

ISG Construction Ltd

**Millwood School
New Classroom Block**

Surface Water Management Report

Compiled by:

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REVISION HISTORY

A	22.08.23	Issued for Planning	MDS
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Preliminary Note

This report has been produced by Mark Symonds who has over 19 years' experience in infrastructure engineering (in particular surface water management design) and has qualifications including: BSc (Hons) Civil Engineering (2003); HND Civil Engineering Studies (2002); and OND Construction Studies (2000).

1. Introduction

Bradshaw Gass & Hope LLP have produced this surface water management report in support of an application for a new classroom block at Millwood School, School Street, Bury, M26 3BW (hereafter referred to as the 'Site').

The report describes and demonstrates how the surface water run-off rate and volume from the Site will be managed to adhere to National and local planning policies, regulations, and relevant design guidance, which include:

- National Planning Policy Framework (NPPF), July 2021, Paragraphs 153-158 and 159-169;
- National Planning Practice Guidance (NPPG) ('Flood Risk and Coastal Change' section), released in March 2014 and updated in August 2022;
- National Standards for Sustainable Drainage Systems (SuDS) set out by the Department for Environment, Food & Rural Affairs (DEFRA) (2011);
- CIRIA (2010) Planning for SuDS – Making it Happen C687;
- CIRIA SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015);
- Bury Council Preliminary Flood Risk Assessment (May 2011);
- Bury, Rochdale and Oldham Strategic Flood Risk Assessment (November 2009);
- Greater Manchester Surface Water Management Plan (January 2012);
- Bury Council Local Plan - Topic Paper 6 – Flood Risk (October 2018).

Bury Metropolitan Borough Council (acting as Lead Local Flood Authority - LLFA), and United Utilities (local water company and sewerage undertaker), need to be satisfied that the design and drainage principles of the proposed development:

- will address the surface water management and risk of flooding within the site;
- will ensure that the drainage is managed and maintained for its lifetime to prevent flooding;
- will ensure that the development will not increase the risk of flooding to neighbouring land and property.

The report is formatted such that it identifies and references appropriate design parameters, shows by calculation how the proposed drainage strategy can meet the various requirements and ultimately controls, mitigates and reduces future flood risk both on and off site.

2. National Policies and Water Management Guidance

2.1. National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG)

The NPPF (July 2021) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced. This document is used to form this surface water management report, with particular attention to Paragraphs 153 to 158 Planning for Climate Change, and Paragraphs 159 to 169 Planning for Flood Risk.

NPPG, Paragraph 051 states that sustainable drainage systems (SuDS) are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, where they provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban run-off at source; and to combine water management with green space with benefits for amenity, recreation, and wildlife.

Further to this NPPG, Paragraph 080 states that the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable which (in order) are into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain, or another drainage system; to a combined sewer.

2.2. Flood and Water Management Act

The Flood and Water Management Act (FWMA) received royal assent in April 2010, aiming to create a simpler and more effective means of managing flood risk and coastal erosion. The FWMA incorporates and implements some of the recommendations from the Pitt Review (2008), following the severe flooding that affected a large area of the UK in 2007.

The FWMA also places several new duties and responsibilities on LLFAs regarding the management of local flood risk, to: Develop, maintain, apply, and monitor a Local Flood Risk Management Strategy; Approve, adopt, and maintain Sustainable Drainage Systems (SuDS) (yet to be implemented); Establish and maintain a flood risk Asset Register; Investigate incidents of flooding (where appropriate) and publish the findings in a report; Ensure delivery of effective and joined up management of flood risk.

3. Site Setting and Description

3.1. Site Location

The Site is within the grounds of Millwood School, which is approximately 750m west of Radcliffe station. The Site is to the west of the existing school building, and is bound by the school playing fields to the north; School Street to the south; and Manchester, Bolton and Bury Canal to the west.

The address of the Site is Millwood School, School Street, Bury, M26 3BW, with the co-ordinates for the centre of the Site being E: 377845, N: 407110.

3.2. Existing Site and Topography

As detailed on the existing site / topographical survey plan in Appendix A, the Site currently, in a pre-development site mainly consists of the school playing fields with a small area of playground area to the north-east. As most of the development area is a playing field, it is deemed to be a greenfield site.

In terms of topography the Site is relatively flat, with the levels ranging from approximately 78.67m AOD to the centre to approximately 78.40m towards the southern boundary.

3.3. Proposed Development

The proposed site plan is shown in Appendix B, with a full description being stated by the Architect. In brief, and in relation to this surface water management report, the proposal is to build a new classroom block to the west of the existing school building. The new classroom block will have associated playground areas and pedestrian access areas around the perimeter.

3.4. Ground Conditions

A ground investigation report was issued by Sub Surface North-West Limited in July 2023 states that the Site consists of made ground over bands of sand and clay, with groundwater monitored as shallow as 1.38m bgl.

A ground investigation report was also issued by Atkins in February 2010, which also found the Site to consist of made ground over bands of sand and clay with groundwater monitored as shallow as 0.47m bgl. This report also states contamination of the made ground to depths of 600mm.

3.5. Waterbody / Rivers / Canals / Reservoirs

The nearest waterbody to the site is the disused Manchester, Bolton, and Bury Canal, which is approximately 10m west of the Site boundary. There are no other no known waterbodies directly adjacent to the Site.

3.6. Public Sewers

As detailed on the United Utilities pre-development response and asset plan in Appendix D, there is a 150mm diameter surface water sewer to the south of the Site in School Street, that flows in a west to east direction.

3.7. Development Areas

The Site is currently undeveloped, and therefore the surface water from all the Site discharges off the Site at a greenfield rate.

The proposed classroom building and associated proposed playground and footpaths around the perimeter equate to an area of 2,130m² / 0.213 ha. Therefore, the post development surface water run-off area is **0.213 ha**.

4. Surface Water Management Principles

The surface water for the development areas of the site is to be managed so that it adheres to the current national regulations and local authority requirements.

4.1. Run-Off Destination

Surface water run-off is to discharge to one or more of the following in the order of priority shown:

- Discharge into the ground (infiltration);
- Discharge to a surface water body;
- Discharge to a surface water sewer, highway drain or other drain;
- Discharge to combined sewer.

4.2. The Management Train

A concept fundamental to implementing a successful SuDS scheme is the management train. This is a sequence of SuDS components that serve to reduce run-off rates and volumes and reduce pollution. The hierarchy of techniques that are to be used for the surface water management of the development are:

- Prevention - Prevention of run-off by good site design and reduction of impermeable areas;
- Source Control - Dealing with water where and when it falls (e.g. infiltration techniques);
- Site Control - Management of water in the local area (e.g. swales, detention basins);
- Regional Control - Management of run-off from sites (e.g. balancing ponds, wetlands).

4.3. Design Principles

The design principles for the surface water management of the development will be to:

- Ensure that people, property, and critical infrastructure are protected from flooding;
- Ensure that the development does not increase flood risk off site;
- Ensure that SuDS can be economically maintained for the development.

4.4. Peak Surface Water Flow

DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems states:

‘S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100-year rainfall event should never exceed the peak greenfield runoff rate for the same event’.

4.5. Volume Control

DEFRA Non-statutory technical standards for sustainable drainage systems states:

‘S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6-hour rainfall event should never exceed the greenfield runoff volume for the same event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk’.

4.6. Flood Risk within Development

National Non-statutory technical standards for sustainable drainage systems states:

'S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30-year rainfall event.'

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100-year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100-year rainfall event are managed in exceedance routes that minimise the risks to people and property'.

4.7. Pollution / Water Quality

The SuDS design for the development site will ensure that the quality of any receiving water body is not adversely affected and preferably enhanced in accordance with Ciria SuDS Manual C753, Chapter 4.

4.8. Designing for Exceedance

The development site design will be such that when SuDS features fail or are exceeded, exceedance flows do not cause flooding of properties on or off site. This is achieved by completely containing the surface water within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 30-year event. The design of the site ensures that flows from rainfall more than a 1 in 30-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

5. Surface Water Run-Off Destination

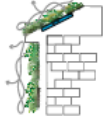
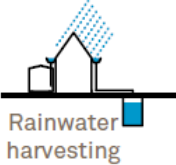
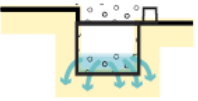
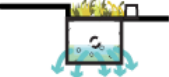
The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

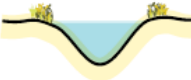
Run-Off Destination	Feasible	Description
Discharge to Ground	No	As stated in Section 3.4, two ground investigation reports state that the Site consists of made ground over bands of sand and clay, with groundwater monitored as shallow as 0.47m and 1.38m bgl. In accordance with CIRIA 753, soakaways are to be at least 1.0m above known groundwater levels, and therefore based on this the groundwater level is too shallow for soakaways to be viable. Also, soakaways cannot be built within contaminated land / made ground, and clay is known to have exceptionally low infiltration value.
Discharge to Surface Water Body	No	The Manchester, Bolton and Bury Canal is 10m north of the Site boundary. However, this canal is not discussed and therefore is not maintained which may result in the blockage of any outfalls and subsequent flooding. Also, discharge to the canal will require the removal of the canal path and wall which is to be preserved, therefore excavation of these features to install new drainage will not be permitted by the Manchester, Bolton and Bury canal society
Discharge to Surface Water Sewer	Yes	As the surface water cannot discharge to ground, and discharge to the canal is not feasible, the only alternative is to discharge to the 150mm surface water sewer south of the Site in School Street.
Discharge to Highway Drain or Other	No	There are no known highway or other drains near to the development site. Therefore, discharge to a highway or other drain is not feasible.
Discharge to Combined Water Sewer	No	There is a combined water sewer in School Street, but direct discharge to this is not required.

6. SuDS Feasibility

To reduce the surface water run-off to the greenfield rate, SuDS methods are to be introduced to the post development design.

SuDS methods as per the Sustainable Drainage System (SuDS) hierarchy, and the Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015, that can be used are detailed below:

	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	 Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	 Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	 Open space	Dependant on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	 Open space	Minimum length 5 metres.
 Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below.	 Street/open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	 Street/open space	Typically surface area is 5-10% of drained area with storage below.

	Description	Setting	Required area
 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	 Street/open space	Account for width to allow safe maintenance typically 2-3 metres wide.
 Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	 Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	 Open space	Dependant on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	 Open space	Typically 5-15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	 Open space	Dependant on runoff volumes and soils.

The feasibility of the above SuDS methods for the post developed site are summarised in the table below:

SuDS Method	Potential Use	Description
Green Roofs	No	The classroom block roof has not been structurally designed for a green roof, and therefore this isn't a feasible SuDS method.
Rainwater Harvesting	Yes	The Site is an extension of an existing school which is already connected to the water main system, and therefore rainwater harvesting for water re-use inside the school will not be practical. However, water butts can be placed at several rainwater pipe locations, where the water can be re-used for irrigation.
Soakaway	No	As stated in Sections 3.4 and 5, two ground investigation reports state that the Site consists of made ground over bands of sand and clay, with groundwater monitored as shallow as 0.47m and 1.38m bgl. In accordance with CIRIA 753, soakaways are to be at least 1.0m above known groundwater levels. Therefore, based on this the groundwater level is too shallow for soakaways to be viable.

		Also, soakaways cannot be built within contaminated land / made ground, and clay is known to have exceptionally low infiltration value.
Filter Strips	Yes	Filter strips in the form of 300x300mm granular trenches filled with 20mm no fines aggregate and housing a perforated pipe, can be formed in the existing grassed area along the footpaths. Surface water from the footpaths can discharge to the filter drain, won't discharge to ground, but will be conveyed to the main drainage network. The filter drain will reduce the surface water run-off rates and act as a pollutant control.
Permeable Surfacing	Yes	There is potential to have permeable surfacing within the playground areas around the perimeter of the new classroom block. The permeable surface will take the surface water run-off from the playground, won't discharge the surface water to ground, but will be conveyed to the main drainage network via a perforated pipe, act as a pollutant control, and will provide attenuation. The granular material within the sub-base will be formed of 20mm granular material, which has a 30% void ratio, and can act as attenuation.
Bioretention Area / Swale / Pond	No	The Site will consist of the new classroom block, footpaths and playground areas only, with the grassed areas within the main Millwood School site remaining as recreational areas. Therefore, these are not a suitable SuDS method.
Raised Planters	Yes	Raised planters can be installed at rainwater down pipe locations, and will take the surface water run-off from the roof area. The surface water from the rainwater pipe will percolate through the raised planter prior to discharge to the main drainage network. The raised planter will also act as a pollutant control.
Underground Storage	Yes	The surface water run-off from the site will be restricted. Therefore, there will be a requirement to have underground storage for storm events up to 1 in 30-year; and to suitably sized so that the volume of water during the 1 in 100-year storm event is kept a minimum at surface level, where it can be contained on the site.

7. Development Greenfield Run-Off Rates

To minimise the surface water run-off from the new fire station site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rates and volume.

7.1. Greenfield Run-Off Rate

The Flood Estimation Handbook (FEH) is often used for the calculation of the greenfield run-off rate, however, relevant documents state that to calculate the greenfield run-off rates on small catchments less than 25km², the IH 124 QBAR equation (and the equation for the instantaneous time to peak for the unit hydrograph approach) is to be used.

The IH method is based on the Flood Studies Report (FSR) approach and is developed for use on catchments less than 25km². It yields the Mean Annual Maximum Flood (QBAR). This reference also recommends the use of Ciria C753 Table 24.2 to generate Growth Factors. These are used to convert QBAR to different return periods for different regions in the UK.

The input variables to establish QBAR are:

Return Period (years) Results based on a range of return periods and the specified RP;

Area Catchment Area (ha) which is adjusted to km² for use in the equation;

SAAR Average annual rainfall in mm (1941-1970) from FSR figure II.3.1;

Soil Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively;

Urban Proportion of area urbanised expressed as a decimal;

Region Number Region number of the catchment based on FSR Figure I.2.4.

QBAR(l/s)

The output variables to establish QBAR are calculated using the following formula (equation yields m³/s):

$$\text{QBAR} = 0.00108 \times \text{AREA}^{0.89} \times \text{SAAR}^{1.17} \times \text{SOIL}^{2.17}$$

The IH 124 Variables (taken from FSR) that are specific to this site are as follows:

Area = 50.00 ha (required area for calculation)

SAAR = 950

Soil = 0.450

Urban Factor = 0.00

Region Number = 10

The calculations in Appendix D show the rate for 50.00ha is 314.0 l/s, but is to be reduced to reflect the surface water catchment area (0.213 ha) of the development site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

$$\text{QBAR} = 1.34 \text{ l/s (6.28 l/s/ha)}$$

Ciria C753 Table 24.2 identifies the growth factors for each of the storm events, based on the known QBAR figure. The growth factors from the table vary depending on the site location. In this case hydrometric area (Region Number) is 10.

Based on the figures shown in the table, the growth factors, and the existing greenfield run-off rates for each of the storm events for the development areas of the site are as follows:

Storm Event	QBAR	Growth Factor (C753 Table 24.2)	Greenfield Run-off Rate
Q ₂	1.34 l/s	0.93	1.2 l/s
Q ₃₀	1.34 l/s	1.70	2.3 l/s
Q ₁₀₀	1.34 l/s	2.08	2.8 l/s

7.2. Greenfield Run-Off Volume

The greenfield run-off volume for the 100-year, 6-hour storm event has also been calculated in the MicroDrainage software using the data from the FEH 2013, with the results shown in Appendix D.

The FEH 2013 data and variables used to calculate the greenfield run-off volume at the Site location area as follows:

Site Location	=	GB 377929 407139 SD 77929 07139
Area	=	0.213 ha
SAAR	=	1054
CWI	=	123.486
SPR Host	=	47.000
URBTEXT	=	0.00

Based on these calculation results (Appendix D), the greenfield run-off volume for the surface water management area of the Site is:

Q ₁₀₀ (6-Hour)	=	71.85m ³ (337.34m ³ /ha)
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8. Below Ground Drainage Networks and Surface Water Management Calculations

8.1. Climate Change Allowance

The NPPF makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are taken from the Environment Agency guidance summarised in Figure 1 below.

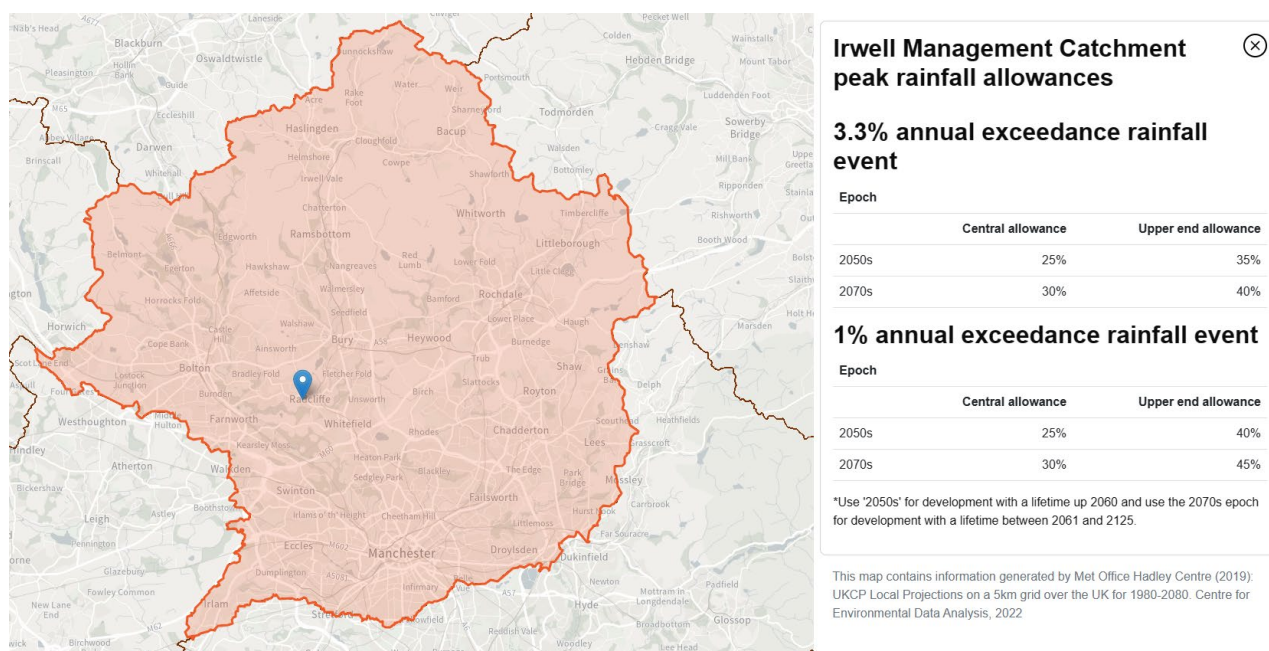


Figure 1 - Department for Environment Food & Rural Affairs – Climate Change Allowances

The lifetime of the extension is likely to be beyond 2061, and therefore the Epoch 2070's is to be used with Upper End Allowance. Therefore, the climate change allowance for the pre and post development surface water run-off will be **40%** and **45%** for the 30-year and 100-year storms, respectively.

8.2. Surface Water Network Calculations

The calculations to determine the post development surface water run-off rates are based on the surface water run-off area of 0.153 ha, and the rainfall data given by the FEH 2013.

8.3. Surface Water Drainage Network and Management

As shown on the below ground drainage layout drawing in Appendix E, the proposed surface water network will consist of 150mm diameter pipes, 460mm diameter inspection chambers, water butts, filter drains, permeable surfacing, raised planters, a flow control chamber containing a hydro-brake and orifice, a below ground attenuation tank in the form of cellular units.

The surface water run-off from the roof areas will discharge to the main drainage network via water butts and raised planters, and the surface water run-off from the external areas will discharge to the main drainage via filter drains and permeable surfacing.

The surface water network will flow to the south of the Site, where it will pass through the flow control chamber, prior to discharge to the 150mm diameter surface water sewer in School Street.

The restricted surface water will surcharge the drainage network and will be attenuated within the cellular units to prevent flooding.

8.4. Surface Water Run-Off Rate

For the surface water run-off from the Site to be at the greenfield run-off rate, they are to be restricted to 1.2 l/s for the 1 in 2-year storm event, 2.3 l/s for the 1 in 30-year storm event including 40% allowance, and 2.8 l/s for the 1 in 100-year storm event including 45% allowance.

To achieve the equivalent greenfield run-off rates, it is proposed to use a complex flow control chamber, where a hydro-brake at the invert level of the chamber will restrict the surface water during 1-year and 30-year storm event + 40% allowance, and an orifice plate set higher in the chamber, will allow additional surface water flow from the chamber during the 100-year storm event + 45% allowance.

As shown in the output calculation from the MicroDrainage computer software in Appendix F, if the hydro-brake opening is set at 54mm, with a design head of 0.80m, and a design flow of 1.2 l/s (2-year greenfield rate), and an orifice is set 1.20m above the hydro-brake with a 35mm opening, the maximum surface water run-off rates for each storm event will be as follows:

Strom	-	Rate	-	Critical Storm Event
Q ₂	-	1.2 l/s	-	480-minute winter storm duration
Q _{30 + cc}	-	1.3 l/s	-	600-minute winter storm duration
Q _{100 + cc}	-	2.8 l/s	-	600-minute winter storm duration

A summary of the post development surface water run-off rates compared to the greenfield rates are as follows:

Greenfield Rate to Post Development Rate

Strom	-	Greenfield	-	Post Dev	-	Difference
Q ₂	-	1.2 l/s	-	1.2 l/s	-	Equivalent
Q _{30+ 40%}	-	2.3 l/s	-	1.3 l/s	-	43% Reduction
Q _{100 + 45%}	-	2.8 l/s	-	2.8 l/s	-	Equivalent

The results show that the post development run-off rates are equivalent to the 1-year and 100-year greenfield rates, and a 43% reduction of the 30-year greenfield rate.

Therefore, as the greenfield rates have not been exceeded, the discharge rates are deemed to be acceptable, as they meet the requirements set out in the SBC Surface Water Drainage Strategy Guidance and DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems – S2 (see Section 4.4).

8.5. Surface Water Run-Off Volume

The surface water run-off volumes for the post development site can be calculated for 1 in 100-Year the 6-hour duration (Inc. 45% allowance), based on the peak discharge rate of 2.8 l/s, where:

$$Q_{100 (6\text{-hour})} - 2.8 \text{ l/s} \times (60 \times 60 \times 6) - 60,480 \text{ litres} - 60.48\text{m}^3$$

A summary of the post development surface water run-off volume compared to the greenfield volumes are as follows:

Greenfield Volume to Post Development Volume

Strom	-	Greenfield	-	Post Dev	-	Difference
Q ₁₀₀	-	71.85m ³	-	60.48m ³	-	16% Reduction

The post development surface water run-off volume is a 9% reduction of the greenfield volume for the same storm event and duration.

Therefore, the discharge volume is deemed to be acceptable, as it meets the requirements set out in the DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems – S4 and S6 (see Section 4.5).

8.6. Surface Water Attenuation Calculations

As stated above, the post development run-off rates are restricted, there will be a requirement for surface water attenuation.

The attenuation structures / methods will be formed of a below ground attenuation tank in the form of cellular units, and the sub-base of the permeable surface systems in the playground south of the Site. Note sub-base for other permeable surfacing not used for attenuation due to level difference).

As detailed in the MicroDrainage calculations (Appendix F) and surface water management layout (Appendix E) the attenuation volumes and details for the SuDS method are as follows:

Cellular Units

Attenuation Tank Length	-	24.00m
Attenuation Tank Width	-	4.50m
Attenuation Tank Area	-	108.00m ²
Attenuation Tank Depth	-	1.20m
Porosity	-	0.95
Attenuation Tank Volume	-	123.10m³
<i>Overall Tank Volume</i>	-	<i>129.60m³</i>

Permeable Paving

Paving / Sub-Base Area	-	129.00m ²
Sub-Base Depth	-	0.30m
Porosity	-	0.30
Attenuation Volume	-	11.60m³

The MicroDrainage calculations (Appendix F) show that with these SuDS methods and volumes, no flooding will occur for all storms up to and including the 100-year + 45% allowance.

Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems – S7 to S9 (see Section 4.6).

9. Maintenance Requirements

The management and maintenance of the surface water drainage networks and SuDS features will be undertaken by caretakers of the Millwood School site and will form part of the regular management and maintenance regime of the school. Details of the required maintenance and management of the drainage and SuDS are as follows:

9.1. Surface Water Drainage Network, Cellular Units and Flow Control Chamber

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from manholes (where may cause risk performance)	Monthly
Where rainfall into network from above, check surface or filter for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from pipework by jetting.	Annually or as required
Repair/check all inlets, outlets, and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

9.2. Filter Drains, Permeable Surfacing and Raised Planters

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions.	Monthly for 3 months, then six monthlies
Debris removal from on surface of filter drains, permeable surfacing and raised planters or near system (where may cause risk performance).	Monthly
Rainfall infiltration into filter drains, permeable surfacing and raised planters is ensured working effectively.	As required, but at least twice a year

9.3. Linked and Further Maintenance Activities

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance for the new residential landscaped / garden areas. A log of all maintenance activities is to be kept and made available to the local planning authority (LPA) and / or the Lead Local Flood Authority (LLFA) on request.

10. Surface Water Design Exceedance

In the unlikely event of an extreme storm greater than 100-year + 45% allowance, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur.

Flood water will follow the existing / proposed topography of the ground and will flow away from the new classroom block and existing school building towards the southern boundary and into School Street.

Surface water will not flow towards any other buildings / properties prior to discharging onto School Street. Water will be contained in School Street due to the road having a gradient towards the canal (flows in channels) and upstand kerbs.

11. Water Quality

The level of water treatment is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26 sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment.

11.1. Roof and External Areas Pollutant Hazard

C753 Table 26.2 Pollution Hazard Level = Low

C753 Table 26.2 Pollution Hazard Index:

Total Suspended Solid (TSS)	=	0.3
Metals	=	0.2
Hydrocarbons	=	0.05
Pollution Hazard Index	=	<u>0.55</u>

11.2. Roof and External Areas Pollutant Mitigation

Mitigation Measures:

Permeable Surfacing and Raised Planters

Lowest Mitigation Indices:

Total Suspended Solid (TSS)	=	0.7
Metals	=	0.6
Hydrocarbons	=	0.7
SuDS Mitigation Indices	=	<u>2.00</u>

The mitigation indices are greater than the pollution hazard index, and therefore suitable water quality is achieved.

12. Development Management and Construction Phase

All existing drainage networks within the development area are to be maintained during construction.

12.1. Construction Environment Management Plan

Full details of the construction environment management plan (CEMP) have to be confirmed by the chosen contractor. However, the CEMP will conform to the requirements of CIRIA 753 – The SuDS Manual – Chapter 31, and will include:

12.2. Construction Access

The main construction traffic will access the site from the south of the Site (School Street) and will ensure that traffic over the proposed cellular units will be avoided.

12.3. Sediments and Traps

Sediment basins and traps are to be installed before any major site earthworks take place, with further sediment traps and silt fences being installed as the earthworks progresses. This will keep sediment contained on site at appropriate locations.

12.4. Run-Off Control Measures

Run-off control measures are to be used in conjunction with sediment traps to divert water around planned earthworks areas to remove silt. Any surface water upstream of the site is to be diverted around the development areas, and to be discharged to the existing drainage system. The surface water run-off destination for the diverted surface water will continue as existing.

12.5. Main Surface Water Run-Off Systems

The main drainage network, cellular units and flow control chambers, and outfall to existing drainage network are to be built prior to any phase of construction of site. Surface water from each of the phased area is to discharge to the new drainage network, where the water is adequately restricted, and water quality maintained before discharging to the existing sewer network. Temporary inlet and outlet protection measures and appropriate silt traps are to be installed to prevent silt ingress into the main drainage network.

12.6. Clearing and Earthworks

Clearing and earthworks will only start when adequate erosion and sediment control measures are in place. Once the development areas are cleared, earthworks will follow immediately to ensure that the ground cover can be re-established quickly. Adjacent land to that being developed will be left undisturbed for as long as possible.

12.7. Surface Stabilisation Measures

Surface stabilisation measures will be applied to completed areas, channels ditches and other disturbed areas after the land is cleared and profiled. Permanent stabilisation measures will be installed as soon as possible after final profiling.

12.8. Construction of Permeable Surfacing

Construction of permeable paving is to be left to the later stages of construction. Unsuitable sediment is to be removed from surfacing prior to installation of sand binder layer and paving.

13. Conclusion / Summary

13.1. SuDS Principles and Discharge Destination

All feasible SuDS methods, and surface water discharge destination have been assessed, with the feasible SuDS methods being water butts, filter drains, permeable surfacing, raised planters, cellular units, and a flow control chamber, and the surface water destination being to a surface water sewer.

13.2. Peak Flow Control

The post development run-off rates are equivalent to the 1-year and 100-year greenfield rates, and a 43% reduction of the 30-year greenfield rate. Therefore, as the greenfield rates have not been exceeded, the discharge rates are deemed to be acceptable, as they meet the requirements set out in the SBC Surface Water Drainage Strategy Guidance and DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems – S2 (see Section 4.4).

13.3. Volume Control

The post development surface water run-off volume is a 9% reduction of the greenfield volume for the same storm event and duration. Therefore, the discharge volume is deemed to be acceptable, as it meets the requirements set out in the DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems – S4 and S6 (see Section 4.5).

13.4. Flood Risk within the Development

The below ground cellular unit structure and sub-base of the permeable surfacing will be suitably sized so that no flooding occurs for all storms up to and including the 100-year + 45% allowance event. Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems – S7 to S9 (see Section 4.6).

13.5. Maintenance

The management and maintenance of the surface water drainage networks and SuDS features will be undertaken by caretakers of the Millwood School site and will form part of the regular management and maintenance regime of the school.

13.6. Exceedance Event

Flood water will follow the existing / proposed topography of the ground and will flow away from the new classroom block and existing school building towards the southern boundary and into School Street.

Surface water will not flow towards any other buildings / properties prior to discharging onto School Street. Water will be contained in School Street due to the road having a gradient towards the canal (flows in channels) and upstand kerbs.

13.7. Water Quality

The level of water treatment is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26 sets out the Pollution Hazard Indices for different land classifications, and how to calculate that against the SuDS mitigation indices to show suitable levels of treatment. With the pollutant control chamber, the mitigation indices are greater than the pollution hazard index, and therefore suitable water quality is achieved.

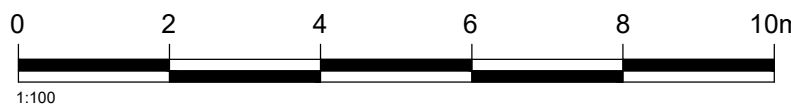
Appendix A - Topographical Survey

Appendix B - Proposed Site Plan



Room	Area	
Classroom 1	62.18	Sq.m
Classroom 2	62.18	Sq.m
Classroom 3	62.18	Sq.m
Classroom 4	62.18	Sq.m
Classroom 5	62.18	Sq.m
Classroom 6	62.18	Sq.m
Classroom 7	62.18	Sq.m
Group Room	7.78	Sq.m
Group Room	7.78	Sq.m
Group Room	7.78	Sq.m
Group Room	7.78	Sq.m
Group Room	7.78	Sq.m
Group Room	7.78	Sq.m
Food Prep	6.17	Sq.m
Food Prep	6.17	Sq.m
Food Prep	6.17	Sq.m
Food Prep	6.17	Sq.m
Food Prep	6.17	Sq.m
Food Prep	6.17	Sq.m
Hygiene Room	19.54	Sq.m
Hygiene Room	19.54	Sq.m
Hygiene Room	19.54	Sq.m
Hygiene Room	11.59	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Acc. WC	3.15	Sq.m
Store	3.08	Sq.m
Store	3.08	Sq.m
Store	3.08	Sq.m
Store	3.08	Sq.m
Store	5.14	Sq.m
Cleaner	3.15	Sq.m
Hall Store	18.76	Sq.m
Multi-Use Room (Hall)	127.09	Sq.m
Library	20.75	Sq.m
Food Technology Room	20.70	Sq.m
Sensory Integration Room	17.64	Sq.m
Rebound Room	18.00	Sq.m
Dark Room	11.63	Sq.m
Light Room	12.37	Sq.m
Soft Play Room	20.60	Sq.m
Staff WC	4.87	Sq.m
Staff WC	4.37	Sq.m
Comms. Room	8.05	Sq.m
Staff Room	20.30	Sq.m
Deputy Head Office	17.32	Sq.m
General Office	21.55	Sq.m
Plant Room	20.93	Sq.m
Corridors	304.59	Sq.m
NETT INTERNAL FLOOR AREA	1318.45	Sq.m
GROSS INTERNAL FLOOR AREA	1379.00	Sq.m

- Tarmac
208 Sq.m
- Soft Surfacing
405 Sq.m



status

PRELIMINARY

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This drawing shall be read in conjunction with all other relevant drawings, specifications and associated documentation. Any discrepancies, errors or omissions are to be reported to the originator before proceeding with work.

All dimensions are to be checked on site by the contractor prior to proceeding with any work.

Hazard Identification

ref

hazard

date

P9	MINOR ADJUSTMENTS FOLLOWING RECEIPT OF COMMENTS AT MEETING 09.07.23	ST	06.07.23
P8	LAYOUT ADJUSTED FOLLOWING RECEIPT OF COMMENTS AT MEETING 19.06.23	ST	22.06.23
P7	ADJUSTMENTS TO ROOMS RULES WITH CLIENT COMMENTS RCD: 15.06.23	ST	15.06.23
P6	LAYOUT ADJUSTED FOLLOWING RECEIPT OF COMMENTS AT MEETING 06.06.23	ST	13.06.23
P5	LAYOUT ADJUSTED FOLLOWING RECEIPT OF COMMENTS AT MEETING 23.05.23	ST	26.05.23
P4	LAYOUT ADJUSTED FOLLOWING RECEIPT OF ISG COMMENTS	ST	19.05.23
P3	LAYOUT REWORKED	ST	18.05.23
P2	LAYOUT ADJUSTMENTS / CLASSROOM ADDED	ST	08.12.22
P1	FIRST ISSUE	ST	07.12.22
ref	revision	by	date

B
G
H

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Bradshaw Gass & Hope LLP

client

ISG CONSTRUCTION LTD

project

MILLWOOD PRIMARY
SPECIAL SCHOOL
NEW CLASSROOM BLOCK

drawing

PROPOSED FLOOR PLAN

drawn by

ST

date

DEC 22

checked by

date

scale

1:100

ref

A0

diag no

2128.26.301

rev

P9



Appendix C - United Utilities Asset Plan

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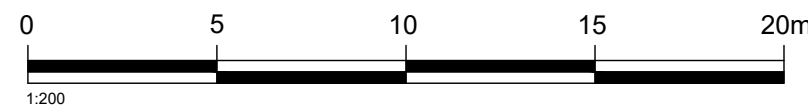
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6400	87.55	CO	84.8	30		VC	24	1 in 8	6304	84.02	CO	78.69	375		VC	21.82555	1 in 167.588861	
6401	78.31	CO	75.51	30		VC	14.31782		6303	82.26	CO	82.06	225		VC	67.00746	1 in 22	
9609	78.04	SW	72.35	525		VC	18.68452	1 in 311	9603	66.6	SW	62.16	825		VC	11		
9607				450		VC	13.9001		9110		FO	70	100		PVC	7.701531	1 in 13	
9602	64.04	CO	59.4	30		VC	12.26862	1 in 175	1108	77.78	FO	74.72	100		VC	9.648598	1 in 288	
9602	79	CO	76.87	150		VC	19.01624	1 in 95	7002	80.17	SW	78.62	100		ST	31.70607		
7262	80.94	FO	79.09	225		VC	23.02173	1 in 35	6301	84.21	SW	79.84	100		CO	37.21038	1 in 266	
9603	77.38	CO	75.43	30		VC	13.54602	1 in 123	1105	77.86	CO	74.94	375		VC	29.96655	1 in 130	
8418	78.2	CO	75.13	225		VC	8.434151		6302	79.06	CO	75.81	300		VC	85.49269	1 in 450	
8303	79.31	CO	75.92	30		VC	10.4296	1 in 203	9914	SW	72.48	525		VC	8.761227	1 in 488		
9007	77.38	CO	75.43	300		VC	14.37598	1 in 96	1102	78.31	CO	75.31	300		VC	7.701064	1 in 277	
9303	78.57	SW	75.53	600		VC	12.3767	1 in 155	8051	SW	0	150		VC	119			
1901				0		VC	20.86925		7203	78.84	SW	77.34	225		VC	9.218544	1 in 77	
1908				375		VC	30.2129		9901	FO	150	150		VC	15.67032			
9404	78.99	CO	76.39	300		VC	20.2461	1 in 50	1402	78.8	CO	76.5	300		VC	16.15549	1 in 1616	
9302	78.04	SW	75.73	450		BR	34.95751	1 in 216										
6291				0		VC	36.23534											
1911				100		PVC	11.69776											
7209	79.27	FO	77.4	100		VC	7.211102	1 in 48										
1907				375		VC	33.95303											
1303	78.99	CO	75.39	375		VC	21.47091	1 in 165										
0201	79.29	CO	76.39	300		VC	133.825	1 in 191										
0098	77.28	CO	75.28	300		VC	6.407768	1 in 106										
9808	76.44	SW	72.28	525		VC	20.55658	1 in 167										
6302	84.19	CO	78.56	375		VC	24.74862	1 in 130.25722										
8202	78.84	CO	75.21	225		VC	12.80923	1 in 1281										
1010	77.34	CO	75.17	300		VC	7.147377	1 in 89										
1413	78.51	SW	76.82	300		PVC	17.95455	1 in 200										
1914				100		PVC	19.90383											
0096				0		VC	14.31782											
0921				100		PSC	5.470058											
1219				300		VC	29.69697											
7209	79.78	CO	77.61	300		VC	4.469697	1 in 35										
8313	78.77	FO	76.7	300		VC	6.16198	1 in 162										
0964				150		PVC	14.78795											
0405	77.35	SW	75.51	900		GRP	77.7244											
8406	78.49	FO	74.7	600		BR	56.04468	1 in 117										
9910				150		VC	51.94293											
9811	78.54	SW	76.77	300		VC	9.7	1 in 235										
9811	77.8	SW	72.29	525		CO	20.77332	1 in 2077										
7263	78.61	CO	77.17	225		VC	37.80212											
0220				100		VC	184.8866											
7216				150		VC	17.44833											
1303				300		VC	25.53882											
1904				150		VC	31.43329											
7303	81.06	CO	77.39	375		VC	22	1 in 244										
1801	64.74	CO	59.91	970		BR	31.30292	1 in 522										
7301	81.18	CO	77.31	375		VC	27.0097											
1305	78.84	CO	75.21	225		VC	25.07897	1 in 157										
7220				150		VC	17.471352											
0804	64.09	SW	0	225		VC	111.7587											
6410				150		VC	3.009218											
1302	79.04	CO	75.72	375		VC	22.84732	1 in 74										
0927				100		VC	4.447526											
0409	77.35	SW	75.49	900		GRP	72.7872											
0409	77.27	CO	72.54	780		VC	30.59412	1 in 133										
0001	77.12	CO	75.72	225		VC	15.83007											
9001				0		VC	49.63181											
0404	77.31	CO	72.88	800		VC	44.97126											
1117				100		VC	2.25565											
6208	81.28	SW	78.83	225		UN	44.01136	1 in 41										
8803	78.44	SW	76.67	300		VC	54.76517											
6209	81.74	SW	79.28	1050		VC	42.36598	1 in 170										
1908				100		VC	50.173	1 in 1003										
8315	78.12	CO	76.07	150		VC	7											
1308	78.77	CO	74.76	375		VC	11.7533											
0918				100		VC	24.39738											
0906				150		VC	22.84732	1 in 152										
2301	79.05	CO	75.94	375		VC	20.76028	1 in 166										
6305	83.92	SW	79.67	1100		VC	28.84441											
7301	80.21	FO	76.36	225		VC	14.16109											
0917				100		BR	88.43403	1 in 894										
9801				58.98		VC	23.14269	1 in 129										
9301	78.16	SW	75.91	450		VC	13.72544											
0903				150		VC	4.288466											
0919				100		VC	16.4642											
7211				0	225	VC	20.1553	1 in 258										
6202	81.34	SW	79.89	150		VC	10.16386	1 in 13										
9405	77.42	CO	76.22	225		VC	13.63933	1 in 127										
6203	81.22	CO	76.61	225		VC	13.32715											
9605				150		BR	36.42731	1 in 1										
9406	77.23	CO	73.74	650		BR	38.47077	1 in 1924										
8801	65.98	CO	58.89	750		VC	27.4441	1 in 103										
9915				75.27	225	VC	18											
7311				0	225	VC	14.77088	1 in 246										
8304	79	CO	76.04	300		VC	9.801412											
7223				300		VC	8.770547											
1012				225		BR	52.07419	1 in 55										
8300	79.47	CO	75.68	600		VC	34.0147	1 in 23										
7400	83.18	CO	80.56	375		VC	27.17709	1 in 126										
1007	77.44	CO	73.67	600		VC	1.949028											
8604				100		VC	22.77159	1 in 285										
9304	78.45	SW	75.45	600		VC	13.95955	1 in 146										
1412	78.85	CO	76.7	300		VC	57.37388											
9604	78.04	FO	75.0	150		VC	6.345555											
0406	77.24	SW	75.89	725		VC	27.20294											
7204	79.11	FO	77.25	225		VC	3.865497	1 in 17										
2802	84.14	CO	59.19	1000		VC	45											
7294	78.61	CO	75.03	300		VC	12.01762											
0911				150		VC	20.25104											
8315				150		VC	19.10497											
7312				0	225	BR	72.00594	1 in 288										
1103	78.24	CO	70.8	708		VC	33.10777											
1905				150		VC	3.162276											
9811	78.77	CO	76.77	225		VC	8											
7305	80.11	CO	77.91	300		VC	36.39946	1 in 5										
9804	75.26	SW	71.91	600		VC	9.170621	1 in 92										
9913				SW	74.04	225	VC	10.52266										
0908				SW	71.36	708	VC	106.4519	1 in 190			</						

Appendix D - Greenfield SW Run-Off Rates and Volume Calculations

Flo Consult UK Ltd		Page 1																																										
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Millwood School Greenfield Run-Off Rate Calculation																																											
Date 15/08/2023	Designed by MDS																																											
File	Checked by MDS																																											
Innovyze	Source Control 2020.1.3																																											
IH 124 Mean Annual Flood Input <table><tr><td>Return Period (years)</td><td>2</td><td>Soil</td><td>0.450</td></tr><tr><td>Area (ha)</td><td>50.000</td><td>Urban</td><td>0.000</td></tr><tr><td>SAAR (mm)</td><td>950</td><td>Region Number</td><td>Region 10</td></tr></table> Results l/s <table><tr><td>QBAR Rural</td><td>314.0</td></tr><tr><td>QBAR Urban</td><td>314.0</td></tr><tr><td>Q2 years</td><td>292.4</td></tr><tr><td>Q1 year</td><td>273.2</td></tr><tr><td>Q2 years</td><td>292.4</td></tr><tr><td>Q5 years</td><td>373.6</td></tr><tr><td>Q10 years</td><td>433.3</td></tr><tr><td>Q20 years</td><td>493.7</td></tr><tr><td>Q25 years</td><td>514.9</td></tr><tr><td>Q30 years</td><td>532.4</td></tr><tr><td>Q50 years</td><td>580.9</td></tr><tr><td>Q100 years</td><td>653.1</td></tr><tr><td>Q200 years</td><td>741.0</td></tr><tr><td>Q250 years</td><td>769.3</td></tr><tr><td>Q1000 years</td><td>954.5</td></tr></table>			Return Period (years)	2	Soil	0.450	Area (ha)	50.000	Urban	0.000	SAAR (mm)	950	Region Number	Region 10	QBAR Rural	314.0	QBAR Urban	314.0	Q2 years	292.4	Q1 year	273.2	Q2 years	292.4	Q5 years	373.6	Q10 years	433.3	Q20 years	493.7	Q25 years	514.9	Q30 years	532.4	Q50 years	580.9	Q100 years	653.1	Q200 years	741.0	Q250 years	769.3	Q1000 years	954.5
Return Period (years)	2	Soil	0.450																																									
Area (ha)	50.000	Urban	0.000																																									
SAAR (mm)	950	Region Number	Region 10																																									
QBAR Rural	314.0																																											
QBAR Urban	314.0																																											
Q2 years	292.4																																											
Q1 year	273.2																																											
Q2 years	292.4																																											
Q5 years	373.6																																											
Q10 years	433.3																																											
Q20 years	493.7																																											
Q25 years	514.9																																											
Q30 years	532.4																																											
Q50 years	580.9																																											
Q100 years	653.1																																											
Q200 years	741.0																																											
Q250 years	769.3																																											
Q1000 years	954.5																																											
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Flo Consult UK Ltd		Page 1																										
4 Market Square	Millwood School																											
Old Amersham	Greenfield Run-Off																											
Buckinghamshire, HP7 0DQ	Volume Calculations																											
Date 22/08/2023	Designed by MDS																											
File	Checked by MDS																											
Innovyze		Source Control 2020.1.3																										
<u>Greenfield Runoff Volume</u> FEH Data <table> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>Storm Duration (mins)</td> <td>360</td> </tr> <tr> <td>FEH Rainfall Version</td> <td>2013</td> </tr> <tr> <td>Site Location</td> <td>GB 377929 407139 SD 77929 07139</td> </tr> <tr> <td>Data Type</td> <td>Point</td> </tr> <tr> <td>Areal Reduction Factor</td> <td>1.00</td> </tr> <tr> <td>Area (ha)</td> <td>0.213</td> </tr> <tr> <td>SAAR (mm)</td> <td>1054</td> </tr> <tr> <td>CWI</td> <td>123.486</td> </tr> <tr> <td>SPR Host</td> <td>47.000</td> </tr> <tr> <td>URBEXT (USER)</td> <td>0.0000</td> </tr> </table> Results <table> <tr> <td>Percentage Runoff (%)</td> <td>51.04</td> </tr> <tr> <td>Greenfield Runoff Volume (m³)</td> <td>71.853</td> </tr> </table>			Return Period (years)	100	Storm Duration (mins)	360	FEH Rainfall Version	2013	Site Location	GB 377929 407139 SD 77929 07139	Data Type	Point	Areal Reduction Factor	1.00	Area (ha)	0.213	SAAR (mm)	1054	CWI	123.486	SPR Host	47.000	URBEXT (USER)	0.0000	Percentage Runoff (%)	51.04	Greenfield Runoff Volume (m³)	71.853
Return Period (years)	100																											
Storm Duration (mins)	360																											
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SPR Host	47.000																											
URBEXT (USER)	0.0000																											
Percentage Runoff (%)	51.04																											
Greenfield Runoff Volume (m³)	71.853																											
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Appendix E - Below Ground Drainage Layout and Details



	Architects Consulting Engineers Quantity Surveyors		21 Silverwell Street Bolton BL1 1PR t: 01204 525321 email: info@bghbolton.co.uk www.bghbolton.co.uk	
	Bradshaw Gass & Hope LLP			
client				
ISG CONSTRUCTION LTD				
project				
MILLWOOD SCHOOL NEW CLASSROOM BLOCK				
drawing				
SURFACE SURFACE MANAGEMENT LAYOUT				
drawn by		MDS	date	15.08.23
checked by		BH	date	
scale			1:200	A1
dwg no			2128.26.301	rev P1

Appendix F- Surface Water Management Calculations



Micro
Drainage

Half Drain Time : 235 minutes.

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
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Flo Consult UK Ltd							Page 2	
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ				Millwood School Surface Water Management Calculations				
Date 22/08/2023				Designed by MDS				
File Millwood Extension - SW ...				Checked by MDS				
Innovyze				Source Control 2020.1.3				
<u>Summary of Results for 2 year Return Period</u>								
Storm Event		Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
8640 min	Summer	76.978	0.078	0.0	1.0	1.0	8.0	O K
10080 min	Summer	76.972	0.072	0.0	0.9	0.9	7.4	O K
15 min	Winter	77.027	0.127	0.0	1.1	1.1	13.1	O K
30 min	Winter	77.067	0.167	0.0	1.1	1.1	17.1	O K
60 min	Winter	77.106	0.206	0.0	1.2	1.2	21.1	O K
120 min	Winter	77.159	0.259	0.0	1.2	1.2	26.6	O K
180 min	Winter	77.183	0.283	0.0	1.2	1.2	29.0	O K
240 min	Winter	77.195	0.295	0.0	1.2	1.2	30.2	O K
360 min	Winter	77.205	0.305	0.0	1.2	1.2	31.3	O K
480 min	Winter	77.207	0.307	0.0	1.2	1.2	31.5	O K
600 min	Winter	77.204	0.304	0.0	1.2	1.2	31.2	O K
720 min	Winter	77.198	0.298	0.0	1.2	1.2	30.6	O K
960 min	Winter	77.181	0.281	0.0	1.2	1.2	28.8	O K
1440 min	Winter	77.140	0.240	0.0	1.2	1.2	24.7	O K
2160 min	Winter	77.086	0.186	0.0	1.2	1.2	19.1	O K
2880 min	Winter	77.045	0.145	0.0	1.1	1.1	14.9	O K
4320 min	Winter	76.994	0.094	0.0	1.0	1.0	9.6	O K
5760 min	Winter	76.973	0.073	0.0	0.9	0.9	7.5	O K
Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
8640 min	Summer	0.595	0.0	133.8	4424			
10080 min	Summer	0.546	0.0	143.0	5152			
15 min	Winter	33.314	0.0	13.9	32			
30 min	Winter	21.881	0.0	18.6	44			
60 min	Winter	13.869	0.0	24.0	70			
120 min	Winter	9.221	0.0	32.1	124			
180 min	Winter	7.128	0.0	37.4	180			
240 min	Winter	5.911	0.0	41.4	232			
360 min	Winter	4.527	0.0	47.7	292			
480 min	Winter	3.737	0.0	52.5	370			
600 min	Winter	3.218	0.0	56.6	448			
720 min	Winter	2.848	0.0	60.1	524			
960 min	Winter	2.349	0.0	66.1	672			
1440 min	Winter	1.795	0.0	75.7	950			
2160 min	Winter	1.380	0.0	87.6	1336			
2880 min	Winter	1.150	0.0	97.2	1700			
4320 min	Winter	0.895	0.0	113.3	2380			
5760 min	Winter	0.753	0.0	127.2	3016			
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4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Millwood School Surface Water Management Calculations	
Date 22/08/2023	Designed by MDS	
File Millwood Extension - SW ...	Checked by MDS	
Innovyze	Source Control 2020.1.3	

Flo Consult UK Ltd		Page 5
4 Market Square	Millwood School	
Old Amersham	Surface Water	
Buckinghamshire, HP7 0DQ	Management Calculations	
Date 22/08/2023	Designed by MDS	
File Millwood Extension - SW ...	Checked by MDS	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 78.600

Complex Structure

Cellular Storage

Invert Level (m) 76.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	108.0	0.0	2.600	0.0	0.0
0.200	108.0	0.0	2.800	0.0	0.0
0.400	108.0	0.0	3.000	0.0	0.0
0.600	108.0	0.0	3.200	0.0	0.0
0.800	108.0	0.0	3.400	0.0	0.0
1.000	108.0	0.0	3.600	0.0	0.0
1.200	108.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	21.5
Max Percolation (l/s)	35.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	78.100	Cap Volume Depth (m)	0.300

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0054-1200-0800-1200
Design Head (m)	0.800
Design Flow (l/s)	1.2
Flush-Flo™	Calculated

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4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Millwood School Surface Water Management Calculations	
Date 22/08/2023	Designed by MDS	
File Millwood Extension - SW ...	Checked by MDS	
Innovyze		Source Control 2020.1.3

Hydro-Brake® Optimum

Objective Minimise upstream storage

Application Surface

Sump Available Yes

Diameter (mm) 54

Invert Level (m) 76.900

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)	0.800	1.2	Kick-Flo®	0.482	1.0
Flush-Flo™	0.238	1.2	Mean Flow over Head Range	-	1.0

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	1.0	1.200	1.4	3.000	2.2	7.000	3.2
0.200	1.2	1.400	1.5	3.500	2.3	7.500	3.3
0.300	1.2	1.600	1.6	4.000	2.5	8.000	3.4
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.5
0.500	1.0	2.000	1.8	5.000	2.8	9.000	3.6
0.600	1.1	2.200	1.9	5.500	2.9	9.500	3.7
0.800	1.2	2.400	2.0	6.000	3.0		
1.000	1.3	2.600	2.0	6.500	3.1		

Orifice

Diameter (m) 0.035 Discharge Coefficient 0.600 Invert Level (m) 78.100

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4 Market Square Old Amersham Buckinghamshire, HP7 0DQ		Millwood School Surface Water Management Calculations																																																																																																																																																																																																																																											
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Innovyze		Source Control 2020.1.3																																																																																																																																																																																																																																											
Summary of Results for 30 year Return Period (+40%) Half Drain Time : 775 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Σ Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>77.288</td><td>0.388</td><td>0.0</td><td>1.2</td><td>1.2</td><td>39.8</td><td>O K</td></tr><tr><td>30 min Summer</td><td>77.422</td><td>0.522</td><td>0.0</td><td>1.2</td><td>1.2</td><td>53.6</td><td>O K</td></tr><tr><td>60 min Summer</td><td>77.563</td><td>0.663</td><td>0.0</td><td>1.2</td><td>1.2</td><td>68.0</td><td>O K</td></tr><tr><td>120 min Summer</td><td>77.666</td><td>0.766</td><td>0.0</td><td>1.2</td><td>1.2</td><td>78.6</td><td>O K</td></tr><tr><td>180 min Summer</td><td>77.722</td><td>0.822</td><td>0.0</td><td>1.2</td><td>1.2</td><td>84.3</td><td>O K</td></tr><tr><td>240 min Summer</td><td>77.756</td><td>0.856</td><td>0.0</td><td>1.2</td><td>1.2</td><td>87.8</td><td>O K</td></tr><tr><td>360 min Summer</td><td>77.789</td><td>0.889</td><td>0.0</td><td>1.3</td><td>1.3</td><td>91.2</td><td>O K</td></tr><tr><td>480 min Summer</td><td>77.800</td><td>0.900</td><td>0.0</td><td>1.3</td><td>1.3</td><td>92.4</td><td>O K</td></tr><tr><td>600 min Summer</td><td>77.798</td><td>0.898</td><td>0.0</td><td>1.3</td><td>1.3</td><td>92.2</td><td>O K</td></tr><tr><td>720 min Summer</td><td>77.794</td><td>0.894</td><td>0.0</td><td>1.3</td><td>1.3</td><td>91.7</td><td>O K</td></tr><tr><td>960 min Summer</td><td>77.778</td><td>0.878</td><td>0.0</td><td>1.2</td><td>1.2</td><td>90.0</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>77.744</td><td>0.844</td><td>0.0</td><td>1.2</td><td>1.2</td><td>86.6</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>77.700</td><td>0.800</td><td>0.0</td><td>1.2</td><td>1.2</td><td>82.1</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>77.661</td><td>0.761</td><td>0.0</td><td>1.2</td><td>1.2</td><td>78.0</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>77.588</td><td>0.688</td><td>0.0</td><td>1.2</td><td>1.2</td><td>70.5</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>77.521</td><td>0.621</td><td>0.0</td><td>1.2</td><td>1.2</td><td>63.7</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>77.457</td><td>0.557</td><td>0.0</td><td>1.2</td><td>1.2</td><td>57.1</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>105.537</td><td>0.0</td><td>41.0</td><td>34</td></tr><tr><td>30 min Summer</td><td>70.662</td><td>0.0</td><td>55.2</td><td>48</td></tr><tr><td>60 min Summer</td><td>45.321</td><td>0.0</td><td>71.5</td><td>76</td></tr><tr><td>120 min Summer</td><td>27.047</td><td>0.0</td><td>85.5</td><td>134</td></tr><tr><td>180 min Summer</td><td>19.964</td><td>0.0</td><td>94.7</td><td>192</td></tr><tr><td>240 min Summer</td><td>16.080</td><td>0.0</td><td>101.7</td><td>250</td></tr><tr><td>360 min Summer</td><td>11.835</td><td>0.0</td><td>112.3</td><td>366</td></tr><tr><td>480 min Summer</td><td>9.534</td><td>0.0</td><td>120.7</td><td>482</td></tr><tr><td>600 min Summer</td><td>8.061</td><td>0.0</td><td>127.5</td><td>570</td></tr><tr><td>720 min Summer</td><td>7.025</td><td>0.0</td><td>133.3</td><td>622</td></tr><tr><td>960 min Summer</td><td>5.640</td><td>0.0</td><td>142.7</td><td>748</td></tr><tr><td>1440 min Summer</td><td>4.154</td><td>0.0</td><td>157.1</td><td>1014</td></tr><tr><td>2160 min Summer</td><td>3.089</td><td>0.0</td><td>176.3</td><td>1436</td></tr><tr><td>2880 min Summer</td><td>2.519</td><td>0.0</td><td>191.5</td><td>1852</td></tr><tr><td>4320 min Summer</td><td>1.908</td><td>0.0</td><td>217.3</td><td>2684</td></tr><tr><td>5760 min Summer</td><td>1.580</td><td>0.0</td><td>240.0</td><td>3480</td></tr><tr><td>7200 min Summer</td><td>1.371</td><td>0.0</td><td>260.1</td><td>4320</td></tr></table>				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	77.288	0.388	0.0	1.2	1.2	39.8	O K	30 min Summer	77.422	0.522	0.0	1.2	1.2	53.6	O K	60 min Summer	77.563	0.663	0.0	1.2	1.2	68.0	O K	120 min Summer	77.666	0.766	0.0	1.2	1.2	78.6	O K	180 min Summer	77.722	0.822	0.0	1.2	1.2	84.3	O K	240 min Summer	77.756	0.856	0.0	1.2	1.2	87.8	O K	360 min Summer	77.789	0.889	0.0	1.3	1.3	91.2	O K	480 min Summer	77.800	0.900	0.0	1.3	1.3	92.4	O K	600 min Summer	77.798	0.898	0.0	1.3	1.3	92.2	O K	720 min Summer	77.794	0.894	0.0	1.3	1.3	91.7	O K	960 min Summer	77.778	0.878	0.0	1.2	1.2	90.0	O K	1440 min Summer	77.744	0.844	0.0	1.2	1.2	86.6	O K	2160 min Summer	77.700	0.800	0.0	1.2	1.2	82.1	O K	2880 min Summer	77.661	0.761	0.0	1.2	1.2	78.0	O K	4320 min Summer	77.588	0.688	0.0	1.2	1.2	70.5	O K	5760 min Summer	77.521	0.621	0.0	1.2	1.2	63.7	O K	7200 min Summer	77.457	0.557	0.0	1.2	1.2	57.1	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	105.537	0.0	41.0	34	30 min Summer	70.662	0.0	55.2	48	60 min Summer	45.321	0.0	71.5	76	120 min Summer	27.047	0.0	85.5	134	180 min Summer	19.964	0.0	94.7	192	240 min Summer	16.080	0.0	101.7	250	360 min Summer	11.835	0.0	112.3	366	480 min Summer	9.534	0.0	120.7	482	600 min Summer	8.061	0.0	127.5	570	720 min Summer	7.025	0.0	133.3	622	960 min Summer	5.640	0.0	142.7	748	1440 min Summer	4.154	0.0	157.1	1014	2160 min Summer	3.089	0.0	176.3	1436	2880 min Summer	2.519	0.0	191.5	1852	4320 min Summer	1.908	0.0	217.3	2684	5760 min Summer	1.580	0.0	240.0	3480	7200 min Summer	1.371	0.0	260.1	4320
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30 min Summer	70.662	0.0	55.2	48																																																																																																																																																																																																																																									
60 min Summer	45.321	0.0	71.5	76																																																																																																																																																																																																																																									
120 min Summer	27.047	0.0	85.5	134																																																																																																																																																																																																																																									
180 min Summer	19.964	0.0	94.7	192																																																																																																																																																																																																																																									
240 min Summer	16.080	0.0	101.7	250																																																																																																																																																																																																																																									
360 min Summer	11.835	0.0	112.3	366																																																																																																																																																																																																																																									
480 min Summer	9.534	0.0	120.7	482																																																																																																																																																																																																																																									
600 min Summer	8.061	0.0	127.5	570																																																																																																																																																																																																																																									
720 min Summer	7.025	0.0	133.3	622																																																																																																																																																																																																																																									
960 min Summer	5.640	0.0	142.7	748																																																																																																																																																																																																																																									
1440 min Summer	4.154	0.0	157.1	1014																																																																																																																																																																																																																																									
2160 min Summer	3.089	0.0	176.3	1436																																																																																																																																																																																																																																									
2880 min Summer	2.519	0.0	191.5	1852																																																																																																																																																																																																																																									
4320 min Summer	1.908	0.0	217.3	2684																																																																																																																																																																																																																																									
5760 min Summer	1.580	0.0	240.0	3480																																																																																																																																																																																																																																									
7200 min Summer	1.371	0.0	260.1	4320																																																																																																																																																																																																																																									
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Summary of Results for 30 year Return Period (+40%)

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
8640 min Summer	77.388	0.488	0.0	1.2	1.2	50.1	O K
10080 min Summer	77.308	0.408	0.0	1.2	1.2	41.8	O K
15 min Winter	77.337	0.437	0.0	1.2	1.2	44.9	O K
30 min Winter	77.488	0.588	0.0	1.2	1.2	60.3	O K
60 min Winter	77.646	0.746	0.0	1.2	1.2	76.6	O K
120 min Winter	77.766	0.866	0.0	1.2	1.2	88.8	O K
180 min Winter	77.832	0.932	0.0	1.3	1.3	95.6	O K
240 min Winter	77.873	0.973	0.0	1.3	1.3	99.9	O K
360 min Winter	77.918	1.018	0.0	1.3	1.3	104.4	O K
480 min Winter	77.938	1.038	0.0	1.3	1.3	106.5	O K
600 min Winter	77.942	1.042	0.0	1.3	1.3	106.9	O K
720 min Winter	77.937	1.037	0.0	1.3	1.3	106.4	O K
960 min Winter	77.914	1.014	0.0	1.3	1.3	104.0	O K
1440 min Winter	77.870	0.970	0.0	1.3	1.3	99.5	O K
2160 min Winter	77.800	0.900	0.0	1.3	1.3	92.4	O K
2880 min Winter	77.733	0.833	0.0	1.2	1.2	85.5	O K
4320 min Winter	77.609	0.709	0.0	1.2	1.2	72.7	O K
5760 min Winter	77.494	0.594	0.0	1.2	1.2	60.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.226	0.0	279.0	5112
10080 min Summer	1.120	0.0	297.0	5752
15 min Winter	105.537	0.0	46.0	34
30 min Winter	70.662	0.0	61.8	48
60 min Winter	45.321	0.0	80.2	76
120 min Winter	27.047	0.0	95.8	132
180 min Winter	19.964	0.0	106.1	188
240 min Winter	16.080	0.0	114.0	246
360 min Winter	11.835	0.0	125.9	358
480 min Winter	9.534	0.0	135.2	472
600 min Winter	8.061	0.0	142.9	580
720 min Winter	7.025	0.0	149.4	684
960 min Winter	5.640	0.0	159.7	780
1440 min Winter	4.154	0.0	175.2	1086
2160 min Winter	3.089	0.0	197.6	1552
2880 min Winter	2.519	0.0	214.7	2000
4320 min Winter	1.908	0.0	243.6	2872
5760 min Winter	1.580	0.0	269.1	3752

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<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FEH</td> </tr> <tr> <td>Return Period (years)</td> <td>30</td> </tr> <tr> <td>FEH Rainfall Version</td> <td>2013</td> </tr> <tr> <td>Site Location</td> <td>GB 377929 407139 SD 77929 07139</td> </tr> <tr> <td>Data Type</td> <td>Point</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> </tr> <tr> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Climate Change %</td> <td>+40</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.213 <table> <thead> <tr> <th>Time (mins)</th> <th>Area (ha)</th> <th>Time (mins)</th> <th>Area (ha)</th> <th>Time (mins)</th> <th>Area (ha)</th> </tr> <tr> <th>From:</th> <th>To:</th> <th>From:</th> <th>To:</th> <th>From:</th> <th>To:</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>4 0.043</td> <td>8</td> <td>12 0.043</td> <td>16</td> <td>20 0.042</td> </tr> <tr> <td>4</td> <td>8 0.043</td> <td>12</td> <td>16 0.042</td> <td></td> <td></td> </tr> </tbody> </table>			Rainfall Model	FEH	Return Period (years)	30	FEH Rainfall Version	2013	Site Location	GB 377929 407139 SD 77929 07139	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 %	+40	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	From:	To:	From:	To:	From:	To:	0	4 0.043	8	12 0.043	16	20 0.042	4	8 0.043	12	16 0.042		
Rainfall Model	FEH																																																	
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Model Details

Storage is Online Cover Level (m) 78.600

Complex Structure

Cellular Storage

Invert Level (m) 76.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	108.0	0.0	2.600	0.0	0.0
0.200	108.0	0.0	2.800	0.0	0.0
0.400	108.0	0.0	3.000	0.0	0.0
0.600	108.0	0.0	3.200	0.0	0.0
0.800	108.0	0.0	3.400	0.0	0.0
1.000	108.0	0.0	3.600	0.0	0.0
1.200	108.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 6.0
Membrane Percolation (mm/hr) 1000 Length (m) 21.5
Max Percolation (l/s) 35.8 Slope (1:X) 0.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 78.100 Cap Volume Depth (m) 0.300

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference MD-SHE-0054-1200-0800-1200
Design Head (m) 0.800
Design Flow (l/s) 1.2
Flush-Flo™ Calculated

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Date 22/08/2023			Designed by MDS					
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Innovyze			Source Control 2020.1.3					
<u>Summary of Results for 100 year Return Period (+45%)</u>								
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	
8640 min Summer	77.706	0.806	0.0	1.2	1.2	82.7	O K	
10080 min Summer	77.655	0.755	0.0	1.2	1.2	77.4	O K	
15 min Winter	77.505	0.605	0.0	1.2	1.2	62.1	O K	
30 min Winter	77.718	0.818	0.0	1.2	1.2	83.9	O K	
60 min Winter	77.946	1.046	0.0	1.4	1.4	107.3	O K	
120 min Winter	78.104	1.204	0.0	1.4	1.4	123.7	O K	
180 min Winter	78.186	1.286	0.0	2.2	2.2	132.0	O K	
240 min Winter	78.268	1.368	0.0	2.5	2.5	136.4	O K	
360 min Winter	78.349	1.449	0.0	2.8	2.8	139.6	Flood Risk	
480 min Winter	78.351	1.451	0.0	2.8	2.8	139.7	Flood Risk	
600 min Winter	78.358	1.458	0.0	2.8	2.8	139.9	Flood Risk	
720 min Winter	78.354	1.454	0.0	2.8	2.8	139.8	Flood Risk	
960 min Winter	78.321	1.421	0.0	2.7	2.7	138.5	Flood Risk	
1440 min Winter	78.231	1.331	0.0	2.4	2.4	134.7	O K	
2160 min Winter	78.154	1.254	0.0	2.0	2.0	129.4	O K	
2880 min Winter	78.110	1.210	0.0	1.5	1.5	124.5	O K	
4320 min Winter	77.976	1.076	0.0	1.4	1.4	110.4	O K	
5760 min Winter	77.856	0.956	0.0	1.3	1.3	98.1	O K	
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)				
8640 min Summer	1.540	0.0	351.1	5112				
10080 min Summer	1.402	0.0	372.7	5872				
15 min Winter	143.989	0.0	63.0	34				
30 min Winter	97.296	0.0	84.5	48				
60 min Winter	62.801	0.0	111.4	76				
120 min Winter	37.082	0.0	131.6	132				
180 min Winter	27.208	0.0	144.9	188				
240 min Winter	21.825	0.0	155.0	242				
360 min Winter	15.974	0.0	170.1	350				
480 min Winter	12.790	0.0	181.6	440				
600 min Winter	10.759	0.0	190.8	476				
720 min Winter	9.339	0.0	198.6	554				
960 min Winter	7.464	0.0	210.8	710				
1440 min Winter	5.447	0.0	213.1	1026				
2160 min Winter	4.003	0.0	256.4	1504				
2880 min Winter	3.238	0.0	276.4	2024				
4320 min Winter	2.430	0.0	310.5	2908				
5760 min Winter	2.000	0.0	341.2	3760				
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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 377929 407139 SD 77929 07139
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 %	+45

Time Area Diagram

Total Area (ha) 0.213

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4 0.043	8	12 0.043	16	20 0.042
4	8 0.043	12	16 0.042		

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Model Details

Storage is Online Cover Level (m) 78.600

Complex Structure

Cellular Storage

Invert Level (m) 76.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	108.0	0.0	2.600	0.0	0.0
0.200	108.0	0.0	2.800	0.0	0.0
0.400	108.0	0.0	3.000	0.0	0.0
0.600	108.0	0.0	3.200	0.0	0.0
0.800	108.0	0.0	3.400	0.0	0.0
1.000	108.0	0.0	3.600	0.0	0.0
1.200	108.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 6.0
Membrane Percolation (mm/hr) 1000 Length (m) 21.5
Max Percolation (l/s) 35.8 Slope (1:X) 0.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 78.100 Cap Volume Depth (m) 0.300

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference MD-SHE-0054-1200-0800-1200
Design Head (m) 0.800
Design Flow (l/s) 1.2
Flush-Flo™ Calculated

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