

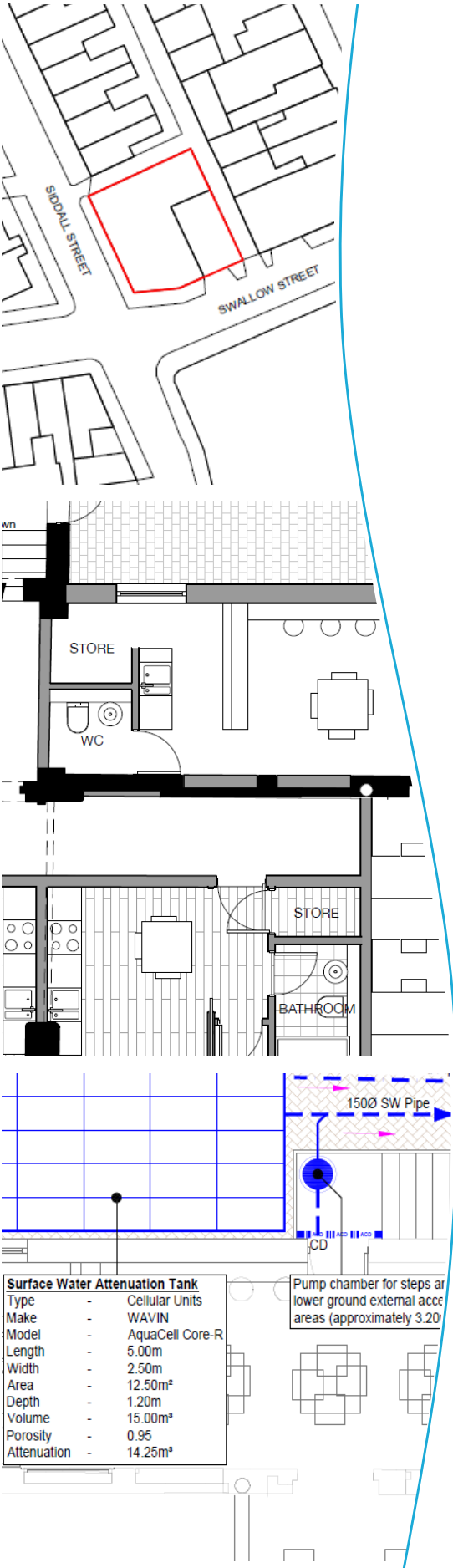
Project_
**Swallow Street
Levenshulme, Manchester**

Title_
Surface Water Management Report

Project No_
1191

Date_
August 2025

Revision_
A



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1. Introduction

Flo Consult UK Ltd have prepared this surface water management report, in support of a planning application, for a new residential development at Swallow Street, Levenshulme, Manchester (hereafter referred to as 'the Site').

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

- National Planning Policy Framework (NPPF), December 2024, Paragraphs 162-163 and 182;
- National Planning Practice Guidance (NPPG), 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);
- DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

And local policies including:

- Manchester City, Salford City and Trafford Councils Level 1 SFRA (May 2010);
- Manchester City, Salford City and Trafford Councils Level 2 SFRA (March 2011);
- Manchester City Council – Local Flood Risk Management Strategy (March 2014);
- Manchester Local Development Framework – Core Strategy Development Plan (July 2012).

Subsequently, Manchester City Council, acting as Lead Local Flood Authority (LLFA), 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;
- and will ensure that the development will not increase the risk of flooding to neighbouring land and property.

2. National / Local Policies and Water Management Guidance

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

The NPPF (December 2024) 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 162-163 (Planning for Climate Change) and Paragraph 182 (Sustainable Drainage).

NPPG, Paragraph 055 (Reference ID:7-055-20220825) 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 056 (Reference ID:7-056-20220825) 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 takes forward some of the proposals from three previous strategy documents published by the UK Government - Future Water (2008), Making Space for Water (2008) and the UK Government's response to the Sir Michael Pitt's Review of the summer 2007 floods. In doing so it gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

2.3. Manchester Local Development Framework – Core Strategy Development Plan

Relevant Policy EN 08 states:

'All new development will be expected to be adaptable to climate change in terms of the design, layout, siting, and function of both buildings and associated external spaces. In achieving developments which are adaptable to climate change developers should minimise flood risk by appropriate siting, drainage, and treatment of surface areas to ensure rainwater permeability, and will be permitted to use green infrastructure elements such as green roofs'.

Relevant Policy EN 14 states:

'All new development should minimise surface water run-off, including through Sustainable Drainage Systems (SUDS) and the appropriate use of Green Infrastructure. Developers should have regard to the surface water run-off rates in the SFRA User Guide. In CDAs, evidence to justify the surface water run-off approach / rates will be required'.

Relevant Policy EN 17 states:

'Development should avoid any adverse impact on water quality, including during the construction phase, and wherever possible should seek to enhance water quality, both chemical and ecological; Development should minimise surface water run-off from development and associated roads, and maximise the use of appropriate sustainable drainage systems, to minimise groundwater contamination, and to avoid pollutants reaching watercourses; Development close to a watercourse should also ensure that waste or litter cannot enter the watercourse from the site; Development should, where feasible and appropriate, seek to open up any culverted or hidden watercourse beneath the site to improve the ecological status of that watercourse'.

3. Site Setting and Description

3.1. Site Location

The Site is in a residential area of Levenshulme, is approximately 250m north of Levenshulme train station, and as shown in Appendix A, is bound by a residential dwellings to the north, a n access alley and residential dwellings leading to Stockport Road the east, Swallow Street to the south, and Siddall Street to the west.

The postcode at the Site is M12 4GD, with the co-ordinates being - Easting: 387260, Northing: 394810.

3.2. Existing Site and Topography

As detailed in Appendix B, the Site, in a pre-development state, consists of an existing warehouse building, which covers most of the Site area, with exception to the external loading area to the south-west. As all the Site is developed, it is deemed to be a 'Brownfield Site'.

In terms of topography, the Site is generally flat (due to extent of warehouse building) with floor levels ranging from 54.00m AOD to 54.32m AOD, and the external loading area being approximately 54.28m AOD.

3.3. Proposed Development

The proposed site plans are shown in Appendix C, with a full description of the Site being provided by the Architect.

In brief, and relation to this report, the Site, in a post development state will consist of the extension and refurbishment of the warehouse building to residential units.

The extension will be in the form of a new lower ground floor and partly into the existing loading bay area. The lower ground floor will be accessed by new steps within the existing loading bay area.

3.4. Ground Conditions

The ground conditions can be determined by the British Geological Survey (BGS) website, where it shows the Site to have glaciofluvial deposits of Till Devensian (diamicton), over bedrock consisting of Collyhurst Sandstone Formation (sandstone).

The BGS website also shows data from a borehole log approximately 20m north of the Site (Stockport Road), which shows the ground to predominantly consist of made ground over clay (see Appendix D).

3.5. Waterbodies

The are no known waterbodies near the Site, with the nearest being Gore Brook approximately 500m to the north.

3.6. Existing Drainage / Sewers

The United Utilities asset plan in Appendix E shows there is a 225mm combined water sewer in the access alley to the east of the Site, and a 225mm increasing to 300mm surface water sewer in Swallow Street and Siddall Street, respectively.

Architect plans show rainwater down pipes in the existing loading area, and therefore is assumed that surface water run-off from the building discharges to a below ground drainage network, and to the 225mm surface water sewer in Swallow Street.

3.7. Development Areas

The Site area equates to approximately 300m² / 0.030 ha. The Site, in a pre-development state, is all developed, and therefore the pre-development surface water run-off area is 0.030 ha, with an urban factor of 1.0.

All the Site, in a post development state, is also developed, and therefore the surface water management area also equates to **0.030 ha**.

4. Surface Water Management Principles

The surface water for 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:

'S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1-year rainfall event and the 1 in 100-year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event'.

4.5. Volume Control

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

'S5 Where reasonably practicable, for developments which have been previously developed, 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 must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that 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 S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk'.

4.6. Flood Risk within Development

DEFRA 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 will be achieved by designing suitable ground exceedance or flood pathways, and run-off will be completely contained within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 100-year event.

The design of the site ensures that flows from rainfall more than a 1 in 100-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

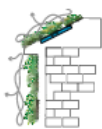
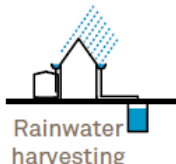
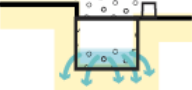
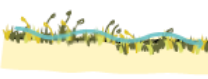
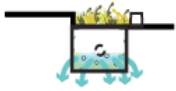
The destination of the surface water run-off from the Site, in a post development state, has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

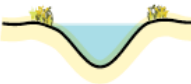
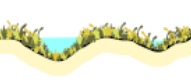
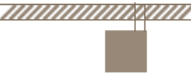
Run-Off Destination	Feasible / Required?	Description
Discharge to Ground	No	<p>BGS data identifies the ground at the Site to predominantly consist of clay.</p> <p>Clay is known to have exceptionally low or no infiltration value, and therefore the ground is unsuitable for infiltration.</p> <p>In accordance with Approved Document H, a soakaway also needs to be at least 5m from existing / proposed structure. Given the relatively small external area to the south-west this cannot be achieved.</p> <p>Therefore, due to the ground conditions and site areas, discharging the surface water to ground will not be feasible.</p>
Discharge to Surface Water Body	No	There are no known surface waterbodies near the Site, and therefore this is not a feasible surface water run-off destination.
Discharge to Surface Water Sewer	Yes	<p>As the ground and external areas are not suitable for discharge to ground, and there are no known waterbodies near the Site, the alternative is to discharge, at a restricted rate, to the 225mm surface water sewer in Swallow Street.</p> <p>This will replicate the pre-development surface water run-off destination.</p>
Discharge to Highway Drain or Other	No	There are no known highway or other drains near the Site, and therefore this is not a feasible surface water run-off destination.
Discharge to Combined Water Sewer	No	There is a 225mm combined water sewer in the access alley to the east of the Site. However, as the surface can discharge to the surface water sewer, this discharge destination is not required.

6. SuDS Feasibility

To reduce the surface water run-off from the Site in a post development state and to ensure water quality, SuDS methods are to be introduced to the 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 Site are summarised in the table below:

SuDS Method	Feasible Use?	Description
Living Roofs	No	The existing warehouse building roof, and proposed extension roof will be pitched, and therefore not suitable for living roofs.
Rainwater Harvesting	No	<p>In accordance with BS8515:2009 + A1:2013, (standard calculation of rainfall yield against water demand) the annual demand of the buildings is likely to be greater than the annual rainwater yield (relatively small roof area compared number of residential units).</p> <p>Therefore, the use of rainwater harvesting is not a feasible SuDS method.</p>
Soakaway	No	<p>BGS data identifies the ground at the Site to predominantly consist of clay. Clay is known to have exceptionally low or no infiltration value, and therefore the ground is unsuitable for infiltration.</p> <p>A soakaway also needs to be at least 5m from structures. Given the relatively small external area to the south-west this cannot be achieved. Therefore, due to the ground conditions and site areas, discharging the surface water to ground will not be feasible.</p>

Filter Drains	No	There are no external landscape areas where filter drains can be utilised, and therefore this is not a feasible SuDS method for the Site.
Permeable Paving	Yes	<p>Permeable paving systems can be formed in existing loading bay / new external access areas of the Site, and will take the surface water run-off from the external areas.</p> <p>The surface water will not discharge directly to ground (for reasons stated above) but will be conveyed via a perforated pipe from the sub-base of the paving system, and into the main drainage network.</p> <p>A permeable paving will also act as a pollutant control.</p>
Swale / Bioretention area / Ponds	No	<p>There are no external landscape areas within the Site where the use of these SuDS methods can be utilised.</p> <p>Therefore, these SuDS methods are not feasible.</p>
Hardscape Storage	No	<p>Surface water run-off from the external area of the Site (existing loading bay / new access area) to discharge to the permeable paving systems.</p> <p>Therefore, there is no requirements for hardscape storage.</p>
Underground Storage	Yes	<p>The surface water run-off from the Site will be restricted.</p> <p>Therefore, there will be a requirement to have underground storage for storm events up to 1 in 30-year; and to be suitably sized so that the volume of water during the 1 in 100-year storm event is kept at a minimum at surface level, where it can be contained on the Site.</p>

7. Development Greenfield Run-Off Rate and Volumes

To minimise the surface water run-off from the Site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rates and volume where possible.

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 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 km ² 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):

QBAR = **0.00108 x AREA^{0.89} x SAAR^{1.17} x SOIL^{2.17}**

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

Area	=	50.00 ha
SAAR	=	800
Soil	=	0.450
Urban Factor	=	0.75 (actual 1.0, but 0.75 highest for calculation)
Region Number	=	10

Based on these variables, and the calculation results provided by the MicroDrainage computer software (Appendix F), the QBAR for a 50.00ha catchment area is:

QBAR = 702.8 l/s

This figure is for the catchment area of 50.00 ha, and is to be reduced to reflect the surface water management area (0.030 ha) of the Site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

QBAR = **0.42l/s (14.05 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 greenfield run-off rates for each of the storm events for the surface water management areas of the Site are as follows:

Storm Event	QBAR	Growth Factor (C753 Table 24.2)	Greenfield Run-off Rate
Q ₂	0.42 l/s	0.93	0.4 l/s
Q ₃₀	0.42 l/s	1.70	0.7 l/s
Q ₁₀₀	0.42 l/s	2.08	0.9 l/s

Note: Greenfield rates are rounded up to single decimal place to adhere to MicroDrainage calculations.

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 2022 (shown as 2013 in calculations), with the results shown in Appendix F.

The FEH 2022 data and variables used to calculate the greenfield run-off volume at the Site location area as follows:

Site Location	=	GB 387260 394810 SJ 87260 94810
Area	=	0.030 ha
SAAR	=	864
CWI	=	120.442
SPR Host	=	47.00
URBTEXT	=	0.5 (actual 1.0, but 0.75 highest for calculation)

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

Q ₁₀₀ (6-Hour)	=	10.13m ³ (337.67m ³ /ha)
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8. Pre-Development Surface Water Run-Off Rates and Volume

The pre-development surface water run-off rates and volume are to be calculated, to establish the rate at which the surface water currently discharges off the Site, and for the post development to be a reduction of the rates and not exceeding the volume to reduce the probability of flooding.

The calculations to determine the pre-development surface water run-off rates and volume are based on the pre-development surface water run-off area of 0.030 ha, the rainfall data given by the FEH 2022 (shown as 2013 in calculations), and simulation / calculations in the MicroDrainage computer software (see Appendix G).

Based on the FEH 2022 data and computer software results, the pre-development surface water run-off rates are as follows:

Q ₂	=	3.5 l/s (15-minute storm duration)
Q ₃₀	=	9.5 l/s (15-minute storm duration)
Q ₁₀₀	=	12.0 l/s (15-minute storm duration)

Based on the FEH 2022 data and computer software results, the pre-development surface water run-off volume is as follows:

Q ₁₀₀	=	18.14m ³ (360-minute storm duration)
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9. Climate Change

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.

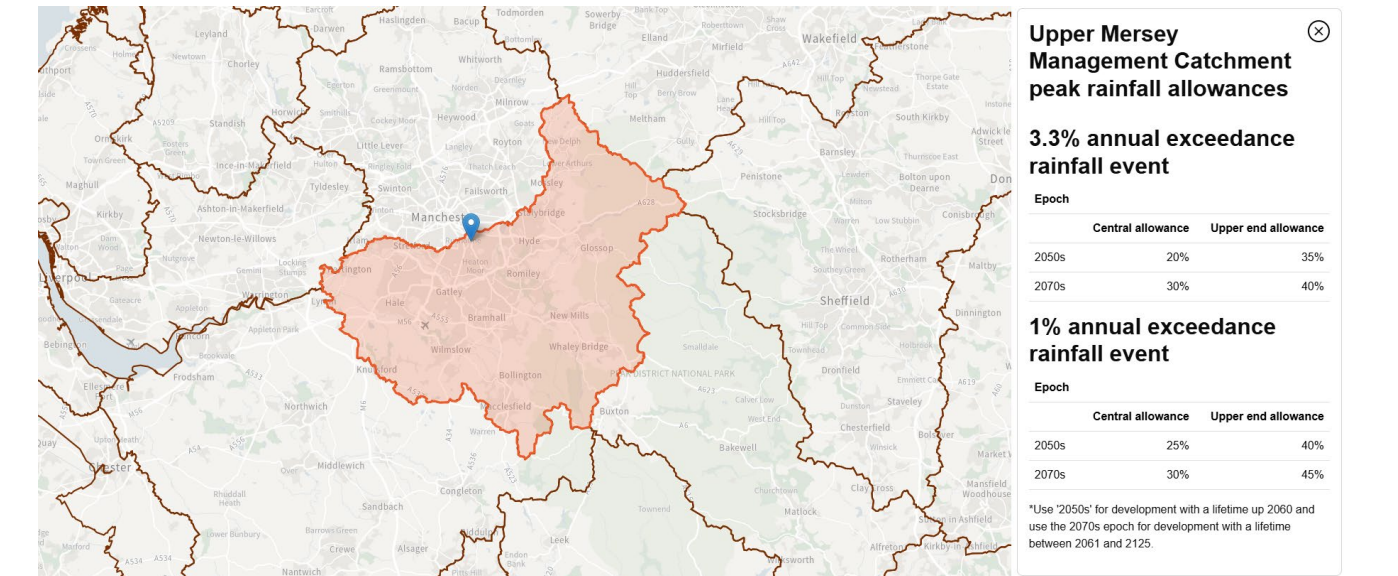


Figure 1 - DEFRA's Climate Change Allowances

The lifetime of the dwellings 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 surface water run-off will be **40% and 45%** for the 30-year and 100-year storm respectively.

10. Surface Water Management Calculation

10.1. Surface Water Network Calculations

The calculations to determine the post development surface water run-off rates and required attenuation volume, are based on the post development surface water run-off area of 0.030 ha, the rainfall data given by the FEH 2022 (shown as FEH 2013 in MicroDrainage, but 2022 used), and a run-off coefficient (Cv) of 1.0.

10.2. Surface Water Drainage Network

As shown on the below ground drainage layout in Appendix H, the proposed surface water network will consist of 150mm diameter suspended and below ground drainage pipes, 100mm perforated pipes, 460mm inspection and silt trap chambers, permeable paving, a flow control chamber containing a hydro-brake, and an attenuation tank in the form of cellular units.

The surface water run-off from the building roof areas will discharge to the main network via trapped rainwater pipes and trapped gullies where possible (containing first 5mm of water), and the surface water run-off from the external areas will discharge to the main network via the permeable paving system.

The surface water network will flow to the south-west of the Site, where the surface water will flow through the flow control chamber prior to discharge to the 225mm surface water sewer in Swallow Street.

Surface water is to be restricted by the flow control, with the restricted surface water surcharging the network and being attenuated within the tank in the form of cellular units and sub-base of the permeable paving.

10.3. Surface Water Run-Off Rate

For the surface water run-off from the Site, in a post-development state, to be at the greenfield run-off rate, they are to be restricted to 0.4 l/s for the 1 in 2-year storm event, 0.7 l/s for the 1 in 30-year storm event including 40% allowance, and 0.9 l/s for the 1 in 100-year storm event including 45% allowance.

For the surface water run-off from the Site, in a post-development state, to be a reduction of the pre-development rates are to be restricted to less than 3.5 l/s for the 1 in 2-year storm event, 9.5 l/s for the 1 in 30-year storm event including 40% allowance; and 12.0 l/s for the 1 in 100-year storm event including 40% allowance.

An assessment of the suitable flow control opening, and subsequent surface water discharge also needs to be assessed, where CIRIA document C753 – The SuDS Manual states that: *‘the flow controls / orifice design should be designed so that it has simplicity on operation, and has resistance to clogging, blocking or mechanical failure’*.

For this development, the 2-year greenfield run-off rate (0.4 l/s) is deemed to be too low, where the flow control opening to achieve this greenfield rate will have to be at a size where it is likely to cause blockage and subsequent flooding. The suitable / minimum size of the flow control opening (hydro-brake opening) to reduce the risk of blockage is deemed to be 87mm.

As shown in the output calculation from the MicroDrainage computer software in Appendix I, if the hydro-brake opening is set at 40mm, the design flow of 0.8 l/s, with a design head of 1.20m, the maximum surface water run-off rates for each storm event will be as follows:

Q ₂	-	0.6 l/s	-	120-minute summer storm duration
Q _{30 + 40% CC}	-	0.7 l/s	-	120-minute winter storm duration
Q _{100 + 45% CC}	-	0.8 l/s	-	120-minute winter storm duration

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

Greenfield Rate to Post Development Rate

Storm	-	Greenfield	-	Post Dev	-	Difference
Q ₂	-	0.4 l/s	-	0.6 l/s	-	Increase
Q _{30 + CC}	-	0.7 l/s	-	0.7 l/s	-	Equivalent
Q _{100 + CC}	-	0.9 l/s	-	0.8 l/s	-	Reduction

Pre-Development Rate to Post Development Rate

Storm	-	Pre-Dev	-	Post Dev	-	Difference
Q ₂	-	3.5 l/s	-	0.6 l/s	-	Reduction
Q _{30 + CC}	-	9.5 l/s	-	0.7 l/s	-	Reduction
Q _{100 + CC}	-	12.0 l/s	-	0.8 l/s	-	Reduction

The surface water run-off rates exceed the 2-year greenfield rate, but the equivalent to the 30-year and a reduction of 100-year greenfield rate and pre-development rates

Therefore, the rates are acceptable as they adhere to the requirements of DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems - S3, where the rates are reduced to as close as possible to greenfield rates, but do not exceed the pre-development rates

10.4. Surface Water Run-Off Volume

The post development surface water run-off volume for the Site can be calculated for 1 in 100-Year the 6-hour duration (Inc. 45% allowance), based on the peak discharge rate, where:

$$Q_{100(6\text{-hour})} = 0.8 \text{ l/s} \times (60 \times 60 \times 6) = 17,280\text{m}^3 = \mathbf{17.28\text{m}^3}$$

A summary of the post development surface water run-off volume compared to the greenfield and pre-development volumes is follows:

Greenfield Volume to Post Development Volume

Storm	-	Greenfield	-	Post Dev	-	Difference
Q ₁₀₀	-	10.13m ³	-	17.28m ³	-	Increase

Pre-Development Volume to Post Development Volume

Storm	-	Pre-Dev	-	Post Dev	-	Difference
Q ₁₀₀	-	18.14m ³	-	17.28m ³	-	Reduction

The surface water run-off volume for the 100-year, 6-hour storm event is an increase of the greenfield run-off volume but is a reduction of the pre-development volume.

Therefore, adheres to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems – S5 where the volumes are reduced to as close as possible to greenfield volume, but does not exceed the pre-development volume.

10.5. Surface Water Network and Attenuation Calculations

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

Ciria SuDS Manual 2015, Paragraph 10.2.4 states that: *'Exceedance flows (i.e. flows in excess of those for which the system is designed) should be managed safely in above-ground space such that risks to people and property are acceptable'*.

Attenuation structures are to be a below ground attenuation tank in the form of cellular units, and the sub-base material of the permeable paving system. As detailed in the MicroDrainage calculations (Appendix I) and surface water management layout (Appendix H), the attenuation volume and details for these SuDS methods are as follows:

Cellular Units

Attenuation Tank Length	-	5.00m ²
Attenuation Tank Width	-	2.50m ²
Attenuation Tank Area	-	12.50m ²
Attenuation Tank Depth	-	1.20m
Attenuation Tank Volume	-	15.00m ³
Porosity	-	0.95
Attenuation Volume	-	14.25m³

Permeable Paving Sub-Base

Permeable Sub-Base Area	-	24.00m ²
Permeable Sub-Base Depth	-	0.25m
Permeable Sub-Base Volume	-	6.00m ³
Porosity	-	0.3
Attenuation Volume	-	1.80m³

The MicroDrainage calculations (Appendix G) show that with the proposed cellular unit and permeable paving sub-base volume, no flooding will occur for all storms up to and including the 100-year + 45% storm event.

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

11. Maintenance Requirements

Details of the maintenance required, and the parties to carry out the maintenance of all drainage aspects, to ensure that the SuDS methods are working affectively, and subsequently reducing the risk of flooding on the Site, are set out below.

11.1. Drainage Responsibilities

The management and maintenance of the surface water drainage networks and SuDS features within the Site and will be by contractors appointed by the estate management company for the new multi residential building, where payments of the works will form part of the property deeds and / or rental agreements.

A copy of the drainage design layout / details and a drainage maintenance / management document will be handed to the occupants on completion of the property purchase, where they will be made aware of the features within the Site, and responsibility to maintain the drainage features shown on said drawings and details.

11.2. Maintenance and Management Document on Completion

The document produced, and handed to the owners of the new properties, will state the following:

'The owners & parties with responsibilities for the surface water drainage system on this development will comprise of the following stakeholders:

Private Apartment Owners

All of which is clearly defined on the surface water management and foul water drainage plan included within your handover pack & property deeds package.

As you are a residential unit owner on this development, you have responsibilities for the maintenance of the surface water drainage system which fall within the 'development boundary' (shown as red boundary on Architectural drawings).

Failure to maintain or removal of surface water drainage features may result in civil litigation with neighbouring owners if flooding occurs as a result.

Surface water drainage pipes, inspection chambers, permeable paving, attenuation tanks and flow control chambers within the development boundary are owned by all residents. Communal sums are to be taken and given to an appointed estate management company to carry out necessary maintenance / repairs & replacement of drainage features.

The communal sums will form part of the ground rent for the apartment, and will include the management and maintenance of all other communal areas within the development site.

The operation and frequency of the maintenance and management set out in this report and as shown on the drainage layout are to be carried out as follows:

Drainage Networks, Cellular Units, Flow Control Chamber

Operation	Frequency
<i>Inspect and identify any areas that are not operating correctly, if required, take remedial actions</i>	<i>Monthly for 3 months, then six monthlies</i>
<i>Debris removal from manholes (where may cause risk performance)</i>	<i>Monthly</i>
<i>Where rainfall into network from above, check surface or filter for blockage or silt, algae, or other matter by jetting</i>	<i>As required, but at least twice a year</i>

<i>Remove sediment from pipework by jetting.</i>	<i>Annually or as required</i>
<i>Repair/check all inlets, outlets, and overflow pipes</i>	<i>As required</i>
<i>Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed</i>	<i>Annually and after large storms</i>

Permeable Paving

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

11.3. Linked and Further Maintenance and Maintenance Activities

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance plan for the multi-residential unit building.

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.

12. Surface Water Exceedance Event

In the unlikely event of an extreme storm greater than 100-year + 45% potential flooding could occur.

Surface water flow paths to follow existing and proposed ground topography of the existing / proposed external areas (are of flow control and attention), where water will flow to the south-west corner of the Site, and into Swallow Street.

Surface water will flow away from the new residential building (ground floor levels higher than external levels, with raised walls around steps to low ground floor) and will not flow towards any other buildings or properties prior to discharging to Swallow Street.

Therefore, there will not be an increase in flood risk to any neighbouring properties in an extreme storm event.

13. Water Quality

The level of water treatment (for external areas subject to pollutants) 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.

13.1. External Area Pollutant Hazard

C753 Table 26.2 Pollution Hazard Level	=	Low
C753 Table 26.2 Pollution Hazard Index:		
• Total Suspended Solid (TSS)	=	0.5
• Metals	=	0.4
• Hydrocarbons	=	0.4
Pollution Hazard Index	=	<u>1.30</u>

13.2. External Area Pollutant Mitigation

Mitigation Measures:

- **Permeable Paving**

Permeable Paving Pollutant 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.

Note: Surface water run-off from residential building roof to have very low pollutants. Therefore, roof surface water run-off will not affect the water quality.

14. Development Management and Construction Phase

All existing drainage networks (if found) within the Site are to be maintained during construction. The flow control and cellular units are to be the first part of the drainage network to be built. This will ensure that the surface water discharge at a reduced rate during all phases of the build.

14.1. Construction Environment Management Plan

Full details of the construction environment management plan (CEMP) are to be confirmed by the chosen contractor who has been appointed for the development. However, it will conform to the requirements of CIRIA 753 – The SuDS Manual – Chapter 31, and will include:

14.2. Construction Access

The main construction traffic will access the site from the south-west boundary (Swallow Street). The set-up areas will be limited to avoid the attenuation tank, with protection measures (i.e. concrete slab) put over the installed attenuation tank to prevent damage during vehicle movements.

14.3. Sediments and Traps

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

14.4. 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 silts. Any surface water upstream of the site is to be diverted around the development areas, and to discharge to the surface water sewer. The surface water run-off destination for the diverted surface water will continue as existing.

14.5. Main Surface Water Run-Off Systems

The flow control chamber and cellular units are to be built prior to any phase of construction of site. Temporary inlet and outlet protection measures and appropriate silt traps are to be installed to prevent silt ingress into the main drainage network.

14.6. 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.

14.7. 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.

14.8. Construction of Permeable Paving

Construction of the 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.

15. Conclusion / Summary

15.1. Discharge Destination and SuDS Principles

All feasible SuDS methods, and surface water discharge destination have been assessed, with the feasible SuDS methods being permeable paving, a flow control chamber and an attenuation tank in the form of cellular units, with the surface water destination being to a surface water sewer.

15.2. Peak Flow Control

The surface water run-off rates exceed the 2-year greenfield rate, but the equivalent to the 30-year and a reduction of 100-year greenfield rate and pre-development rates. Therefore, the rates are acceptable as they adhere to the requirements of DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems - S3, where the rates are reduced to as close as possible to greenfield rates, but do not exceed the pre-development rates

15.3. Volume Control

The surface water run-off volume for the 100-year, 6-hour storm event is an increase of the greenfield run-off volume but is a reduction of the pre-development volume. Therefore, adheres to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems – S5 where the volumes are reduced to as close as possible to greenfield volume, but does not exceed the pre-development volume.

15.4. Flood Risk within the Development

With the proposed cellular unit and permeable paving sub-base volume, no flooding will occur for all storms up to and including the 100-year + 45% storm event. Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems - S7 to S9.

15.5. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features within the Site and will be by contractors appointed by the estate management company for the new multi residential building, where payments of the works will form part of the property deeds and / or rental agreements.

A copy of the drainage design layout / details and a drainage maintenance / management document will be handed to the occupants on completion of the property purchase, where they will be made aware of the features within the Site, and responsibility to maintain the drainage features shown on said drawings and details.

15.6. Surface Water Exceedance Design

Surface water flow paths to follow existing and proposed ground topography of the existing / proposed external areas (are of flow control and attention), where water will flow to the south-west corner of the Site, and into Swallow Street. Surface water will flow away from the new residential building (ground floor levels higher than external levels, with raised walls around steps to low ground floor) and will not flow towards any other buildings or properties prior to discharging to Swallow Street. Therefore, there will not be an increase in flood risk to any neighbouring properties in an extreme storm event.

15.7. Water Quality

The level of water treatment is to be assessed against the details set out in Ciria SuDS Manual C753. Chapter 26. The mitigation indices are greater than the pollution hazard index, and therefore suitable water quality is achieved.

15.8. Construction Environment Management Plan

The cellular units and flow control chamber are to be the first part of the drainage network to be built. This will ensure that the surface water discharge is suitably restricted without flooding, The CEMP will conform to the requirements of CIRIA 753 – The SuDS Manual – Chapter 31.



LOCATION PLAN
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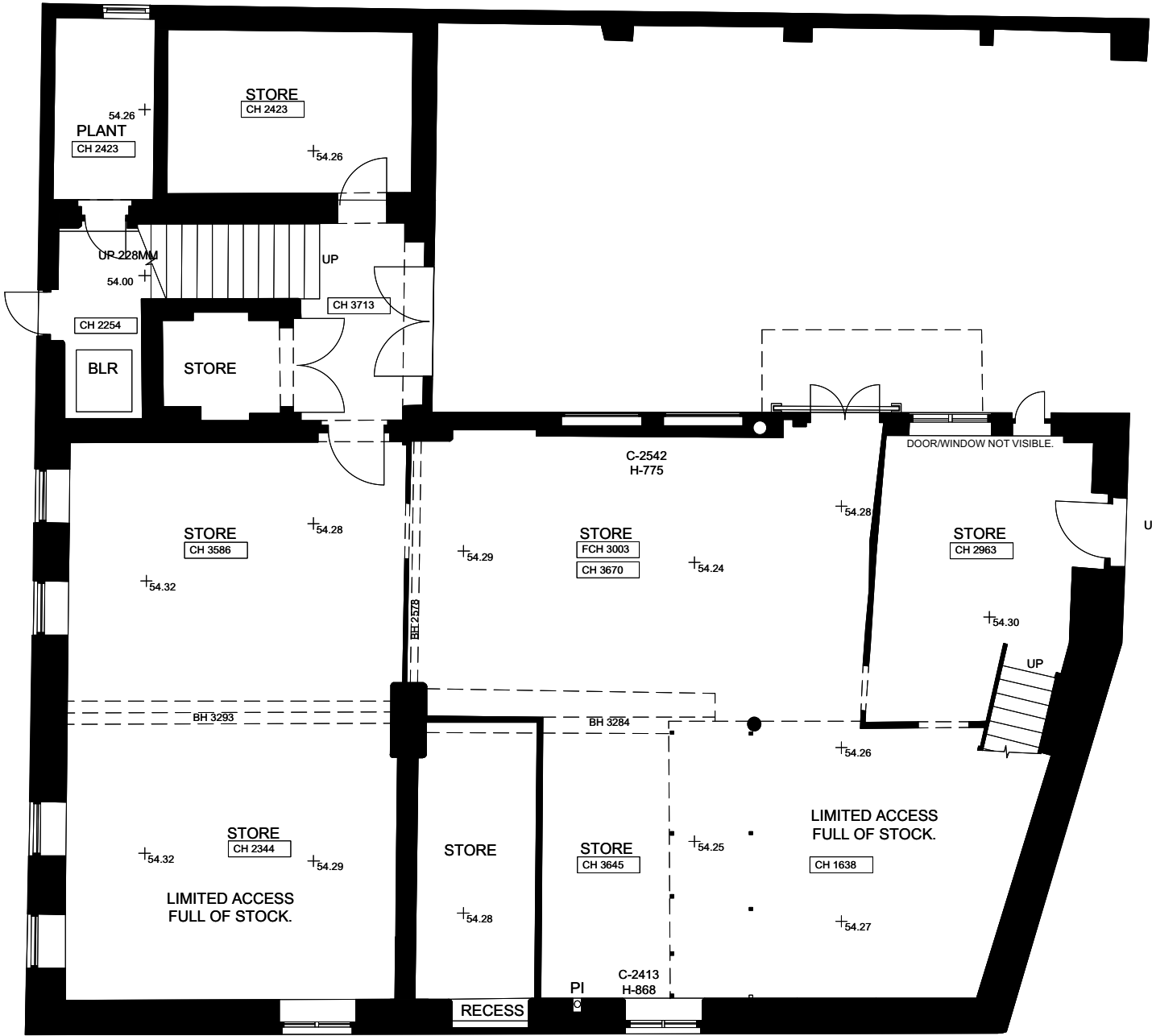
0M 10M 20M 30M 40M 50M 60M 70M

REVISION	DATE	DESCRIPTION

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PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT	
ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: Location Plan	
SCALE: 1:1250 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_001	

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EXISTING GROUND FLOOR PLAN
1:100 @ A3

EXISTING GROUND FLOOR PLAN
1:100 @ A3



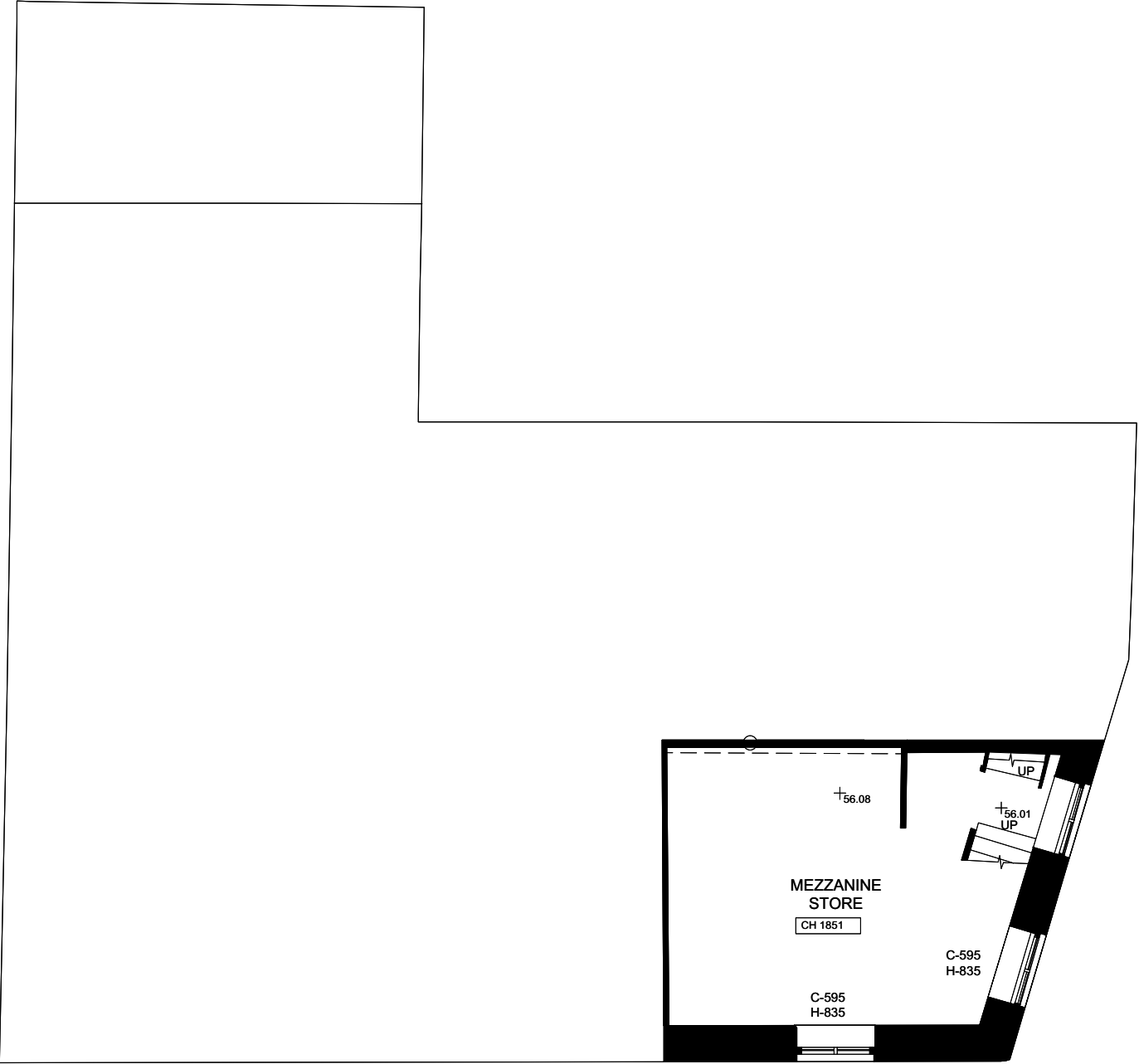
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REVISION	DATE	DESCRIPTION

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PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT	
ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: EXISTING GF PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_021	

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EXISTING MEZZANINE FLOOR PLAN
1:100 @ A3

EXISTING MEZZANINE FLOOR PLAN
1:100 @ A3

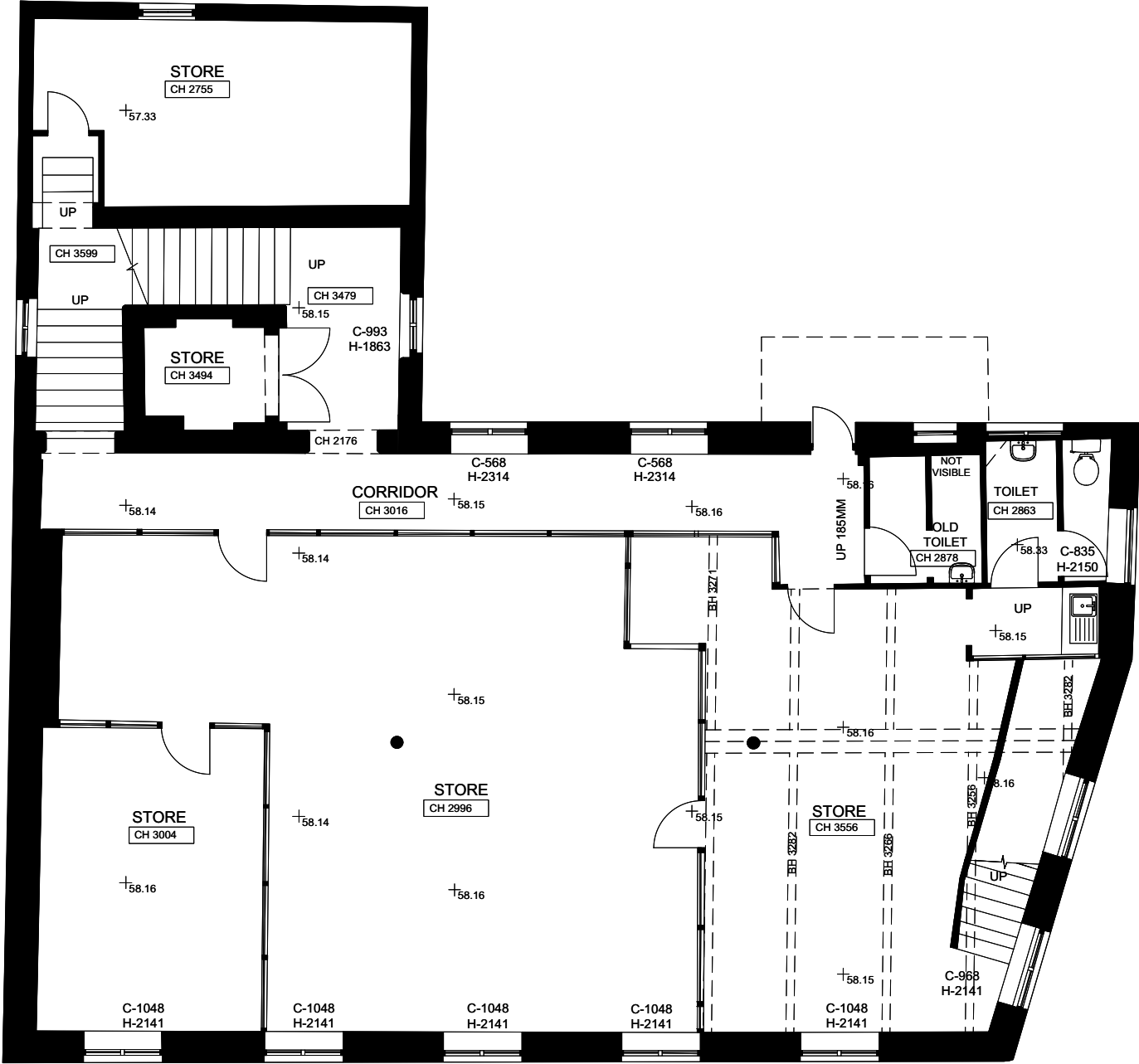


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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: EXISTING MEZZANINE PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_022	

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EXISTING FIRST FLOOR PLAN
1:100 @ A3

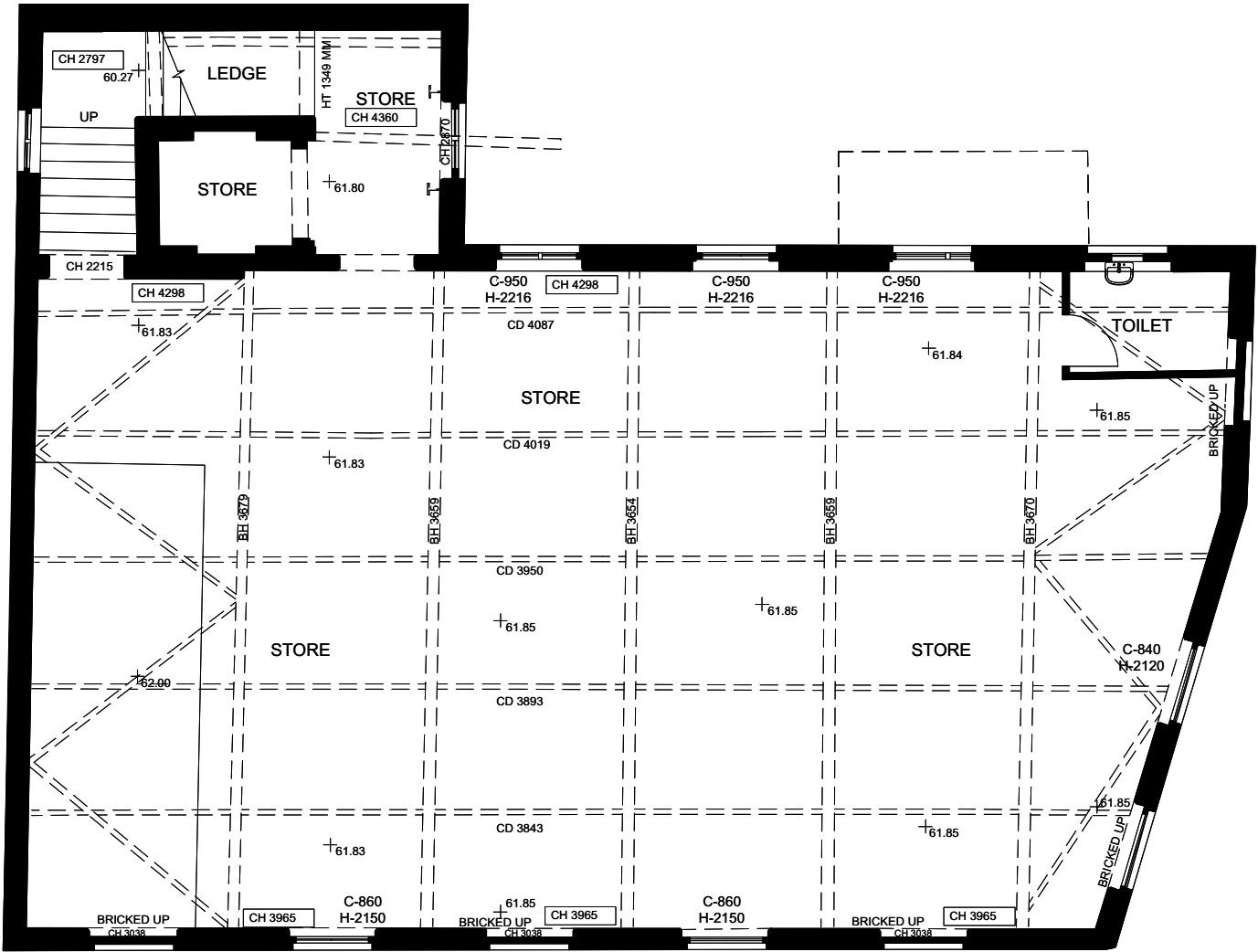


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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: EXISTING 1F PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_023	

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EXISTING SECOND FLOOR PLAN
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1:100 @ A3

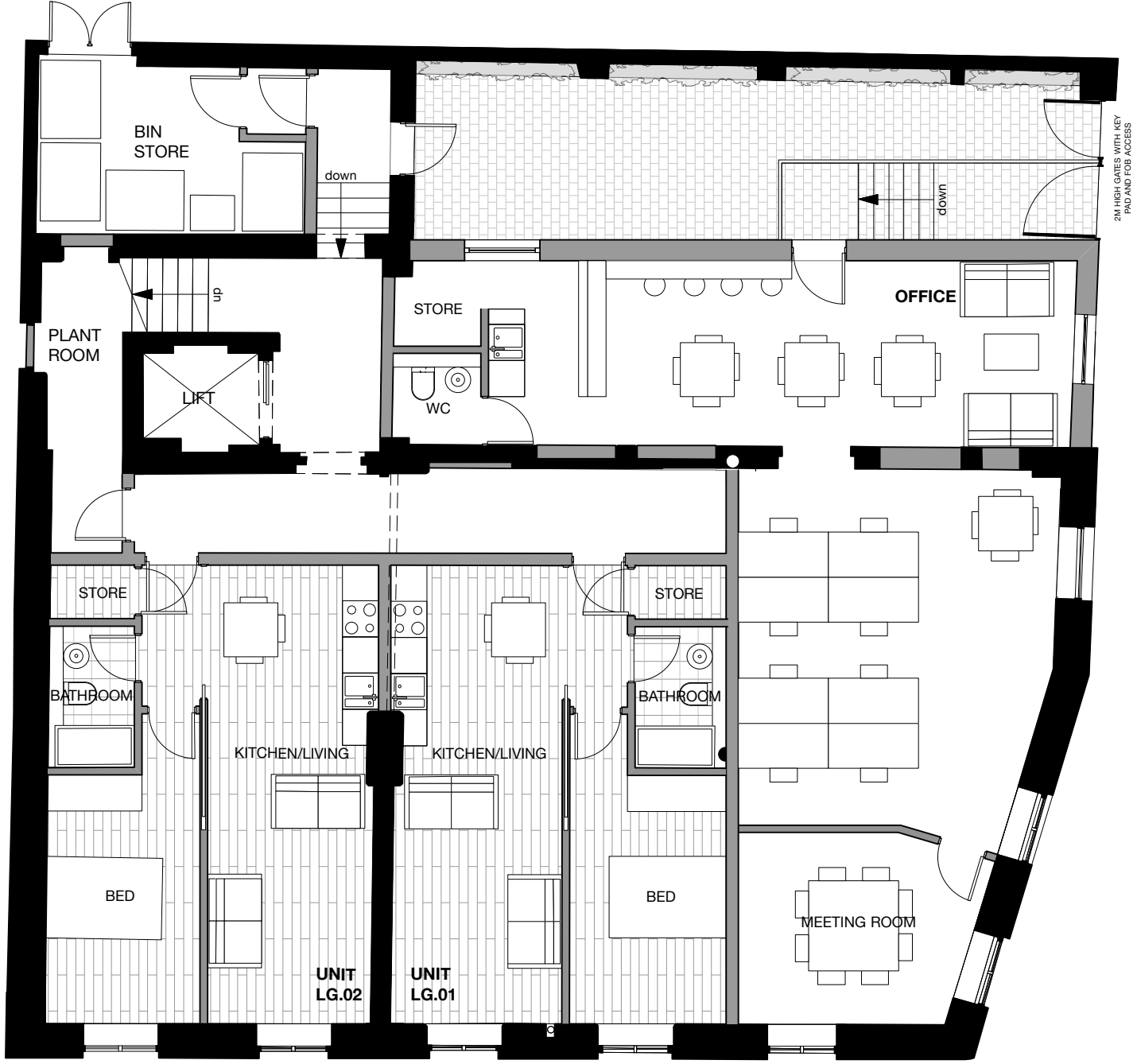


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DRAWING NO: A619_P_024	

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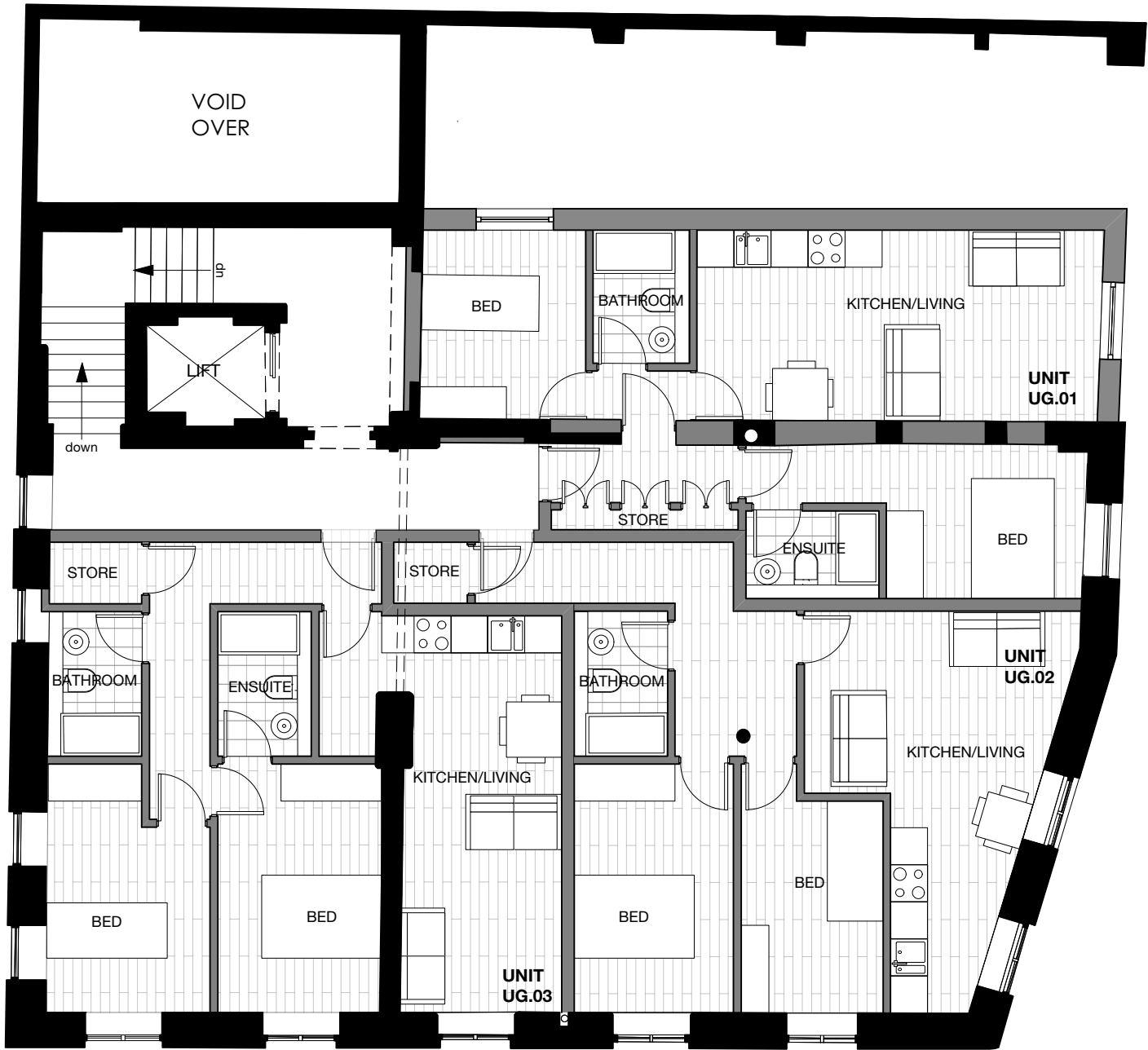
LOWER GROUND FLOOR

PROPOSED LOWER GROUND FLOOR PLAN
1:100 @ A3

CLIENT:	
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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED LGF PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_100C	

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UPPER GROUND FLOOR

PROPOSED UPPER GROUND FLOOR PLAN
1:100 @ A3

REVISION	DATE	DESCRIPTION

CLIENT:	
PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT	
ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED UGF PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_101	

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FIRST FLOOR

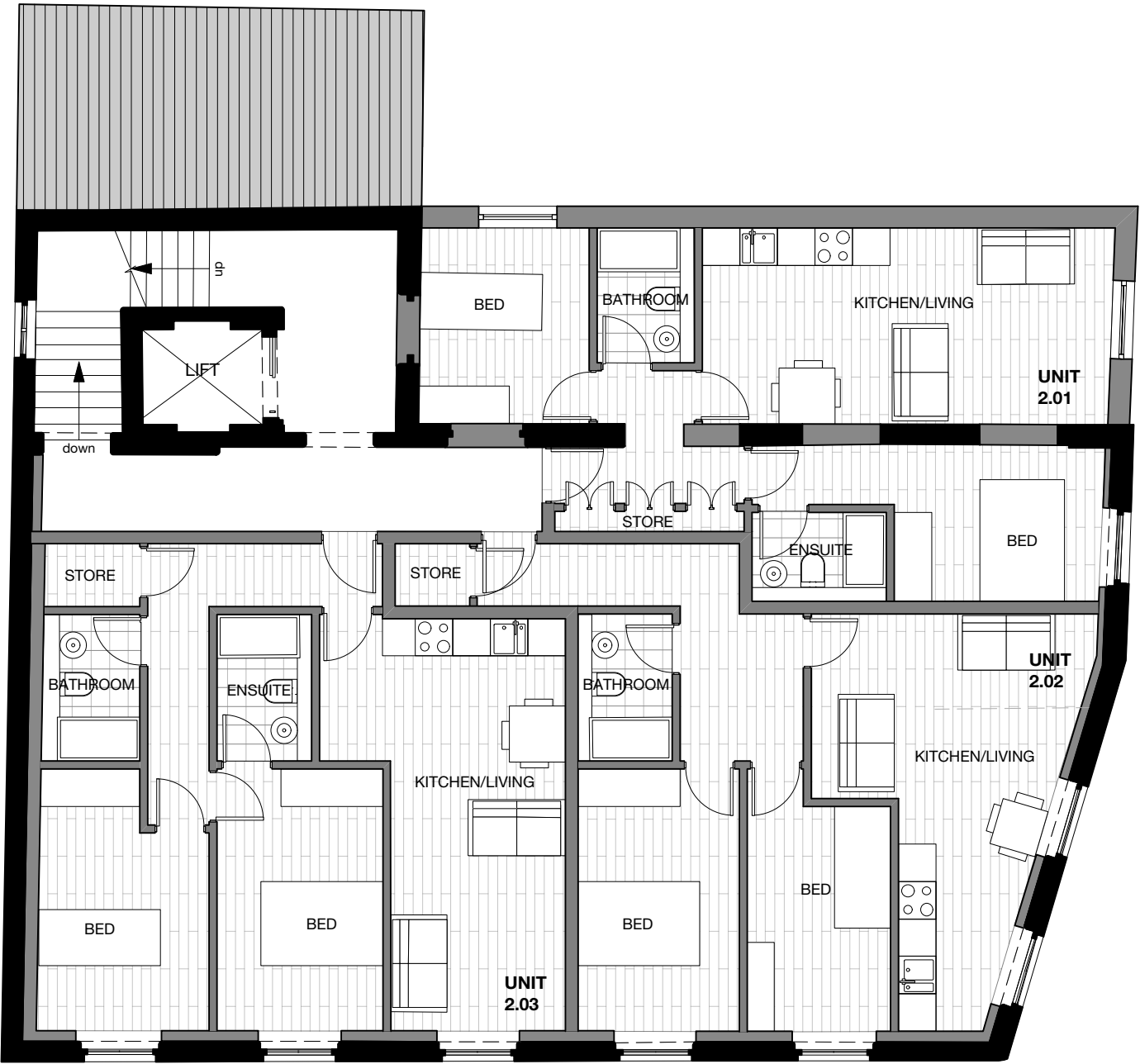
PROPOSED FIRST FLOOR PLAN
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REVISION	DATE	DESCRIPTION

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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED 1F PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
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SECOND FLOOR

PROPOSED SECOND FLOOR PLAN
1:100 @ A3

REVISION	DATE	DESCRIPTION
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CLIENT:	
PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT	
ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED 2F PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_103	

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THIRD FLOOR

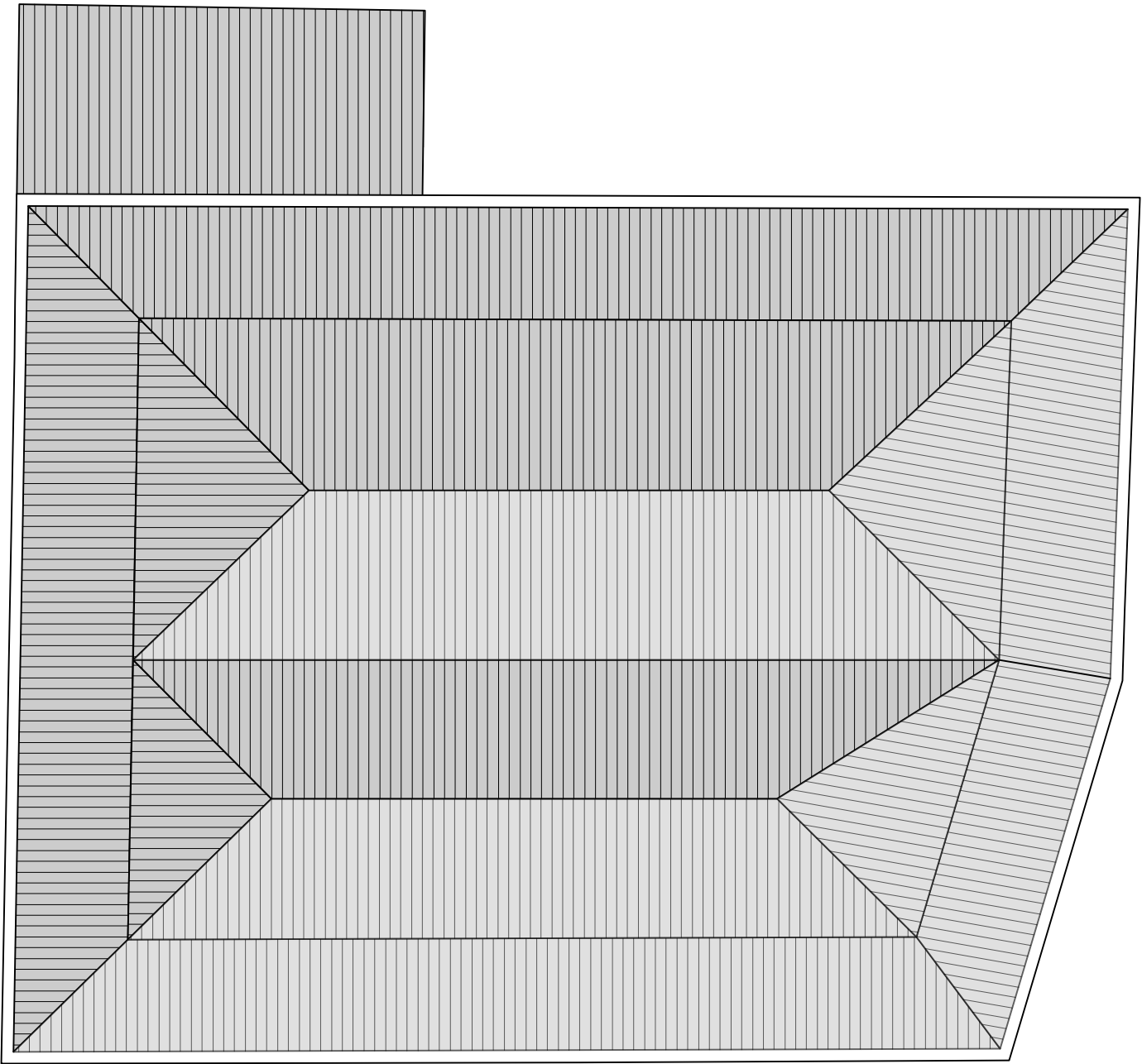
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REVISION	DATE	DESCRIPTION
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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED 3F PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_104	

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ROOF PLAN

PROPOSED ROOF PLAN
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ADDRESS: SWALLOW STREET, LEVENSHULME	
DRAWING TITLE: PROPOSED ROOF PLAN	
SCALE: 1:100 @ A3	DATE: MARCH 2022
DRAWING NO: A619_P_105	

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(B11857) Wt. 17862—S154—5,000 12/26 Gp. 100. O.A.

SECTION OF

Bonholes

SJ89SE13

Levenshulme

G.S.M. No. *12, 14, 15*

20, 21

on standard

Maps: One-inch *85*

Six-inch *111 N.E.*

County *Lancs*

Height Above O.D.

Latitude

Longitude

Communicated by

Manchester Corporation

Date of Sinking

Made by

Dip of Strata

		Thickness.		Depth from Surface.	
<p>No. <i>12</i> <i>12 on site map</i> <i>Exact position uncertain.</i> No. 102. <i>172.61 ft. O.D.</i> <i>In Stockport Road 100 yds. S. of corner with Chapel St.</i> <i>LEVENSHULME.</i></p>					
<p><i>No. 20</i> <i>111 N.E.E.</i></p>	<i>Made ground</i>	<i>1 -</i>	<i>0.30</i>	<i>1 -</i>	<i>0.30</i>
	<i>Yellow clay</i>	<i>3 2</i>	<i>1.27</i>	<i>4 2</i>	
	<i>Brown clay</i>	<i>8 3</i>	<i>3.79</i>	<i>12 5</i>	
	<i>Sandy brown clay</i>	<i>- 4</i>	<i>3.89</i>	<i>12 9</i>	
	<i>Stiff brown clay</i>	<i>3 3</i>	<i>4.88</i>	<i>16 -</i>	
	<i>Stony clay.</i>	<i>8 -</i>	<i>7.32</i>	<i>24 -</i>	
	<i>Red sandy clay.</i>	<i>3 -</i>	<i>8.23</i>	<i>27 -</i>	
	<i>Sandy brown clay</i>	<i>12 6</i>	<i>12.04</i>	<i>39 6</i>	
	<i>Heavy clay.</i>	<i>3 6</i>	<i>13.11</i>	<i>43 -</i>	
	<i>Soft loamy clay.</i>	<i>7 -</i>	<i>15.24</i>	<i>50 -</i>	
<p>No. <i>14</i> <i>14 on site map</i> No. 31. <i>157.75 ft. O.D.</i> <i>Corner of Victoria Road & Albert Road.</i> <i>LEVENSHULME.</i></p>					
<p><i>No. 14</i> <i>111 N.E.E.</i></p>	<i>Soil remains.</i>	<i>2 -</i>	<i>0.61</i>	<i>2 -</i>	
	<i>Yellow stony clay.</i>	<i>3 -</i>	<i>1.52</i>	<i>5 -</i>	
	<i>Yellow clay.</i>	<i>9 -</i>	<i>4.27</i>	<i>14 -</i>	
<p>No. <i>13</i> <i>13 on site map</i> No. 3. <i>67 ft. O.D.</i> <i>In Stockport Road. 50 yds S. of corner with St. Peter's Hall Road.</i> <i>LEVENSHULME.</i></p>					
<p><i>No. 13</i> <i>111 N.E.E.</i></p>	<i>Filled up stuff.</i>	<i>3 -</i>	<i>0.91</i>	<i>3 -</i>	
	<i>Brown clay.</i>	<i>14 6</i>	<i>5.33</i>	<i>17 6</i>	

SJ89/148-150

(111867) Wk 17052-5154-5200 12/55 84 100 O.A.

SECTION OF

Boulders

at

Levenshulme

G.S.M. No. 14. 20, 21.
12, 14, 15

on standard

Maps: One-inch

95

Six-inch

111 N.E.

County

Lancs

Height above O.D.

Latitude

Longitude

Communicated by

Manchester Corporation

Date of Sinking

Made by

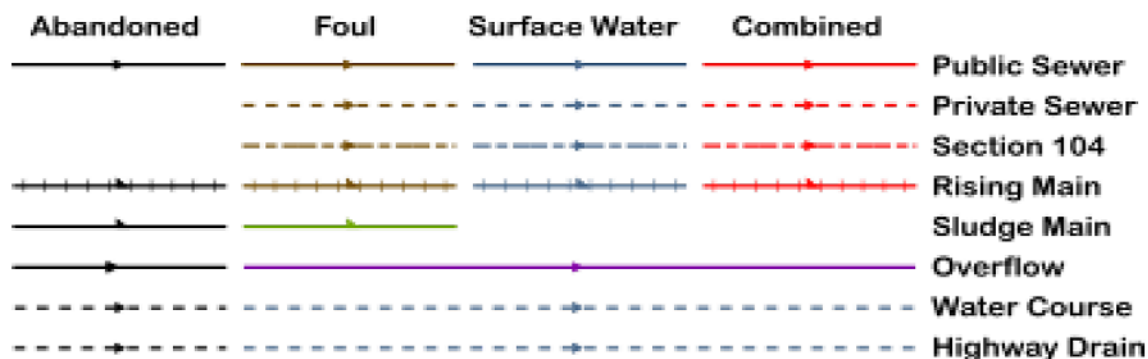
Dip of Strata

		Thickness		Depth from Surface	
No. 12	12.00 ft. O.D.				
No. 102	172.61 ft. O.D.				
In Street Road 100 yds. S. of corner with Chapel St. LEVENSHULME.					
No. 20	Made ground	1	-	1	-
SJ89/148	Yellow clay	3	2	4	2
SJ8739 9416	Brown clay	8	3	12	5
[III N.E.]	Sandy brown clay	-	4	12	9
	Stiff brown clay	3	3	16	-
	Stony clay.	8	-	24	-
	Red sandy clay.	3	-	27	-
	Sandy brown clay	12	6	39	6
	Heavy clay.	3	6	43	-
	Soft loamy clay.	7	-	50	-
No. 31	157.75 ft. O.D.				
Corner of Victoria Road & Albert Road. LEVENSHULME.					
No. 14	Soil remains.	2	-	2	-
[III N.E.]	Yellow stony clay.	3	-	5	-
	Yellow clay.	9	-	14	-
No. 34	174.67 ft. O.D.				
In Street Road. 50 yds S. of corner with St. Peter's Hall Road. LEVENSHULME.					
[III N.E.] No. 21	Filled up stuff.	3	-	3	-
	Brown clay.	14	6	17	6
SJ89/150					
SJ8724 9492					



Lines 11/NE
12, 13, 1
? Lines 11/NE/11 missing?

Wastewater Symbolology



All point assets follow the standard colour convention: **red** – combined **brown** - foul
blue – surface water **purple** - overflow

Manhole	Side Entry Manhole
Head of System	Outfall
Extent of Survey	Screen Chamber
Rodding Eye	Inspection Chamber
Inlet	Bifurcation Chamber
Discharge Point	Lamp Hole
Vortex	T Junction / Saddle
Penstock	Catchpit
Washout Chamber	Valve Chamber
Valve	Vent Column
Air Valve	Vortex Chamber
Non Return Valve	Penstock Chamber
Soakaway	Network Storage Tank
Gully	Sewer Overflow
Cascade	Ww Treatment Works
Flow Meter	Ww Pumping Station
Hatch Box	Septic Tank
Oil Interceptor	Control Kiosk
Summit	DNM Network Monitoring Point
Drop Shaft	Change of Characteristic
Orifice Plate	



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IH 124 Mean Annual Flood

Input

Return Period (years) 2 SAAR (mm) 864 Urban 0.750
Area (ha) 50.000 Soil 0.450 Region Number Region 10

Results 1/s

QBAR Rural 281.0
QBAR Urban 702.8

Q2 years 718.0

Q1 year 611.4
Q2 years 718.0
Q5 years 861.6
Q10 years 928.6
Q20 years 989.6
Q25 years 1005.3
Q30 years 1017.8
Q50 years 1050.1
Q100 years 1106.0
Q200 years 1183.5
Q250 years 1206.8
Q1000 years 1351.6

Greenfield Runoff Volume

FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	2013
Site Location	GB 387260 394810 SJ 87260 94810
Data Type	Point
Areal Reduction Factor	1.00
Area (ha)	0.030
SAAR (mm)	864
CWI	120.442
SPR Host	47.000
URBEXT (USER)	0.5000

Results

Percentage Runoff (%)	55.86
Greenfield Runoff Volume (m³)	10.130

Flo Consult UK Ltd		Page 1
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Swallow Street Pre-Development SW Run-Off Calculations	
Date 13/08/2025	Designed by MDS	
File	Checked by MDS	
Innovyze	Network 2020.1.3	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 387260 394810 SJ 87260 94810
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	1.000
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.019	4-8	0.004	8-12	0.004	12-16	0.003

Total Area Contributing (ha) = 0.030

Total Pipe Volume (m³) = 0.177

Simulation Criteria for Storm

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0			
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0			

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	1.000
Site Location	GB 387260 394810 SJ 87260 94810	Cv (Winter)	0.840
Data Type	Point	Storm Duration (mins)	30

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
 FEH Rainfall Version 2013 Cv (Summer) 1.000
 Site Location GB 387260 394810 SJ 87260 94810 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 2, 30, 100
 Climate Change (%) 0, 0, 0

US/MH			Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water Surcharged Flooded			
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	Level (m)	Depth (m)	Volume (m³)	Flow / Cap.
1.000	1 30	Summer	2	+0%					10.032	-0.118	0.000	0.10
1.001	2 15	Summer	2	+0%					10.001	-0.099	0.000	0.25

		Half Drain		Pipe		
PN	US/MH Name	Overflow (l/s)	Time (mins)	Flow (l/s)	Level Exceeded	Status
1.000	1			1.4	OK	
1.001	2			3.5	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
 FEH Rainfall Version 2013 Cv (Summer) 1.000
 Site Location GB 387260 394810 SJ 87260 94810 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 2, 30, 100
 Climate Change (%) 0, 0, 0

									Water	Surcharged	Flooded	
	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth	Volume	Flow /
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)	(m)	(m³)	Cap.
1.000	1 15	Summer	30	+0%					10.051	-0.099	0.000	0.22
1.001	2 15	Summer	30	+0%					10.042	-0.058	0.000	0.67

Half Drain Pipe							
PN	US/MH Name	Overflow (l/s)	Time (mins)	Flow (l/s)	Level Exceeded	Status	
1.000	1			3.1		OK	
1.001	2			9.5		OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
 FEH Rainfall Version 2013 Cv (Summer) 1.000
 Site Location GB 387260 394810 SJ 87260 94810 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
 Analysis Timestep Fine Inertia Status OFF
 DTS Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 2, 30, 100
 Climate Change (%) 0, 0, 0

									Water	Surcharged	Flooded	
	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth	Volume	Flow /
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)	(m)	(m³)	Cap.
1.000	1 15	Summer	100	+0%					10.065	-0.085	0.000	0.28
1.001	2 15	Summer	100	+0%					10.059	-0.041	0.000	0.86

		Half Drain		Pipe			
PN	US/MH Name	Overflow (l/s)	Time (mins)	Flow (l/s)	Level Exceeded	Status	
1.000	1			3.9	OK		
1.001	2			12.0	OK		

Summary Wizard of 360 minute 100 year Winter I+0% for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH Data Type Point
FEH Rainfall Version 2013 Cv (Summer) 1.000
Site Location GB 387260 394810 SJ 87260 94810 Cv (Winter) 1.000

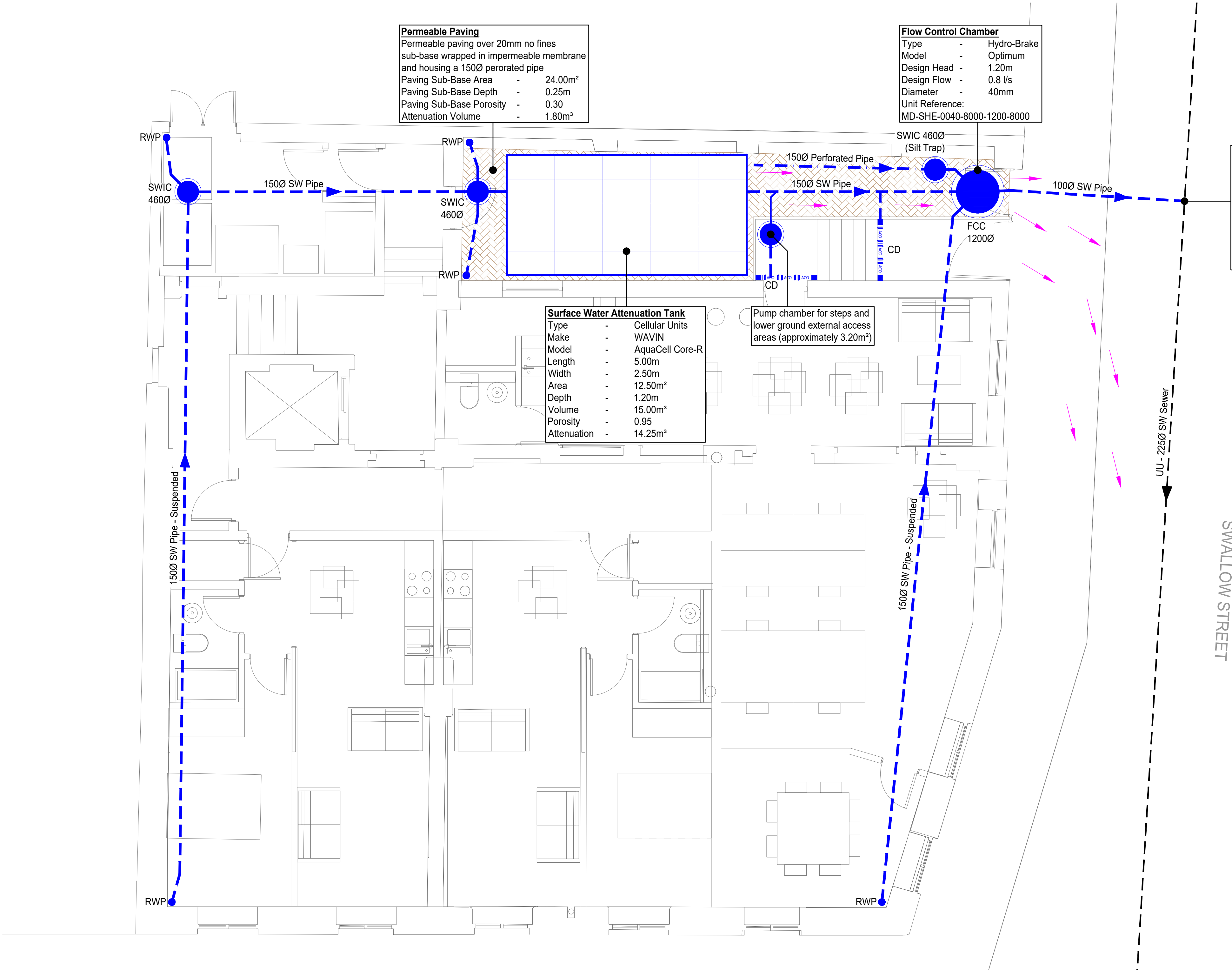
Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 0

							Water	Surcharged	Flooded	Half Drain			
	US/MH						Level	Depth	Volume	Flow / Overflow	Discharge	Time	
PN	Name	Event				(m)	(m)	(m)	(m³)	Cap.	(l/s)	Vol (m³)	(mins)
1.000	1	360 minute 100 year Winter I+0%	12.000	10.027	-0.123	0.000	0.07					9.068	
1.001	2	360 minute 100 year Winter I+0%	12.000	9.989	-0.111	0.000	0.15					18.138	

Pipe
US/MH Flow
PN Name (l/s) Status

1.000	1	1.0	OK
1.001	2	2.1	OK



Permeable Paving
Permeable paving over 20mm no fines sub-base wrapped in impermeable membrane and housing a 1500 perforated pipe

Paving Sub-Base Area	-	24.00m ²
Paving Sub-Base Depth	-	0.25m
Paving Sub-Base Porosity	-	0.30
Attenuation Volume	-	1.80m ³

Flow Control Chamber

Type	-	Hydro-Brake
Model	-	Optimum
Design Head	-	1.20m
Design Flow	-	0.8 l/s
Diameter	-	40mm

Unit Reference:
MD-SHE-0040-8000-1200-8000

Surface Water Discharge
Surface water to connect / discharge to existing 2250 surface water sewer. Connection and discharge rates to be confirmed by local authority and subject to Section 106 agreement with United Utilities. Peak Surface Water Discharge Rates:

Q2	-	0.6 l/s
Q30 + CC	-	0.7 l/s
Q100 + CC	-	0.8 l/s

*Equivalent to and reduction of greenfield run-off rates.

Surface Water Attenuation Tank

Type	-	Cellular Units
Make	-	WAVIN
Model	-	AquaCell Core-R
Length	-	5.00m
Width	-	2.50m
Area	-	12.50m ²
Depth	-	1.20m
Volume	-	15.00m ³
Porosity	-	0.95
Attenuation	-	14.25m ³

Pump chamber for steps and lower ground external access areas (approximately 3.20m²)

Surface Water Exceedance Event
In the unlikely event of an extreme storm greater than 100-year + 45% potential flooding could occur.

Surface water flow paths to follow existing and proposed ground topography of the existing / proposed external areas (are of flow control and attention), where water will flow to the south-west corner of the Site, and into Swallow Street.

Surface water will flow away from the new residential building (ground floor levels higher than external levels, with raised walls around steps to low ground floor) and will not flow towards any other buildings or properties prior to discharging to Swallow Street.

Therefore, there will not be an increase in flood risk to any neighbouring properties in an extreme storm event.

Drainage Key

- Proposed Surface Water Drainage
- 1500 Proposed Perforated Pipe
- Existing Surface Water Sewer
- Permeable Paving System
- Channel Drain
- Exceedance Flow Path

P1	ISSUED FOR APPROVAL	MDS	NC	13.08.25
Rev	Description	Dm	Chk	Date

Client
PINNACLE ESTATES LTD

Project
**SWALLOW STREET
LEVENSHULME, MANCHESTER**

Drawing
**SURFACE WATER MANAGEMENT
LAYOUT AND DETAILS**

Scale
1:50@A1

Date
13.08.25

Drawn by
MDS

Checked
NC

Status
APPROVAL

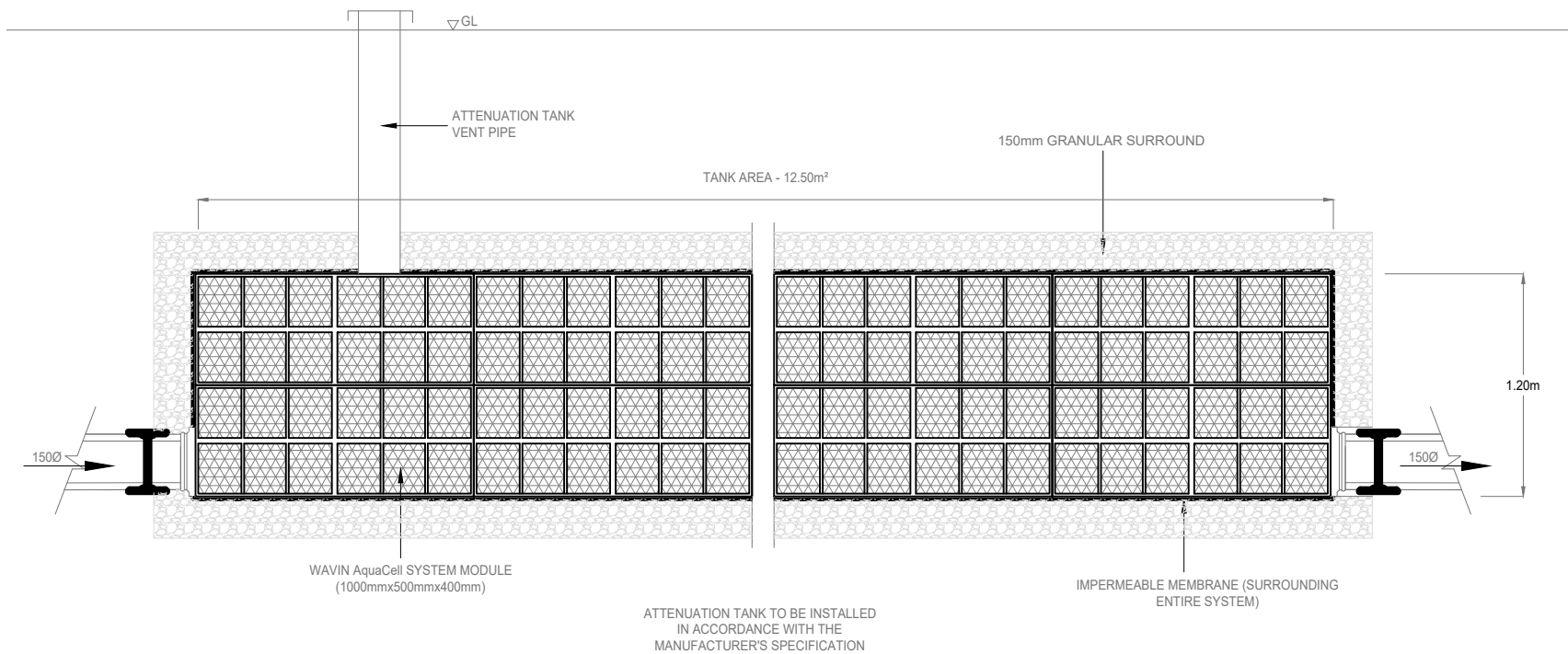
Flo

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Buckinghamshire, HP5 2XD
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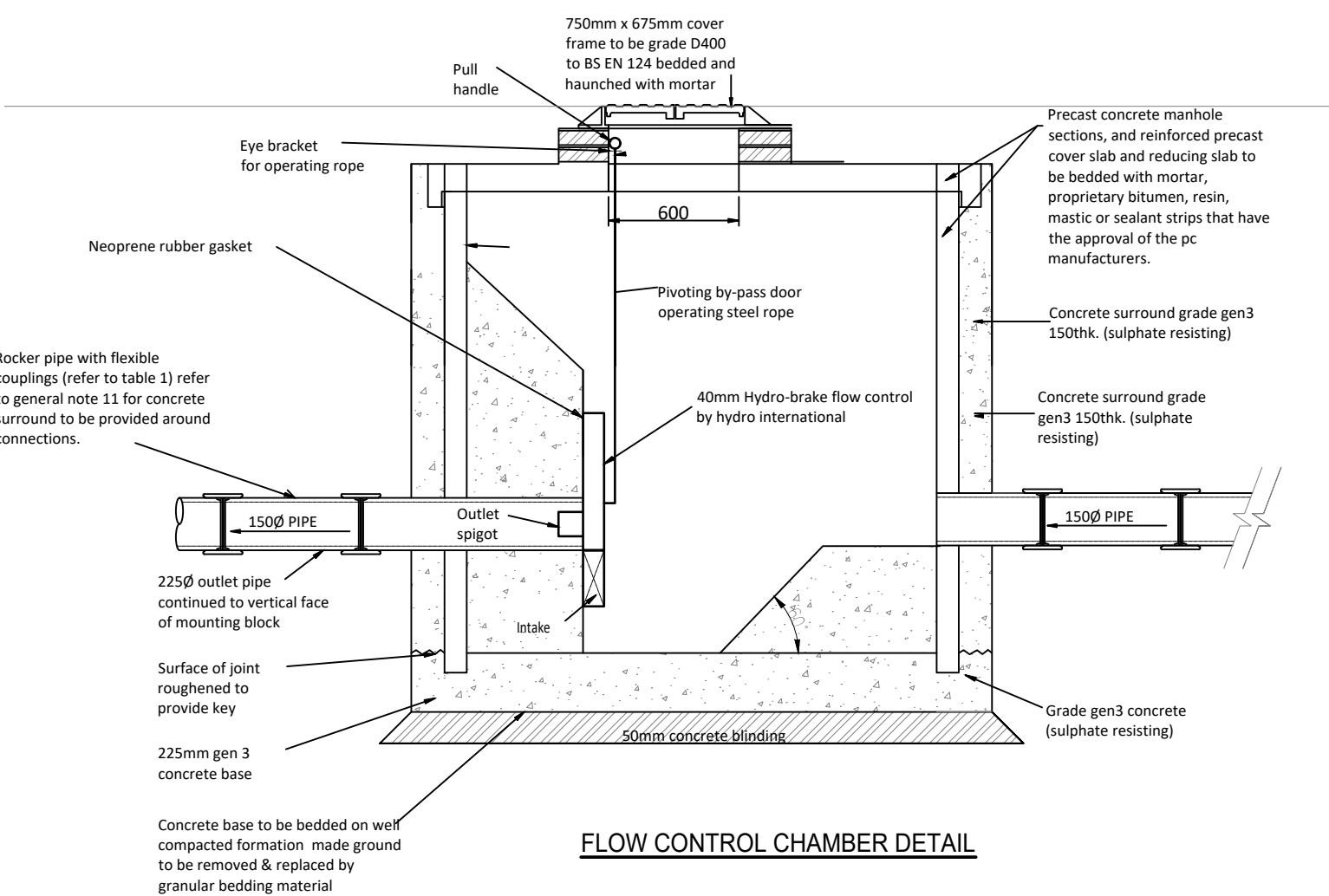
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Drg. No.
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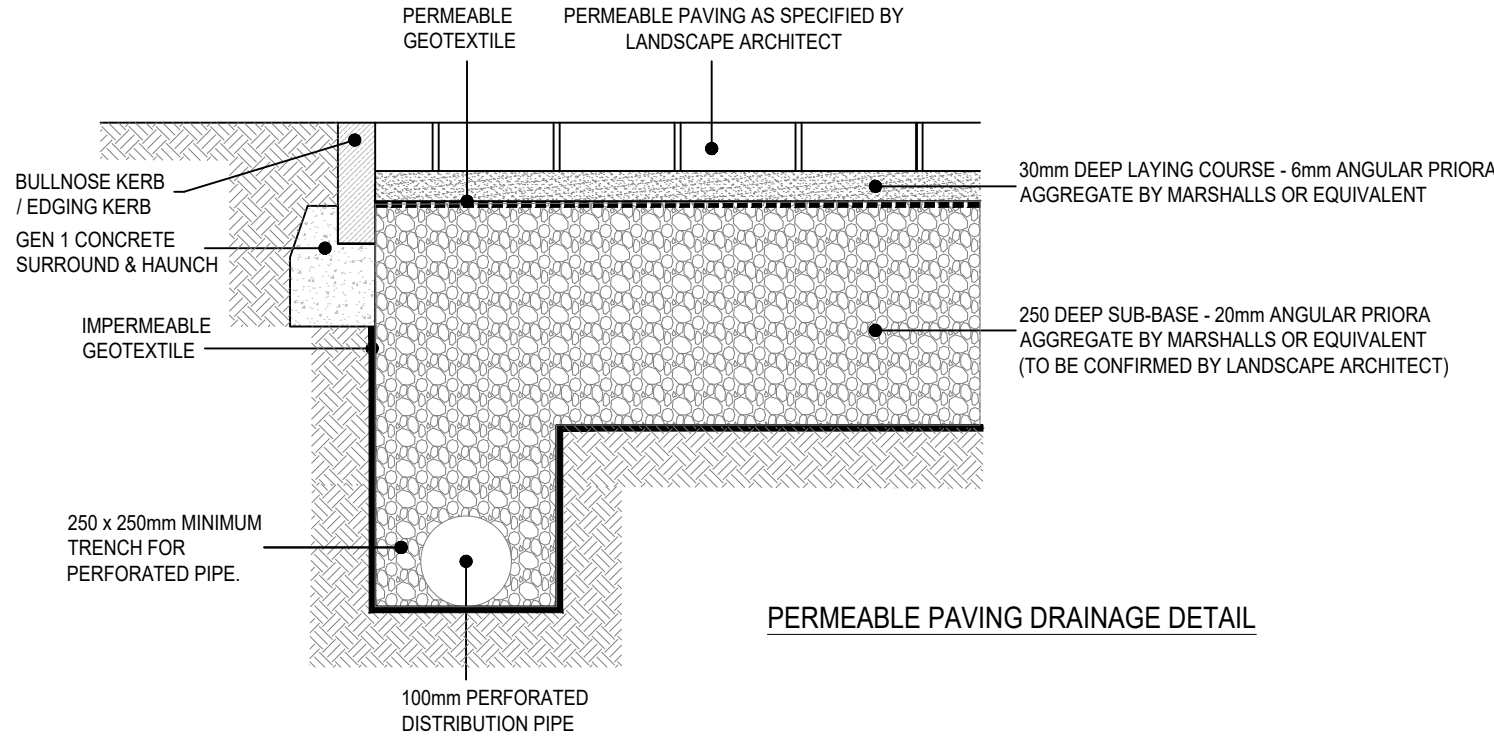
Rev
P1



TYPICAL ATTENUATION TANK DETAIL



FLOW CONTROL CHAMBER DETAIL



PERMEABLE PAVING DRAINAGE DETAIL

Flo Consult UK Ltd		Page 1
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Swallow Street Surface Water Management Calculations	
Date 13/08/2025 File Swallow Street - SW Management Ca...	Designed by MDS Checked by MDS	
Innovyze	Source Control 2020.1.3	

Summary of Results for 2 year Return Period

Half Drain Time : 49 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	52.841	0.161	0.0	0.6	0.6	1.9	O K
30 min Summer	52.882	0.202	0.0	0.6	0.6	2.4	O K
60 min Summer	52.904	0.224	0.0	0.6	0.6	2.7	O K
120 min Summer	52.928	0.248	0.0	0.6	0.6	2.9	O K
180 min Summer	52.927	0.247	0.0	0.6	0.6	2.9	O K
240 min Summer	52.917	0.237	0.0	0.6	0.6	2.8	O K
360 min Summer	52.890	0.210	0.0	0.6	0.6	2.5	O K
480 min Summer	52.861	0.181	0.0	0.6	0.6	2.1	O K
600 min Summer	52.835	0.155	0.0	0.6	0.6	1.8	O K
720 min Summer	52.813	0.133	0.0	0.6	0.6	1.6	O K
960 min Summer	52.780	0.100	0.0	0.5	0.5	1.2	O K
1440 min Summer	52.745	0.065	0.0	0.5	0.5	0.8	O K
2160 min Summer	52.728	0.048	0.0	0.4	0.4	0.6	O K
2880 min Summer	52.720	0.040	0.0	0.3	0.3	0.5	O K
4320 min Summer	52.712	0.032	0.0	0.2	0.2	0.4	O K
5760 min Summer	52.708	0.028	0.0	0.2	0.2	0.3	O K
15 min Winter	52.841	0.161	0.0	0.6	0.6	1.9	O K
30 min Winter	52.882	0.202	0.0	0.6	0.6	2.4	O K
60 min Winter	52.902	0.222	0.0	0.6	0.6	2.6	O K
120 min Winter	52.918	0.238	0.0	0.6	0.6	2.8	O K
180 min Winter	52.907	0.227	0.0	0.6	0.6	2.7	O K
240 min Winter	52.887	0.207	0.0	0.6	0.6	2.5	O K
360 min Winter	52.843	0.163	0.0	0.6	0.6	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	33.315	0.0	2.4	22
30 min Summer	21.736	0.0	3.1	33
60 min Summer	13.613	0.0	4.0	54
120 min Summer	8.976	0.0	5.3	88
180 min Summer	6.925	0.0	6.1	124
240 min Summer	5.725	0.0	6.7	158
360 min Summer	4.347	0.0	7.7	224
480 min Summer	3.555	0.0	8.4	286
600 min Summer	3.036	0.0	9.0	348
720 min Summer	2.667	0.0	9.4	406
960 min Summer	2.172	0.0	10.2	522
1440 min Summer	1.624	0.0	11.5	748
2160 min Summer	1.217	0.0	12.9	1104
2880 min Summer	0.996	0.0	14.1	1468
4320 min Summer	0.760	0.0	16.1	2200
5760 min Summer	0.634	0.0	17.8	2888
15 min Winter	33.315	0.0	2.4	22
30 min Winter	21.736	0.0	3.1	34
60 min Winter	13.613	0.0	4.0	56
120 min Winter	8.976	0.0	5.3	94
180 min Winter	6.925	0.0	6.1	132
240 min Winter	5.725	0.0	6.7	166
360 min Winter	4.347	0.0	7.7	232

Summary of Results for 2 year Return Period

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
480 min Winter	52.805	0.125	0.0	0.5	0.5	1.5	O K
600 min Winter	52.776	0.096	0.0	0.5	0.5	1.1	O K
720 min Winter	52.756	0.076	0.0	0.5	0.5	0.9	O K
960 min Winter	52.737	0.057	0.0	0.4	0.4	0.7	O K
1440 min Winter	52.722	0.042	0.0	0.3	0.3	0.5	O K
2160 min Winter	52.713	0.033	0.0	0.3	0.3	0.4	O K
2880 min Winter	52.708	0.028	0.0	0.2	0.2	0.3	O K
4320 min Winter	52.704	0.024	0.0	0.2	0.2	0.3	O K
5760 min Winter	52.701	0.021	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	3.555	0.0	8.4	292
600 min Winter	3.036	0.0	9.0	350
720 min Winter	2.667	0.0	9.4	404
960 min Winter	2.172	0.0	10.2	510
1440 min Winter	1.624	0.0	11.5	746
2160 min Winter	1.217	0.0	12.9	1104
2880 min Winter	0.996	0.0	14.1	1468
4320 min Winter	0.760	0.0	16.1	2204
5760 min Winter	0.634	0.0	17.8	2944

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 387260 394810 SJ 87260 94810	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.030

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.010	4 8	0.010	8 12	0.010

Flo Consult UK Ltd		Page 4
4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Swallow Street Surface Water Management Calculations	
Date 13/08/2025	Designed by MDS	
File Swallow Street - SW Management Ca...	Checked by MDS	
Innovyze	Source Control 2020.1.3	

Model Details

Storage is Online Cover Level (m) 54.280

Complex Structure

Cellular Storage

Invert Level (m) 52.680 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)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	12.5	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	12.5	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	12.5	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	12.5	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	12.5	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	12.5	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	12.5	0.0	3.000	0.0	0.0	4.800	0.0	0.0
1.400	0.0	0.0	3.200	0.0	0.0	5.000	0.0	0.0
1.600	0.0	0.0	3.400	0.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 2.4
Membrane Percolation (mm/hr) 1000 Length (m) 10.0
Max Percolation (l/s) 6.7 Slope (1:X) 0.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 53.930 Cap Volume Depth (m) 0.250

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0040-8000-1200-8000
Design Head (m) 1.200
Design Flow (l/s) 0.8
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 40
Invert Level (m) 52.680
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)	1.200	0.8	Kick-Flo®	0.353	0.5
Flush-Flo™	0.175	0.6	Mean Flow over Head Range	-	0.6

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	0.800	0.7	2.000	1.0	4.000	1.4	7.000	1.8
0.200	0.6	1.000	0.7	2.200	1.0	4.500	1.4	7.500	1.8
0.300	0.5	1.200	0.8	2.400	1.1	5.000	1.5	8.000	1.9
0.400	0.5	1.400	0.9	2.600	1.1	5.500	1.6	8.500	1.9
0.500	0.5	1.600	0.9	3.000	1.2	6.000	1.7	9.000	2.0
0.600	0.6	1.800	1.0	3.500	1.3	6.500	1.7	9.500	2.0

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4 Market Square Old Amersham Buckinghamshire, HP7 0DQ	Swallow Street 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 : 155 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	53.267	0.587	0.0	0.6	0.6	7.0	O K
30 min Summer	53.439	0.759	0.0	0.7	0.7	9.0	O K
60 min Summer	53.581	0.901	0.0	0.7	0.7	10.7	O K
120 min Summer	53.625	0.945	0.0	0.7	0.7	11.2	O K
180 min Summer	53.617	0.937	0.0	0.7	0.7	11.1	O K
240 min Summer	53.602	0.922	0.0	0.7	0.7	11.0	O K
360 min Summer	53.568	0.888	0.0	0.7	0.7	10.5	O K
480 min Summer	53.533	0.853	0.0	0.7	0.7	10.1	O K
600 min Summer	53.500	0.820	0.0	0.7	0.7	9.7	O K
720 min Summer	53.467	0.787	0.0	0.7	0.7	9.3	O K
960 min Summer	53.405	0.725	0.0	0.6	0.6	8.6	O K
1440 min Summer	53.290	0.610	0.0	0.6	0.6	7.2	O K
2160 min Summer	53.134	0.454	0.0	0.6	0.6	5.4	O K
2880 min Summer	52.951	0.271	0.0	0.6	0.6	3.2	O K
4320 min Summer	52.787	0.107	0.0	0.5	0.5	1.3	O K
5760 min Summer	52.743	0.063	0.0	0.5	0.5	0.7	O K
15 min Winter	53.267	0.587	0.0	0.6	0.6	7.0	O K
30 min Winter	53.440	0.760	0.0	0.7	0.7	9.0	O K
60 min Winter	53.586	0.906	0.0	0.7	0.7	10.8	O K
120 min Winter	53.635	0.955	0.0	0.7	0.7	11.3	O K
180 min Winter	53.622	0.942	0.0	0.7	0.7	11.2	O K
240 min Winter	53.604	0.924	0.0	0.7	0.7	11.0	O K
360 min Winter	53.553	0.873	0.0	0.7	0.7	10.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	102.928	0.0	7.6	25
30 min Summer	67.956	0.0	10.1	38
60 min Summer	42.826	0.0	12.7	66
120 min Summer	25.473	0.0	15.2	120
180 min Summer	18.779	0.0	16.8	150
240 min Summer	15.134	0.0	18.0	182
360 min Summer	11.186	0.0	20.0	252
480 min Summer	9.049	0.0	21.6	320
600 min Summer	7.689	0.0	22.9	390
720 min Summer	6.737	0.0	24.1	458
960 min Summer	5.484	0.0	26.1	594
1440 min Summer	4.113	0.0	29.4	860
2160 min Summer	3.067	0.0	32.9	1256
2880 min Summer	2.479	0.0	35.4	1588
4320 min Summer	1.821	0.0	39.0	2248
5760 min Summer	1.462	0.0	41.7	2936
15 min Winter	102.928	0.0	7.6	25
30 min Winter	67.956	0.0	10.1	38
60 min Winter	42.826	0.0	12.7	64
120 min Winter	25.473	0.0	15.2	118
180 min Winter	18.779	0.0	16.8	154
240 min Winter	15.134	0.0	18.0	190
360 min Winter	11.186	0.0	20.0	268

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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
480 min Winter	53.499	0.819	0.0	0.7	0.7	9.7	O K
600 min Winter	53.446	0.766	0.0	0.7	0.7	9.1	O K
720 min Winter	53.394	0.714	0.0	0.6	0.6	8.5	O K
960 min Winter	53.299	0.619	0.0	0.6	0.6	7.3	O K
1440 min Winter	53.125	0.445	0.0	0.6	0.6	5.3	O K
2160 min Winter	52.846	0.166	0.0	0.6	0.6	2.0	O K
2880 min Winter	52.758	0.078	0.0	0.5	0.5	0.9	O K
4320 min Winter	52.728	0.048	0.0	0.4	0.4	0.6	O K
5760 min Winter	52.718	0.038	0.0	0.3	0.3	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	9.049	0.0	21.6	344
600 min Winter	7.689	0.0	22.9	418
720 min Winter	6.738	0.0	24.1	490
960 min Winter	5.484	0.0	26.1	634
1440 min Winter	4.112	0.0	29.4	916
2160 min Winter	3.067	0.0	32.9	1216
2880 min Winter	2.479	0.0	35.4	1508
4320 min Winter	1.821	0.0	39.0	2204
5760 min Winter	1.462	0.0	41.7	2888

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 387260 394810 SJ 87260 94810	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.030

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.010	4 8	0.010	8 12	0.010

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Model Details

Storage is Online Cover Level (m) 54.280

Complex Structure

Cellular Storage

Invert Level (m) 52.680 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)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	12.5	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	12.5	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	12.5	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	12.5	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	12.5	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	12.5	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	12.5	0.0	3.000	0.0	0.0	4.800	0.0	0.0
1.400	0.0	0.0	3.200	0.0	0.0	5.000	0.0	0.0
1.600	0.0	0.0	3.400	0.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 2.4
Membrane Percolation (mm/hr) 1000 Length (m) 10.0
Max Percolation (l/s) 6.7 Slope (1:X) 0.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 53.930 Cap Volume Depth (m) 0.250

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0040-8000-1200-8000
Design Head (m) 1.200
Design Flow (l/s) 0.8
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 40
Invert Level (m) 52.680
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)	1.200	0.8	Kick-Flo®	0.353	0.5
Flush-Flo™	0.175	0.6	Mean Flow over Head Range	-	0.6

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	0.800	0.7	2.000	1.0	4.000	1.4	7.000	1.8
0.200	0.6	1.000	0.7	2.200	1.0	4.500	1.4	7.500	1.8
0.300	0.5	1.200	0.8	2.400	1.1	5.000	1.5	8.000	1.9
0.400	0.5	1.400	0.9	2.600	1.1	5.500	1.6	8.500	1.9
0.500	0.5	1.600	0.9	3.000	1.2	6.000	1.7	9.000	2.0
0.600	0.6	1.800	1.0	3.500	1.3	6.500	1.7	9.500	2.0

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Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 184 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	53.467	0.787	0.0	0.7	0.7	9.3	O K
30 min Summer	53.706	1.026	0.0	0.7	0.7	12.2	O K
60 min Summer	53.932	1.252	0.0	0.8	0.8	14.7	O K
120 min Summer	53.994	1.314	0.0	0.8	0.8	15.4	Flood Risk
180 min Summer	53.987	1.307	0.0	0.8	0.8	15.4	Flood Risk
240 min Summer	53.972	1.292	0.0	0.8	0.8	15.2	O K
360 min Summer	53.942	1.262	0.0	0.8	0.8	14.9	O K
480 min Summer	53.909	1.229	0.0	0.8	0.8	14.5	O K
600 min Summer	53.879	1.199	0.0	0.8	0.8	14.2	O K
720 min Summer	53.852	1.172	0.0	0.8	0.8	13.9	O K
960 min Summer	53.796	1.116	0.0	0.8	0.8	13.2	O K
1440 min Summer	53.674	0.994	0.0	0.7	0.7	11.8	O K
2160 min Summer	53.489	0.809	0.0	0.7	0.7	9.6	O K
2880 min Summer	53.326	0.646	0.0	0.6	0.6	7.7	O K
4320 min Summer	53.037	0.357	0.0	0.6	0.6	4.2	O K
5760 min Summer	52.817	0.137	0.0	0.6	0.6	1.6	O K
15 min Winter	53.467	0.787	0.0	0.7	0.7	9.3	O K
30 min Winter	53.708	1.028	0.0	0.7	0.7	12.2	O K
60 min Winter	53.937	1.257	0.0	0.8	0.8	14.8	O K
120 min Winter	54.012	1.332	0.0	0.8	0.8	15.6	Flood Risk
180 min Winter	54.004	1.324	0.0	0.8	0.8	15.5	Flood Risk
240 min Winter	53.980	1.300	0.0	0.8	0.8	15.3	Flood Risk
360 min Winter	53.936	1.256	0.0	0.8	0.8	14.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.430	0.0	10.0	25
30 min Summer	90.103	0.0	13.4	39
60 min Summer	57.232	0.0	17.0	66
120 min Summer	33.423	0.0	19.9	122
180 min Summer	24.510	0.0	21.9	158
240 min Summer	19.727	0.0	23.5	190
360 min Summer	14.609	0.0	26.2	258
480 min Summer	11.888	0.0	28.4	328
600 min Summer	10.159	0.0	30.3	396
720 min Summer	8.947	0.0	32.1	466
960 min Summer	7.327	0.0	35.0	604
1440 min Summer	5.514	0.0	39.5	870
2160 min Summer	4.099	0.0	44.0	1260
2880 min Summer	3.295	0.0	47.2	1644
4320 min Summer	2.393	0.0	51.4	2428
5760 min Summer	1.901	0.0	54.3	3000
15 min Winter	135.430	0.0	10.0	25
30 min Winter	90.103	0.0	13.4	38
60 min Winter	57.232	0.0	17.0	66
120 min Winter	33.423	0.0	19.9	120
180 min Winter	24.510	0.0	21.9	172
240 min Winter	19.727	0.0	23.5	196
360 min Winter	14.609	0.0	26.2	272

Summary of Results for 100 year Return Period (+45%)

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
480 min Winter	53.880	1.200	0.0	0.8	0.8	14.3	O K
600 min Winter	53.833	1.153	0.0	0.8	0.8	13.7	O K
720 min Winter	53.785	1.105	0.0	0.8	0.8	13.1	O K
960 min Winter	53.690	1.010	0.0	0.7	0.7	12.0	O K
1440 min Winter	53.508	0.828	0.0	0.7	0.7	9.8	O K
2160 min Winter	53.263	0.583	0.0	0.6	0.6	6.9	O K
2880 min Winter	52.981	0.301	0.0	0.6	0.6	3.6	O K
4320 min Winter	52.752	0.072	0.0	0.5	0.5	0.9	O K
5760 min Winter	52.731	0.051	0.0	0.4	0.4	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	11.888	0.0	28.4	350
600 min Winter	10.159	0.0	30.3	426
720 min Winter	8.947	0.0	32.1	500
960 min Winter	7.327	0.0	35.0	644
1440 min Winter	5.514	0.0	39.5	922
2160 min Winter	4.099	0.0	44.0	1328
2880 min Winter	3.295	0.0	47.2	1704
4320 min Winter	2.393	0.0	51.3	2244
5760 min Winter	1.901	0.0	54.3	2912

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
FEH Rainfall Version	2013	Cv (Winter)	1.000
Site Location	GB 387260 394810 SJ 87260 94810	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.030

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
0	4 0.010	4	8 0.010	8	12 0.010

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Model Details

Storage is Online Cover Level (m) 54.280

Complex Structure

Cellular Storage

Invert Level (m) 52.680 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)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	12.5	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	12.5	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	12.5	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	12.5	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	12.5	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	12.5	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	12.5	0.0	3.000	0.0	0.0	4.800	0.0	0.0
1.400	0.0	0.0	3.200	0.0	0.0	5.000	0.0	0.0
1.600	0.0	0.0	3.400	0.0	0.0			

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 2.4
Membrane Percolation (mm/hr) 1000 Length (m) 10.0
Max Percolation (l/s) 6.7 Slope (1:X) 0.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 53.930 Cap Volume Depth (m) 0.250

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0040-8000-1200-8000
Design Head (m) 1.200
Design Flow (l/s) 0.8
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 40
Invert Level (m) 52.680
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)	1.200	0.8	Kick-Flo®	0.353	0.5
Flush-Flo™	0.175	0.6	Mean Flow over Head Range	-	0.6

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	0.800	0.7	2.000	1.0	4.000	1.4	7.000	1.8
0.200	0.6	1.000	0.7	2.200	1.0	4.500	1.4	7.500	1.8
0.300	0.5	1.200	0.8	2.400	1.1	5.000	1.5	8.000	1.9
0.400	0.5	1.400	0.9	2.600	1.1	5.500	1.6	8.500	1.9
0.500	0.5	1.600	0.9	3.000	1.2	6.000	1.7	9.000	2.0
0.600	0.6	1.800	1.0	3.500	1.3	6.500	1.7	9.500	2.0