GREENER GRID PARK

LAND OFF GLENIFFER ROAD, PAISLEY

APPENDIX 2: OUTLINE SUSTAINABLE DRAINAGE STRATEGY

JANUARY 2021

Prepared by
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TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

Statkraft UK Ltd. ('the Applicant') are proposing the installation of a Greener Grid Park facility ('the Development') on greenfield land off Gleniffer Road, Neilston ('the Site').

Arcus Consultancy Services Ltd ('Arcus') has been commissioned by the Applicant to undertake an Outline Sustainable Drainage Strategy ('OSDS') in relation to the Development 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];
- Renfrewshire Council, Drainage Assessment: Notes for Guidance[6]; and

A detailed Site layout is provided in Annex A.

1.2 Site Context

The approximately 14-hectare (ha) Site is located approximately 400 metres (m) northwest of Sergeantlaw, off Gleniffer Road, Paisley; and opposite of the existing Neilston substation at National Grid Reference (NGR) E 245079, N 659842, as shown in Plate 1.

A topographic survey has been conducted at the Site, which indicates that Site elevations range from approximately 192 to 215 m Above Ordnance Datum (m AOD), with general Site topography falling from the south east to north west.

[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/.

[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/

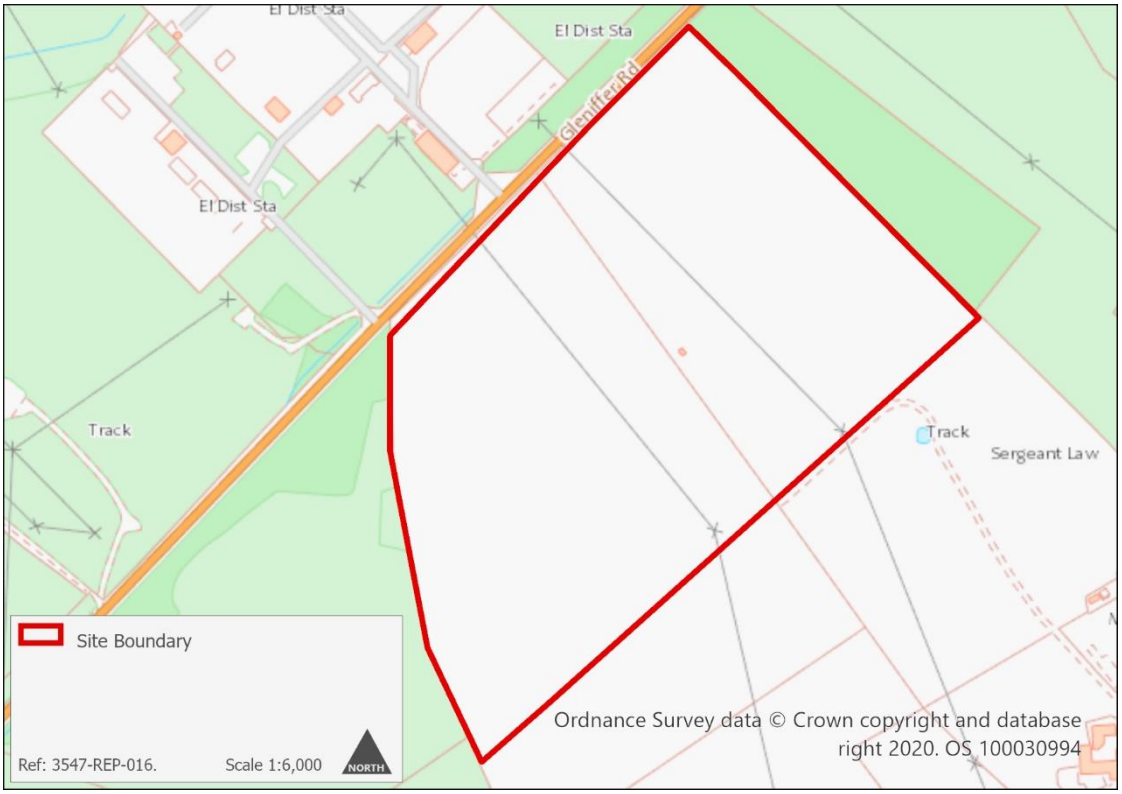
[3] SEPA, Technical Flood Risk Guidance for Stakeholders (2019). [Online]. Available at: https://www.sepa.org.uk/environment/land/planning/guidance-and-advice-notes/

[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

[5] CIRIA, The SuDS Manual (C753) (2015). [Online]. Available at: https://www.ciria.org/AsiCommon/Controls/BSA/Downloader.aspx

[6] Renfrewshire Council, Drainage Assessment: Notes for Guidance. [Online]. Available at: http://www.renfrewshire.gov.uk/media/1097/Drainage-assessment-guidance/pdf/Drainage_assessment_guidance.pdf?m=1455808042243

Plate 1: Site Location



This OSDS aims to model the required surface water attenuation volume from the proposed hardstanding area and provide an outline drainage design to ensure that surface water at the Development can be appropriately drained.

1.3 Development Infrastructure

The detailed design of the Development indicates hardstanding areas will accumulate to approximately 0.84 hectares (ha), as detailed further in Table 1.

Table 1: Proposed Impermeable Areas

Development Unit	**Number of Units**	**Per Unit Area (m^2)**	**Accumulative Units Area (m^2)**
Switchgear Container	35	31	1085
Transformers with 7 m Bus Bars	14	73.7	1031.8
LV Switch House	7	68.25	478.1
Firewall	7	23.4	163.8
Emergency Backup Diesel Generator	7	22	154
Communications House	7	29.7	207.9
Cooler	28	27.1	758.8
Disconnector	8	9.9	79.2
Additional Building	6	12.2	73.2
Tarmacked Junction	1	181.6	181.6
Total Impermeable Area (m^2)	9531		
Total Impermeable Area (ha)	0.95		

The proposed battery and transformer units will be accommodated within container units which will be raised via plinths, with example units shown in Plate 2. Such containers and transformer units are therefore not considered to contribute towards the impermeable footprint of the Development, as the ground under the containers will remain unchanged from the baseline scenario or underlain by permeable aggregate.

Plate 2: Raised Battery Storage Units [7, 8]

[7] Philip Dennis Wholesaler Offices Battery Storage, Barnstaple (2018). [Online]. Available at: https://www.solarpowerportal.co.uk/news/tesla_and_anesco_batteries_combine_for_4mw_energy_storage_installs_at_food

[8] Battery Storage Facility, Creyke Beck, Cottingham (2020). [Online]. Available at: https://network6.org.uk/featured/green-light-for-2-5-acre-battery-energy-storage-facility/

As such, this OSDS aims to model the required surface water attenuation volume from the hardstanding area and provide an outline drainage design to ensure that the Development can be appropriately drained.

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

The proposed junction onto Gleniffer Road will comprise of asphalt hardstanding and, as such, is deemed impermeable.

1.4 BRE 365 Testing

Infiltration testing to BRE 365 standard has been carried out at the Site by Mason Evans Ltd on behalf of Arcus in August 2020, with two soakaway test pits utilised in areas of low elevations to the north (SA01) and south (SO02) of the Site.

SA01 identified medium dense clayey sand and gravel to depths of 0.45 m below ground level (m bgl), with superficial deposits comprising slightly clayey sandy fine to coarse gravel to depths of 0.7 m bgl, with weathered basalt bedrock at the base of the test pit.

SA02 identified topsoil to 1 m bgl, with the base of the trial pit comprising of soft to firm very sandy and gravel heavy clay.

SA01 produced satisfactory infiltration results, with an infiltration rate of 0.00000615 m/s (0.2214 m/hour).

SA02 did not provide any infiltration results and as such it is considered infiltration in this area of the Site is unfeasible.

The infiltration capacity of each test pit location correlates with the contrasting geology at the Site, with British Geological Survey (BGS) Geology records[9] indicating the northern areas of the Site comprise of Sargeantlaw basaltic bedrock and with southern areas comprising of Gleniffer basaltic bedrock.

Further details and results related to the BRE 365 infiltration testing conducted can be found in Annex B.

2 DRAINAGE DESIGN PARAMETERS

2.1 Greenfield Run-off rates

The existing surface water run-off rates (greenfield rate) in areas of the Site which will comprise of the development are outlined in order to inform the required storage volumes to be implemented at the Development and is based on the proposed hardstanding areas outlined in Table 1.

Calculations for the greenfield run-off rates were derived using the Flood Estimation Handbook (FEH) rainfall data and ICP SuDS method using Micro Drainage software, with a QBar rate of 136.4 l/s calculated, as shown in Annex C of this report.

Greenfield rates have been calculated for reference only, as the proposed SuDS structure will have no positive discharge and therefore Q_{BAR} has not been used in the sizing of the SuDS structures.

[9] British Geological Survey, Geology of Britain Viewer. [Online]. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html?

2.2 Hierarchical Drainage Options

In accordance with the SuDS Manual and Sewers for Scotland the information within Table 2 outlines the most appropriate option to dispose of surface water from the Development along with the rationale.

As per Table 2, the surface water drainage network serving the Development will discharge of flows via infiltration.

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	✓	BRE365 infiltration testing indicates that infiltration is practicable.
Discharge to watercourse	×	Infiltration is deemed practicable.
Discharge to surface water sewer	×	Infiltration is deemed practicable.
Discharge to combined sewer	×	Infiltration is deemed practicable.

2.3 Required Storage Volume

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 return period.

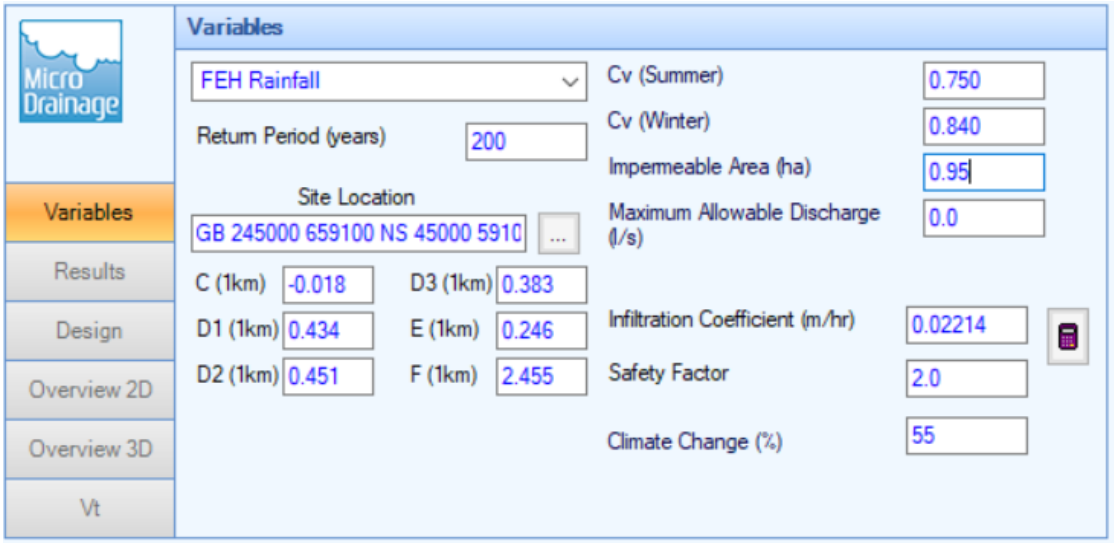
A 55 % increase in the rainfall during these events has been included ('+55 %') to account for the potential effects of climate change over the operational life of the Development, in accordance with SEPA Climate Change Allowances[10].

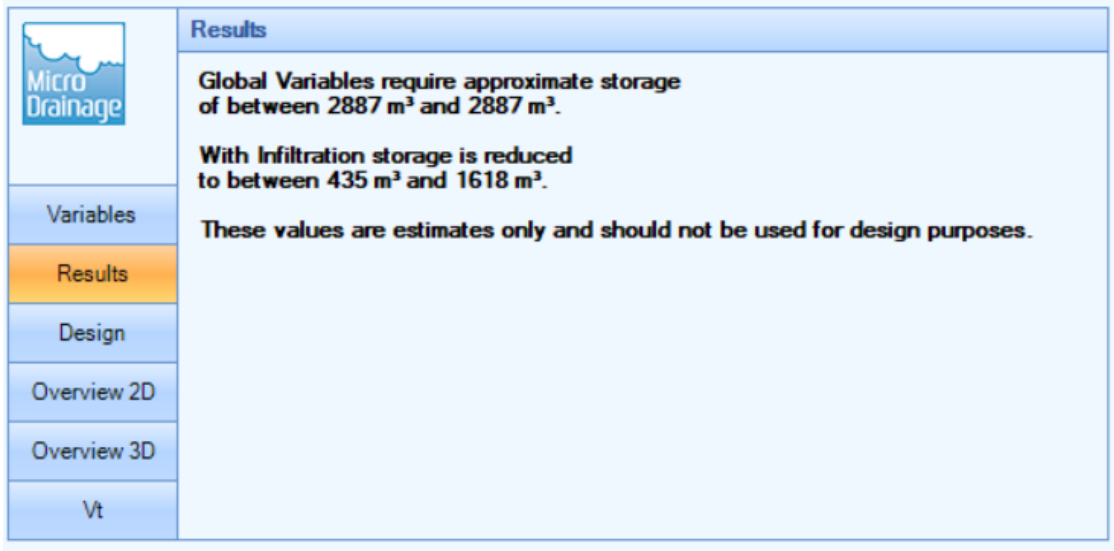
Therefore, the temporary storage required to hold the increase in run-off from the Site is shown below in Plate 3 for the 1:200-year (+55 % CC) event as calculated using Micro Drainage software.

The overall storage volume required to attenuate surface water flows for the 1:200-year (+55 %) event are shown in Plate 3, based on the areas of hardstanding outlined in Table 1.

[10] SEPA, Climate Change Allowances for Flood Risk Assessments in Land Use Planning (2019). [Online]. Available at: https://www.sepa.org.uk/media/426913/lups_cc1.pdf

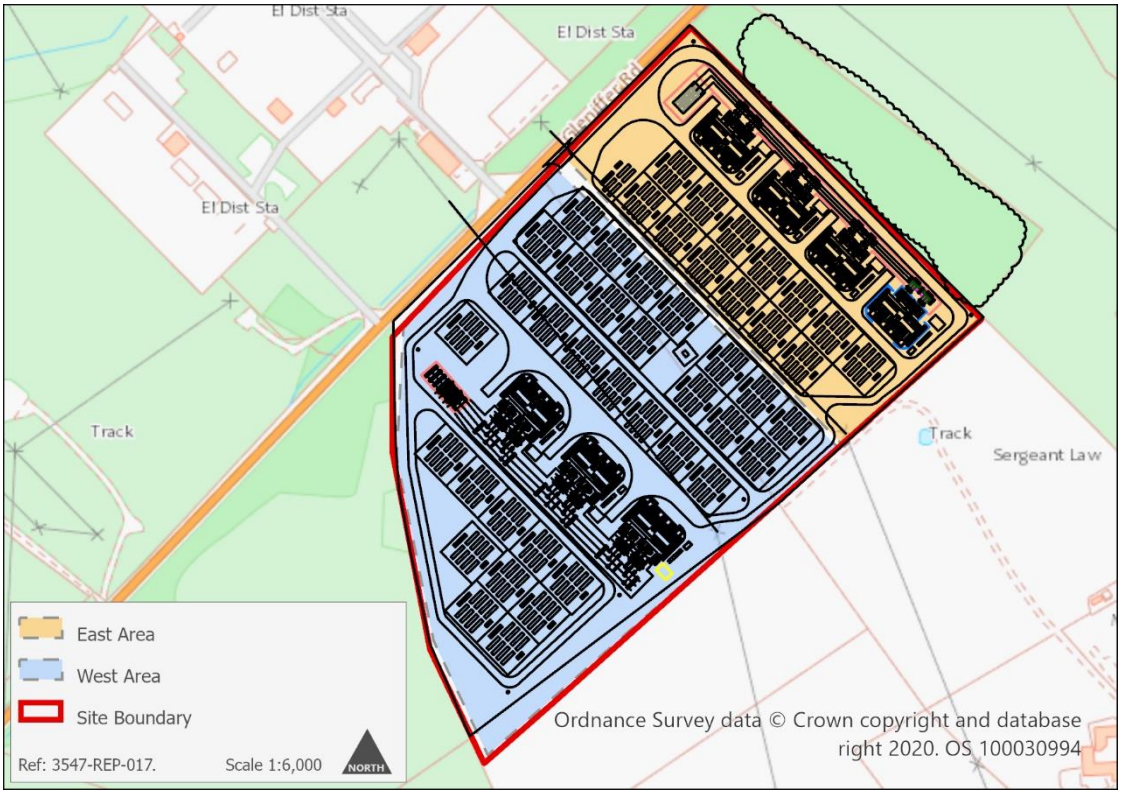
Plate 3: Calculated required storage volumes for 200-year return period (+55%) (m3) (taken from Micro Drainage)





In order to enable the proposed surface water network to serve the entirety of the Site, the Site will be divided into an east and west catchment, comprising 0.51 ha and 0.44 ha of impermeable areas respectively. The proposed eastern and western areas are shown below in Plate 4.

Plate 4: Areas Served by Surface Water Drainage Network



As such the required storage volume across the two areas considering the impermeable infrastructure within the Development and a 55 % climate change allowance is in the range of 435 to 1618 m^3.

SuDS measures are outlined within Section 3 of this report.

3 OUTLINE DRAINAGE STRATEGY

3.1 SuDS Measures

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

The Developer's Contractor will adhere to the following guidance:

- DEFRA: Sustainable Drainage Systems - Non-statutory technical standards for sustainable drainage systems (2015);
- The Construction Industry Research and Information Association (CIRIA), Environmental Good Practice on Site (C741) (2015);
- CIRIA, The SuDS Manual (2015); and
- CIRIA, Control of Water Pollution from Construction Sites (C532) (2001).

The eastern area of the Site will utilise an infiltration basin to the east of the Site to serve the 0.51 ha of impermeable area, as shown in Annex A.

The western area of the Site will utilise cellular storage crates to the north west of the Site to serve the 0.44 ha of impermeable area, as shown in Annex A.

The proposed features will be served by filter drains to be located alongside the proposed onsite tracks in order to convey surface water flows to the features.

In accordance with Building Regulations[11] the attenuation and infiltration features will be located 5 m from any public road or building and 2.5 m from any boundary line.

3.1.1 Eastern Area

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 infiltration basin will comprise of the approximate dimensions in accordance with the SuDS Manual:

- Area of 798 m²;
- Base area of 390 m²;
- Maximum depth of 1.2 m; and
- Side slope ratio of 1:4.

As the aforementioned infiltration test pits did not strike groundwater, it is considered that during periods of high-water table the proposed feature will not be impacted by groundwater fluctuations.

In order to enhance the ecological benefit of the infiltration basin feature and slow the flows across the feature, native wildflower and grass mix should be planted within the feature and banks.

The design parameters of the infiltration basin have been incorporated into Micro Drainage in order to present the attenuation ability of the storage infrastructure during a 1:200-year (+55%) event.

The calculated infiltration coefficient of 0.2214 m/hour has been applied as the infiltration rate for the feature.

Outputs from Micro Drainage indicate that the infiltration basin will attenuate surface water runoff without overtopping in up to the 1:200-year (+55% climate change allowance) critical storm event, as shown in Plate 5, with detailed outputs shown in Annex D.

Plate 5: Calculated Infiltration Basin Outputs for 200-Year (+55%) 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 Filtration (l/s)	Σ Max Outflow (l/s)	Maximum Volume (m³)	Status
2880 min Winter	5.257	2192	1.196	1.196	0.0	3.7	3.7	695.6	Flood Risk

3.1.2 Western Area

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 cellular storage units will comprise the following approximate dimensions in accordance with the SuDS Manual, with an example unit shown in Plate 6:

- Area of 575 m²; and
- Maximum depth of 1.2 m.

As the aforementioned infiltration test pits did not strike groundwater, it is considered that during periods of high-water table the proposed feature will not be impacted by groundwater fluctuations.

[11] HM Government, Building Regulation H: Drainage and Waste Disposal (2015). [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/442889/BR_PDF_AD_H_2015.pdf

The proposed cellular storage units will be implemented with a minimum 300 mm freeboard between the surface and the soffit of the units.

Inspection chambers will be implemented upon the appropriate crossings and locations of storage features and the serving network, which will be finalised during the detailed design phase.

Plate 6: Example Cellular Storage Units[12]

The design parameters of the cellular storage units have been incorporated into Micro Drainage in order to present the attenuation ability of the storage infrastructure during a 1:200-year (+55%) event.

The calculated infiltration coefficient of 0.2214 m/hour has been applied as the infiltration rate for the feature.

Outputs from Micro Drainage indicate that the cellular storage will attenuate surface water runoff without overtopping in up to the 1:200-year (+55 % climate change allowance) critical storm event, as shown in Plate 7, with detailed outputs shown in Annex E.

Plate 7: Calculated Cellular Storage Outputs for 200-Year (+55 %) 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 Filtration (l/s)	Σ Max Outflow (l/s)	Maximum Volume (m³)	Status
2880 min Winter	5.257	2748	1.196	1.196	0.0	1.8	1.8	653.1	Flood Risk

4 LONG TERM MANAGEMENT AND TIMESCALES

4.1 Timescales

Drainage measures outlined within this section should be implemented as soon as practicable by the Developer's Contractor but in any event before the construction of any impermeable surfaces which are proposed to drain into the approved drainage system, as required by the condition.

Measures such as drainage ditches adjacent to access tracks and cross drainage should be installed at the same time as the excavations / soils stripping, or as soon as practicable

[12] Hydro International. [Online]. Available at: https://hydro-int.com/en/products/stormbloc-optimum

thereafter. Drainage measures should be installed prior to the laydown of hardcore / crushed stone.

4.2 Responsibilities and Long-Term Management

It will be the responsibility of the Construction Contractor to maintain effective drainage measures and rectify drainage measures that are not functioning adequately. The Contractor will also have responsibility for reporting on the functionality of drainage measures during regular Safety, Health and Environmental Quality meetings.

After the construction phase of the Development, the temporary construction area within the Site will be decommissioned and terrain will be restored back to grassland. As such, the drainage measures serving this area should also be infilled with suitable soils, where possible.

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. Should drainage measures require dredging or unblocking, this will be undertaken as soon as practicable by a local contractor.

Annex F and G outline the management and maintenance programmes for the infiltration basin and cellular storage structures respectively.

5 CONCLUSION

This report outlines the existing surface water run-off rates at the Site and provides details of the volume of storage required to attenuate an increase in flow during and following construction.

Infiltration testing to BRE365 standard has been conducted at the Site and indicates grounds are suitable for surface water disposal via infiltration.

The proposed Development has been divided into west and east regions, which will be served by cellular storage crates and a infiltration basin feature respectively.

The proposed cellular storage crates and infiltration basin structures proposed within this report are shown to attenuate surface water flows in up to a 1:200-year (+55 % climate change allowance) event.

A Long-Term Maintenance Plan for the proposed drainage network is included in Annex F and G.

ANNEX A – SITE LAYOUT

OUTLINE PLANTING SPECIFICATION

The handling of plants to be in accordance with National Plant Specification 'Handling and Establishing Landscape Plants'. All plants and planting operations are to comply with the requirements and recommendations of all current relevant British Standard specification including but not limited to:

- BS 8545 - Trees: From Nursery to Independence in the Landscape
- BS 3936-1:1992 - Nursery stock. Specification for trees and shrubs
- BS 3882:2015 - Specification for topsoil
- BS 4428:1989 - Code of practice for general landscape operations (excluding hard surfaces) (AMD 6784)
- BS 5837: 2012 - Trees in relation to design, demolition and construction. Recommendations

All planting to be carried out during appropriate climatic conditions and where possible in the optimal planting period October through until March. Existing topsoil and/or imported, clean/inert horticultural ameliorant's from sustainable sources.

Clearance:
Shrub Planting
Clear all grass and perennial vegetation including brambles, suckering and epocormic growth. All arising's to be removed from site.
Tree Planting
Clear all grass and perennial vegetation including brambles, suckering and epicormic growth within 500mm radius to the base of each pant. All arising's to be removed from site.

Herbicide and cultivation
Topsoil and surface vegetation (areas covered by grass and clearance work as above has occurred) to be treated with two applications of selective broadleaf herbicide prior to planting and seeding, where necessary, avoiding bulb and wildflowers and strictly in accordance with the Control of Pesticides Regulations 1986 (COPR) (as amended 1997) (or, otherwise, updated/superseded legislation) and following manufacturer's instructions by qualified staff.

General
All rubbish and debris to be removed from site. Stone picking of all stones and debris over 25mm to be undertaken across site. All trees and shrubs to be retained to be protected during works in line with BS5837:2012.

Tree works
Any required works to existing trees to be undertaken in line with BS 3998:2010.

Topsoil
Where necessary, topsoil shall be a minimum of 400mm deep over new planting areas and graded to fall. Imported topsoil must be BS 3882:2015 compliant and existing topsoil must be cultivated in accordance with BS 3882:2015 outside RPAs of existing trees. No cultivation should take place in wet/ waterlogged conditions and within the RPAs of existing trees.

Trees
Feathered trees to be planted in pits 800x800x450mm or dimensions of rootball, whichever is greater. Tree to be supported by 1Nr stake (1500mm long, per tree, 600mm above ground, 75mm diameter), and 1no. bio-degradeable tie.

Proposed Native Species Shrub Mix
Bare root shrubs to be planted 0.3 plants per m^2, planted in areas cultivated to 150mm deep, in pits 100 x 100 x 100mm deep.
All shrub plants to be planted with shrub shelter/rabbit guard, cane and mulch mat to base.

Proposed Native Species Hedgerow Mix
Hedges to comprise a double staggered row of plants 400mm apart within each row, overall 5 plants per linear metre. Species mixed throughout the hedge line in random groups of 3/5. 500mm wide trench excavated to take plants and topsoil cultivated to 450mm depth prior to application of fertiliser. All native planting shall be of local provenance.

Mulch
All tree and hedge planting areas to be covered using coarse bark mulch 75mm deep.

Grass
All seeded areas to be cultivated and levelled as required removing any stones, rubble, subsoil, general construction waste.

Plant position
Final position of tree and shrub planting subject to confirmation of service location and approval of statutory undertakers. Allow for location of service information prior to work commencing on site.

Plant Quality
Supplier listed in the Horticultural Trades Association, Nursery Certification Scheme.

Planting Schedule

Specimen Tree Planting

Number	Abbreviation	Species	Height	Girth	Specification
26 No.	Ac	Acer campestre	150-175cm		2x :BR :Feather
4 No.	Agl	Alnus glutinosa	150-175cm		2x :BR :Feather
9 No.	Bp	Betula pendula	150-175cm		2x :BR :Feather
21 No.	Psy	Pinus sylvestris	150-175cm		4x :RB
21 No.	Ptr	Populus tremula	150-175cm		2x :BR :Feather
7 No.	Sau	Sorbus aucuparia	150-175cm		2x :BR :Feather

Total :88 No.

Native Species Shrub Mix

Number	Abbreviation	Species	Height	Specification	Spacing
128 No.	Ac	Acer campestre	60-80cm	1+1 :BR :Transplant	0.3/m²
701 No.	Cm	Crataegus monogyna	60-80cm	1+1 :BR :Transplant	0.3/m²
319 No.	Psp	Prunus spinosa	60-80cm	1+1 :BR :Transplant	0.3/m²
128 No.	Sn	Sambucus nigra	60-80cm	1+1 :BR :Transplant	0.3/m²

Total :1276 No.

Native Species Hedgerow Mix

Number	Abbreviation	Species	Height	Specification	Spacing
445 No.	Cav	Corylus avellana	60-80cm	1+1 :BR :Transplant	5/m
2442 No.	Cm	Crataegus monogyna	60-80cm	1+1 :BR :Transplant	5/m
224 No.	Ia	Ilex aquifolium	60-80cm	1+1 :BR :Transplant	5/m
224 No.	Rca	Rosa canina	60-80cm	1+1 :BR :Transplant	5/m
224 No.	Sn	Sambucus nigra	60-80cm	1+1 :BR :Transplant	5/m
889 No.	Sau	Sorbus aucuparia	60-80cm	1+1 :BR :Transplant	5/m

Total :4448 No.

Grass Areas

Weight	Seed Mix Name	Seed Mix Details	Sowing Rate
10297 g	EH1F	Wild Flowers for Hedgerows	1.5g/m²

KEY

- Site Boundary

EXISTING FEATURES

- Existing Vegetation To Be Retained
- Existing Overhead Cables
- Existing Overhead Cables 6m Buffer

PROPOSED FEATURES

- Proposed Native Species Hedgerow
  Approx. Total Length: 0.83km
  Native Species Hedgerow Mix, 5/lm
- Proposed Native Species Trees
- Proposed Native Species Shrub Mix
  Approx. Total Area: 0.42Ha
  Native Species Shrub Mix, 0.3/m^2
- Proposed Native Species Grassland and Wildflower Mix
  Approx. Total Area: 0.67Ha
  EH1F, Wild Flowers for Hedgerows, Emorsgate, 1.5g/m^2

SITE LOCATION PLAN SCALE: 1:20000

REVISION SCHEDULE

Rev	Date	Description
A	19.01.21	Revised to match the latest layout (WM)

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. ALL DIMENSIONS , CHANGES, LEVELS AND COORDINATES ARE IN METERS UNLESS DEFINED OTHERWISE.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.
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GRID REFERENCE: NS 45100 59850

PROJECT: Neilston Battery Storage

TITLE: Figure 1.14 Landscape Masterplan

CLIENT: Statkraft UK Ltd

DATE: 18.11.20 SCALE: 1:1250@A1

DRAWN: WM DRAWING NO.: 3547-DR-LAN-101

CHECKED: CH REVISION: A

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ANNEX B – BRE 365 INFILTRATION TESTING RESULTS

MASON EVANS

Geo-Environmental Consultants

Arcus Consultancy Services Ltd
1C, Swinegate Court East
3 Swinegate
York
Y018AJ

Our ref: P20/182/01/CW/KO

31 August 2020

Sent by Email Only

For the attention of Mr R Duff

Dear Sirs

LETTER REPORT ON SOAKAWAY TESTING
GLENNIFER ROAD, NEILSTON

Introduction

In July 2020, we were requested by Arcus Consultancy Services Limited (the Client), to undertake an assessment of the underlying soils below the proposed development on a site near Glennifer Road, Neilston in relation to infiltration rates and soakaway design.

SKF Limited were commissioned to undertake the testing that took place on the 17th August 2020, comprising 2 No. soakaway tests. The intrusive investigations are now complete, and we would offer the following comments.

Ground Conditions

Works comprised 2 No. soakaway tests undertaken in the north and south of the site to calculate indicative infiltration rates at the site. Two trial pits were excavated to a depth of 0.70 mbgl (SA01) and 1.00 mbgl (SA02) by mini-digger and utilised for soakaway testing in general accordance with BRE Special Digest 365. A location plan of soakaway positions, as provided by Arcus Consultancy Services Limited is included within Appendix A.

Trial pits SA01 and SA02 both recorded topsoil to a depth of 0.25 mbgl. Within trial pit SA01, granular soils were encountered immediately beneath the topsoil, described at medium dense brown clayey SAND and GRAVEL with occasional cobbles to a depth of 0.45 mbgl. Underlying these granular soils, gravel described as red slightly clayey sandy fine to coarse angular GRAVEL of basalt was recorded to a depth 0.70 m at the base of trial pit SA01. Presumed weathered basalt bedrock was recorded at the base of SA01. Underlying topsoil within trial pit SA01, cohesive deposits were recorded to 1.00 mbgl at the base of the trial pit described as soft to firm light brown very sandy very gravelly CLAY.

Groundwater strikes were not recorded within either trial pits.

Soakaway Testing

Two soakaway tests (SA01 and SA02) were undertaken. The results of the soakaway tests are indicated in Table 01 below.

TABLE 01 - Soakaway Test Results

Soakaway Test	Depth of Trial Pit (mbgl)	Water Level at Start (mbgl)	Water Level at End (mbgl)	Time Elapsed (minutes)	Infiltration Rate (m/s)
SA01	0.70	0.21	0.60	305	0.00000615
SA02	1.00	0.32	0.32	152	NO RESULT

From the infiltration rates recorded, it is noted that SA01 in the northern site area is more amenable to soakaways compared to SA02 in the south of the site. Soakaway SA02 has not been able to have an infiltration rate calculated due to insufficient drainage within the pit. It is anticipated that the high clay content within the cohesive material encountered within SA02 is prohibiting infiltration.

Conclusions

Based on results from the soakaway testing, we consider that the soils encountered within trial pit SA01 in the north of the site are generally suitable for use within a soakaway design. However, an infiltration rate was not able to be calculated due to insufficient drainage within soakaway pits SA02 in the south of the site. Although a figure could not be determined at these positions, this demonstrates that the soils have a poor permeability, and soakaways would not be suitable for use within these areas.

We trust the above meets your current needs, but if there are any queries please do not hesitate to contact the undersigned.

Yours faithfully
MASON EVANS PARTNERSHIP LIMITED

Neil Thomson
Director

Encs

Appendix A

LOCATION OF SOAKAWAY TESTS

NOTES

Site boundary

SA01 to SA02 — Soakaway tests excavated and carried out by SKF Ltd (August 2018)

REV	DATE	DETAILS

ARCUS CONSULTANCY SERVICES Ltd

PROJECT TITLE

GLENIFFER ROAD
NEILSTON

DRAWING TITLE

LOCATION OF
SOAKAWAY TESTS

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
RC	CW	NT	31.08.20	Not to Scale

PROJECT No.	DRAWING No.	REVISION
P20/182	P20/182/LR/F/01	

MASON EVANS
Geo-Environmental Consultants
t: 0141 420 2025 e: mail@masonevans.co.uk
The Piazza, 95 Morrison Street, Glasgow, G5 8BE

A4 border: 297 X 210

Appendix B

TRIAL PIT LOGS
RESULTS OF SOAKAWAY TESTS

SKF Ltd
Ground Investigation & Site Surveys

SKF Ltd, Constablewood Estate, Brisbane Glen, Largs
TEL: 01475 672409 or 07795 493892 FAX: 01475 672409

TRIAL PIT NO. SA01

Contract: GLENIFFER RD, NEILSTON
Contract No: 5895
Status: FINAL

Client: MASON EVANS PARTNERSHIP
Pit Dimensions: 1.30 X 0.40
Co-ordinates E

Date: 17/08/2020
Equipment: VOLVO EC27C
N

Description of Strata	Legend	Depth	Level	Sampling	SPT Blows U Blows Hand Vane	Pipe
Ground Surface						
TOPSOIL / turf [GL-0.25].		0.25				
Medium dense brown clayey SAND and GRAVEL with occasional cobbles. Gravel fine to coarse and angular to sub rounded.		0.45				
Recovered as red slightly clayey sandy fine to coarse angular GRAVEL of basalt. Presumed weathered bedrock. At 0.70m hard obstruction, presumed bedrock.		0.70				

Water Strikes
Strike: Dry Flow:

Details
Casing: Final Depth: 0.70

Stability: Stable
Shoring: None
Backfilling: Backfilled on completion
Notes: Soakaway test carried out.

Logged by: KB Checked by: SKF

SYMBOLS KEY

B - BULK
U - UNDISTURBED
D - SMALL DISTURBED
J - JAR
V - VIAL
W - WATER
NR - NO RECOVERY
* - ESTIMATED DENSITY

ALL DIMENSIONS ARE IN METRES

SKF Ltd
Ground Investigation & Site Surveys

SKF Ltd, Constablewood Estate, Brisbane Glen, Largs
TEL: 01475 672409 or 07795 493892 FAX: 01475 672409

TRIAL PIT NO. SA02

Contract: GLENIFFER RD, NEILSTON
Contract No: 5895
Status: FINAL

Client: MASON EVANS PARTNERSHIP
Pit Dimensions: 1.50 X 0.40
Co-ordinates E

Date: 17/08/2020
Equipment: VOLVO EC27C
N

Description of Strata	Legend	Depth	Level	Sampling	SPT Blows U Blows Hand Vane	Pipe
Ground Surface						
TOPSOIL / turf [GL-0.25].		0.25				
Soft to firm light brown very sandy very gravelly CLAY. Gravel fine to coarse and angular to sub rounded.		1.00				

Water Strikes
Strike: Dry Flow:

Details
Casing: Final Depth: 1.00

Stability: Stable
Shoring: None
Backfilling: Backfilled on completion
Notes: Soakaway test carried out.

Logged by: KB Checked by: SKF

SYMBOLS KEY

B - BULK
U - UNDISTURBED
D - SMALL DISTURBED
J - JAR
V - VIAL
W - WATER
NR - NO RECOVERY
* - ESTIMATED DENSITY

ALL DIMENSIONS ARE IN METRES

RESULTS OF SOAKAGE TEST

SKF Ltd
Ground Investigation & Site Surveys

TEST PIT NO. **SA01**

Contract Name: GLENNIFER RD, NEILSTON
Contract No.: 5895
Date: 17/08/2020
Weather: SHOWERS
Time to fill pit: 2 MINS
Ground Level (mAOD)
Dimensions (m)
Length: 1.30
Width: 0.40
Depth: 0.70

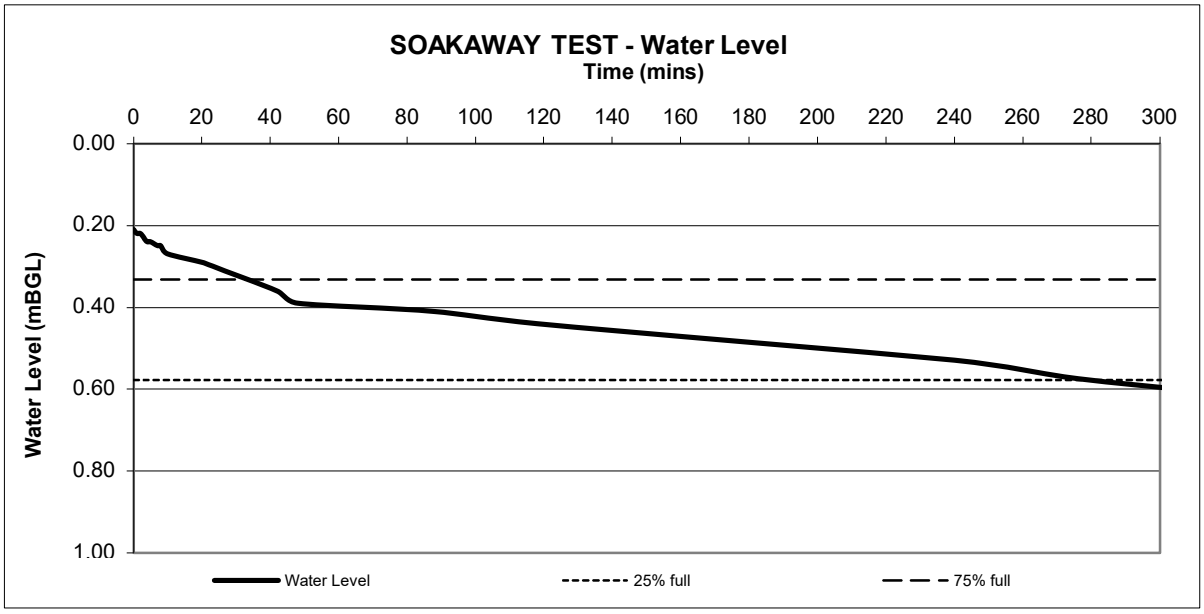
From graph (seconds)
tp75-25 = 15300

Using formula $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$ from BRE Digest 365

f = soil infiltration rate
Vp75-25 = volume of outflow between 75% and 25% eff. depth
ap50 = mean surface area (pit sides to 50% eff. depth + base)
tp75-25 = time for outflow between 75% and 25% eff. depth

Time (mins)	Water Level (mBGL)	Water Level (mAOD)
0.00	0.21	
1.00	0.22	
2.00	0.22	
3.00	0.23	
4.00	0.24	
5.00	0.24	
7.00	0.25	
8.00	0.25	
10.00	0.27	
20.00	0.29	
23.00	0.30	
42.00	0.36	
48.00	0.39	
88.00	0.41	
118.00	0.44	
240.00	0.53	
272.00	0.57	
305.00	0.60	

INFILTRATION RATE (m/s) **f = 0.00000615**



RESULTS OF SOAKAGE TEST

SKF Ltd
Ground Investigation & Site Surveys

TEST PIT NO. SA02

Contract Name: GLENNIFER RD, NEILSTON
Contract No.: 5895
Date: 17/08/2020
Weather: SHOWERS
Time to fill pit: 2 MINS
Ground Level (mAOD)
Dimensions (m)
Length: 1.50
Width: 0.40
Depth: 1.00

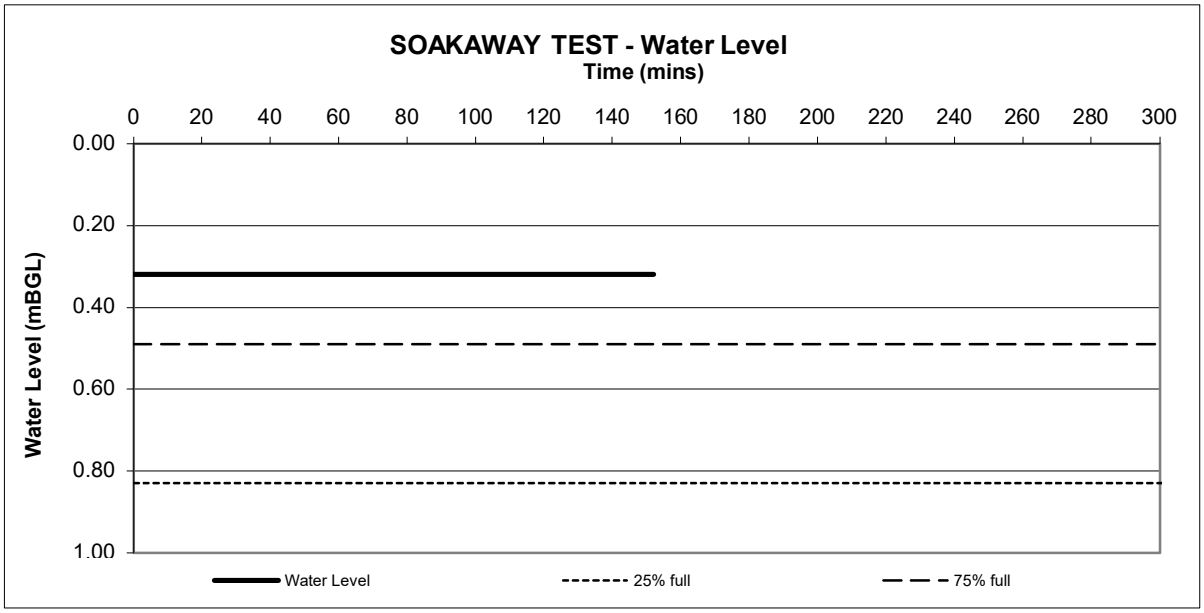
From graph (seconds)
tp75-25 =

Using formula $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$ from BRE Digest 365

f = soil infiltration rate
Vp75-25 = volume of outflow between 75% and 25% eff. depth
ap50 = mean surface area (pit sides to 50% eff. depth + base)
tp75-25 = time for outflow between 75% and 25% eff. depth

Time (mins)	Water Level (mBGL)	Water Level (mAOD)
0.00	0.32	
1.00	0.32	
2.00	0.32	
3.00	0.32	
4.00	0.32	
5.00	0.32	
10.00	0.32	
22.00	0.32	
35.00	0.32	
45.00	0.32	
62.00	0.32	
92.00	0.32	
152.00	0.32	

INFILTRATION RATE (m/s) f = N/A



ANNEX C –RURAL RUNOFF OUTPUT

ICP SUDS Mean Annual Flood

Input

Return Period (years) 200 SAAR (mm) 1400 Urban 0.000
Area (ha) 13.800 Soil 0.450 Region Number Region 2

Results l/s

QBAR Rural 136.4
QBAR Urban 136.4

Q200 years 406.5

Q1 year 118.7
Q30 years 258.8
Q100 years 358.8

ANNEX D – INFILTRATION BASIN 1:200 (+55 %) DESIGN OUTPUT

Summary of Results for 200 year Return Period (+55%)

Half Drain Time : 1825 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.358	0.358	1.9	158.3	O K
30 min Summer	0.439	0.439	2.1	199.4	O K
60 min Summer	0.532	0.532	2.3	249.9	O K
120 min Summer	0.639	0.639	2.5	310.9	O K
180 min Summer	0.707	0.707	2.6	351.3	O K
240 min Summer	0.756	0.756	2.8	381.8	O K
360 min Summer	0.825	0.825	2.9	426.3	O K
480 min Summer	0.873	0.873	3.0	458.0	O K
600 min Summer	0.908	0.908	3.1	481.9	Flood Risk
720 min Summer	0.935	0.935	3.1	500.4	Flood Risk
960 min Summer	0.976	0.976	3.2	529.4	Flood Risk
1440 min Summer	1.022	1.022	3.3	562.3	Flood Risk
2160 min Summer	1.062	1.062	3.4	591.9	Flood Risk
2880 min Summer	1.084	1.084	3.5	608.8	Flood Risk
4320 min Summer	1.074	1.074	3.5	600.9	Flood Risk
5760 min Summer	1.052	1.052	3.4	584.5	Flood Risk
7200 min Summer	1.027	1.027	3.4	566.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	166.137	0.0	27
30 min Summer	105.048	0.0	41
60 min Summer	66.422	0.0	70
120 min Summer	41.998	0.0	130
180 min Summer	32.120	0.0	190
240 min Summer	26.555	0.0	248
360 min Summer	20.310	0.0	368
480 min Summer	16.791	0.0	486
600 min Summer	14.487	0.0	604
720 min Summer	12.842	0.0	724
960 min Summer	10.669	0.0	962
1440 min Summer	8.216	0.0	1282
2160 min Summer	6.327	0.0	1664
2880 min Summer	5.257	0.0	2052
4320 min Summer	3.938	0.0	2900
5760 min Summer	3.208	0.0	3704
7200 min Summer	2.737	0.0	4544

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
8640 min Summer	1.001	1.001	3.3	547.8	Flood Risk
10080 min Summer	0.976	0.976	3.2	529.7	Flood Risk
15 min Winter	0.396	0.396	2.0	177.5	O K
30 min Winter	0.484	0.484	2.2	223.6	O K
60 min Winter	0.587	0.587	2.4	280.5	O K
120 min Winter	0.704	0.704	2.6	349.6	O K
180 min Winter	0.777	0.777	2.8	395.6	O K
240 min Winter	0.831	0.831	2.9	430.4	O K
360 min Winter	0.907	0.907	3.1	481.7	Flood Risk
480 min Winter	0.961	0.961	3.2	518.8	Flood Risk
600 min Winter	1.000	1.000	3.3	547.1	Flood Risk
720 min Winter	1.031	1.031	3.4	569.4	Flood Risk
960 min Winter	1.079	1.079	3.5	605.2	Flood Risk
1440 min Winter	1.135	1.135	3.6	647.3	Flood Risk
2160 min Winter	1.173	1.173	3.7	677.5	Flood Risk
2880 min Winter	1.196	1.196	3.7	695.6	Flood Risk
4320 min Winter	1.177	1.177	3.7	680.1	Flood Risk
5760 min Winter	1.142	1.142	3.6	652.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
8640 min Summer	2.403	0.0	5368
10080 min Summer	2.154	0.0	6160
15 min Winter	166.137	0.0	26
30 min Winter	105.048	0.0	41
60 min Winter	66.422	0.0	70
120 min Winter	41.998	0.0	128
180 min Winter	32.120	0.0	186
240 min Winter	26.555	0.0	244
360 min Winter	20.310	0.0	360
480 min Winter	16.791	0.0	476
600 min Winter	14.487	0.0	592
720 min Winter	12.842	0.0	706
960 min Winter	10.669	0.0	932
1440 min Winter	8.216	0.0	1364
2160 min Winter	6.327	0.0	1732
2880 min Winter	5.257	0.0	2192
4320 min Winter	3.938	0.0	3116
5760 min Winter	3.208	0.0	4032

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
7200 min Winter	1.101	1.101	3.5	621.5	Flood Risk
8640 min Winter	1.059	1.059	3.4	590.2	Flood Risk
10080 min Winter	1.020	1.020	3.3	561.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
7200 min Winter	2.737	0.0	4904
8640 min Winter	2.403	0.0	5792
10080 min Winter	2.154	0.0	6648

Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
Site Location	GB 245000 659100 NS 45000 59100
C (1km)	-0.018
D1 (1km)	0.434
D2 (1km)	0.451
D3 (1km)	0.383
E (1km)	0.246
F (1km)	2.455
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+55

Time Area Diagram

Total Area (ha) 0.515

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.172	4	8	0.172	8	12	0.172

Model Details

Storage is Online Cover Level (m) 1.200

Infiltration Basin Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02214 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.02214

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	390.0	1.200	798.4

ANNEX E – CELLULAR STORAGE 1:200 (+55 %) DESIGN OUTPUT

Summary of Results for 200 year Return Period (+55%)

Half Drain Time : 3088 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.246	0.246	1.8	134.3	O K
30 min Summer	0.310	0.310	1.8	169.3	O K
60 min Summer	0.388	0.388	1.8	212.2	O K
120 min Summer	0.484	0.484	1.8	264.4	O K
180 min Summer	0.548	0.548	1.8	299.3	O K
240 min Summer	0.597	0.597	1.8	325.9	O K
360 min Summer	0.669	0.669	1.8	365.7	O K
480 min Summer	0.723	0.723	1.8	394.9	O K
600 min Summer	0.765	0.765	1.8	417.8	O K
720 min Summer	0.799	0.799	1.8	436.4	O K
960 min Summer	0.855	0.855	1.8	467.3	O K
1440 min Summer	0.928	0.928	1.8	507.1	Flood Risk
2160 min Summer	0.984	0.984	1.8	537.2	Flood Risk
2880 min Summer	1.008	1.008	1.8	550.5	Flood Risk
4320 min Summer	0.993	0.993	1.8	542.4	Flood Risk
5760 min Summer	0.974	0.974	1.8	532.1	Flood Risk
7200 min Summer	0.952	0.952	1.8	520.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	166.137	0.0	27
30 min Summer	105.048	0.0	41
60 min Summer	66.422	0.0	70
120 min Summer	41.998	0.0	130
180 min Summer	32.120	0.0	190
240 min Summer	26.555	0.0	250
360 min Summer	20.310	0.0	368
480 min Summer	16.791	0.0	488
600 min Summer	14.487	0.0	606
720 min Summer	12.842	0.0	726
960 min Summer	10.669	0.0	966
1440 min Summer	8.216	0.0	1444
2160 min Summer	6.327	0.0	2160
2880 min Summer	5.257	0.0	2624
4320 min Summer	3.938	0.0	3336
5760 min Summer	3.208	0.0	4152
7200 min Summer	2.737	0.0	4968

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
8640 min Summer	0.928	0.928	1.8	507.0	Flood Risk
10080 min Summer	0.902	0.902	1.8	492.6	Flood Risk
15 min Winter	0.276	0.276	1.8	150.7	O K
30 min Winter	0.348	0.348	1.8	189.9	O K
60 min Winter	0.436	0.436	1.8	238.4	O K
120 min Winter	0.545	0.545	1.8	297.6	O K
180 min Winter	0.618	0.618	1.8	337.4	O K
240 min Winter	0.674	0.674	1.8	368.0	O K
360 min Winter	0.758	0.758	1.8	414.1	O K
480 min Winter	0.821	0.821	1.8	448.5	O K
600 min Winter	0.871	0.871	1.8	475.7	O K
720 min Winter	0.912	0.912	1.8	498.1	Flood Risk
960 min Winter	0.981	0.981	1.8	536.0	Flood Risk
1440 min Winter	1.075	1.075	1.8	587.1	Flood Risk
2160 min Winter	1.155	1.155	1.8	630.7	Flood Risk
2880 min Winter	1.196	1.196	1.8	653.1	Flood Risk
4320 min Winter	1.170	1.170	1.8	639.2	Flood Risk
5760 min Winter	1.142	1.142	1.8	623.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
8640 min Summer	2.403	0.0	5800
10080 min Summer	2.154	0.0	6656
15 min Winter	166.137	0.0	26
30 min Winter	105.048	0.0	41
60 min Winter	66.422	0.0	70
120 min Winter	41.998	0.0	128
180 min Winter	32.120	0.0	186
240 min Winter	26.555	0.0	246
360 min Winter	20.310	0.0	362
480 min Winter	16.791	0.0	480
600 min Winter	14.487	0.0	598
720 min Winter	12.842	0.0	714
960 min Winter	10.669	0.0	948
1440 min Winter	8.216	0.0	1408
2160 min Winter	6.327	0.0	2088
2880 min Winter	5.257	0.0	2748
4320 min Winter	3.938	0.0	3900
5760 min Winter	3.208	0.0	4448

Summary of Results for 200 year Return Period (+55%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
7200 min Winter	1.107	1.107	1.8	604.6	Flood Risk
8640 min Winter	1.066	1.066	1.8	582.4	Flood Risk
10080 min Winter	1.022	1.022	1.8	558.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
7200 min Winter	2.737	0.0	5408
8640 min Winter	2.403	0.0	6312
10080 min Winter	2.154	0.0	7256

Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
Site Location	GB 245000 659100 NS 45000 59100
C (1km)	-0.018
D1 (1km)	0.434
D2 (1km)	0.451
D3 (1km)	0.383
E (1km)	0.246
F (1km)	2.455
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+55

Time Area Diagram

Total Area (ha) 0.438

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.146	4	8	0.146	8	12	0.146

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.02214 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02214

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	575.0	575.0	1.200	575.0	575.0

ANNEX F – INFILTRATION BASIN MAINTANENCE PROGRAMME

[13]

Maintenance schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – for split ways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or as required
	Inspect banksides, structure and any pipework etc for evidence of physical damage	Monthy
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Monthly
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23 of the SuDS Manual)
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10 % or more of the treatment area
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediments from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)

[13] Based on Table 13.2 - Operation and maintenance requirements for infiltration basins of the SuDS Manual

Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Realignment of rip-rap	As required
	Repair-rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

ANNEX G – CELLULAR STORAGE MAINTANENCE PROGRAMME

14

Maintenance schedule	**Required action**	**Typical frequency**
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

[14] Based on Table 21.3 - Operation and maintenance requirements for attenuation storage tanks of the SuDS Manual