Our Ref: J-3184-02
04 December 2023

SB Plymouth Ltd.
Hoe Lodge
Hoe Road
Plymouth
PL1 2AP

RE: Proposed Internal Alterations and Extension to Hoe Lodge Restaurant.
Hoe Road, Plymouth. PL1 2AP.

Critical Drainage Area - Flood Risk Assessment

Introduction

SB Plymouth Ltd are proposing to construct a new entrance porch and covered seating area with interior modifications to the Hoe Lodge Restaurant, Hoe Road, Plymouth. As part of the planning process, it has become apparent that the site is in the Plymouth Critical Drainage Area. As such further consideration is required for the disposal of surface water from the development.

In accordance with Paragraph 167 of the National Planning Policy Framework (NPPF 2021, footnote 55), a Flood Risk Assessment (FRA) is required where a development is located within a Critical Drainage Area. In order to address this requirement, Engineering and Development Solutions have been commissioned to develop an FRA and outline the surface water drainage strategy for the proposed development.

A site location is demonstrated in **Figure 1** below and the proposed site layout is included in **Annex A**.

An initial inspection of the Environment Agency indicative flood map shows the site is located within Flood Zone 1 and therefore is deemed to be at low risk from fluvial or tidal flooding. Subsequently, the primary aim of this report is to ensure that the development of the site does not increase flood risk elsewhere. This can be achieved by providing a suitable drainage scheme that manages surface water runoff created by the development.

This report comprises the FRA for the proposed development, in line with the National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG) and the Plymouth City Council: Local Flood Risk Management Strategy.

Site Description

The approximate Ordnance Survey Grid Reference for the site is SX 47881 53910. The site is on the western side of Hoe Road, and currently consists of a restaurant, bar, and patio seating area on Plymouth Hoe. The proposal is to construct a new entrance porch and to provide a roof over the existing yard areas to accommodate a new seating area / bar for the restaurant. Other interior modifications include an extension to the existing kitchen and relocating the stores.

The EA indicative flood map (see **Figure 2**) shows the site is located within Flood Zone 1 (low probability). The site is located within a Critical Drainage Area. Consequently, this means that the drainage for any new building requires more detailed consideration.

[redacted]

Figure 1. Site Location Plan

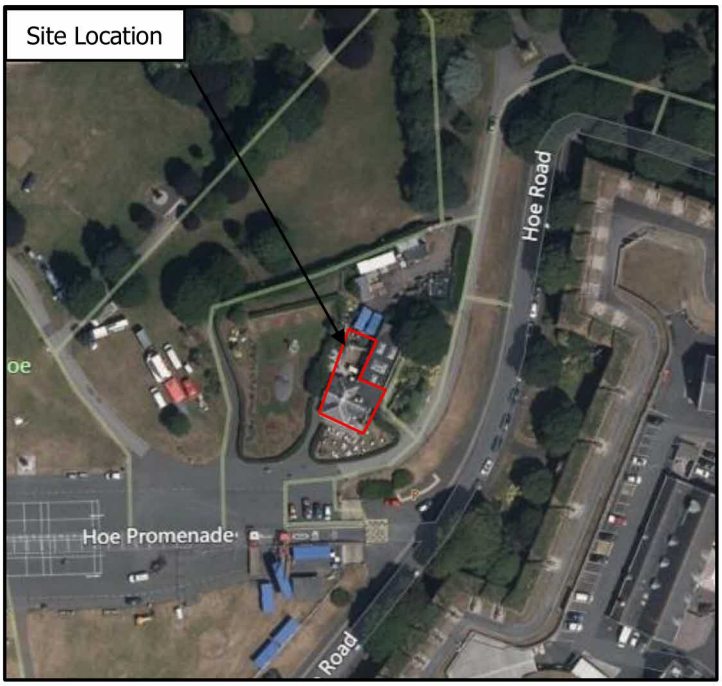

Figure 2. Site Aerial Plan

[redacted]

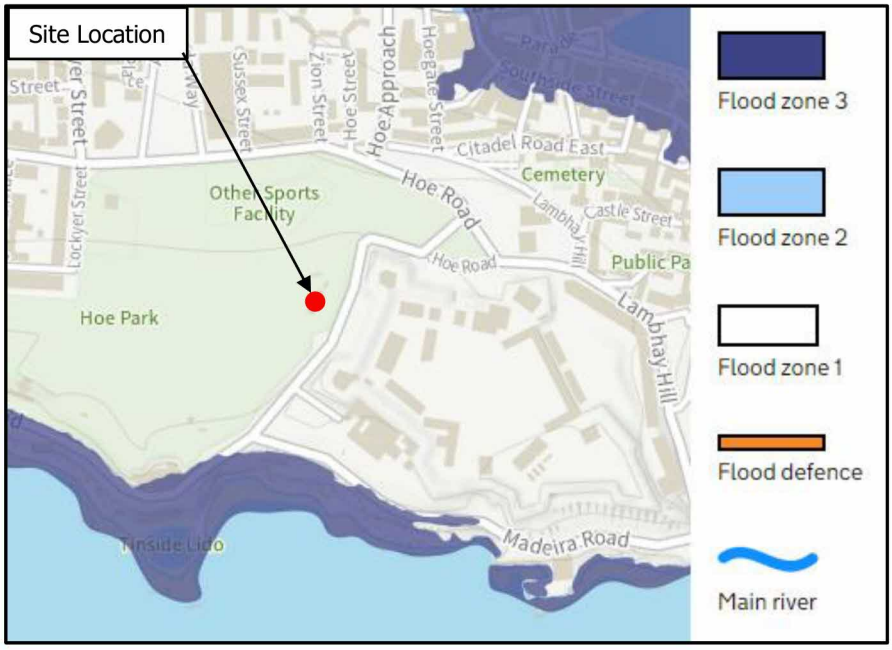

Figure 3. Environment Agency Flood Map for Planning (Rivers & Sea) Extract

Flood Risks

Fluvial and Tidal Flooding

The Environment Agency indicative flood map (**Figure 3**, above) shows that the site is in Flood Zone 1 (less than 1 in 1,000 annual probability of river or sea flooding) and not at risk from either fluvial or tidal flooding.

Groundwater Flooding

Groundwater flooding is linked to the ability of the ground to hold water and the ability of the underlying geological strata to bear water. It is considered that groundwater is not an issue on this site, which falls at a constant rate and is not near to a valley or other feature which may restrict the onward flow of groundwater. As such the risk of groundwater flooding is low and is not considered any further in this report.

Overland/Surface Water Flow

The site is situated on the top of a catchment located within Hoe Park; it is anticipated that any overland flows generated upstream of the site would infiltrate into the ground.

The Environment Agency map below (**Figure 4**) shows the risk of flooding from surface water for the site. It indicates that the site is at a very low risk of flooding from surface water flooding.

[redacted]

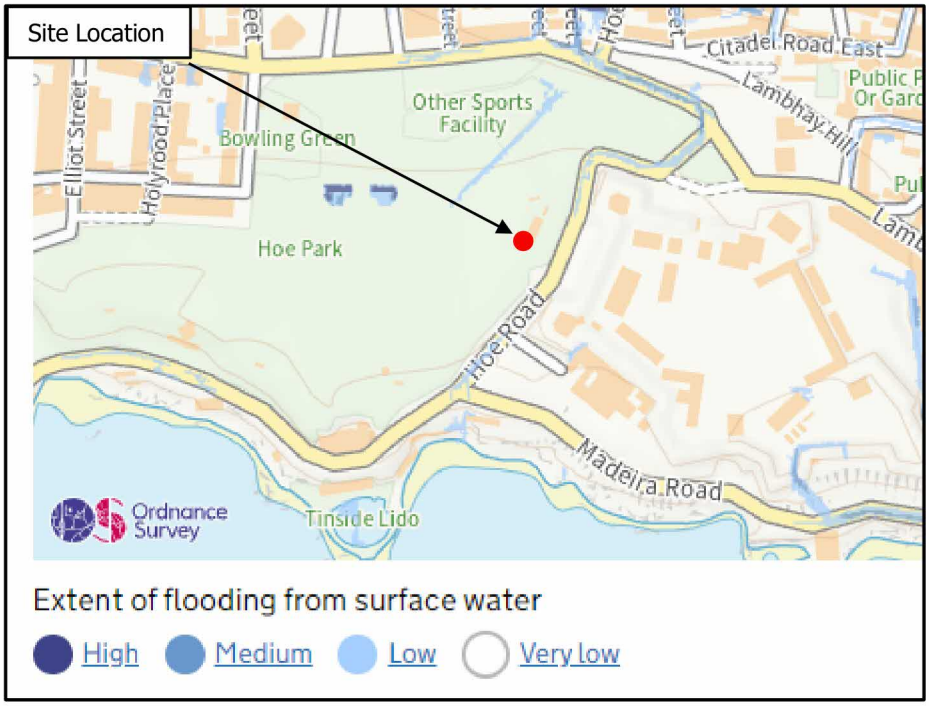

Figure 4. Environment Agency Risk of Surface Water Flooding Map

Flooding as a Result of Development

Development and paving of permeable areas have potential to increase flood risk to properties down slope of the site due to increased runoff. The design of the proposed surface water drainage system is key to mitigating these risks, in this case, the proposal is for a new porch and covered seating for the restaurant/bar on an area which is already built/paved. Therefore, there is limited potential to increase runoff from the site as there is no increase in impermeable area.

By designing the site's surface water drainage infrastructure in accordance with the advice reproduced below, the proposed development will not increase flood risk to third parties down slope and has potential to provide betterment.

Minimum Drainage Standards Required from the Environment Agency

All new developments will have to play their part in reducing current rainfall runoff rates. This requirement also applies to brownfield sites that will have to match the same standards. The surface water drainage hierarchy should be followed by using infiltration as far as is practicable. Further guidance on such systems can be found in the CIRIA SuDS Manual and in Lead Local Flood Authority guidance.

All off-site surface water discharges from developments should mimic greenfield performance up to a maximum 1 in 10-year discharge rate. On site all surface water should be safely managed up to the 1 in 100 plus climate change conditions. This will require additional water storage areas to be created thereby contributing to a reduction in flooding downstream.

With regards to the guidance above, two drainage options are proposed below dependent on ground conditions.

[redacted]

Drainage Design – Infiltration System (Option 1)

The primary drainage solution for developments in Plymouth would be to divert all surface water runoff from the impermeable areas for the new build elements of the development to a watercourse. The nearest body of water is Plymouth Sound which is located 180m to the south. However, this would be an impractical connection for a minor project such as this due to the need to cross multiple third party land areas, a busy public highway and outfall over a cliff face.

In accordance with the guidance, the next preferred drainage solution in the hierarchy would be to drain all surface water runoff from the development to ground soakaways designed to a minimum 100-year return period storm with a 50% climate change allowance.

The Building Regulations Part H places several restrictions on the siting of soakaways which should be complied with. This includes that soakaways should not be sited within 5m of any building or road. They should also be sufficiently far from other soakaways and drainage fields so that the overall soakage capacity of the ground is not exceeded or the effectiveness of the units impaired.

To provide a detailed design for such an infiltration system, site investigation would be required to ascertain the percolation rates of the sub-soil. As a site investigation has not yet been carried out, an infiltration rate of 0.15m/hr has been assumed to produce an outline design of the soakaway system.

Analysis using Micro Drainage software indicates that soakaways of dimensions 2m (width) x 3m (length) x 1.2m (depth) based on modular infiltration units with a 95% void ratio would be adequate to accommodate runoff from all new proposed impermeable areas.

The soakaways are based on the worst-case design storm (100 year) with rainfall intensities increased by 50% to allow for the effects of climate change over the lifetime of the development.

The proposed development layout (Drawing **3001B**) included in **Annex A** shows the layout of the proposed soakaway for the development.

A system of downpipes and gullies would convey surface water from the new impermeable areas of the development into the soakaways. At this stage, the connections to the soakaway are shown indicative.

Surface runoff from the roof of the existing restaurant building is assumed to drain as per current arrangements and will not be directed into the soakaway.

Drainage Design – Attenuation System (Option 2)

Inspection of SWW mapping shows there are no surface water sewers close to the site, and as such a discharge to surface water sewer is not feasible. The existing building is currently served by existing downpipes which drain into the existing South West Water combined sewer situated in Alfred Road, adjacent to the eastern boundary of the site.

Should subsoil conditions prove to be unsuitable for the use of soakaways, then it is proposed to connect runoff from new roof areas to the SWW combined system. Flow rates and volumes would be no greater than those originating from the site at present as the area to be enclosed by the proposed roofing is already covered in impermeable concrete surfacing. Indeed, the development offers an opportunity to reduce runoff rates by introducing attenuation to flows.

The greenfield runoff rate for the development has been calculated, using the ICP SUDS method, to be less than 1 l/s based on a return period of 100 years, as such a peak discharge rate of 1 l/s is considered to be appropriate for this site.

Surface water originating from the new impermeable areas of the development (roofs,) would drain via a positively piped drainage system towards a flow control device. MicroDrainage Software has been used to size the storage required to facilitate a discharge limited to 1.0 l/s from the site. These calculations indicate that a minimum tank size of $4m^3$ free volume is required to accommodate the worst-case design storm (100-year) with rainfall intensities increased by 50% to account for the effects of.

The required tank size could be achieved by using an attenuation tank with dimensions 2m (w) x 2.5m (l) x 0.8m (d), based on modular units with a 95% void ratio. If the upstream flow rate exceeds 1.0 l/s, the system will back up into the proposed attenuation tank.

The tank should be lined with an impermeable membrane to prevent the escape of water into the surrounding ground. A system of downpipes and underground drainage network will divert surface water from the new extension into the existing drainage network, as indicated on the plan included in **Annex A**.

Exceedance Events

During any rainfall event in excess of the design storm described above, or should pipework or gullies become blocked, the system has potential to become surcharged. It is anticipated that surcharging of the system would result in the exceedance flows flowing overland and would run in a westerly direction away from the site towards the Alfred Road, where it would be conveyed away from the site as per the pre-development scenario.

Maintenance

Management and maintenance responsibility for the surface water drainage system will fall to the site owner.

Soakaway maintenance activities will broadly comprise regular maintenance. Occasional tasks and remedial work where necessary. As per the guidance outlined in **Table 1** below. Inspection of the surface water drainage system can generally be undertaken during routine property maintenance activities e.g. for grass cutting, leaf collection and/or litter collection.

SOAKAWAYS		
Regular maintenance	Inspect for sediment and debris in upstream silt traps and floor of inspection tube or chamber	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from upstream silt traps and floor of inspection tube or chamber	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean units if performance deteriorates or failure occurs	As required

[redacted]

	Replacement of clogged geotextile (will required reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year then annually
	Check soakaway to ensure emptying is occurring	Annually

Table 1 Recommended Soakaway Maintenance Tasks

Maintenance (Attenuation System)

Maintenance activities for the attenuation surface water drainage system will broadly comprise the recommendation shown in **Table 2**, below, which has been reproduced from Susdrain and the CIRIC SuDS Manual (C753).

ATTENUATION TANK		
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 form the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank form 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 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

Table 2 Attenuation System: Maintenance Recommendations

[redacted]

Conclusions

- The site is within the Plymouth Critical Drainage area and special consideration has been given to surface water drainage of the site. The proposed drainage infrastructure has been designed in accordance with guidance outlined in the Plymouth City Council: Local Flood Risk Management Strategy.

- Two potential drainage options have been outlined to drain surface water from the development dependent on ground conditions, an infiltration solution Option 1 and an attenuation solution Option 2. Ground investigations will be undertaken at the detailed design stage to confirm the drainage option to be adopted.

- The potential surface water drainage layouts are shown on Drawing **3001B** included in **Annex A**. This will control the surface water runoff rate from the site and ensure it meets the drainage guidance for this area. The development offers the opportunity to reduce runoff rates compared to the existing situation regardless of which drainage option is subsequently implemented.

- The drainage system will remain in private ownership and the property owner will be responsible for maintenance of the system. Maintenance will comprise periodic inspection of gutters, downpipes and chambers, with removal of silt and debris as necessary.

- Provided the recommendations outlined in this report are adopted in the development proposal, then there is the capacity to manage the surface water runoff from the development. With regard to the criteria outlined in the NPPF, PPG and Local Flood Risk Management Strategy, the development is appropriate on this site from a flood risk perspective.

Yours sincerely
For and on behalf of EDS

[redacted]

Joshua Munyard
Project Engineer

Enc. Annex A Proposed Drainage Layout
Annex B Calcs

[redacted]

ANNEX A – PROPOSED DRAINAGE LAYOUT

KEY

PROPOSED PRIVATE SURFACE WATER DRAINAGE 100mm @ 1:100min (UNLESS STATED)

PROPOSED SOAKAWAY CONSTRUCTED USING MODULAR INFILTRATION UNITS

PROPOSED PRIVATE SURFACE WATER POLYPROPYLENE INSPECTION CHAMBER (475Ø/600Ø P.P.I.C.)

PROPOSED CATCHPIT WITH LEAF AND DEBRIS FILTER

FLOOD ROUTING

EXISTING PUBLIC COMBINED SEWER SHOWN INDICATIVELY

Garden

CAUTION ! UNDERGROUND UTILITY SERVICES NOT SHOWN ON DRAWING

PROPOSED COVERED EXTENSION APPROX IMPERMEABLE AREA 100m2

EXTENSION IS PROPOSED TO BE BUILT OVER AN EXISTING PUBLIC SEWER EITHER A REQUEST TO BUILD OVER APPLICATION OR A SEVER DIVERSION NEEDS TO BE SUBMITTED TO SWW

Public WC's

roof plan 1:50

EXISTING ROOF TO DRAIN AS PER EXISTING SCENARIO.

PROPOSED SOAKAWAY CONSISTING OF MODULAR INFILTRATION UNITS (AQUACELL OR SIMILAR) USING AN ASSUMED RATE OF 0.150m/hr PROVIDING A MINIMUM USABLE STORAGE VOLUME OF 6.84m³ 2m (w) × 3m (l) x 1.2m (d)

SURFACE WATER DRAINAGE LAYOUT OPTION A INFILTRATION

SCALE AT 1:100

KEY

PROPOSED PRIVATE SURFACE WATER DRAINAGE 100mm @ 1:100min (UNLESS STATED)

PROPOSED ATTENUATION TANKS CONSTRUCTED USING MODULAR UNITS

PROPOSED FLOW CONTROL DEVICE

PROPOSED PRIVATE SURFACE WATER POLYPROPYLENE INSPECTION CHAMBER (475Ø/600Ø P.P.I.C.)

PROPOSED CATCHPIT WITH LEAF AND DEBRIS FILTER

FLOOD ROUTING

EXISTING PUBLIC COMBINED SEWER SHOWN INDICATIVELY

CAUTION ! UNDERGROUND UTILITY SERVICES NOT SHOWN ON DRAWING

31.5m

Garden

PROPOSED COVERED EXTENSION APPROX IMPERMEABLE AREA 100m²

EXTENSION IS PROPOSED TO BE BUILT OVER AN EXISTING PUBLIC SEWER EITHER A REQUEST TO BUILD OVER APPLICATION OR A SEVER DIVERSION NEEDS TO BE SUBMITTED TO SWW

33.7m

30.7m

PROPOSED CONNECTION TO PUBLIC COMBINE SEWER SHOWN INDICATIVELY SUBJECT TO A S106 APPLICATION CONTRACTOR TO CONFIRM DEPTH AND LOCATION OF PUBLIC SEWER

EXISTING ROOF TO DRAIN AS PER EXISTING SCENARIO

OUTFALL ROUTE SHOWN INDICATIVELY

West S

PROPOSED ATTENUATION TANK CONSISTING OF MODULAR UNITS (AQUACELL OR SIMILAR) PROVIDING A MINIMUM USABLE STORAGE VOLUME OF 4m³ 2m (w) × 2.5m (l) ×0.8m (d)

PROPOSED PRE-CAST CONCRETE MANHOLE CONTAINING A FLOW CONTROL DEVICE LIMITING FLOWS TO 1.0 l/s AT 0.90m HEAD

31.7m

Tree

SURFACE WATER DRAINAGE LAYOUT OPTION A ATTENUATION

SCALE AT 1:200

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NOTES

1. This drawing is copyright. Refer to details above.
2. This drawing is only to be used for the purposes described in the status box below. Work to figured dimensions only, do not scale for construction purposes.
3. This drawing is to be read in conjunction with all other drawings, details and specifications pertaining to the work described. It should only be used for the purpose marked in the status box below, and shall not be used for construction unless clearly marked CONSTRUCTION.
4. Materials and workmanship shall comply to the appropriate British Standards and Codes of Practice unless otherwise stated.
5. The activities required to construct the work, shown on drawings clearly marked CONSTRUCTION, may be subject to the provisions of the Construction (Design & Management) Regulations 2015. The Contractor and Client must ensure that they are adequately conversant with these regulations and that the appropriate procedures required under the regulations are observed at all times.
6. The contractor is responsible for locating services prior to excavation. Any services shown on the drawing should be considered 'indicative' only. Where no services are shown on the drawing it does not necessarily mean there are no services present, only that a services search has not been undertaken. Where in doubt refer to HSE booklet "avoiding danger from underground services"
7. Design Risk Assessment

   A risk assessment relating to potential hazards associated with the works described within this drawing, in so far as they have been designed by EDS Ltd, has been undertaken. Risks identified have been eliminated by design wherever practicable. The status with regard to residual risks is as follows:

   The work is at an early planning stage and is not sufficiently advanced to allow a meaningful assessment of risks to be undertaken at this time.

Designer - EDS Drawing revision - B
Date - 03.11.23

DATE	DRWN	CHKD	REV.	NOTES
27.11.23	JM	EB	B	ATTENUATION TANK RELOCATED
03.11.23	JM	TPS	A	PRELIMINARY ISSUE

PROJECT MANAGER.-	TIM SULLIVAN
PROJECT ENGINEER.-	JOSHUA MUNYARO
DRAWN DATE.-	NOV 2023
SCALE & SHEET SIZE.-	AS STATED @ A1

PRELIMINARY

EDS
Engineering & Development Solutions
- Flood Risk Assessment
- SuDS and Surface Water
- Foul and Sewage Treatment
- Highway Design
- Civil Engineering
- Statutory Approvals

EDS, Unit E4, Threemilestone Industrial Estate, Threemilestone, Truro, Cornwall TR4 9LD (01872) 306311 (Mob) 07973816457

Email: jan@eadsolutions.co.uk
www.eadsolutions.co.uk

CLIENT
SB PLYMOUTH LIMITED

PROJECT
PROPOSED EXTENSION AT THE HOE LODGE RESTRAUNT, PLYMOUTH

DRAWING TITLE
SURFACE WATER DRAINAGE LAYOUT

PROJECT No.	DRAWING No.	REV.
J-3184	3001	B

ANNEX B – CALCS

Summary of Results for 100 year Return Period (+50%)

Half Drain Time : 37 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.041	0.441	0.0	0.9	0.9	2.1	O K
30 min Summer	35.127	0.527	0.0	0.9	0.9	2.5	O K
60 min Summer	35.162	0.562	0.0	0.9	0.9	2.7	O K
120 min Summer	35.081	0.481	0.0	0.9	0.9	2.3	O K
180 min Summer	35.002	0.402	0.0	0.9	0.9	1.9	O K
240 min Summer	34.916	0.316	0.0	0.9	0.9	1.5	O K
360 min Summer	34.767	0.167	0.0	0.9	0.9	0.8	O K
480 min Summer	34.678	0.078	0.0	0.9	0.9	0.4	O K
600 min Summer	34.628	0.028	0.0	0.8	0.8	0.1	O K
720 min Summer	34.604	0.004	0.0	0.8	0.8	0.0	O K
960 min Summer	34.600	0.000	0.0	0.7	0.7	0.0	O K
1440 min Summer	34.600	0.000	0.0	0.5	0.5	0.0	O K
2160 min Summer	34.600	0.000	0.0	0.3	0.3	0.0	O K
2880 min Summer	34.600	0.000	0.0	0.3	0.3	0.0	O K
4320 min Summer	34.600	0.000	0.0	0.2	0.2	0.0	O K
5760 min Summer	34.600	0.000	0.0	0.2	0.2	0.0	O K
7200 min Summer	34.600	0.000	0.0	0.1	0.1	0.0	O K
8640 min Summer	34.600	0.000	0.0	0.1	0.1	0.0	O K
10080 min Summer	34.600	0.000	0.0	0.1	0.1	0.0	O K
15 min Winter	35.112	0.512	0.0	0.9	0.9	2.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	153.600	0.0	2.9	16
30 min Summer	105.900	0.0	4.0	28
60 min Summer	69.450	0.0	5.2	46
120 min Summer	40.789	0.0	6.1	80
180 min Summer	29.855	0.0	6.7	114
240 min Summer	23.920	0.0	7.2	148
360 min Summer	17.496	0.0	7.9	204
480 min Summer	13.967	0.0	8.4	260
600 min Summer	11.703	0.0	8.8	314
720 min Summer	10.114	0.0	9.1	368
960 min Summer	8.013	0.0	9.6	0
1440 min Summer	5.740	0.0	10.3	0
2160 min Summer	4.102	0.0	11.1	0
2880 min Summer	3.246	0.0	11.7	0
4320 min Summer	2.369	0.0	12.8	0
5760 min Summer	1.922	0.0	13.8	0
7200 min Summer	1.660	0.0	14.9	0
8640 min Summer	1.488	0.0	16.1	0
10080 min Summer	1.369	0.0	17.2	0
15 min Winter	153.600	0.0	3.2	16

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Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	35.224	0.624	0.0	0.9	0.9	3.0	O K
60 min Winter	35.258	0.658	0.0	0.9	0.9	3.1	O K
120 min Winter	35.137	0.537	0.0	0.9	0.9	2.6	O K
180 min Winter	35.014	0.414	0.0	0.9	0.9	2.0	O K
240 min Winter	34.870	0.270	0.0	0.9	0.9	1.3	O K
360 min Winter	34.680	0.080	0.0	0.9	0.9	0.4	O K
480 min Winter	34.604	0.004	0.0	0.8	0.8	0.0	O K
600 min Winter	34.600	0.000	0.0	0.7	0.7	0.0	O K
720 min Winter	34.600	0.000	0.0	0.6	0.6	0.0	O K
960 min Winter	34.600	0.000	0.0	0.5	0.5	0.0	O K
1440 min Winter	34.600	0.000	0.0	0.3	0.3	0.0	O K
2160 min Winter	34.600	0.000	0.0	0.2	0.2	0.0	O K
2880 min Winter	34.600	0.000	0.0	0.2	0.2	0.0	O K
4320 min Winter	34.600	0.000	0.0	0.1	0.1	0.0	O K
5760 min Winter	34.600	0.000	0.0	0.1	0.1	0.0	O K
7200 min Winter	34.600	0.000	0.0	0.1	0.1	0.0	O K
8640 min Winter	34.600	0.000	0.0	0.1	0.1	0.0	O K
10080 min Winter	34.600	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	105.900	0.0	4.5	30
60 min Winter	69.450	0.0	5.9	48
120 min Winter	40.789	0.0	6.8	86
180 min Winter	29.855	0.0	7.6	124
240 min Winter	23.920	0.0	8.1	156
360 min Winter	17.496	0.0	8.8	206
480 min Winter	13.967	0.0	9.4	252
600 min Winter	11.703	0.0	9.8	0
720 min Winter	10.114	0.0	10.2	0
960 min Winter	8.013	0.0	10.8	0
1440 min Winter	5.740	0.0	11.6	0
2160 min Winter	4.102	0.0	12.4	0
2880 min Winter	3.246	0.0	13.1	0
4320 min Winter	2.369	0.0	14.3	0
5760 min Winter	1.922	0.0	15.5	0
7200 min Winter	1.660	0.0	16.7	0
8640 min Winter	1.488	0.0	18.0	0
10080 min Winter	1.369	0.0	19.3	0

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 247887 53907 SX 47887 53907
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+50

Time Area Diagram

Total Area (ha) 0.010

Time (mins) From:	To:	Area (ha)
0	4	0.010

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Model Details

Storage is Online Cover Level (m) 36.000

Cellular Storage Structure

Invert Level (m) 34.600 Safety Factor 3.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	5.0	5.0	0.801	0.0	12.2
0.800	5.0	12.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0048-1000-0900-1000
Design Head (m)	0.900
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	48
Invert Level (m)	34.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	1.0	Kick-Flo®	0.428	0.7
Flush-Flo™	0.212	0.9	Mean Flow over Head Range	-	0.8

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	0.8	1.200	1.1	3.000	1.7	7.000	2.5
0.200	0.9	1.400	1.2	3.500	1.8	7.500	2.6
0.300	0.9	1.600	1.3	4.000	2.0	8.000	2.7
0.400	0.8	1.800	1.4	4.500	2.1	8.500	2.8
0.500	0.8	2.000	1.4	5.000	2.2	9.000	2.9
0.600	0.8	2.200	1.5	5.500	2.3	9.500	2.9
0.800	0.9	2.400	1.6	6.000	2.4		
1.000	1.0	2.600	1.6	6.500	2.5		

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Summary of Results for 100 year Return Period (+50%)

Half Drain Time : 266 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	34.485	0.485	0.2	2.8	O K
30 min Summer	34.656	0.656	0.2	3.7	O K
60 min Summer	34.826	0.826	0.2	4.7	O K
120 min Summer	34.893	0.893	0.2	5.1	O K
180 min Summer	34.905	0.905	0.2	5.2	O K
240 min Summer	34.903	0.903	0.2	5.1	O K
360 min Summer	34.891	0.891	0.2	5.1	O K
480 min Summer	34.868	0.868	0.2	4.9	O K
600 min Summer	34.840	0.840	0.2	4.8	O K
720 min Summer	34.810	0.810	0.2	4.6	O K
960 min Summer	34.753	0.753	0.2	4.3	O K
1440 min Summer	34.652	0.652	0.2	3.7	O K
2160 min Summer	34.529	0.529	0.2	3.0	O K
2880 min Summer	34.437	0.437	0.1	2.5	O K
4320 min Summer	34.309	0.309	0.1	1.8	O K
5760 min Summer	34.225	0.225	0.1	1.3	O K
7200 min Summer	34.170	0.170	0.1	1.0	O K
8640 min Summer	34.130	0.130	0.1	0.7	O K
10080 min Summer	34.104	0.104	0.1	0.6	O K
15 min Winter	34.545	0.545	0.2	3.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	153.600	0.0	18
30 min Summer	105.900	0.0	33
60 min Summer	69.450	0.0	62
120 min Summer	40.789	0.0	122
180 min Summer	29.855	0.0	176
240 min Summer	23.920	0.0	202
360 min Summer	17.496	0.0	266
480 min Summer	13.967	0.0	334
600 min Summer	11.703	0.0	404
720 min Summer	10.114	0.0	472
960 min Summer	8.013	0.0	608
1440 min Summer	5.740	0.0	880
2160 min Summer	4.102	0.0	1276
2880 min Summer	3.246	0.0	1644
4320 min Summer	2.369	0.0	2380
5760 min Summer	1.922	0.0	3112
7200 min Summer	1.660	0.0	3824
8640 min Summer	1.488	0.0	4576
10080 min Summer	1.369	0.0	5248
15 min Winter	153.600	0.0	18

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Summary of Results for 100 year Return Period (+50%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	34.738	0.738	0.2	4.2	O K
60 min Winter	34.932	0.932	0.2	5.3	O K
120 min Winter	35.016	1.016	0.2	5.8	O K
180 min Winter	35.038	1.038	0.2	5.9	O K
240 min Winter	35.035	1.035	0.2	5.9	O K
360 min Winter	35.018	1.018	0.2	5.8	O K
480 min Winter	34.988	0.988	0.2	5.6	O K
600 min Winter	34.949	0.949	0.2	5.4	O K
720 min Winter	34.908	0.908	0.2	5.2	O K
960 min Winter	34.826	0.826	0.2	4.7	O K
1440 min Winter	34.683	0.683	0.2	3.9	O K
2160 min Winter	34.517	0.517	0.2	2.9	O K
2880 min Winter	34.394	0.394	0.1	2.2	O K
4320 min Winter	34.232	0.232	0.1	1.3	O K
5760 min Winter	34.131	0.131	0.1	0.7	O K
7200 min Winter	34.071	0.071	0.1	0.4	O K
8640 min Winter	34.049	0.049	0.1	0.3	O K
10080 min Winter	34.045	0.045	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	105.900	0.0	33
60 min Winter	69.450	0.0	62
120 min Winter	40.789	0.0	118
180 min Winter	29.855	0.0	174
240 min Winter	23.920	0.0	224
360 min Winter	17.496	0.0	280
480 min Winter	13.967	0.0	356
600 min Winter	11.703	0.0	434
720 min Winter	10.114	0.0	508
960 min Winter	8.013	0.0	656
1440 min Winter	5.740	0.0	938
2160 min Winter	4.102	0.0	1340
2880 min Winter	3.246	0.0	1732
4320 min Winter	2.369	0.0	2468
5760 min Winter	1.922	0.0	3176
7200 min Winter	1.660	0.0	3824
8640 min Winter	1.488	0.0	4368
10080 min Winter	1.369	0.0	5072

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 247887 53907 SX 47887 53907
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+50

Time Area Diagram

Total Area (ha) 0.010

Time (mins) From:	To:	Area (ha)
0	4	0.010

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Model Details

Storage is Online Cover Level (m) 36.000

Cellular Storage Structure

Invert Level (m) 34.000 Safety Factor 3.0
Infiltration Coefficient Base (m/hr) 0.15000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.15000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	6.0	6.0	1.201	0.0	18.0
1.200	6.0	18.0			

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