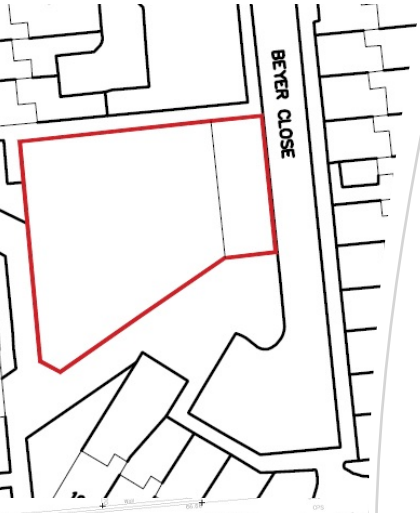

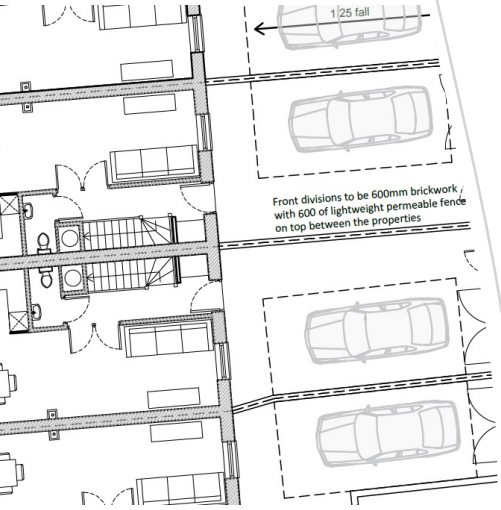


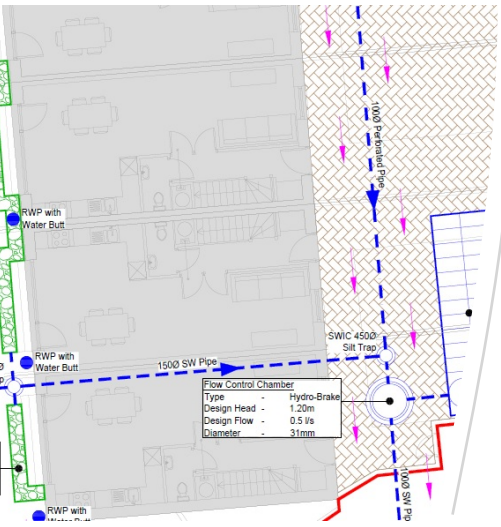


Earth Environmental
& Geotechnical

# Residential Development
# Beyer Close, Gorton
# Manchester, M18 8AR

## Surface Management Report

Revision A
May 2021

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|---|---|
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# 1. Introduction

Earth Environmental and Geotechnical Ltd have produced this surface water management report to discharge Planning Condition 6 for a residential development at Beyer Close, Manchester, which states:

*'Development shall not begin until a surface water drainage scheme for the site, based on sustainable drainage principles has been submitted to and approved in writing by the local planning authority. The development shall be constructed and completed in accordance with the approved details.*

*The scheme shall include:*

- *Surface water drainage layout including discharge points, proposed attenuation and proposed overland flow routes for extreme events (up to a 1 in 100 year including climate change allowance).*
- *Details of surface water attenuation that offers a reduction in surface water runoff rate in line with the Manchester Trafford and Salford Strategic Flood Risk Assessment. Provide at least a 50% reduction in runoff rate compared to the existing rates, as the site is located within Conurbation Core Critical Drainage Area.*
- *Hydraulic calculations to support the drainage proposal.*
- *Details of how the scheme shall be maintained and managed after completion.*

*Reason - To prevent the increased risk of flooding, to improve and protect water quality and ensure future maintenance of the surface water drainage system pursuant to policy EN17 of the Core Strategy'.*

This report describes and demonstrates how the surface water run-off from the post development area will be managed to adhere to national and local planning policy, regulations, and relevant design guidance, which include:

- National Planning Policy Framework (NPPF) 2019 Paragraphs 149-150 and 155-165;
- National Planning Practice Guidance (NPPG);
- Principles of Sustainable drainage systems (SuDS) set out by DEFRA (2011);
- Ciria SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015);
- 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, Salford City and Trafford Councils Level 2 Hybrid SFRA – Guidance Notes (May 2011);
- Manchester City Council – Local Flood Risk Management Strategy (March 2014);
- Manchester Local Development Framework – Core Strategy Development Plan (July 2012).

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 Policies and Water Management Guidance

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

The NPPF 2019 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 149 to 154 Planning for Climate Change, and Paragraphs 155 to 165 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 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 8 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 development site located in a residential area of Gorton, is approximately 150m north east of Belle Vue train station, approximately 250m south west of Gorton train station, and as shown in Appendix A, is bound by dwellings leading on Bryson Walk to the north; Beyer Close to the east; dwellings leading onto Middlewich Walk to the south; and Middlewich Walk leading onto dwellings and Hampden Crescent to the east.

The full site address of the site is land at Beyer Close, Gorton, Manchester, with the nearest postcode being M18 8AR, and the co-ordinates of the centre of the site being: Easting: 388406, Northing: 396395.

## 3.2. Existing Site and Topography

As detailed in Appendix B, the existing site currently undeveloped, and consists of overgrown vegetation with trees to the south east, and mounds of demolition material and earth along the boundary perimeter. As the site is undeveloped it is classed as greenfield.

In term of topography the site is relatively flat, with exception to the mounds around the perimeter. The levels of the site vary from an approximate high point of 66.92m AOD along the eastern boundary, to an approximate low point of 66.32m AOD to the south west boundary.

## 3.3. Proposed Development

The full description of the development site is to be stated by the Architect, with a detailed plan shown in Appendix C. In brief, and stated on the planning decision notice, the development is:

*'Proposed erection of 4 no. three storey town houses with associated car parking, boundary treatments and landscaping'.*

The new parking (driveways) will be formed along the eastern boundary (between new dwellings and Beyer Close), and the garden with patio areas will be to west of the site between the dwelling and Middlewich Walk. There will also be bike and bin store areas to the rear of the gardens, which run along the western boundary.

## 3.4. Ground Conditions

A ground investigation and infiltration tests are yet to take place at the development site. However, data for the ground conditions can be sourced from the British Geological Survey (BGS) website, where it identifies the development site to have superficial deposits of Till Devensian (clay, sand, and gravel), over bedrock consisting of Collyhurst Sandstone Formation (sandstone).

The BGS website also shows borehole log data from areas within 250m of the site and within the same superficial deposit / strata (see Figure 1 for location and Appendix D for details), which identify the strata of the ground to predominantly consist of clay. The data between the boreholes is consistent, and therefore it is assumed that the ground at the development site predominantly consist of clay.

*Figure 1 – BGS Borehole Location*

### 3.5. Waterbodies

There are no known waterbodies, rivers, canals, or reservoirs directly adjacent to the development site, with the nearest main waterbody being Gore Brook approximately 300m to the south, and Gorton Lower Reservoir approximately 500m to the east of the site.

### 3.6. Public Sewers and On-Site Drainage

As detailed on the United Utilities asset plans in Appendix E, there are separate 450mm to 525mm surface water sewers, and 300mm diameter foul water sewers that flow in a north to south direction below Beyer Close (east of site), before flowing from east to west direction along the southern boundary of the site.

The site is currently undeveloped, and therefore it is assumed that there are no existing drainage networks within the development boundary.

### 3.7. Development Areas

The overall site boundary area is approximately 810m² / 0.081 ha.

The pre-development site is undeveloped, and therefore is deemed to be greenfield with an urban factor of 0.00.

The surface water run-off from the 4 new dwellings, associated driveways, patios, and bin / bike store areas will discharge to a below ground drainage network, which equates to 430m² / 0.043 ha, with the surface water run-off from garden and soft landscaping areas, equating to 380m² / 0.038 ha, discharging off the site at a natural / greenfield rate.

The surface water run-off from the soft landscaping and garden areas will continue to discharge of the site at a natural greenfield rate, and therefore are not included in the surface water management calculations. Therefore, the surface water management area will consist of the 4 new dwellings, associated driveways, patios, and bin / bike store areas which equates to **0.043 ha**.

# 4. Surface Water Management Principles

## 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

The peak surface water flow from the post development site will adhere to the NPPF guidance, and Manchester City, Salford City and Trafford Councils Level 2 Hybrid SFRA – Guidance Notes May 2011, which states that:

*'Development should aim to deliver Greenfield runoff on Greenfield sites up to a 1 in 100-year storm event, considering climate change'.*

Therefore, based on this guidance, the aim will be to restrict the surface water run-off to greenfield.

## 4.5. Flood Risk

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

## 4.6. Pollution

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.

## 4.7. 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 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

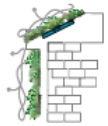
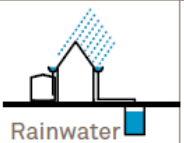
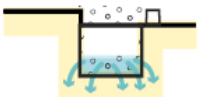
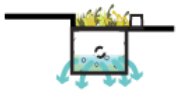
The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

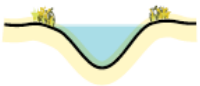
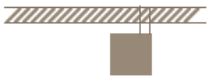
| **Run-Off Destination** | **Feasible** | **Description** |
|---|---|---|
| Discharge to Ground | No | BGS data identifies the development site to have superficial deposits of Till Devensian (clay, sand, and gravel), over bedrock consisting of Collyhurst Sandstone Formation (sandstone).<br><br>The BGS borehole log data within the same strata also identifies the strata of the ground to predominantly consist of clay.<br><br>As the boreholes are consistent, it is assumed therefore that the ground at the development site predominantly consist of clay (exceptionally low infiltration value), and therefore discharging the surface water to ground will not be feasible. |
| Discharge to Surface Water Body | No | There are no known waterbodies near to the development site, and therefore discharge of the surface water to a waterbody is not feasible. |
| **Discharge to Surface Water Sewer** | **Yes** | As the ground is deemed to be unsuitable for infiltration, and there are no known waterbodies near to the development site, the only alternative is to discharge the surface water to the 450mm – 525mm surface water sewer within Beyer Close / south of the site. |
| Discharge to Highway Drain or Other | No | There are no know highway drains or other drains near the development site, and therefore discharge to a highway or other drain is not a feasible destination. |
| Discharge to Combined Water Sewer | No | There are no know combined sewers near the development site, and therefore discharge to a combined sewer is not a feasible destination. |

## 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 maintenancce 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** | **Feasible Use** | **Description** |
|---|---|---|
| Green Roofs | No | The new dwellings are to have pitched roofs, and therefore green roofs would not be advantageous, and therefore are not a feasible SuDS method. |
| **Rainwater Harvesting** | **Yes** | Rainwater harvesting for water re-use has not been considered for the development due to the cost of a dual pipe network.<br><br>However, a water butt could be installed for at least one rainwater pipe for each dwelling (locations to be confirmed), so that the water can be used for irrigating the garden areas. |
| Soakaway | No | As stated previously, the BGS data identifies the development site to have superficial deposits of Till Devensian (clay, sand, and gravel), over bedrock consisting of Collyhurst Sandstone Formation (sandstone).<br><br>The BGS borehole log data within the same strata also identifies the strata of the ground to predominantly consist of clay. |

| | | |
|---|---|---|
| | | As the boreholes are consistent, it is assumed therefore that the ground at the development site predominantly consist of clay (exceptionally low infiltration value), and therefore discharging the use of soakaways are not feasible. |
| **Filter Strips** | **Yes** | There is potential to install filter drains within the gardens of the dwelling, which will take the surface water run-off from the patio and bin / bike stores areas.<br><br>Due to the ground conditions the filter drains will not infiltrate the surface water to ground, but will convey the surface water to the main drainage network and act as a pollutant control at source. |
| **Permeable Paving / Surfacing** | **Yes** | There is potential to install permeable paving / surfacing within the driveway areas of each of the dwellings<br><br>Due to the ground conditions the permeable paving / surfacing systems will not infiltrate the surface water to ground, but will convey the surface water to the main drainage network, and act as a pollutant control at source. |
| Swales / Shallow Pond | No | Most of small soft landscaping areas within the development site are to be used as a private garden or for planting.<br><br>Therefore, due to the insufficient areas and development levels areas the use of these SuDS methods are not feasible. |
| Hardscape Storage | No | The external hard standing areas of the site are to be used for driveways and patio areas only. Therefore, there is limited areas for hardscape storage, and is not a feasible SuDs method. |
| **Underground Storage** | **Yes** | The surface water management strategy will be to discharge the surface water run-off from the post development site at the greenfield rate, where practical.<br><br>The controlled rate will be at a lower rate than the surface water run-off rate, therefore there will be a requirement to have underground storage.<br><br>This will prevent flooding for storm events up to the 1 in 30-year; and to suitable 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 site. |

# 7. Development Greenfield Run-Off Rate and Volumes

To minimise the surface water run-off from the new development areas of the site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rate and volumes.

## 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 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):

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

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 | = | 864 |
| Soil | = | 0.45 |
| Urban Factor | = | 0.00 |
| Region Number | = | 10 |

The calculations in Appendix F, show the rate for 50.00ha is 281.0 l/s, but is to be reduced to reflect the surface water catchment area (0.043 ha) of the development site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

QBAR = **<u>0.24 l/s (5.62 l/s/ha)</u>**

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 |
|---|---|---|---|
| $Q_1$ | 0.24 l/s | 0.87 | **0.2 l/s** |
| $Q_{30}$ | 0.24 l/s | 1.70 | **0.4 l/s** |
| $Q_{100}$ | 0.24 l/s | 2.08 | **0.5 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 Flood Estimation Handbook (FEH), with the results shown in Appendix F.

The FEH data and variables used to calculate the greenfield run-off volume at the development site locations are as follows:

Site Location = GB 388450 396650 SJ 88450 96650

C (1km) = -0.027

D1 (1km) = 0.333

D2(1km) = 0.400

D3 (1km) = 0.293

E (1km) = 0.303

F (1km) = 2.458

Areal Reduction Factor = 1.000

Area = 88.500 ha

SAAR = 910

CWI = 122.142

SPR Host = 39.700

URBTEXT = 0.00

Based on these variables, and the calculation results provided by the MicroDrainage computer software (Appendix F), the greenfield run-off volume for the overall catchment area of 88.500 ha, at the site location, is:

$Q_{100\ (6\text{-Hour})}$ = 25,555.916m³

This figure is to be reduced to reflect the surface water catchment area of the development site which is 0.043 ha. Therefore, the greenfield run-off volume for the development site area has been calculated to be:

$Q_{100\ (6\text{-Hour})}$ = **12.42m³ (288.77m³/ha)**

# 8. Below Ground Drainage Networks and Surface Water Management Calculations

## 8.1. 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 (Table 2) summarised in Table 4 below.

| Applies across all of England | Total change anticipated for the 2020's | Total change anticipated for the 2050's | Total change anticipated for the 2080's |
|---|---|---|---|
| Upper End | 10% | 20% | **40%** |
| Central | 5% | 10% | 20% |

The baseline year is 1961 to 1990. It is anticipated the life span of the new dwellings will be approximately 80 years, and therefore will fall at least into the 2080's and will have rainfall intensity increase of 40%.

This increase in rainfall is to be taken into consideration for the surface water management of the proposed development site (100-year event), to ensure that the probability of flooding remains low.

## 8.2. Surface Water Network Calculations

The FEH data and variables used to calculate the required below ground attenuation network and attenuation volumes at the development site are as follows:

SW Catchment Area = 0.043 ha

Site Location = GB 388450 396650 SJ 88450 96650

C (1km) = -0.027

D1 (1km) = 0.333

D2(1km) = 0.400

D3 (1km) = 0.293

E (1km) = 0.303

F (1km) = 2.458

Time of Entry = 5 minutes

## 8.3. Surface Water Drainage Networks

As shown on the below ground drainage layout drawing in Appendix G, the main surface water drainage network will consist of 450mm diameter inspection chambers; 150mm a diameters pipes; 100mm perforated pipes; permeable paving systems; filter drains; rainwater harvesting butts; a flow control chamber; and a below ground attenuation tank in the form of cellular units.

The surface water run-off from the dwelling roof areas will discharge to the network via water butts, and trapped gullies to the permeable paving and filter drain systems (directly to perforated pipe); the surface water run-off from the driveways will discharge to the network via permeable paving; and the surface water run-off from the patio and bin / bike store areas will discharge to the network vial filter drains.

The surface water within the network will pass through the flow control and pollutant control chamber, prior to discharge to the 525mm diameter United Utilities surface water sewer with Beyer Close / south of development. The restricted surface water will surcharge the network, and will be attenuated within the attenuation tanks, and permeable paving sub-base.

### 8.4. Surface Water Run-Off Rate

Manchester City, Salford City and Trafford Councils Level 2 Hybrid SFRA – Guidance Notes May 2011 states: *'Development should aim to deliver Greenfield runoff on Greenfield sites up to a 1 in 100-year storm event, considering climate change'.*

Therefore, for the surface water run-off from the development site to adhere to the SFRA requirements, and subsequently to be at the greenfield run-off rates, the surface water run-off rates for post development site are to be restricted to 0.2 l/s for the 1 in 1-year storm event; 0.4 l/s for the 1 in 30-year storm event, and 0.5 l/s for the 1 in 100-year storm event including 40% rainfall intensity increase (climate change).

The practicality of reducing to the equivalent greenfield rate will depend on the flow control size / diameter. If the flow control opening / diameter is too small to achieve the greenfield rates, there will be an increased risk of blockage and subsequent flooding.

Therefore, the flow control is to be sized appropriately to reduce the risk of blockage, but to reduce the surface water run-off rates from the post development site to as low as possible. This is to adhere to Ciria document C753 – The SuDS Manual which 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'.

Based on these guidelines, the flow control (hydro-brake) diameter is to be the lowest practical size of 31mm. As shown in the output calculation from the MicroDrainage computer software in Appendix H, if the hydro-brake opening is set at 34mm, with a design head of 1.200m (height of cellular units), and a design flow of 0.50 l/s (equivalent 100-year greenfield rate), the maximum surface water run-off rates for each storm event will be as follows:

| **Strom** | **-** | **Rate** | **-** | **Critical Storm Event** |
|---|---|---|---|---|
| **$Q_1$** | **-** | **0.3 l/s** | - | 180-minute winter storm duration |
| **$Q_{30}$** | **-** | **0.4 l/s** | - | 180-minute winter storm duration |
| **$Q_{100}$** | **-** | **0.5 l/s** | - | 240-minute winter storm duration |

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

**Pre-Development Rate to Post Development Rate**

| **Strom** | **-** | **Greenfield** | **-** | **Post Dev** | **-** | **Difference** |
|---|---|---|---|---|---|---|
| $Q_1$ | - | 0.2 l/s | - | 0.3 l/s | - | 1.50 x Greenfield |
| $Q_{30}$ | - | 0.4 l/s | - | 0.4 l/s | - | Equivalent Greenfield |
| $Q_{100}$ | - | 0.5 l/s | - | 0.5 l/s | - | Equivalent Greenfield |

The surface water run-off rates are greater than the 1-year greenfield rates but the equivalent of the 30-year and 100-year greenfield rates. Therefore, as the surface water run-off rates discharging to the existing sewer is equivalent to greenfield run-off rates during the extreme storm events (30-year and 100-year), the surface water management meets the requirements of Policy EN17 of the Core Strategy, and will ensure that the development will not increase the risk of flooding to neighbouring land and/or property.

## 8.5. Surface Water Run-Off Volume

The surface water run-off volumes for the post development site have also been calculated for 1 in 100-Year the 6-hour duration (Inc. 40% RII), based on the peak 100-year + 40% climate change surface water run-off rate, which is:

| | | | | | | |
|---|---|---|---|---|---|---|
| $Q_{100}$ | - | 0.5 l/s x 60 x 60 x 6 | - | 10,800 litres | - | **10.80m³** |

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

**Greenfield Volume to Post Development Volume**

| **Strom** | **-** | **Greenfield** | **-** | **Post Dev** | **-** | **Difference** |
|---|---|---|---|---|---|---|
| $Q_{100}$ | - | 12.42m³ | - | 10.80m³ | - | 0.87 x Greenfield (13% betterment) |

The surface water run-off volume for the 100-year, 6-hour storm event is a 13% betterment than the greenfield run-off volume. Therefore, as the surface water run-off volume discharges to the existing sewer at the equivalent greenfield run-off volume, the surface water management meets the requirements of Policy EN17 of the Core Strategy, and will ensure that the development will not increase the risk of flooding to neighbouring land and/or property.

## 8.6. Surface Water Attenuation Calculations

As the positively drained areas of the post development site are being restricted, there will be a requirement for below ground attenuation to prevent flooding.

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

The surface water attenuation for the development site will be within the attenuation tank (comprising of cellular units), and sub-base of permeable paving system. As detailed in the MicroDrainage calculations (Appendix H) and surface water management layout (Appendix G) the attenuation volumes for each of the SuDS methods re as follows:

**Attenuation Tank - Cellular Units**

| | | |
|---|---|---|
| Area | - | 14.00m² |
| Depth | - | 1.20m |
| Porosity | - | 0.95 |
| Volume | - | **15.96m³** |

**Permeable Paving**

| | | |
|---|---|---|
| Paving Area | - | 150.00m² |
| Sub-Base Depth | - | 0.30m |
| Porosity | - | 0.30 |
| Volume | - | **13.50m³** |

The MicroDrainage calculations (Appendix H) show that with these SuDs methods and volumes, no flooding will occur for all storms up to and including the 1 in 100-year event + 40% climate change.

# 9. Management and 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 or near the site.

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the dwellings, where payments of the works will form part of the property deeds and / or rental agreements, and will be carried out as follows:

## 9.1. Surface Water Drainage Network

| 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. Flow Control and Cellular Units

| 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 flow control chamber and attenuation tank (where may cause risk performance) | Monthly |
| Where rainfall into flow control chamber and attenuation tank 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 upstream surface water network 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 |

### 9.3. Permeable Paving and Filter Drain

| 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 catchment surface of paving and areas near filter drain (where may cause risk performance) | Monthly |
| Where rainfall infiltration into paving and filter drain, check surface for blockage or silt, algae, or other matter by jetting | As required, but at least twice a year |

### 9.4. 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 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. Water Quality / Pollution Control

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.

**Dwelling Roof and Patio Area Pollutant Hazard**

C753 Table 26.2 Pollution Hazard Level = Very Low

C753 Table 26.2 Pollution Hazard Index:

- Total Suspended Solid (TSS) = 0.2
- Metals = 0.2
- Hydrocarbons = 0.05

Pollution Hazard Index = **0.45**

**Dwelling Roof and Patio Area Pollutant Mitigation**

Mitigation Measures:

- Filter Drain

Filter Drain Pollutant Mitigation Indices

- Total Suspended Solid (TSS) = 0.4
- Metals = 0.4

- Hydrocarbons = 0.5

SuDS Mitigation Indices = **1.30**

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

**Driveway 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 = **1.30**

**Driveway Area Pollutant Mitigation**

Mitigation Measures:

- Permeable Surfacing

Permeable Paving Pollutant Mitigation Indices

Total Suspended Solid (TSS) = 0.7

Metals = 0.6

Hydrocarbons = 0.7

SuDS Mitigation Indices = **2.00**

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

## 11. Surface Water Design Exceedance

In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow from the east of the site to the south east boundary.

The ground outside the development boundary continues to fall in a south east direction along Middlewich Walk, across a grassed recreational area, and to Hampden Crescent. Therefore, flood water will also flow across these areas and discharge into Hampden Crescent.

Flood water will flow away from the proposed dwellings within the site, will not flow directly towards existing dwellings / properties outside the development boundary. The flood water will be contained within Hampden Crescent due to the road having a gradient (water to flow along road) and upstand kerbs.

# 12. Conclusion / Summary

## 12.1. SuDS Principles and SW Discharge Destination

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

## 12.2. Peak Flow Control

The surface water run-off rates are greater than the 1-year greenfield rates but the equivalent of the 30-year and 100-year greenfield rates. Therefore, as the surface water run-off rates discharging to the existing sewer is equivalent to greenfield run-off rates during the extreme storm events (30-year and 100-year), the surface water management meets the requirements of Policy EN17 of the Core Strategy, and will ensure that the development will not increase the risk of flooding to neighbouring land and/or property.

## 12.3. Volume Control

The surface water run-off volume for the 100-year, 6-hour storm event is a 13% betterment than the greenfield run-off volume. Therefore, as the surface water run-off volume discharges to the existing sewer at the equivalent greenfield run-off volume, the surface water management meets the requirements of Policy EN17 of the Core Strategy, and will ensure that the development will not increase the risk of flooding to neighbouring land and/or property.

## 12.4. Flood Risk within the Development

The drainage network and below ground attenuation tank has been suitably sized so that no flooding occurs within the network during the 1 in 1-year; 1 in 30-year; and 1 in 100-year storm event + 40% climate change.

## 12.5. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the dwellings, where payments of the works will form part of the property deeds and / or rental agreements.

## 12.6. Exceedance Events

In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow from the east of the site to the south east boundary.

Flood water will flow away from the proposed dwellings within the site, will not flow directly towards existing dwellings / properties outside the development boundary. The flood water will be contained within Hampden Crescent due to the road having a gradient (water to flow along road) and upstand kerbs.

## 12.7. Water Quality

The level of water treatment has been assessed against the details set out in Ciria SuDS Manual C753. Chapter 26, which 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.

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

# Appendix A

# Site Location Plan

N

General Notes:

All site dimensions shall be verified by the Contractor on site prior to commencing any works.

Do not scale from this drawing.

Design intent drawing only. Construction to comply with latest building regulation & legal requirements.

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| Rev | Description | Date | Dr by | App by |
|---|---|---|---|---|
| B | Boundary line updated | | | |

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www.studiotashkeel.com

client name
Mr. Jonathan Blackston

project
**Beyer Close**

drawing
**Location plan**

| project number | | scale |
|---|---|---|
| 2003109 | | 1/1250 @ A3 |
| drawing number | rev | issue status |
| PL001 | B | Planning |

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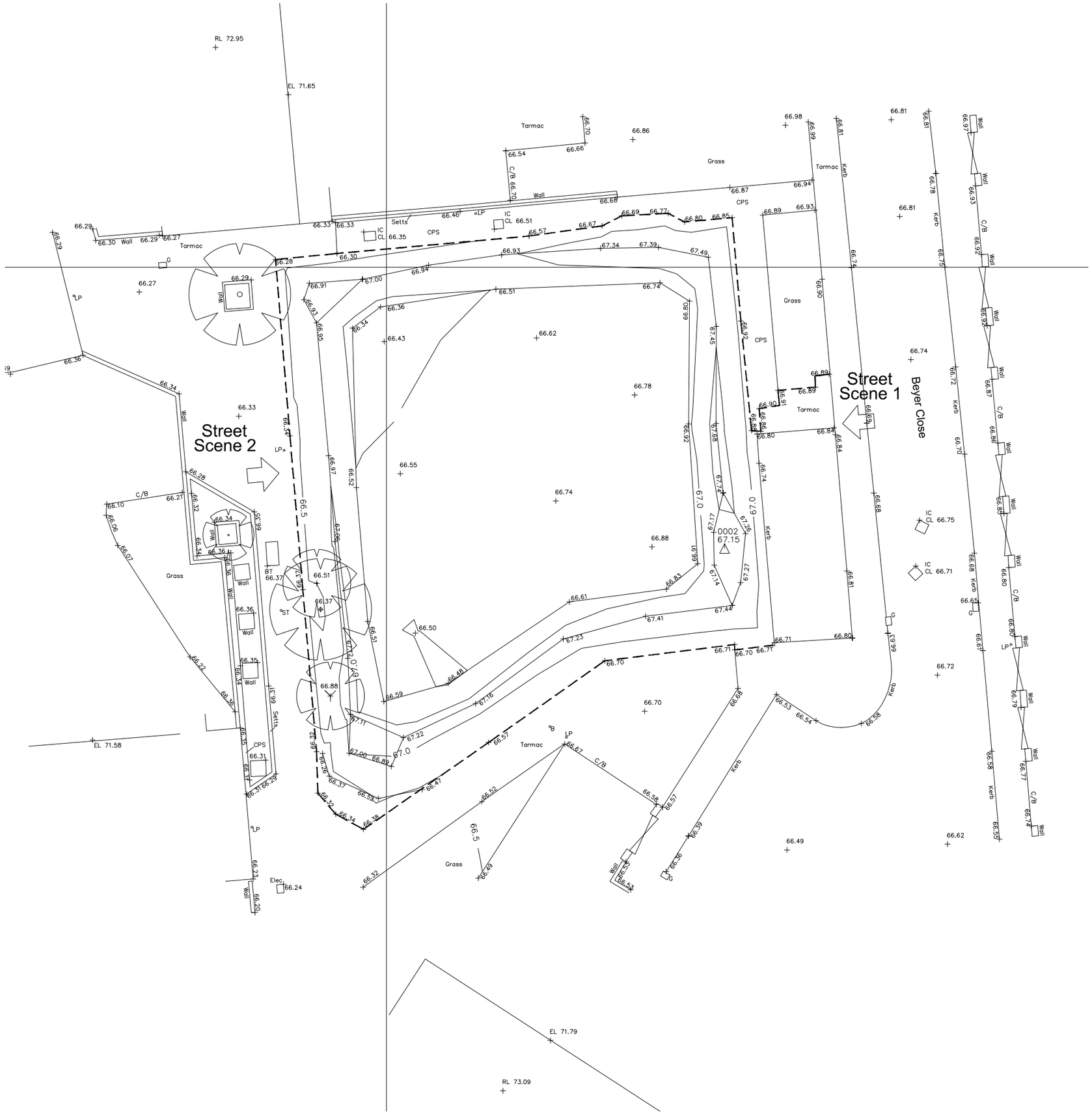
# Location Plan
Scale 1:1250 @ A3

# Appendix B

# Topographical Survey

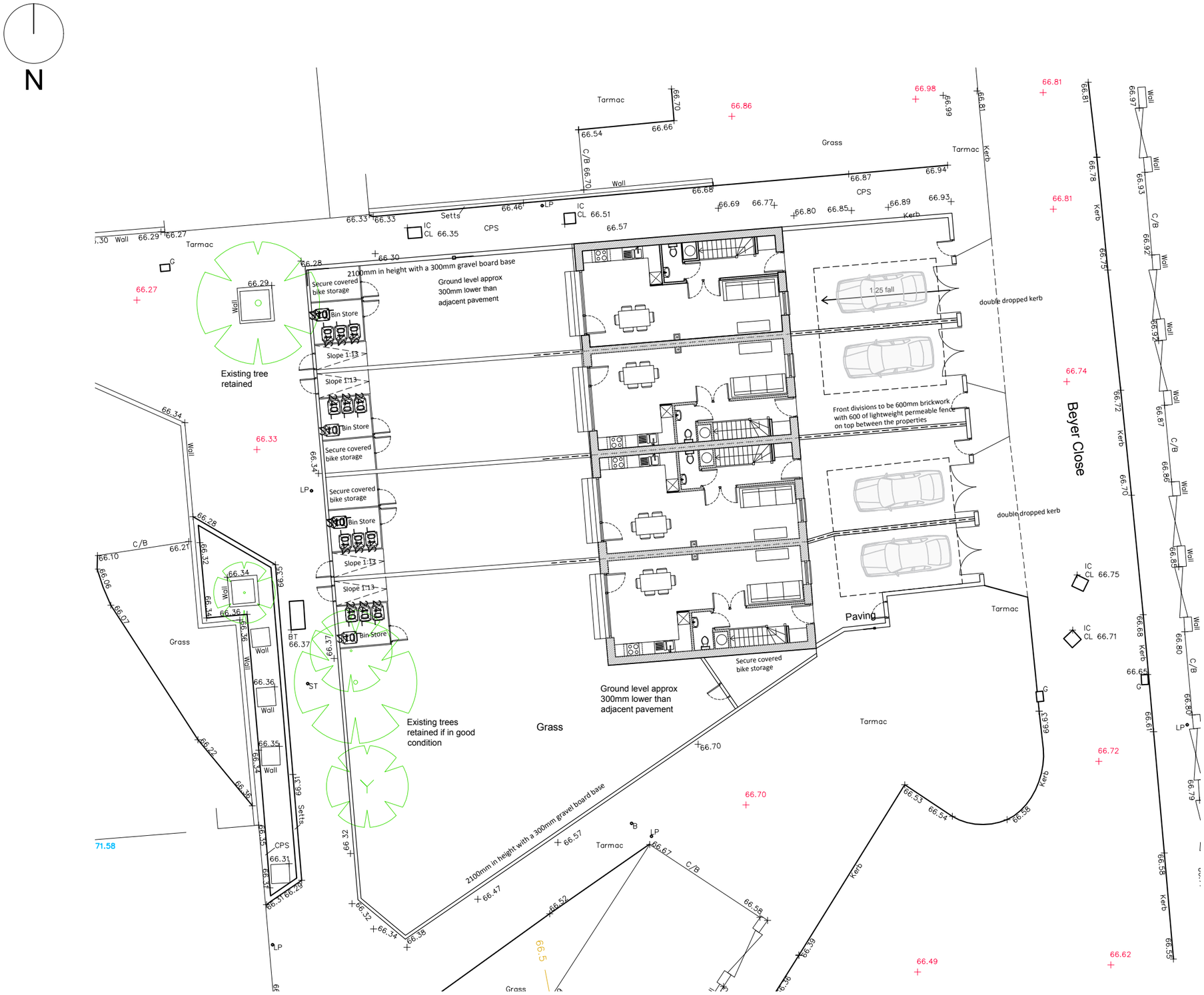



# EXISTING SITE PLAN (TOPOGRAPHICAL)

1:200

# Appendix C

# Proposed Site Plans




# Site Plan

Scale 1:200 @ A3

**General Notes:**

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| Rev | Description | Date | Dr by | App by |
|---|---|---|---|---|
| B | Side gate removed | 28/10/20 | AM | MK |

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client name
**Mr. Jonathan Blackston**

project
**Beyer Close**

drawing
**Site plan**

| project number | | scale |
|---|---|---|
| 2003109 | | 1/200 @ A3 |
| **drawing number** | **rev** | **issue status** |
| PL002 | B | Planning |

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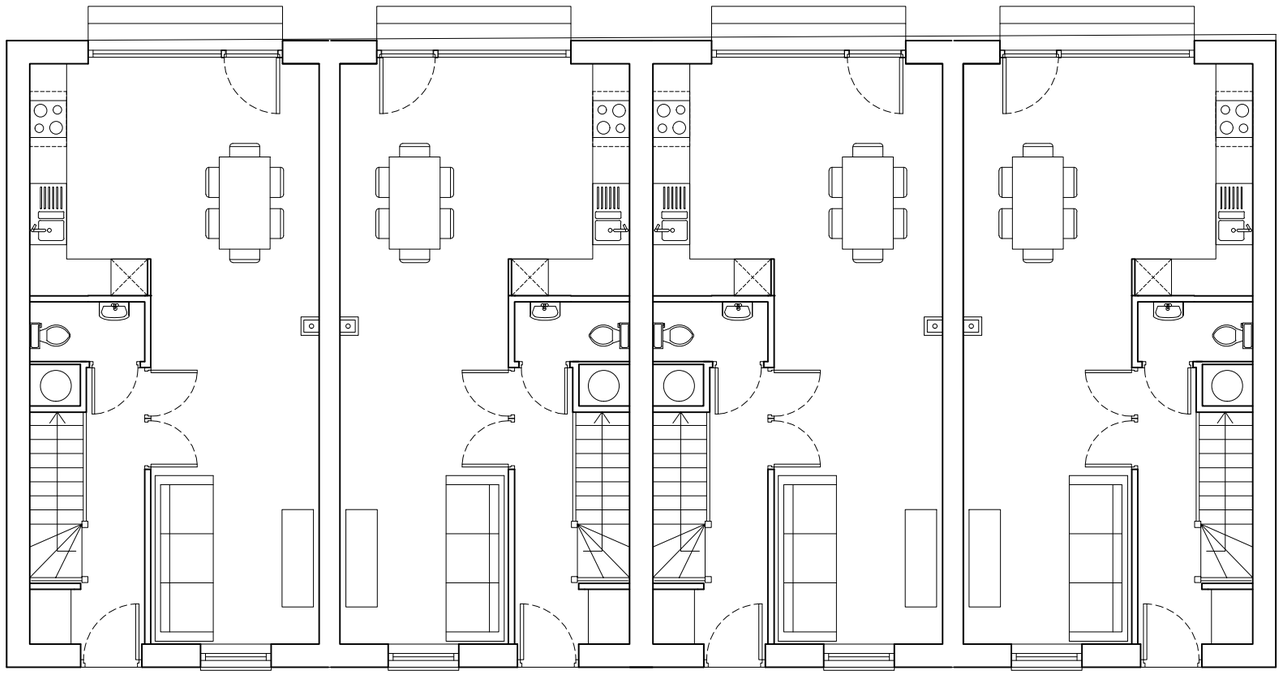
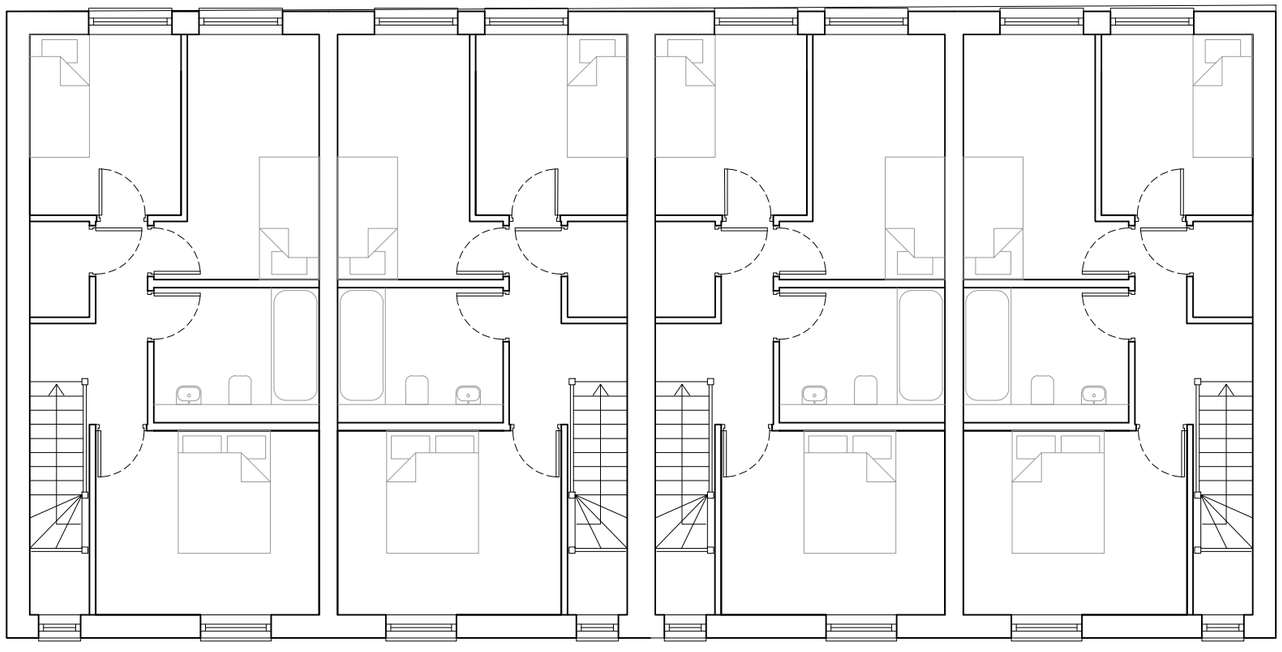
N



## Proposed GA Ground Floor
Scale 1:100 @ A3



## Proposed GA First Floor
Scale 1:100 @ A3

## Schedule
4 x 3 bedroom units

Internal Area 88.4sqm per unit
44.2sqm per floor

**General Notes:**

**All site dimensions shall be verified by the Contractor on site prior to commencing any works.**

**Do not scale from this drawing.**

**Design intent drawing only. Construction to comply with latest building regulation & legal requirements.**

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| Rev | Description | Date | Dr by | App by |
|---|---|---|---|---|
| B | Label amended | | | |

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**client name**
Mr. Jonathan Blackston

**project**
**Beyer Close**

**drawing**
**GA Floor plans**
**Ground Floor and First floor**

| project number | | scale |
|---|---|---|
| 2003109 | | 1/100 @ A3 |
| **drawing number** | **rev** | **issue status** |
| PL004 | B | Planning |

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# Appendix D

# BGS Data

SJ89NE 8815 9618 664

# H B BORING & COMPANY LTD

TEL: 0257 428081

| CLIENT | BOREHOLE NO |
|---|---|
| MANCHESTER CITY COUNCIL | 3 |

| DATE | SCALE | BORING METHOD | LOCATION | JOB NO | Sheet: |
|---|---|---|---|---|---|
| 20-22/6/94 | 1 to 50 | CABLE PERCUSSIVE | HYDE ROAD | 195 | 1 |

| Drilling & Casing Progress | SAMPLE/TEST Type & No. | SAMPLE/TEST Depth(M) | SPT N - value or COHESION | DESCRIPTION | O D LEVEL | LEGEND | DEPTH |
|---|---|---|---|---|---|---|---|
| 20.6 | U 42 | 0.00 | | MADE GROUND - Topsoil with brick fragments and some fine to coarse gravel. | 63.30 | | 0.0 |
| | U 56 | 0.50 - 0.95 | | | 62.90 | | 0.40 |
| | D | 1.00 | | Firm to stiff brown and orange brown with grey mottling silty sandy CLAY with a little fine to medium gravel. | | | |
| | U 53 | 1.50 - 1.95 | | | | | |
| | D | 2.00 | | | | | |
| | B 2.40 - 2.90<br>C 2.40 - 2.85 | | N 24 | Firm to stiff and stiff brown slightly fissured silty sandy CLAY with a little fine gravel and occasional root fibres with associated grey staining. Occasional cobbles below 2.40m. | 60.90 | | 2.40 |
| | U 40 | 3.50 - 3.95 | | | | | |
| | D | 4.00 | | Stiff dark brown silty sandy and very sandy CLAY with a little fine to medium gravel. | 59.30 | | 4.00 |
| | U 36 | 4.60 - 5.05 | | | | | |
| | D | 5.10 | | | | | |
| | U 42 | 5.70 - 6.15 | | | | | |
| | D | 6.20 | | | | | |
| | U 45 | 6.50 - 6.95 | | | | | |
| | D | 7.00 | | | | | |
| | U 40 | 7.60 - 8.05 | | | | | |
| | D | 8.10 | | | | | |
| | U 50 | 8.60 - 9.05 | | | | | |
| | D | 9.10 | | | | | |
| | U 50 | 9.50 - 9.95 | | | | | |
| | D | 10.00 | | | | | |

## BOREHOLE LOGSHEET

Water Observations, Remarks, Etc

Water entry at 25.80m, standing at 23.00m after 20 mins. Chiselling 16.50-16.80 0.50 Hr, 18.60-19.00 0.75 Hr, 21.60-21.80 0.50 Hr, 22.70-23.00m 0.50 Hr, 23.60-24.00m 1Hr, 26.50-27.00 1Hr.

British Geological Survey

**GEO-RESEARCH LTD.**
BRIGHTON ROAD,
HEATON NORRIS,
STOCKPORT, CHESHIRE.

| | |
|---|---|
| Borehole No. | 11 ~~5389NE1182~~ |
| Sheet No. | 1 8835 9619 |
| Date Commenced | 29/5/75 |
| Date Completed | 29/5/75 |
| Scale | 1:50 |

CONTRACT: STORM WATER RELIEF SEWER

LOCATION: GORTON

| Stratum | Legend | Thick-ness | Depth | Sample No. | N Value | Level m | Remarks |
|---|---|---|---|---|---|---|---|
| | | | GL | | | 64.80 | |
| Brick FILL | | 1.400 | 0.450<br>1.400 | D1 | | 63.40 | |
| Firm grey/brown silty CLAY with occasional pebbles | | 0.600 | 1.500<br>2.000 | D2<br>U1 | | 62.80 | |
| Stiff brown silty CLAY with occasional pebbles and sand inclusions | | 5.000 | 2.500<br>3.000<br>3.700<br>4.000<br>5.000<br>6.000<br>6.500<br>7.000 | D3<br>U2<br>D4<br>U3<br>U4<br>D5<br>U5 | | 57.80 | |
| Borehole Complete | | | | | | | On completion of borehol at 7.000, Casing at 3.00 Water Nil. Borehole backfilled as casing withdrawn. |

British Geological Survey

# TRIAL PIT RECORDS

STRATA SURVEYS LTD.,
HOLMES CHAPEL ROAD,
MIDDLEWICH, CHESHIRE.
Telephone: Middlewich (STD 0606 84) 4637

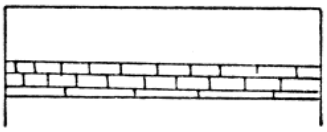
Job No: 3673/23 Location: TAYLOR STREET, MANCHESTER Scale 1:50

Client: MANCHESTER CITY COUNCIL

## T.P. No. 3

| Description of Strata (Ground Level) | Reduced Level | Legend | Thickness | Depth | Samples from | Samples to | Type | NMC | Apparent Cohesion kN/m2 | Ø degrees | Daily Progress Water Levels Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL | | | 0.10 | 0.10 | | | | | | | 1/10/87 |
| DARK BROWN SILTY SANDY GRAVELLY (BRICK) CLAY FILL | | | 0.40 | 0.50 | | | | | | | 388112 |
| STIFF BROWN SILTY CLAY FILL | | | 0.45 | 0.95 | | | | | | | 396573 |
| SOFT BECOMING VERY SOFT BROWN SILTY CLAY FILL | | | 1.15 | 2.10 | 1.10 | | V1 | | 35 | | SLOW ⊥ 1.10 |
| BROWN AMORPHOUS & FIBROUS PEAT OCCASIONAL METAL | | | 0.15 | 2.25 | | | | | | | |
| SOFT GREY BROWN SILTY CLAY | | | 0.45 | 2.70 | | | | | | | TRIAL PIT DRY |
| STIFF BROWN/GREY FISSURED GRAVELLY SILTY CLAY | | | (0.40) | 3.10 | | | | | | | STABLE |
| TRIAL PIT COMPLETE AT 3.10M. | | | | | | | | | | | |

WEST FACE OF PIT



0.35 BRICK RAFT FOUNDED AT 0.60M.
0.60

## T.P. No. 4

| Description of Strata (Ground Level) | Reduced Level | Legend | Thickness | Depth | Samples from | Samples to | Type | NMC | Apparent Cohesion kN/m2 | Ø degrees | Daily Progress Water Levels Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL | | | 0.10 | 0.10 | | | | | | | 1/10/87 |
| DARK BROWN SANDY GRAVELLY SILT FILL WITH OCCASIONAL BRICK COBBLES | | | 0.25 | 0.35 | | | | | | | 388102 |
| FIRM TO STIFF YELLOW BROWN/GREY GRAVELLY SANDY CLAY FILL | | | 0.50 | 0.85 | | | | | | | 396577 |
| SOFT GREY BROWN SANDY GRAVELLY CLAY FILL | | | 0.95 | 1.80 | | | | | | | |
| SOFT TO VERY SOFT GREY BROWN SILTY CLAY | | | 1.00 | 2.80 | | | | | | | |
| STIFF TO VERY STIFF BROWN/GREY FISSURED GRAVELLY SILTY CLAY | | | (0.30) | 3.10 | | | | | | | TRIAL PIT DRY STABLE |
| TRIAL PIT COMPLETE AT 3.10M | | | | | | | | | | | |

U - undisturbed D - disturbed B - bulk W - groundwater P - standard penetration CP - cone penetration V - vane test

Webberley

British Geological Survey

GEO-RESEARCH LTD.
BRIGHTON ROAD,
HEATON NORRIS,
STOCKPORT, CHESHIRE.

| | |
|---|---|
| Borehole No. | 3. 5589NE1176 |
| Sheet No. | 1 8885 9628 |
| Date Commenced | 27/5/75 |
| Date Completed | 27/5/75 |
| Scale | 1:50 |

CONTRACT: STORM WATER RELIEF SEWER

LOCATION: GORTON

| Stratum | Legend | Thick-ness | Depth | Sample No. | N Value | Level m | Remarks |
|---|---|---|---|---|---|---|---|
| | | | GL | | | 71.90 | |
| Brick FILL | | | 1.000 | B1 | | | |
| | | | 1.500 | CP1 | 16 | | |
| | | | 2.000 | B2 | | | |
| | | 2.700 | 2.700 | | | 69.20 | |
| Stiff brown silty CLAY with occasional pebbles and sand inclusions | | | | D1 | | | |
| | | | 3.000 | U1 | | | |
| | | | 3.500 | D2 | | | |
| | | | 4.000 | U2 | | | |
| | | | 4.500 | D3 | | | |
| | | | 5.000 | U3 | | | |
| | | | 6.000 | D4 | | | |
| | | | 6.500 | U4 | | | |
| | | 4.300 | 7.000 | | | 64.90 | |
| Borehole Complete | | | | | | | On completion of borehol at 7.000, Casing at 3.00 Water Nil. Borehole backfilled as casing withdrawn. |

British Geological Survey

# Appendix E

# United Utilities Asset Plans

| | | |
|---|---|---|
| **Scale:** 1:1250<br>**Date:** 05/07/2019 | **SEWER RECORDS** | United Utilities<br>helping life flow smoothly |
| **Address or Site Reference:** Land at Beyer Close Manchester M18 8NB<br>**Printed by:** Property Searches | | |

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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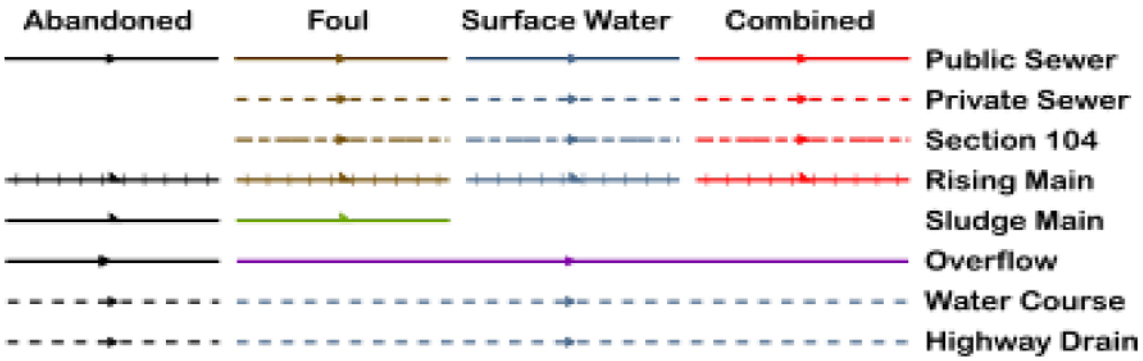
# Wastewater Symbology




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

- Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- Catchpit
- Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- Septic Tank
- Control Kiosk
- Change of Characteristic

# Appendix F

# Greenfield Run-Off Rates and Volume Calculations

## IH 124 Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 1 | Soil | 0.450 |
| Area (ha) | 50.000 | Urban | 0.000 |
| SAAR (mm) | 864 | Region Number | Region 10 |

| **Results** | **l/s** |
|---|---|
| QBAR Rural | 281.0 |
| QBAR Urban | 281.0 |
| Q1 year | 244.5 |
| Q1 year | 244.5 |
| Q2 years | 261.7 |
| Q5 years | 334.4 |
| Q10 years | 387.8 |
| Q20 years | 441.8 |
| Q25 years | 460.8 |
| Q30 years | 476.4 |
| Q50 years | 519.8 |
| Q100 years | 584.5 |
| Q200 years | 663.1 |
| Q250 years | 688.4 |
| Q1000 years | 854.2 |

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## Greenfield Runoff Volume

FEH Data

| | |
|---|---|
| Return Period (years) | 100 |
| Storm Duration (mins) | 360 |
| FEH Rainfall Version | 1999 |
| Site Location | GB 388450 396650 SJ 88450 96650 |
| C (1km) | -0.027 |
| D1 (1km) | 0.333 |
| D2 (1km) | 0.400 |
| D3 (1km) | 0.293 |
| E (1km) | 0.303 |
| F (1km) | 2.458 |
| Areal Reduction Factor | 1.00 |
| Area (ha) | 85.500 |
| SAAR (mm) | 910 |
| CWI | 122.142 |
| SPR Host | 39.700 |
| URBEXT (USER) | 0.0000 |

Results

| | |
|---|---|
| Percentage Runoff (%) | 43.67 |
| Greenfield Runoff Volume ($m^3$) | 25555.916 |

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# Appendix G

# Surface Water Management Layout

N

Existing tree retained

Permeable Paving
Surface water from driveways to percolate through permeable paving / surfacing and into 300mm deep sub-base, formed of 20mm no fines aggregate (0.30 porosity). Surface water to be conveyed to main network via a 100Ø perforated pipe within sub-base material. Rainwater pipe from dwelling to connect to perforated pipe and conveyed to main network.

Filter Drain
Surface water run-off from dwelling roof and patios to discharge to 500x500mm filter drain where surface water is conveyed to main drainage by 100Ø perforated pipe

Filter Drain
Surface water run-off from bin / bike store roof to discharge to 500x500mm filter drain where surface water is conveyed to main drainage by 100Ø perforated pipe

Filter Drain
Surface water run-off from dwelling roof and patios to discharge to 500x500mm filter drain where surface water is conveyed to main drainage by 100Ø perforated pipe

RWP with Water Butt

SWIC 450Ø

SWIC 450Ø Silt Trap

150Ø SW Pipe

100Ø Perforated Pipe

100Ø SW Pipe

Below Ground Attenuation Tank

| | | |
|---|---|---|
| Type | - | Cellular Units |
| Length | - | 7.00m |
| Width | - | 2.00m |
| Area | - | 14.00m² |
| Depth | - | 1.20m |
| Porosity | - | 0.95 |
| Volume | - | 15.95m³ |

Flow Control Chamber

| | | |
|---|---|---|
| Type | - | Hydro-Brake |
| Design Head | - | 1.20m |
| Design Flow | - | 0.5 l/s |
| Diameter | - | 31mm |

100Ø surface water connection / discharge to existing 525Ø sewer. Connection and discharge subject to Section 106 agreement with United Utilities and local authority approval.
Maximum SW Discharge Rates:

| | | |
|---|---|---|
| Q1 | - | 0.2 l/s |
| Q30 | - | 0.4 l/s |
| Q100 + CC | - | 0.5 l/s |

UU 450Ø SW Sewer

UU 300Ø FW Sewer

Beyer Close

UU SW Manhole

UU FW Manhole

UU 225Ø SW Sewer

UU 525Ø SW Sewer

UU 300Ø FW Sewer

UU SW Manhole

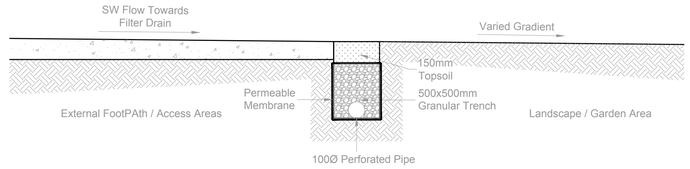
UU FW Manhole

Surface Water Design Exceedance

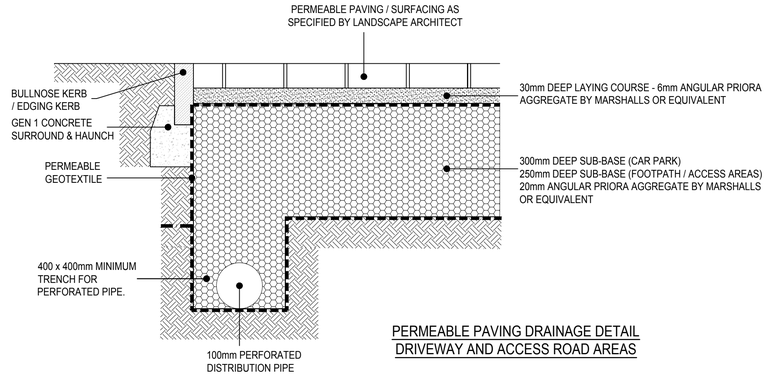
In the unlikely event of an extreme storm greater than 100-year + 40% climate change, or poor maintenance of the SuDS features and / or pipework, potential flooding of the drainage network could occur. Surface water flow paths to follow existing and proposed ground topography, where water will flow from the east of the site to the south east boundary.

The ground outside the development boundary continues to fall in a south east direction along Middlewich Walk, across a grassed recreational area, and to Hampden Crescent. Therefore, flood water will also flow across these areas and discharge into Hampden Crescent.

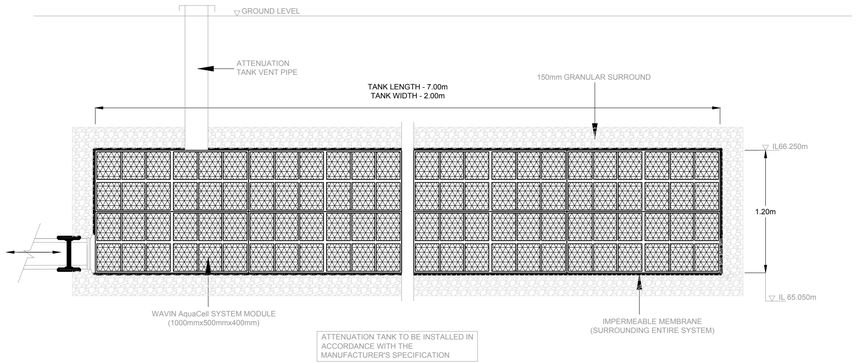
Flood water will flow away from the proposed dwellings within the site, will not flow directly towards existing dwellings / properties outside the development boundary. The flood water will be contained within Hampden Crescent due to the road having a gradient (water to flow along road) and upstand kerbs.




Filter Drain Detail




PERMEABLE PAVING DRAINAGE DETAIL
DRIVEWAY AND ACCESS ROAD AREAS




ATTENUATION TANK DETAIL

- Surface Water Drainage
- Perforated Pipe
- Permeable Paving
- Filter Drain
- Network Exceedance Flow Route
- Development Boundary

| Rev | Description | Drn | Chk | Date |
|---|---|---|---|---|
| P1 | Issued for Planning | MDS | AC | 19.05.21 |

Client
-

Project
Beyer Close
Manchester

Drawing
Surface Water
Management Layout

| Scale | Date | Drawn by | Checked |
|---|---|---|---|
| 1:100@A1 | May '21 | MDS | AC |

Status
Planning

Earth Environmental & Geotechnical

| Job No. | Drg. No. | Rev |
|---|---|---|
| 715 | DR-100 | P1 |

# Appendix H

# Surface Water Management Calculations

## Summary of Results for 1 year Return Period

Half Drain Time : 88 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 | 65.155 | 0.105 | 0.0 | 0.3 | 0.3 | 1.4 | O K |
| 30 min Summer | 65.189 | 0.139 | 0.0 | 0.3 | 0.3 | 1.9 | O K |
| 60 min Summer | 65.222 | 0.172 | 0.0 | 0.3 | 0.3 | 2.3 | O K |
| 120 min Summer | 65.247 | 0.197 | 0.0 | 0.3 | 0.3 | 2.6 | O K |
| 180 min Summer | 65.255 | 0.205 | 0.0 | 0.3 | 0.3 | 2.7 | O K |
| 240 min Summer | 65.255 | 0.205 | 0.0 | 0.3 | 0.3 | 2.7 | O K |
| 360 min Summer | 65.245 | 0.195 | 0.0 | 0.3 | 0.3 | 2.6 | O K |
| 480 min Summer | 65.232 | 0.182 | 0.0 | 0.3 | 0.3 | 2.4 | O K |
| 600 min Summer | 65.218 | 0.168 | 0.0 | 0.3 | 0.3 | 2.2 | O K |
| 720 min Summer | 65.203 | 0.153 | 0.0 | 0.3 | 0.3 | 2.0 | O K |
| 960 min Summer | 65.181 | 0.131 | 0.0 | 0.3 | 0.3 | 1.7 | O K |
| 1440 min Summer | 65.141 | 0.091 | 0.0 | 0.3 | 0.3 | 1.2 | O K |
| 2160 min Summer | 65.097 | 0.047 | 0.0 | 0.3 | 0.3 | 0.6 | O K |
| 2880 min Summer | 65.072 | 0.022 | 0.0 | 0.3 | 0.3 | 0.3 | O K |
| 4320 min Summer | 65.050 | 0.000 | 0.0 | 0.3 | 0.3 | 0.0 | O K |
| 5760 min Summer | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 7200 min Summer | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 8640 min Summer | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 10080 min Summer | 65.050 | 0.000 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 15 min Winter | 65.175 | 0.125 | 0.0 | 0.3 | 0.3 | 1.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 29.449 | 0.0 | 1.6 | 20 |
| 30 min Summer | 18.547 | 0.0 | 2.2 | 34 |
| 60 min Summer | 11.681 | 0.0 | 3.0 | 62 |
| 120 min Summer | 7.357 | 0.0 | 4.0 | 102 |
| 180 min Summer | 5.614 | 0.0 | 4.6 | 136 |
| 240 min Summer | 4.634 | 0.0 | 5.1 | 170 |
| 360 min Summer | 3.536 | 0.0 | 6.0 | 238 |
| 480 min Summer | 2.918 | 0.0 | 6.6 | 306 |
| 600 min Summer | 2.515 | 0.0 | 7.2 | 374 |
| 720 min Summer | 2.227 | 0.0 | 7.6 | 438 |
| 960 min Summer | 1.874 | 0.0 | 8.6 | 566 |
| 1440 min Summer | 1.469 | 0.0 | 10.2 | 810 |
| 2160 min Summer | 1.152 | 0.0 | 11.9 | 1156 |
| 2880 min Summer | 0.969 | 0.0 | 13.3 | 1500 |
| 4320 min Summer | 0.728 | 0.0 | 14.8 | 0 |
| 5760 min Summer | 0.594 | 0.0 | 15.8 | 0 |
| 7200 min Summer | 0.507 | 0.0 | 16.6 | 0 |
| 8640 min Summer | 0.446 | 0.0 | 17.3 | 0 |
| 10080 min Summer | 0.400 | 0.0 | 17.8 | 0 |
| 15 min Winter | 29.449 | 0.0 | 1.9 | 20 |

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## Summary of Results for 1 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 |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 65.215 | 0.165 | 0.0 | 0.3 | 0.3 | 2.2 | O K |
| 60 min Winter | 65.255 | 0.205 | 0.0 | 0.3 | 0.3 | 2.7 | O K |
| 120 min Winter | 65.285 | 0.235 | 0.0 | 0.3 | 0.3 | 3.1 | O K |
| 180 min Winter | 65.292 | 0.242 | 0.0 | 0.3 | 0.3 | 3.2 | O K |
| 240 min Winter | 65.291 | 0.241 | 0.0 | 0.3 | 0.3 | 3.2 | O K |
| 360 min Winter | 65.273 | 0.223 | 0.0 | 0.3 | 0.3 | 3.0 | O K |
| 480 min Winter | 65.247 | 0.197 | 0.0 | 0.3 | 0.3 | 2.6 | O K |
| 600 min Winter | 65.221 | 0.171 | 0.0 | 0.3 | 0.3 | 2.3 | O K |
| 720 min Winter | 65.195 | 0.145 | 0.0 | 0.3 | 0.3 | 1.9 | O K |
| 960 min Winter | 65.157 | 0.107 | 0.0 | 0.3 | 0.3 | 1.4 | O K |
| 1440 min Winter | 65.099 | 0.049 | 0.0 | 0.3 | 0.3 | 0.7 | O K |
| 2160 min Winter | 65.057 | 0.007 | 0.0 | 0.3 | 0.3 | 0.1 | O K |
| 2880 min Winter | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 4320 min Winter | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 5760 min Winter | 65.050 | 0.000 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 7200 min Winter | 65.050 | 0.000 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 8640 min Winter | 65.050 | 0.000 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 10080 min Winter | 65.050 | 0.000 | 0.0 | 0.1 | 0.1 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 18.547 | 0.0 | 2.6 | 34 |
| 60 min Winter | 11.681 | 0.0 | 3.5 | 62 |
| 120 min Winter | 7.357 | 0.0 | 4.5 | 116 |
| 180 min Winter | 5.614 | 0.0 | 5.3 | 146 |
| 240 min Winter | 4.634 | 0.0 | 5.9 | 186 |
| 360 min Winter | 3.536 | 0.0 | 6.8 | 264 |
| 480 min Winter | 2.918 | 0.0 | 7.5 | 334 |
| 600 min Winter | 2.515 | 0.0 | 8.1 | 402 |
| 720 min Winter | 2.227 | 0.0 | 8.7 | 468 |
| 960 min Winter | 1.874 | 0.0 | 9.8 | 594 |
| 1440 min Winter | 1.469 | 0.0 | 11.5 | 824 |
| 2160 min Winter | 1.152 | 0.0 | 13.5 | 1144 |
| 2880 min Winter | 0.969 | 0.0 | 15.2 | 0 |
| 4320 min Winter | 0.728 | 0.0 | 16.8 | 0 |
| 5760 min Winter | 0.594 | 0.0 | 18.1 | 0 |
| 7200 min Winter | 0.507 | 0.0 | 19.0 | 0 |
| 8640 min Winter | 0.446 | 0.0 | 19.8 | 0 |
| 10080 min Winter | 0.400 | 0.0 | 20.4 | 0 |

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## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 1 |
| FEH Rainfall Version | 1999 |
| Site Location | GB 388450 396650 SJ 88450 96650 |
| C (1km) | -0.027 |
| D1 (1km) | 0.333 |
| D2 (1km) | 0.400 |
| D3 (1km) | 0.293 |
| E (1km) | 0.303 |
| F (1km) | 2.458 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 0.043

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.023 | 4 | 8 | 0.020 |

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## Model Details

Storage is Online Cover Level (m) 66.700

## Complex Structure

## Cellular Storage

Invert Level (m) 65.050 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 14.0 | 0.0 | 2.600 | 0.0 | 0.0 |
| 0.200 | 14.0 | 0.0 | 2.800 | 0.0 | 0.0 |
| 0.400 | 14.0 | 0.0 | 3.000 | 0.0 | 0.0 |
| 0.600 | 14.0 | 0.0 | 3.200 | 0.0 | 0.0 |
| 0.800 | 14.0 | 0.0 | 3.400 | 0.0 | 0.0 |
| 1.000 | 14.0 | 0.0 | 3.600 | 0.0 | 0.0 |
| 1.200 | 14.0 | 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) | 25.0 |
| Max Percolation (l/s) | 41.7 | Slope (1:X) | 0.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 66.300 | Cap Volume Depth (m) | 0.300 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0031-5000-1200-5000 |
| Design Head (m) | 1.200 |
| Design Flow (l/s) | 0.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 31 |
| Invert Level (m) | 65.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

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## Hydro-Brake® Optimum Outflow Control

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.200 | 0.5 |
| Flush-Flo™ | 0.137 | 0.3 |
| Kick-Flo® | 0.275 | 0.3 |
| Mean Flow over Head Range | - | 0.4 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 0.3 | 1.200 | 0.5 | 3.000 | 0.7 | 7.000 | 1.1 |
| 0.200 | 0.3 | 1.400 | 0.5 | 3.500 | 0.8 | 7.500 | 1.1 |
| 0.300 | 0.3 | 1.600 | 0.6 | 4.000 | 0.9 | 8.000 | 1.2 |
| 0.400 | 0.3 | 1.800 | 0.6 | 4.500 | 0.9 | 8.500 | 1.2 |
| 0.500 | 0.3 | 2.000 | 0.6 | 5.000 | 0.9 | 9.000 | 1.2 |
| 0.600 | 0.4 | 2.200 | 0.7 | 5.500 | 1.0 | 9.500 | 1.3 |
| 0.800 | 0.4 | 2.400 | 0.7 | 6.000 | 1.0 | | |
| 1.000 | 0.5 | 2.600 | 0.7 | 6.500 | 1.1 | | |

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## Summary of Results for 30 year Return Period

Half Drain Time : 254 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 | 65.535 | 0.485 | 0.0 | 0.4 | 0.4 | 6.5 | O K |
| 30 min Summer | 65.619 | 0.569 | 0.0 | 0.4 | 0.4 | 7.6 | O K |
| 60 min Summer | 65.702 | 0.652 | 0.0 | 0.4 | 0.4 | 8.7 | O K |
| 120 min Summer | 65.762 | 0.712 | 0.0 | 0.4 | 0.4 | 9.5 | O K |
| 180 min Summer | 65.774 | 0.724 | 0.0 | 0.4 | 0.4 | 9.6 | O K |
| 240 min Summer | 65.771 | 0.721 | 0.0 | 0.4 | 0.4 | 9.6 | O K |
| 360 min Summer | 65.754 | 0.704 | 0.0 | 0.4 | 0.4 | 9.4 | O K |
| 480 min Summer | 65.731 | 0.681 | 0.0 | 0.4 | 0.4 | 9.1 | O K |
| 600 min Summer | 65.709 | 0.659 | 0.0 | 0.4 | 0.4 | 8.8 | O K |
| 720 min Summer | 65.688 | 0.638 | 0.0 | 0.4 | 0.4 | 8.5 | O K |
| 960 min Summer | 65.664 | 0.614 | 0.0 | 0.4 | 0.4 | 8.2 | O K |
| 1440 min Summer | 65.609 | 0.559 | 0.0 | 0.4 | 0.4 | 7.4 | O K |
| 2160 min Summer | 65.525 | 0.475 | 0.0 | 0.3 | 0.3 | 6.3 | O K |
| 2880 min Summer | 65.448 | 0.398 | 0.0 | 0.3 | 0.3 | 5.3 | O K |
| 4320 min Summer | 65.261 | 0.211 | 0.0 | 0.3 | 0.3 | 2.8 | O K |
| 5760 min Summer | 65.127 | 0.077 | 0.0 | 0.3 | 0.3 | 1.0 | O K |
| 7200 min Summer | 65.075 | 0.025 | 0.0 | 0.3 | 0.3 | 0.3 | O K |
| 8640 min Summer | 65.054 | 0.004 | 0.0 | 0.3 | 0.3 | 0.1 | O K |
| 10080 min Summer | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 15 min Winter | 65.601 | 0.551 | 0.0 | 0.4 | 0.4 | 7.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 93.202 | 0.0 | 6.8 | 22 |
| 30 min Summer | 55.098 | 0.0 | 8.1 | 36 |
| 60 min Summer | 32.572 | 0.0 | 9.7 | 64 |
| 120 min Summer | 19.255 | 0.0 | 11.6 | 122 |
| 180 min Summer | 14.158 | 0.0 | 12.9 | 180 |
| 240 min Summer | 11.383 | 0.0 | 13.8 | 208 |
| 360 min Summer | 8.370 | 0.0 | 15.3 | 270 |
| 480 min Summer | 6.729 | 0.0 | 16.5 | 338 |
| 600 min Summer | 5.682 | 0.0 | 17.4 | 408 |
| 720 min Summer | 4.948 | 0.0 | 18.2 | 476 |
| 960 min Summer | 4.055 | 0.0 | 19.9 | 616 |
| 1440 min Summer | 3.064 | 0.0 | 22.5 | 886 |
| 2160 min Summer | 2.315 | 0.0 | 25.4 | 1284 |
| 2880 min Summer | 1.897 | 0.0 | 27.7 | 1676 |
| 4320 min Summer | 1.373 | 0.0 | 29.8 | 2428 |
| 5760 min Summer | 1.091 | 0.0 | 31.2 | 3048 |
| 7200 min Summer | 0.913 | 0.0 | 32.3 | 3680 |
| 8640 min Summer | 0.789 | 0.0 | 33.2 | 4400 |
| 10080 min Summer | 0.698 | 0.0 | 33.9 | 0 |
| 15 min Winter | 93.202 | 0.0 | 7.6 | 22 |

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## Summary of Results for 30 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 |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 65.699 | 0.649 | 0.0 | 0.4 | 0.4 | 8.6 | O K |
| 60 min Winter | 65.793 | 0.743 | 0.0 | 0.4 | 0.4 | 9.9 | O K |
| 120 min Winter | 65.871 | 0.821 | 0.0 | 0.4 | 0.4 | 10.9 | O K |
| 180 min Winter | 65.893 | 0.843 | 0.0 | 0.4 | 0.4 | 11.2 | O K |
| 240 min Winter | 65.892 | 0.842 | 0.0 | 0.4 | 0.4 | 11.2 | O K |
| 360 min Winter | 65.871 | 0.821 | 0.0 | 0.4 | 0.4 | 10.9 | O K |
| 480 min Winter | 65.842 | 0.792 | 0.0 | 0.4 | 0.4 | 10.5 | O K |
| 600 min Winter | 65.809 | 0.759 | 0.0 | 0.4 | 0.4 | 10.1 | O K |
| 720 min Winter | 65.777 | 0.727 | 0.0 | 0.4 | 0.4 | 9.7 | O K |
| 960 min Winter | 65.733 | 0.683 | 0.0 | 0.4 | 0.4 | 9.1 | O K |
| 1440 min Winter | 65.640 | 0.590 | 0.0 | 0.4 | 0.4 | 7.8 | O K |
| 2160 min Winter | 65.510 | 0.460 | 0.0 | 0.3 | 0.3 | 6.1 | O K |
| 2880 min Winter | 65.396 | 0.346 | 0.0 | 0.3 | 0.3 | 4.6 | O K |
| 4320 min Winter | 65.118 | 0.068 | 0.0 | 0.3 | 0.3 | 0.9 | O K |
| 5760 min Winter | 65.054 | 0.004 | 0.0 | 0.3 | 0.3 | 0.1 | O K |
| 7200 min Winter | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 8640 min Winter | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 10080 min Winter | 65.050 | 0.000 | 0.0 | 0.2 | 0.2 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 55.098 | 0.0 | 9.2 | 36 |
| 60 min Winter | 32.572 | 0.0 | 11.0 | 64 |
| 120 min Winter | 19.255 | 0.0 | 13.1 | 120 |
| 180 min Winter | 14.158 | 0.0 | 14.5 | 176 |
| 240 min Winter | 11.383 | 0.0 | 15.6 | 228 |
| 360 min Winter | 8.370 | 0.0 | 17.3 | 284 |
| 480 min Winter | 6.729 | 0.0 | 18.5 | 362 |
| 600 min Winter | 5.682 | 0.0 | 19.6 | 440 |
| 720 min Winter | 4.948 | 0.0 | 20.5 | 516 |
| 960 min Winter | 4.055 | 0.0 | 22.4 | 666 |
| 1440 min Winter | 3.064 | 0.0 | 25.4 | 954 |
| 2160 min Winter | 2.315 | 0.0 | 28.7 | 1368 |
| 2880 min Winter | 1.897 | 0.0 | 31.3 | 1788 |
| 4320 min Winter | 1.373 | 0.0 | 33.6 | 2380 |
| 5760 min Winter | 1.091 | 0.0 | 35.3 | 2944 |
| 7200 min Winter | 0.913 | 0.0 | 36.6 | 0 |
| 8640 min Winter | 0.789 | 0.0 | 37.6 | 0 |
| 10080 min Winter | 0.698 | 0.0 | 38.5 | 0 |

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## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 30 |
| FEH Rainfall Version | 1999 |
| Site Location | GB 388450 396650 SJ 88450 96650 |
| C (1km) | -0.027 |
| D1 (1km) | 0.333 |
| D2 (1km) | 0.400 |
| D3 (1km) | 0.293 |
| E (1km) | 0.303 |
| F (1km) | 2.458 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 0.043

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.023 | 4 | 8 | 0.020 |

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## Model Details

Storage is Online Cover Level (m) 66.700

## Complex Structure

## Cellular Storage

Invert Level (m) 65.050 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 14.0 | 0.0 | 2.600 | 0.0 | 0.0 |
| 0.200 | 14.0 | 0.0 | 2.800 | 0.0 | 0.0 |
| 0.400 | 14.0 | 0.0 | 3.000 | 0.0 | 0.0 |
| 0.600 | 14.0 | 0.0 | 3.200 | 0.0 | 0.0 |
| 0.800 | 14.0 | 0.0 | 3.400 | 0.0 | 0.0 |
| 1.000 | 14.0 | 0.0 | 3.600 | 0.0 | 0.0 |
| 1.200 | 14.0 | 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) | 25.0 |
| Max Percolation (l/s) | 41.7 | Slope (1:X) | 0.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 66.300 | Cap Volume Depth (m) | 0.300 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0031-5000-1200-5000 |
| Design Head (m) | 1.200 |
| Design Flow (l/s) | 0.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 31 |
| Invert Level (m) | 65.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

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## Hydro-Brake® Optimum Outflow Control

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.200 | 0.5 |
| Flush-Flo™ | 0.137 | 0.3 |
| Kick-Flo® | 0.275 | 0.3 |
| Mean Flow over Head Range | - | 0.4 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 0.3 | 1.200 | 0.5 | 3.000 | 0.7 | 7.000 | 1.1 |
| 0.200 | 0.3 | 1.400 | 0.5 | 3.500 | 0.8 | 7.500 | 1.1 |
| 0.300 | 0.3 | 1.600 | 0.6 | 4.000 | 0.9 | 8.000 | 1.2 |
| 0.400 | 0.3 | 1.800 | 0.6 | 4.500 | 0.9 | 8.500 | 1.2 |
| 0.500 | 0.3 | 2.000 | 0.6 | 5.000 | 0.9 | 9.000 | 1.2 |
| 0.600 | 0.4 | 2.200 | 0.7 | 5.500 | 1.0 | 9.500 | 1.3 |
| 0.800 | 0.4 | 2.400 | 0.7 | 6.000 | 1.0 | | |
| 1.000 | 0.5 | 2.600 | 0.7 | 6.500 | 1.1 | | |

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## Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 421 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 | 66.157 | 1.107 | 0.0 | 0.5 | 0.5 | 14.7 | O K |
| 30 min Summer | 66.307 | 1.257 | 0.0 | 0.5 | 0.5 | 16.9 | O K |
| 60 min Summer | 66.351 | 1.301 | 0.0 | 0.5 | 0.5 | 19.0 | O K |
| 120 min Summer | 66.391 | 1.341 | 0.0 | 0.5 | 0.5 | 20.9 | O K |
| 180 min Summer | 66.407 | 1.357 | 0.0 | 0.5 | 0.5 | 21.6 | Flood Risk |
| 240 min Summer | 66.411 | 1.361 | 0.0 | 0.5 | 0.5 | 21.9 | Flood Risk |
| 360 min Summer | 66.405 | 1.355 | 0.0 | 0.5 | 0.5 | 21.6 | Flood Risk |
| 480 min Summer | 66.395 | 1.345 | 0.0 | 0.5 | 0.5 | 21.1 | O K |
| 600 min Summer | 66.384 | 1.334 | 0.0 | 0.5 | 0.5 | 20.6 | O K |
| 720 min Summer | 66.372 | 1.322 | 0.0 | 0.5 | 0.5 | 20.0 | O K |
| 960 min Summer | 66.360 | 1.310 | 0.0 | 0.5 | 0.5 | 19.5 | O K |
| 1440 min Summer | 66.337 | 1.287 | 0.0 | 0.5 | 0.5 | 18.4 | O K |
| 2160 min Summer | 66.304 | 1.254 | 0.0 | 0.5 | 0.5 | 16.7 | O K |
| 2880 min Summer | 66.187 | 1.137 | 0.0 | 0.5 | 0.5 | 15.1 | O K |
| 4320 min Summer | 65.912 | 0.862 | 0.0 | 0.4 | 0.4 | 11.5 | O K |
| 5760 min Summer | 65.709 | 0.659 | 0.0 | 0.4 | 0.4 | 8.8 | O K |
| 7200 min Summer | 65.552 | 0.502 | 0.0 | 0.4 | 0.4 | 6.7 | O K |
| 8640 min Summer | 65.428 | 0.378 | 0.0 | 0.3 | 0.3 | 5.0 | O K |
| 10080 min Summer | 65.314 | 0.264 | 0.0 | 0.3 | 0.3 | 3.5 | O K |
| 15 min Winter | 66.303 | 1.253 | 0.0 | 0.5 | 0.5 | 16.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 197.386 | 0.0 | 15.2 | 22 |
| 30 min Summer | 114.062 | 0.0 | 17.6 | 37 |
| 60 min Summer | 65.912 | 0.0 | 20.5 | 66 |
| 120 min Summer | 38.088 | 0.0 | 23.8 | 124 |
| 180 min Summer | 27.635 | 0.0 | 25.9 | 182 |
| 240 min Summer | 22.010 | 0.0 | 27.6 | 242 |
| 360 min Summer | 15.969 | 0.0 | 30.0 | 324 |
| 480 min Summer | 12.718 | 0.0 | 31.9 | 382 |
| 600 min Summer | 10.660 | 0.0 | 33.4 | 444 |
| 720 min Summer | 9.228 | 0.0 | 34.7 | 510 |
| 960 min Summer | 7.493 | 0.0 | 37.6 | 650 |
| 1440 min Summer | 5.586 | 0.0 | 42.0 | 924 |
| 2160 min Summer | 4.165 | 0.0 | 47.0 | 1324 |
| 2880 min Summer | 3.381 | 0.0 | 50.7 | 1728 |
| 4320 min Summer | 2.414 | 0.0 | 53.9 | 2504 |
| 5760 min Summer | 1.901 | 0.0 | 56.3 | 3232 |
| 7200 min Summer | 1.579 | 0.0 | 58.1 | 3968 |
| 8640 min Summer | 1.357 | 0.0 | 59.6 | 4752 |
| 10080 min Summer | 1.194 | 0.0 | 60.8 | 5544 |
| 15 min Winter | 197.386 | 0.0 | 17.1 | 22 |

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## Summary of Results for 100 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 |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 66.352 | 1.302 | 0.0 | 0.5 | 0.5 | 19.1 | O K |
| 60 min Winter | 66.405 | 1.355 | 0.0 | 0.5 | 0.5 | 21.6 | Flood Risk |
| 120 min Winter | 66.456 | 1.406 | 0.0 | 0.5 | 0.5 | 23.9 | Flood Risk |
| 180 min Winter | 66.478 | 1.428 | 0.0 | 0.5 | 0.5 | 24.8 | Flood Risk |
| 240 min Winter | 66.487 | 1.437 | 0.0 | 0.5 | 0.5 | 25.3 | Flood Risk |
| 360 min Winter | 66.486 | 1.436 | 0.0 | 0.5 | 0.5 | 25.2 | Flood Risk |
| 480 min Winter | 66.473 | 1.423 | 0.0 | 0.5 | 0.5 | 24.6 | Flood Risk |
| 600 min Winter | 66.459 | 1.409 | 0.0 | 0.5 | 0.5 | 24.0 | Flood Risk |
| 720 min Winter | 66.445 | 1.395 | 0.0 | 0.5 | 0.5 | 23.4 | Flood Risk |
| 960 min Winter | 66.427 | 1.377 | 0.0 | 0.5 | 0.5 | 22.6 | Flood Risk |
| 1440 min Winter | 66.384 | 1.334 | 0.0 | 0.5 | 0.5 | 20.6 | O K |
| 2160 min Winter | 66.325 | 1.275 | 0.0 | 0.5 | 0.5 | 17.8 | O K |
| 2880 min Winter | 66.204 | 1.154 | 0.0 | 0.5 | 0.5 | 15.3 | O K |
| 4320 min Winter | 65.842 | 0.792 | 0.0 | 0.4 | 0.4 | 10.5 | O K |
| 5760 min Winter | 65.592 | 0.542 | 0.0 | 0.4 | 0.4 | 7.2 | O K |
| 7200 min Winter | 65.401 | 0.351 | 0.0 | 0.3 | 0.3 | 4.7 | O K |
| 8640 min Winter | 65.147 | 0.097 | 0.0 | 0.3 | 0.3 | 1.3 | O K |
| 10080 min Winter | 65.073 | 0.023 | 0.0 | 0.3 | 0.3 | 0.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 114.062 | 0.0 | 19.8 | 36 |
| 60 min Winter | 65.912 | 0.0 | 23.0 | 64 |
| 120 min Winter | 38.088 | 0.0 | 26.7 | 122 |
| 180 min Winter | 27.635 | 0.0 | 29.2 | 180 |
| 240 min Winter | 22.010 | 0.0 | 31.0 | 236 |
| 360 min Winter | 15.969 | 0.0 | 33.7 | 346 |
| 480 min Winter | 12.718 | 0.0 | 35.8 | 442 |
| 600 min Winter | 10.660 | 0.0 | 37.6 | 474 |
| 720 min Winter | 9.228 | 0.0 | 39.0 | 550 |
| 960 min Winter | 7.493 | 0.0 | 42.2 | 706 |
| 1440 min Winter | 5.586 | 0.0 | 47.2 | 1002 |
| 2160 min Winter | 4.165 | 0.0 | 52.7 | 1428 |
| 2880 min Winter | 3.381 | 0.0 | 57.0 | 1824 |
| 4320 min Winter | 2.414 | 0.0 | 60.7 | 2600 |
| 5760 min Winter | 1.901 | 0.0 | 63.4 | 3400 |
| 7200 min Winter | 1.579 | 0.0 | 65.4 | 4184 |
| 8640 min Winter | 1.357 | 0.0 | 67.1 | 4752 |
| 10080 min Winter | 1.194 | 0.0 | 68.5 | 5240 |

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## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| FEH Rainfall Version | 1999 |
| Site Location | GB 388450 396650 SJ 88450 96650 |
| C (1km) | -0.027 |
| D1 (1km) | 0.333 |
| D2 (1km) | 0.400 |
| D3 (1km) | 0.293 |
| E (1km) | 0.303 |
| F (1km) | 2.458 |
| 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 Area Diagram

Total Area (ha) 0.043

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.023 | 4 | 8 | 0.020 |

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## Model Details

Storage is Online Cover Level (m) 66.700

## Complex Structure

## Cellular Storage

Invert Level (m) 65.050 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 14.0 | 0.0 | 2.600 | 0.0 | 0.0 |
| 0.200 | 14.0 | 0.0 | 2.800 | 0.0 | 0.0 |
| 0.400 | 14.0 | 0.0 | 3.000 | 0.0 | 0.0 |
| 0.600 | 14.0 | 0.0 | 3.200 | 0.0 | 0.0 |
| 0.800 | 14.0 | 0.0 | 3.400 | 0.0 | 0.0 |
| 1.000 | 14.0 | 0.0 | 3.600 | 0.0 | 0.0 |
| 1.200 | 14.0 | 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) | 25.0 |
| Max Percolation (l/s) | 41.7 | Slope (1:X) | 0.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 66.300 | Cap Volume Depth (m) | 0.300 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0031-5000-1200-5000 |
| Design Head (m) | 1.200 |
| Design Flow (l/s) | 0.5 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 31 |
| Invert Level (m) | 65.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

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## Hydro-Brake® Optimum Outflow Control

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.200 | 0.5 |
| Flush-Flo™ | 0.137 | 0.3 |
| Kick-Flo® | 0.275 | 0.3 |
| Mean Flow over Head Range | - | 0.4 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 0.3 | 1.200 | 0.5 | 3.000 | 0.7 | 7.000 | 1.1 |
| 0.200 | 0.3 | 1.400 | 0.5 | 3.500 | 0.8 | 7.500 | 1.1 |
| 0.300 | 0.3 | 1.600 | 0.6 | 4.000 | 0.9 | 8.000 | 1.2 |
| 0.400 | 0.3 | 1.800 | 0.6 | 4.500 | 0.9 | 8.500 | 1.2 |
| 0.500 | 0.3 | 2.000 | 0.6 | 5.000 | 0.9 | 9.000 | 1.2 |
| 0.600 | 0.4 | 2.200 | 0.7 | 5.500 | 1.0 | 9.500 | 1.3 |
| 0.800 | 0.4 | 2.400 | 0.7 | 6.000 | 1.0 | | |
| 1.000 | 0.5 | 2.600 | 0.7 | 6.500 | 1.1 | | |

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