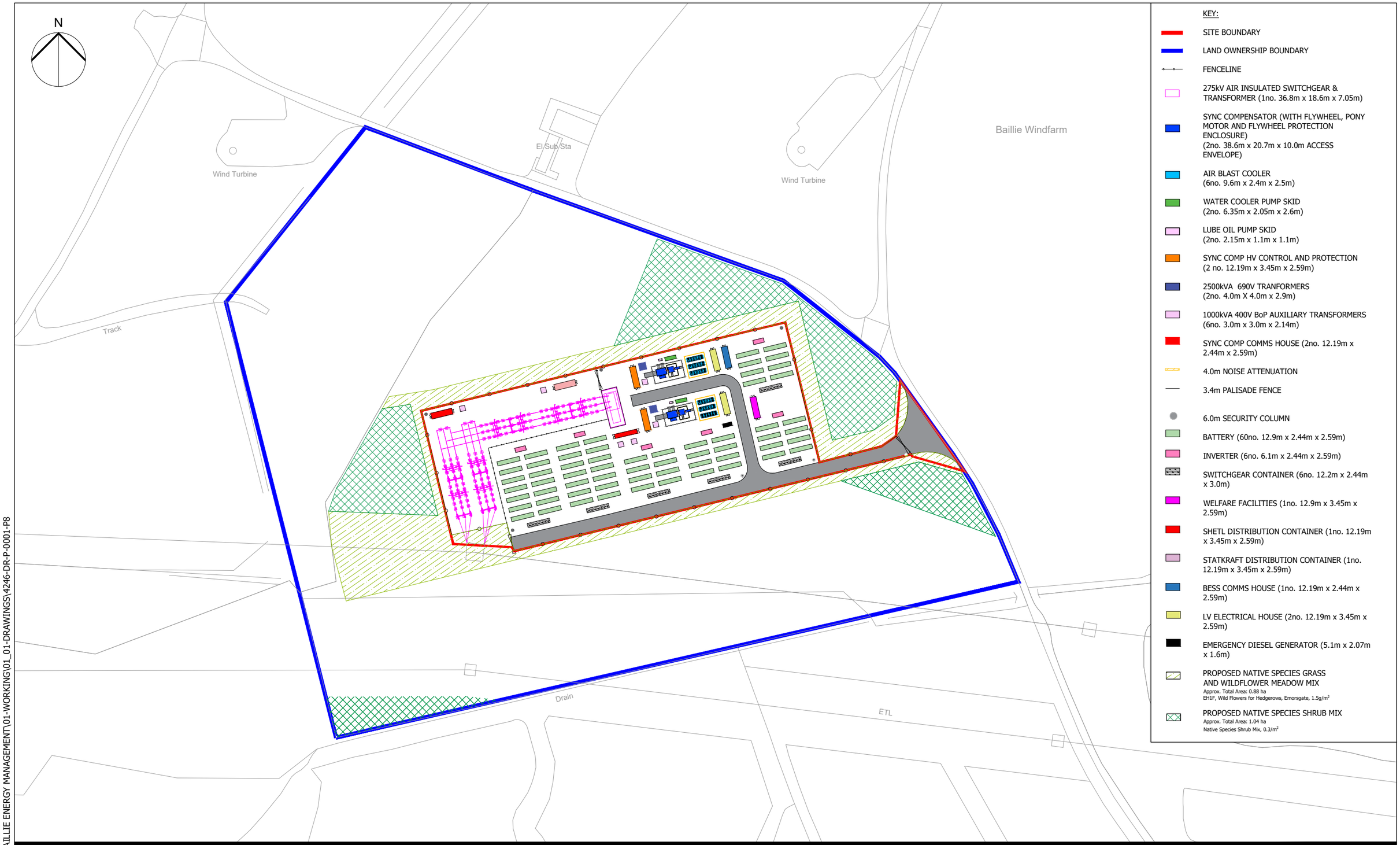
In accordance with Section 7.3 of the HC Flood Risk and Drainage Impact Supplementary Guidance the HC Compliance Certificate has been completed and is available in Appendix G.

7 CONCLUSION

This report provides details on the volume of storage required to attenuate surface water runoff from the construction of the Development.

The proposed pond and associated piped network detailed within this report are shown to not surcharge during a 1:200-year (+35 % CC) event and discharge to the nearest watercourse at a 4 l/s.

APPENDIX A – SITE LAYOUT



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Project Title: BAILLIE GREENER GRID PARK	Drawing Title: PLANNING DRAWING 2 PROPOSED SITE LAYOUT	Purpose of issue: PLANNING	
Client: Statkraft		Designed: KB / Drawn: SR / Checked: KB / Approved: DB	
		Arcus Internal Project No.: 4246	Date: 10/09/21
		Scale @ A3: 1:500	

Drawing Number: 4246-DR-P-0001 | Rev: 8

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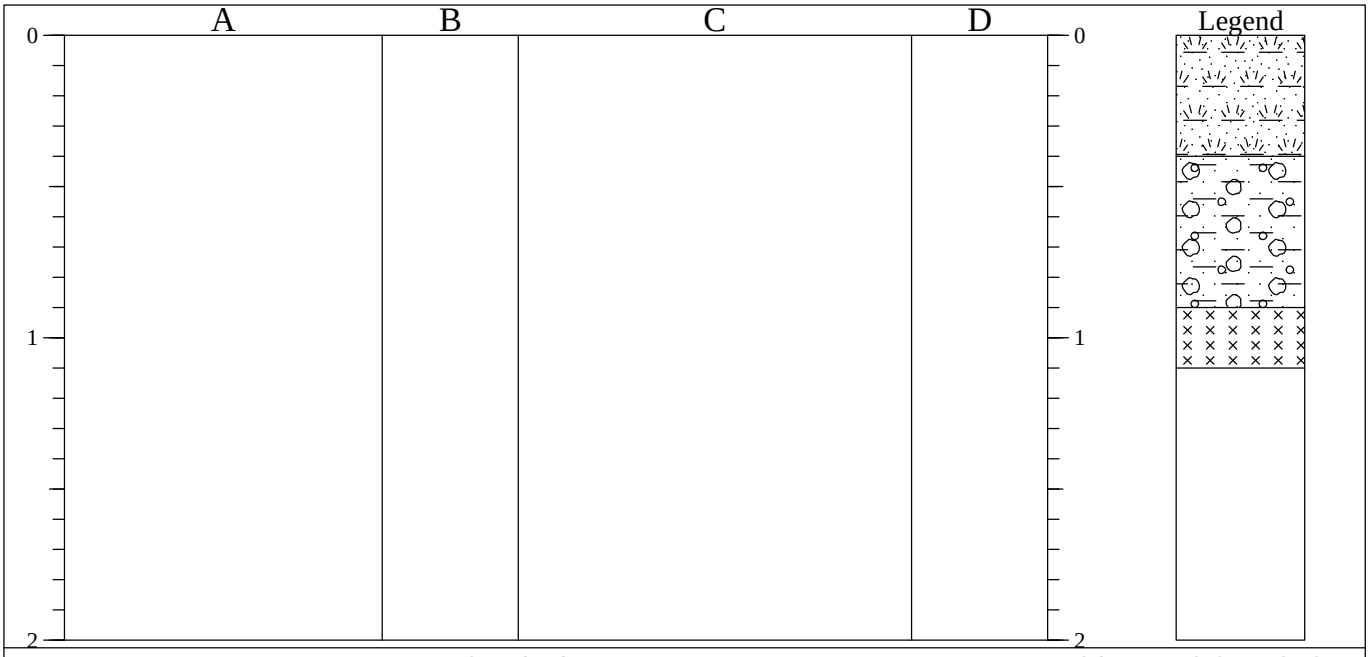
ARCUS

APPENDIX B – INFILTRATION TESTING TECHNICAL NOTE

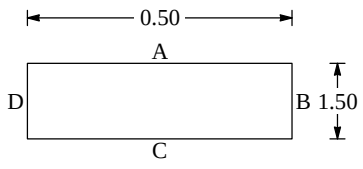
TRIAL PIT LOG

Project				TRIAL PIT No
Baillie Windfarm, Shebster, Caithness				1
Job No	Date	Ground Level (m)	Co-Ordinates ()	
21124-01	30-08-21			
Contractor				Sheet
Blake Geoservices Ltd - www.blake-geoservices.co.uk -				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.40		Brown TOPSOIL			
0.40-0.90		Brown and grey mottled, clayey, very gravelly, SAND with frequent angular, flat, cobbles of brown siltstone, gravel is medium, flat, angular of siltstone, sand is fine.			
0.90-1.10		Grey weathered brown, fissile, SILTSTONE.			

Shoring/Support: N/A
Stability: Stable to base



GENERAL REMARKS

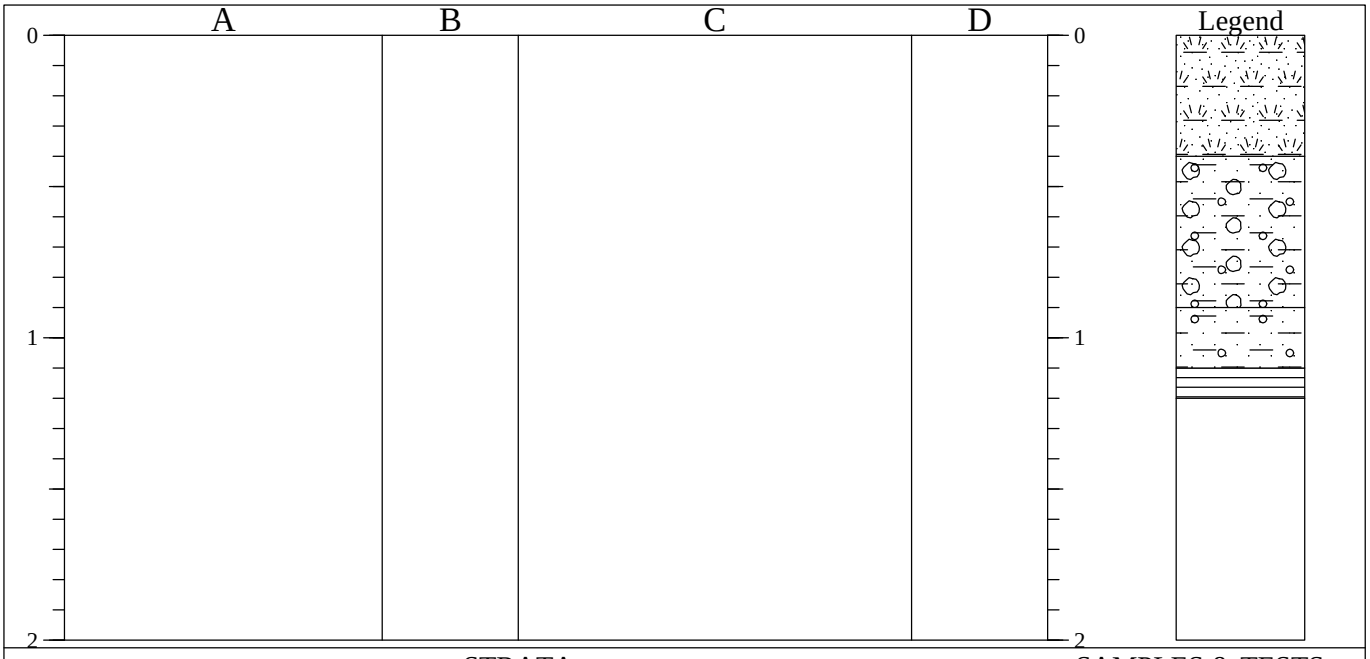
Borehole terminated upon competent rockhead. No groundwater ingress noted.

All dimensions in metres Scale 1:25	Client Mason Evans	Method/ Plant Used 2.5t Tracked 360	Logged By CLB

AGS3 UK TP 21124 SHEBSTER.GPJ AGS 3_1.GDT 3/9/21

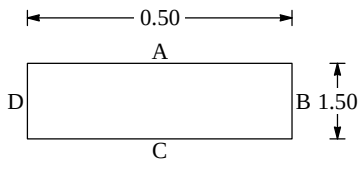
TRIAL PIT LOG

Project				TRIAL PIT No
Baillie Windfarm, Shebster, Caithness				2
Job No	Date	Ground Level (m)	Co-Ordinates ()	
21124-01	30-08-21			
Contractor				Sheet
Blake Geoservices Ltd - www.blake-geoservices.co.uk -				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.40		Brown TOPSOIL			
0.40-0.90		Brown and grey mottled, clayey, very gravelly, SAND with frequent angular, flat, cobbles & boulders of grey mudstone, gravel is medium, flat, angular of mudstone, sand is fine.			
0.90-1.10		Grey, clayey, very gravelly, SAND with occasional angular, flat, cobbles of grey mudstone, gravel is medium, flat, angular of mudstone, sand is fine.			
1.10-1.20		Grey, fissile, MUDSTONE.			

Shoring/Support: N/A
Stability: Stable to base



GENERAL REMARKS

Borehole terminated upon competent rockhead. Slow groundwater ingress noted at 1.10mbgl.

All dimensions in metres Scale 1:25	Client Mason Evans	Method/ Plant Used 2.5t Tracked 360	Logged By CLB

AGS3 UK TP 21124 SHEBSTER.GPJ AGS 3_1.GDT 3/9/21

BLAKE GEOSERVICES LTD
SITE INVESTIGATION CONTRACTORS

Geotechnical Results

Infiltration Test with guidance from BRE Special Digest 365*

Site Baillie Windfarm, Shebster, Caithness
Date 30/08/2021
Location TP1

Length (m) 1.50 **Width (m)** 0.50
Depth (m) 1.10 **Pit filled to (mbgl)** 0.60

Level (mbgl)		Time (min)
0.60		0
		0.5
		1
		1.5
		2
		3
		4
		5
		6
		7
		8
		9
0.60		10
		15
0.60		20
		25

Level (mbgl)		Time (min)
0.60		30
		40
		50
0.60		60
		80
0.60		90
0.60		120
		140
0.60		150
		180
Abandoned - no fall		210
		240
		270
		300

Calculated "f" value (m/s): $<1.0 \times 10^{-8}$

Note:

* These tests were undertaken with guidance from BRE Digest 365 as far as practically possible to allow an indication of f values to be considered for design purposes, often site conditions or safety measures prevent the full guidance of said document to be strictly followed. No pits are left open overnight with water or otherwise. Excavation to depth often proves difficult, as does complete discharge.

BLAKE GEOSERVICES LTD
SITE INVESTIGATION CONTRACTORS

Geotechnical Results

Infiltration Test with guidance from BRE Special Digest 365*

Site Baillie Windfarm, Shebster, Caithness
Date 30/08/2021
Location TP2

Length (m) 1.50 **Width (m)** 0.50
Depth (m) 1.20 **Pit filled to (mbgl)** 0.70

Level (mbgl)		Time (min)
0.70		0
		0.5
		1
		1.5
		2
		3
		4
		5
		6
		7
		8
		9
0.70		10
		15
0.70		20
		25

Level (mbgl)		Time (min)
0.70		30
		40
		50
0.70		60
		80
0.70		90
0.70		120
		140
0.70		150
		180
Abandoned - no fall		210
		240
		270
		300

Calculated "f" value (m/s): $<1.0 \times 10^{-8}$

Note:

* These tests were undertaken with guidance from BRE Digest 365 as far as practically possible to allow an indication of f values to be considered for design purposes, often site conditions or safety measures prevent the full guidance of said document to be strictly followed. No pits are left open overnight with water or otherwise. Excavation to depth often proves difficult, as does complete discharge.

APPENDIX C – ICP RURAL RUNOFF RATES

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.500
Area (ha)	0.503	Urban	0.000
SAAR (mm)	949	Region Number	Region 1

Results l/s

QBAR Rural	4.0
QBAR Urban	4.0
Q200 years	11.1
Q1 year	3.4
Q30 years	7.5
Q100 years	9.8

APPENDIX D – OUTLINE DRAINAGE LAYOUT

N

KEY

PROPOSED FILTER DRAIN

PROPOSED OUTLET PIPE

PROPOSED ATTENUATION POND

PROPOSED INSPECTION CHAMBER

PROPOSED FLOW CONTROL DEVICE

FLOW CONTROL DEVICE
THROTTLED TO 4 L/S

Drain

0 25 50 75 100 125m

SCALE 1:1250

Project Title: BAILLIE ENERGY MANAGEMENT	Drawing Title: OUTLINE DRAINAGE STRATEGY	Purpose of issue: FOR PLANNING			
Client: Statkraft		Designed: RD	Drawn: AdT	Checked: RD	Approved: RD
		Arcus Internal Project No.: 4246		Date: 23/11/2021	
		Scale @ A3: 1:1250			

Drawing Number: 4246-DR-HYDR-0001

Rev: -

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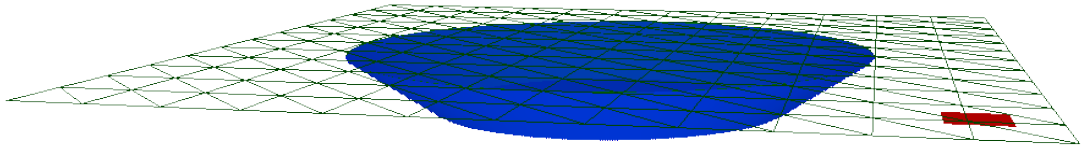
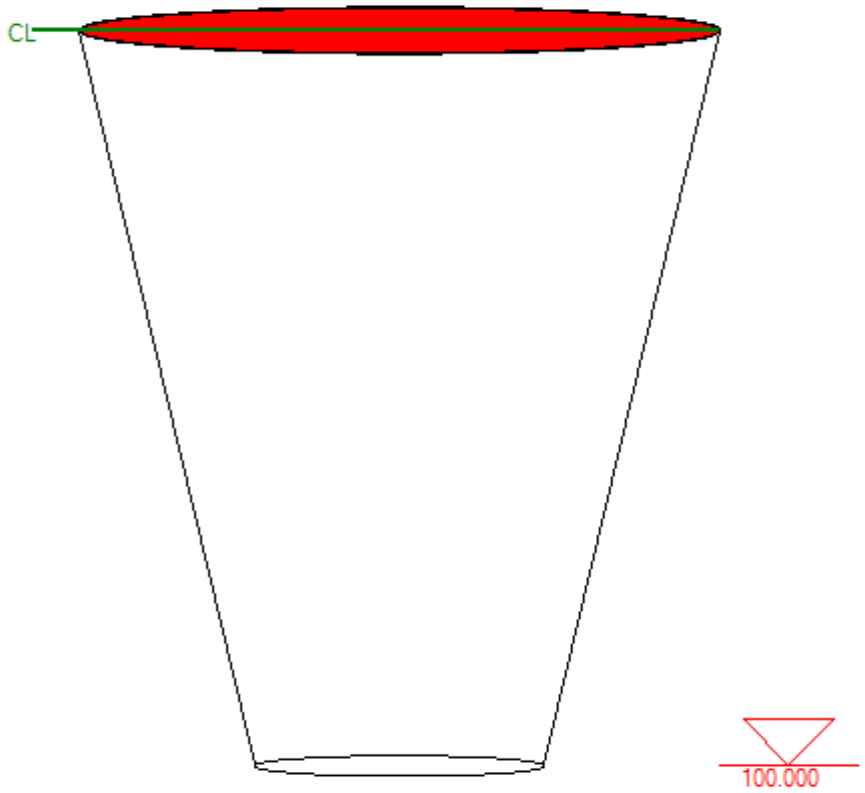
ARCUS

APPENDIX E – MICRODRAINAGE MODEL OUTPUTS





Invert Level of Structure (m): 100.000

Summary of Results for 200 year Return Period (+35%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	100.439	0.439	4.0	114.3	O K
30 min Summer	100.525	0.525	4.0	142.2	O K
60 min Summer	100.620	0.620	4.0	175.2	O K
120 min Summer	100.719	0.719	4.0	212.2	Flood Risk
180 min Summer	100.775	0.775	4.0	234.1	Flood Risk
240 min Summer	100.811	0.811	4.0	248.9	Flood Risk
360 min Summer	100.855	0.855	4.0	267.1	Flood Risk
480 min Summer	100.877	0.877	4.0	276.7	Flood Risk
600 min Summer	100.888	0.888	4.0	281.3	Flood Risk
720 min Summer	100.894	0.894	4.0	284.1	Flood Risk
960 min Summer	100.890	0.890	4.0	282.1	Flood Risk
1440 min Summer	100.873	0.873	4.0	275.0	Flood Risk
2160 min Summer	100.841	0.841	4.0	261.2	Flood Risk
2880 min Summer	100.804	0.804	4.0	245.9	Flood Risk
4320 min Summer	100.685	0.685	4.0	199.1	O K
5760 min Summer	100.540	0.540	4.0	147.4	O K
7200 min Summer	100.418	0.418	4.0	108.0	O K
8640 min Summer	100.322	0.322	4.0	79.6	O K
10080 min Summer	100.249	0.249	4.0	59.4	O K
15 min Winter	100.483	0.483	4.0	128.5	O K
30 min Winter	100.578	0.578	4.0	160.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	125.761	0.0	117.3	26
30 min Summer	78.888	0.0	147.3	40
60 min Summer	49.485	0.0	186.1	70
120 min Summer	31.042	0.0	233.5	128
180 min Summer	23.630	0.0	266.7	186
240 min Summer	19.472	0.0	293.0	246
360 min Summer	14.823	0.0	334.5	364
480 min Summer	12.214	0.0	367.5	482
600 min Summer	10.512	0.0	395.3	578
720 min Summer	9.298	0.0	419.5	628
960 min Summer	7.561	0.0	454.6	760
1440 min Summer	5.650	0.0	508.3	1024
2160 min Summer	4.221	0.0	572.8	1448
2880 min Summer	3.433	0.0	621.0	1852
4320 min Summer	2.476	0.0	671.6	2684
5760 min Summer	1.964	0.0	710.9	3408
7200 min Summer	1.640	0.0	742.4	4104
8640 min Summer	1.416	0.0	769.0	4752
10080 min Summer	1.251	0.0	792.0	5360
15 min Winter	125.761	0.0	131.4	26
30 min Winter	78.888	0.0	165.0	40

Summary of Results for 200 year Return Period (+35%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	100.681	0.681	4.0	197.6	O K
120 min Winter	100.790	0.790	4.0	240.0	Flood Risk
180 min Winter	100.852	0.852	4.0	265.7	Flood Risk
240 min Winter	100.893	0.893	4.0	283.6	Flood Risk
360 min Winter	100.945	0.945	4.0	306.6	Flood Risk
480 min Winter	100.974	0.974	4.0	319.8	Flood Risk
600 min Winter	100.990	0.990	4.0	327.5	Flood Risk
720 min Winter	100.999	0.999	4.0	331.4	Flood Risk
960 min Winter	100.990	0.990	4.0	327.3	Flood Risk
1440 min Winter	100.968	0.968	4.0	317.3	Flood Risk
2160 min Winter	100.919	0.919	4.0	294.9	Flood Risk
2880 min Winter	100.860	0.860	4.0	269.4	Flood Risk
4320 min Winter	100.682	0.682	4.0	197.9	O K
5760 min Winter	100.452	0.452	4.0	118.5	O K
7200 min Winter	100.287	0.287	4.0	69.7	O K
8640 min Winter	100.186	0.186	3.9	43.1	O K
10080 min Winter	100.131	0.131	3.6	29.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	49.485	0.0	208.4	68
120 min Winter	31.042	0.0	261.5	126
180 min Winter	23.630	0.0	298.7	184
240 min Winter	19.472	0.0	328.2	240
360 min Winter	14.823	0.0	374.7	356
480 min Winter	12.214	0.0	411.6	468
600 min Winter	10.512	0.0	442.6	578
720 min Winter	9.298	0.0	469.7	686
960 min Winter	7.561	0.0	508.8	806
1440 min Winter	5.650	0.0	566.9	1098
2160 min Winter	4.221	0.0	641.6	1564
2880 min Winter	3.433	0.0	695.6	2020
4320 min Winter	2.476	0.0	752.3	2900
5760 min Winter	1.964	0.0	796.3	3568
7200 min Winter	1.640	0.0	831.5	4120
8640 min Winter	1.416	0.0	861.3	4752
10080 min Winter	1.251	0.0	887.2	5336

Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
Site Location	GB 302700 965000 ND 02700 65000
C (1km)	-0.023
D1 (1km)	0.449
D2 (1km)	0.403
D3 (1km)	0.316
E (1km)	0.269
F (1km)	2.177
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+35

Time Area Diagram

Total Area (ha) 0.503

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.168	4	8	0.168	8	12	0.168

Model Details

Storage is Online Cover Level (m) 101.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	212.0	1.000	468.7

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0095-4000-1000-4000
Design Head (m)	1.000
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	95
Invert Level (m)	100.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	4.0
Flush-Flo™	0.294	4.0
Kick-Flo®	0.629	3.2
Mean Flow over Head Range	-	3.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.3	3.000	6.7	7.000	10.0
0.200	3.9	1.400	4.7	3.500	7.2	7.500	10.3
0.300	4.0	1.600	5.0	4.000	7.6	8.000	10.6
0.400	3.9	1.800	5.3	4.500	8.1	8.500	10.9
0.500	3.8	2.000	5.5	5.000	8.5	9.000	11.2
0.600	3.4	2.200	5.8	5.500	8.9	9.500	11.5
0.800	3.6	2.400	6.0	6.000	9.3		
1.000	4.0	2.600	6.2	6.500	9.6		

APPENDIX F – POND MAINTENANCE SCHEDULE

Long-term Maintenance Schedule for the Attenuation Pond[1]

Maintenance schedule	**Required action**	**Typical frequency**
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass (in public areas)	Monthly (during growing season)
	Cut meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants for first 3 years	Monthly (as start, then as required)
	Inspect inlets, outlets, bankside, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	(Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing on some build up has occurred, to inform management and disposal options	Half yearly
	Checky any mechanical devices (e.g., penstocks)	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1 m above water level	Annually
	Tidy all dead growth (Scrub clearance) before start of growing season (Note: tree maintenance usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay	Every 1-5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays	Every 5 years, or as required
Occasional Maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, e.g., every 25-50 years
Remedial actions	Repair erosion or other damage	As required
	Replate where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair/rehabilitate inlets, outlet, overflows and vents	As required

[1] Based on Table 23.1 - Operation and maintenance requirements for attenuation pond and wetlands of the SuDS Manual

Long-term Maintenance Schedule for the Attenuation Pond[1]

Maintenance schedule	**Required action**	**Typical frequency**
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass (in public areas)	Monthly (during growing season)
	Cut meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants for first 3 years	Monthly (as start, then as required)
	Inspect inlets, outlets, bankside, structures, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	(Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing on some build up has occurred, to inform management and disposal options	Half yearly
	Checky any mechanical devices (e.g., penstocks)	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1 m above pond base; include max 25% of pond surface)	Annually
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Occasional Maintenance	Remove sediment from the main body of big ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, e.g., every 25-50 years
Remedial actions	Repair erosion or other damage	As required
	Replate where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair/rehabilitate inlets, outlet, overflows and vents	As required

[1] Based on Table 23.1 - Operation and maintenance requirements for attenuation pond and wetlands of the SuDS Manual

APPENDIX G – HIGHLAND COUNCIL ASSESSMENT COMPLIANCE CERTIFICATION

APPENDIX C: SELF CERTIFICATION (overleaf)

The Highland Council / Comhairle na Gàidhealtachd	FRA and DIA Guidance Assessment Compliance Certificate

I certify that all reasonable skill, care and attention to be expected of a qualified and experienced professional in this field have been exercised in carrying out the attached Assessment. I also confirm that I maintain the required Professional Indemnity Insurance*. The report has been prepared in support of the below named development in accordance with the reporting requirements issued by The Highland Council.

Please select Assessment type:

Flood Risk Assessment ☐ Drainage Impact Assessment ☐

Additional Information

Assessment Ref No: Assessment Revision:

Assessment Date: Planning Application No:

Name of Development:

Address of Development:

Name of Developer:

Name and Address of Organisation preparing this Assessment:

Name of Approver: Date:

Signed:

Position Held:

Qualification of person responsible for signing off this Assessment**

* Please attach appropriate evidence of Professional Indemnity Insurance

** A chartered member of a relevant professional institution