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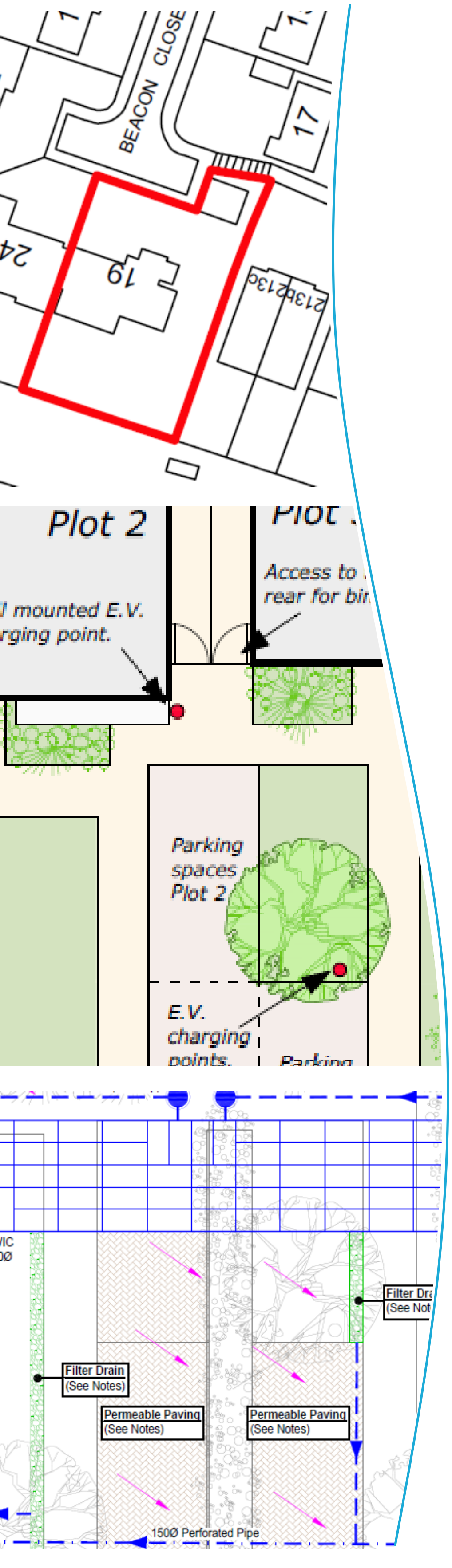

Project_

Residential Development at 19 Beacon Close Uxbridge, UB8 1PX

Title_

Surface Water Management Report

Project No_

1171

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Revision_

A

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Appendices

1. Introduction

Flo Consult UK Ltd have prepared this surface water management report, on behalf of RRAK Properties Ltd, in support of a planning application for a new residential development at 19 Beacon Close, Uxbridge, UB8 1PX (hereafter referred to as 'the Site').

The 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 (as amended February 2025), 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:

- The London Plan (2021) Policy SI 13 (Sustainable Drainage);
- London Borough of Hillingdon Council Preliminary Flood Risk Assessment (May 2011);
- London Borough of Hillingdon Council Local Planning Policy LPP1 (2012) Policy EM6;
- London Borough of Hillingdon Council Local Planning Policy LPP2 (Modification 2019) Policy DMEI 9.

Subsequently, London Borough of Hillingdon Council, acting as Lead Local Flood Authority (LLFA), needs 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 (FWMA) received royal assent in April 2010, aiming to create a simpler and more effective means of managing flood risk and coastal erosion. The FWMA incorporates and implements some of the recommendations from the Pitt Review (2008), following the severe flooding that affected a large area of the UK in 2007.

2.3. London Plan (March 2021) - Policy SI 13 (Sustainable Drainage)

Policy SI 13 States:

A. *'Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.*

B. *Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:*

   1) *rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)*
   2) *rainwater infiltration to ground at or close to source*
   3) *rainwater attenuation in green infrastructure features for gradual release*
   4) *rainwater discharge direct to a watercourse (unless not appropriate)*
   5) *controlled rainwater discharge to a surface water sewer or drain*
   6) *controlled rainwater discharge to a combined sewer.*

C. Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

D. Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity, and recreation'.

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3. Site Setting and Description

3.1. Site Location

The Site is in a rural area of Uxbridge, is approximately 1.5 km north of Uxbridge town centre and station, and as shown in Appendix A, is bound by Beacon Close to the north, residential dwellings to the east and west, and undeveloped residential gardens to the south.

The postcode at the Site is UB8 1PX, with the co-ordinates at the centre of the Site being: E: 505845, N: 185310.

3.2. Existing Site

As detailed on the topographical survey in Appendix B, the Site, in a pre-development state, consists of an existing dwelling to the centre, with garden and driveway areas to the front (north), leading to a detached garage (north-west), and patio areas leading to gardens to the rear (south). The Site is currently developed, and therefore the purpose of this report, is deemed to be **'Brownfield Site'.**

3.3. Topography

In terms of topography, the site has a general fall in a west / south-west direction, with the high-point being towards the north-east boundary at 48.055m AOD, and the low-point being towards the south-west boundary at approximately 46.260m AOD. The floor level of the existing dwelling is approximately 47.335m AOD.

3.4. Proposed Development

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

In brief, and relation to this report, the proposal is to demolish the existing dwelling and detached garage, and to build 4-new dwellings, with parking areas to and small landscape / garden areas to the front (north) and footpath with patio areas leading to gardens to the sides and rear (south).

3.5. Ground Conditions

The ground conditions can be determined by the British Geological Survey (BGS) website, where it shows the Site to have no superficial deposits, and bedrock consisting of London Clay Formation (clay).

The BGS website also shows borehole log data within 150m to the north of the Site (Beacon Close), which shows the ground to predominantly consist of clay, with a shallow ground water level of 1.40m bgl (see Appendix D).

3.6. Waterbodies

The nearest known waterbodies are to the west of the Site, which includes Fray's River (150m), the Grand Union Canal (200m) and the River Colne (250m).

3.7. Public Sewers

The Thames Water asset plan in Appendix E shows there to be a 225mm surface water sewer in Beacon Close (north), which flows in a westerly direction before discharging into the waterbodies to the west.

3.8. Development Areas

The Site boundary is approximately 950m² / 0.095 ha, with the existing development areas equating to 320m² / 0.032 ham and the undeveloped garden areas equating to 630m² / 0.063 ha. Therefore, in terms of pre-development surface water run-off rates and volume calculations, **0.032 h**a is to be used, and for the greenfield run-off calculations, the Site has an urban factor of **0.34** (0.032 ha / 0.095 ha).

The Site, in a post development state, has developed areas equating to approximately 410m² / 0.041 ha, with the landscape / garden areas equating to 540m² / 0.054 ha. The landscape / garden areas will continue to discharge off the Site at a natural / greenfield rate, and therefore, the surface water management area for the Site is **0.041 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 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 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

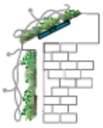
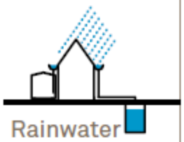
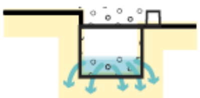
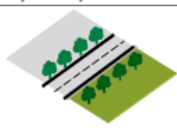
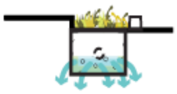
The destination of the surface water run-off from the Site, in a post development state, has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

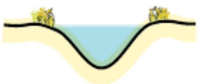
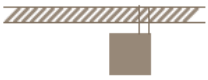
Run-Off Destination	Feasible / Required?	Description
Discharge to Ground	No	BGS data shows the Site to have no superficial deposits, and bedrock consisting of London Clay Formation (clay), with borehole log data (150m to the north of the Site) showing the ground to predominantly consist of clay, with shallow ground water level of 1.40m bgl. Clay is known to have exceptionally low or no infiltration value, and in accordance with CIRIA 753 (varied sections), soakaways need to be at least 1.0m above groundwater. Therefore, due to the presence of clay and the shallow groundwater, discharge to ground is not feasible.
Discharge to Surface Water Body	**Yes**	There are waterbodies 150m- 250m to the west of the Site, with the Thames Water asset plan showing the 225mm surface water sewer discharging to the waterbodies. Therefore, the surface water run-off from the proposed site can discharge to the 225mm surface water sewer in Beacon Close and subsequently to a waterbody.
Discharge to Surface Water Sewer	**Yes**	As above, the surface water can discharge to the 225mm surface water sewer in Beacon Close and subsequently to the waterbodies to the west.
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 are no known combined water sewers near the Site, and therefore this is not a feasible surface water run-off destination.

6. SuDS Feasibility

To reduce the surface water run-off from the Site in a post development state, 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 maintenanccе 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 new dwelling roofs are to be pitched and not structurally designed for living roofs. Therefore, this is not feasible SuDS method.
Rainwater Harvesting	**Yes**	Rainwater harvesting tanks can be installed for each of the new dwellings, where the water can be either re-used for irrigation or for re-use within the dwellings (details to be confirmed). The rainwater harvesting tanks will reduce the surface water run-off volume from the Site, and will reduce water use within the dwellings.
Soakaway	No	As detailed in Section 5, BGS data shows the ground to predominantly consist of clay, with shallow ground water level of 1.40m bgl. Clay is known to have exceptionally low or no infiltration value, and in accordance with CIRIA 753 (varied sections), soakaways need to be at least 1.0m above groundwater. Therefore, due to the presence of clay and shallow groundwater, discharge to ground is not feasible.

Filter Drains	**Yes**	Filter drain systems can be formed along the edge of the footpath areas, and will consist of a 300x300mm, 20mm no fine granular filled trench housing a perforated pipe, below a 200mm deep growing layer. The surface water run-off from the footpath areas will discharge onto and into the filter drain system. The surface water will not infiltrate directly to ground (formation in clay strata), but will be convey the surface water to the main network via a perforated pipe and will reduce run-off rates and act as a pollutant control.
Permeable Surfacing	**Yes**	Permeable surfacing systems can be formed in driveway areas if gee Site, where the surface water run-off from all driveway areas will discharge onto and into the permeable surfacing. The surface water will not discharge directly to ground (formation in clay strata) but will be conveyed via a perforated pipe from the sub-base (consisting of 20mm no fines aggregate) of the permeable surfacing system, and into the main drainage network. A permeable surfacing will reduce the surface water run-off rate from the access and driveway areas and will act as a pollutant control.
Swale / Bioretention area / Ponds	No	The only external areas where these SuDS features can be formed is in the landscape and garden areas of the Site. However, all the garden is to be used as a private amenity space, with planting and trees within the landscape areas Therefore, the use of swales, ponds or bioretention areas are not feasible at the Site.
Hardscape Storage	No	Surface water run-off from the external areas is to discharge to either filter drain or permeable paving systems. Therefore, there is no requirements for hardscape storage.
Underground Storage	**Yes**	The surface water run-off from the Site will be restricted. Therefore, there will be a requirement to have underground storage for storm events up to 1 in 30-year; and to suitably sized so that the volume of water during the 1 in 100-year storm event is kept a minimum at surface level, where it can be contained on the Site.

7. Development Greenfield Run-Off 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 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):

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
SAAR	=	700
Soil	=	0.300
Urban Factor	=	0.34
Region Number	=	6

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 = 167.3 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 (0.041 ha) of the Site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

QBAR = **0.14 l/s (3.35 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 6.

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	0.14 l/s	0.88	**0.1 l/s**
Q_{30}	0.14 l/s	2.40	**0.3 l/s**
Q_{100}	0.14 l/s	3.19	**0.4 l/s**

Note: Rates rounded up to nearest decimal point to reflect MicroDrainage calculation outputs

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

Site Location = GB 505845 185310 TQ 05845 85310

Area = 0.041 ha

SAAR = 700

CWI = 105.000

SPR Host = 47.000

URBTEXT = 0.34

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

$Q_{100\ (6\text{-Hour})}$ = 15.91m³ (387.95m³/ha)

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 0.032 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 = 4.0 l/s (15-minute storm duration)

Q_{30} = 11.9 l/s (15-minute storm duration)

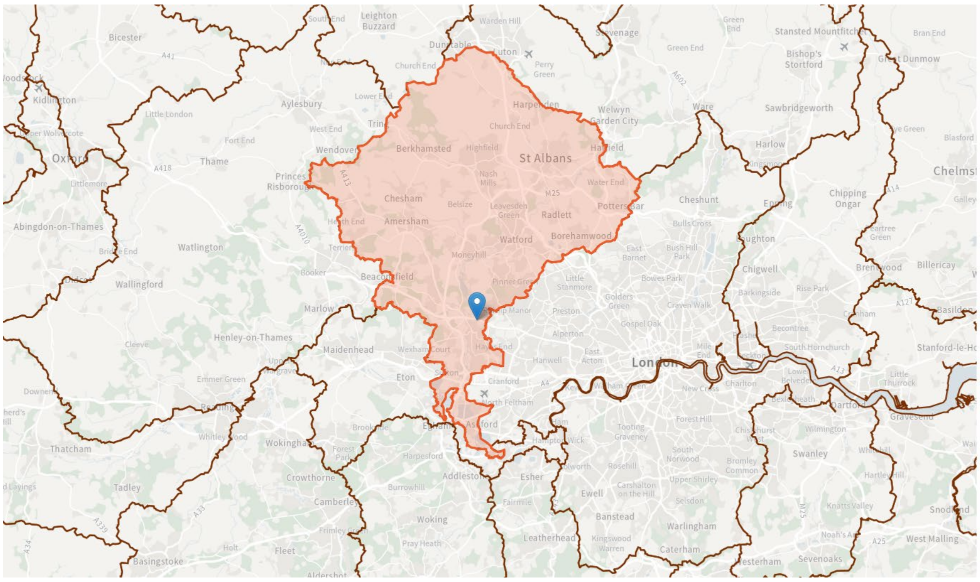
Q_{100} = 14.4 l/s (15-minute storm duration)

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

Q_{100} = 23.84m³ (360-minute storm duration)

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.



Colne Management Catchment peak rainfall allowances

3.3% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	35%
2070s	25%	35%

1% annual exceedance rainfall event

Epoch	Central allowance	Upper end allowance
2050s	20%	40%
2070s	25%	40%

*Use '2050s' for development with a lifetime up 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.

Figure 1 - DEFRAs – Climate Change Allowances

The lifetime of the Site 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 **35%** and **40%** for the 30-year and 100-year storm respectively.

10. Drainage Networks and Surface Water Management Calculation

10.1. Surface Water Network Calculations

The calculations to determine the post development surface water run-off rates, volumes and required attenuation, are based on the post development surface water run-off area of 0.041 ha, the rainfall data given by the FEH 2022 (shown as 2013 in MicroDrainage calculations), and run-off coefficient (Cv) of 1.0.

10.2. Surface Water Drainage Network

As shown on the surface water management layout in Appendix H, the proposed surface water network will consist of 150mm diameter pipes, 100mm perforated pipes, 460mm inspection and silt trap chambers, rainwater harvesting tanks, permeable surfacing systems, filter drains, 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 residential roof areas will discharge to the main network via trapped rainwater pipes / gullies (containing first 5mm of water) and rainwater harvesting tanks, the surface water run-off from the footpath areas will discharge to the main network via filter drains; and the surface water run-off from the driveway areas will discharge to the main network via the permeable paving system.

The surface water network will flow to the north of the Site, and will discharge through the flow control chamber prior to the connection / discharge to the 225mm surface water sewer in Beacon Close, and subsequent waterbodies.

The surface water will be restricted by the hydro-brake. Restricted surface water will surcharge the attenuation tank, in the form of cellular units, which will store the surface water during all storm events up to and including the 100-year + climate change, to prevent flooding.

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 0.1 l/s for the 1 in 2-year storm event, 0.3 l/s for the 1 in 30-year storm event including 35% allowance, and 0.4 l/s for the 1 in 100-year storm event including 40% 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 4.0 l/s for the 1 in 2-year storm event, 11.9 l/s for the 1 in 30-year storm event including 35% allowance; and 14.4 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 (0.1 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 a 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 30mm.

As shown in the output calculation from the MicroDrainage computer software in Appendix I, if the hydro-brake opening is set at 30mm, the design flow at 0.4 l/s (100-year greenfield rate), with a design head of 1.00m, the maximum surface water run-off rates for each storm event will be as follows:

Q_2	-	**0.3 l/s**	-	240-minute winter storm duration
$Q_{30 + 35\% CC}$	-	**0.3 l/s**	-	360-minute winter storm duration
$Q_{100 + 40\% CC}$	-	**0.4 l/s**	-	480-minute winter storm duration

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

Greenfield Rate to Post Development Rate

Storm	**-**	**Greenfield**	**-**	**Post Dev**	**-**	**Difference**
Q_2	-	0.1 l/s	-	0.3 l/s	-	Increase
$Q_{30 + CC}$	-	0.3 l/s	-	0.3 l/s	-	**Equivalent**
$Q_{100 + CC}$	-	0.4 l/s	-	0.4 l/s	-	**Equivalent**

Pre-Development Rate to Post Development Rate

Storm	**-**	**Pre-Dev**	**-**	**Post Dev**	**-**	**Difference**
Q_2	-	4.0 l/s	-	0.3 l/s	-	Reduction
$Q_{30 + CC}$	-	11.9 l/s	-	0.3 l/s	-	Reduction
$Q_{100 + CC}$	-	14.4 l/s	-	0.4 l/s	-	Reduction

The calculations show that the surface water run-off rates are greater than the 2-year greenfield rate, but equivalent to the 30-year and 100-year greenfield rates, and a reduction of pre-development rates.

Therefore, the rates will still adhere to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems (S3).

10.4. 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% climate change allowance), within the MicroDrainage computer software in Appendix H, based on the peak discharge rate, where:

$Q_{100\ (6\text{-hour})}$ = 0.4 l/s x (60 x 60 x 6) = 8,640 litres = **8.64m³**

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

Greenfield Volume to Post Development Volume

Storm	**-**	**Greenfield**	**-**	**Post Dev**	**-**	**Difference**
Q_{100}	-	15.91m³	-	8.64m³	-	Reduction

Pre-Development Volume to Post Development Volume

Storm	**-**	**Pre-Dev**	**-**	**Post Dev**	**-**	**Difference**
Q_{100}	-	23.84m³	-	8.64m³	-	Reduction

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

Therefore, meets the requirements of DEFRA National Non-statutory technical standards for sustainable drainage systems (S5-S6), where the risk of flooding to the surface water sewer and subsequent waterbodies has been reduced.

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 structure formed of below ground attenuation tank in the form of cellular units.

As detailed in the MicroDrainage calculations (Appendix I) and surface water management layout (Appendix H), the attenuation volume and details for this SuDS method is as follows:

Cellular Units

Attenuation Tank Length	-	20.000m
Attenuation Tank Width	-	2.50m
Attenuation Tank Area	-	50.00m²
Attenuation Tank Depth	-	0.80m
Attenuation Tank Volume	-	40.00m³
Porosity	-	0.95
Attenuation Volume	-	**38.00m³**

The MicroDrainage calculations (Appendix I) show that with the cellular unit volume, no flooding will occur for all storms up to and including the 100-year + 40% storm event.

Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems (S7-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 development site and plot boundaries will be by contractors appointed by the owners / residents of each of the new properties, 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 their plot and wider development / open area, 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 House 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 house owner on this development you have responsibilities for the maintenance of the surface water drainage system which fall within the extent of the title which you own as well as in the ‘open areas’ defined 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, rainwater harvesting tanks, filter drains, and permeable surfacing within the title of your property are owned by you as the owner and as such responsibility for maintenance / repairs and replacement are yours as the house owner. Private drainage is identified as any drainage within your plot boundary.

Surface water drainage pipes, manhole chambers, flow control and attenuation tank within the ‘open areas’ are owned by all residents of the development, where communal sums are to be taken and given to an appointed contractor to carry out necessary maintenance / repairs & replacement of drainage features.

Open area drainage is identified as any drainage within the development boundary, but outside your plot boundary.

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, Rainwater Harvesting Tanks, Cellular Units, Flow Control Chamber

Operation	***Frequency***
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	*Monthly for 3 months, then six monthlies*
Debris removal from manholes (where may cause risk	*Monthly*

performance)	
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*

Permeable Paving and Filter Drains

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

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 industrial estate. 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 event of an extreme storm event (greater than 100-year + 40% climate change) flooding of the drainage network could occur.

Surface water flow paths will follow existing and proposed ground topography, where surface water from the network to the front of the dwellings (north) would flow into Beacon Close and to the existing waterbodies (west), and surface water from the network to the rear of the dwellings (south) would flow across residential garden areas and to the existing waterbodies (west)

The surface water will flow away from all the proposed dwellings and will not flow into neighbouring or property prior to discharge to the waterbodies.

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 = **1.30**

13.2. External Area Pollutant Mitigation

Mitigation Measures:

- **Filter Drains and Permeable Surfacing**

Permeable Surfacing / Paving Pollutant Mitigation Indices

Total Suspended Solid (TSS) = 0.7

Metals = 0.6

Hydrocarbons = 0.7

SuDS Mitigation Indices = **2.00**

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

Note: Surface water run-off from residential roof to have very low pollutants, and will flow through trapped gullies and rainwater harvesting tanks prior to discharge to main drainage network. 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 chamber 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 north (Beacon Close). 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 and subsequent waterbodies. 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. This will ensure that the surface water discharge at a reduced rate during all phases of the build. 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 Surfacing and Filter Drains

Construction of permeable surfacing and filter drains are 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 destinations have been assessed, with the feasible SuDS methods being rainwater harvesting tanks, permeable surfacing systems, filter drain systems, a flow control chamber and an attenuation tank in the form of cellular units, with the surface water destination being to a waterbody via a surface water sewer.

15.2. Peak Flow Control

The surface water run-off rates are greater than the 2-year greenfield rate, but equivalent to the 30-year and 100-year greenfield rates, and a reduction of pre-development rates. Therefore, the rates will still adhere to DEFRA National Non-Statutory Technical Standards for Sustainable Drainage Systems (S3).

15.3. Volume Control

The surface water run-off volume for the 100-year, 6-hour storm event is a reduction of the greenfield and pre-development volume. Therefore, meets the requirements of DEFRA National Non-statutory technical standards for sustainable drainage systems (S5-S6), where the risk of flooding to the surface water sewer and subsequent waterbodies has been reduced.

15.4. Flood Risk within the Development

With the cellular unit volume, no flooding will occur for all storms up to and including the 100-year + 40% storm event. Therefore, the attenuation volume is deemed to be acceptable, as they meet the requirements set out in the Non-Statutory Technical Standards for Sustainable Drainage Systems (S7-S9).

15.5. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features within the development site and plot boundaries will be by contractors appointed by the owners / residents of each of the new properties, 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 their plot and wider development / open area, and responsibility to maintain the drainage features shown on said drawings and details.

15.6. Surface Water Exceedance Design

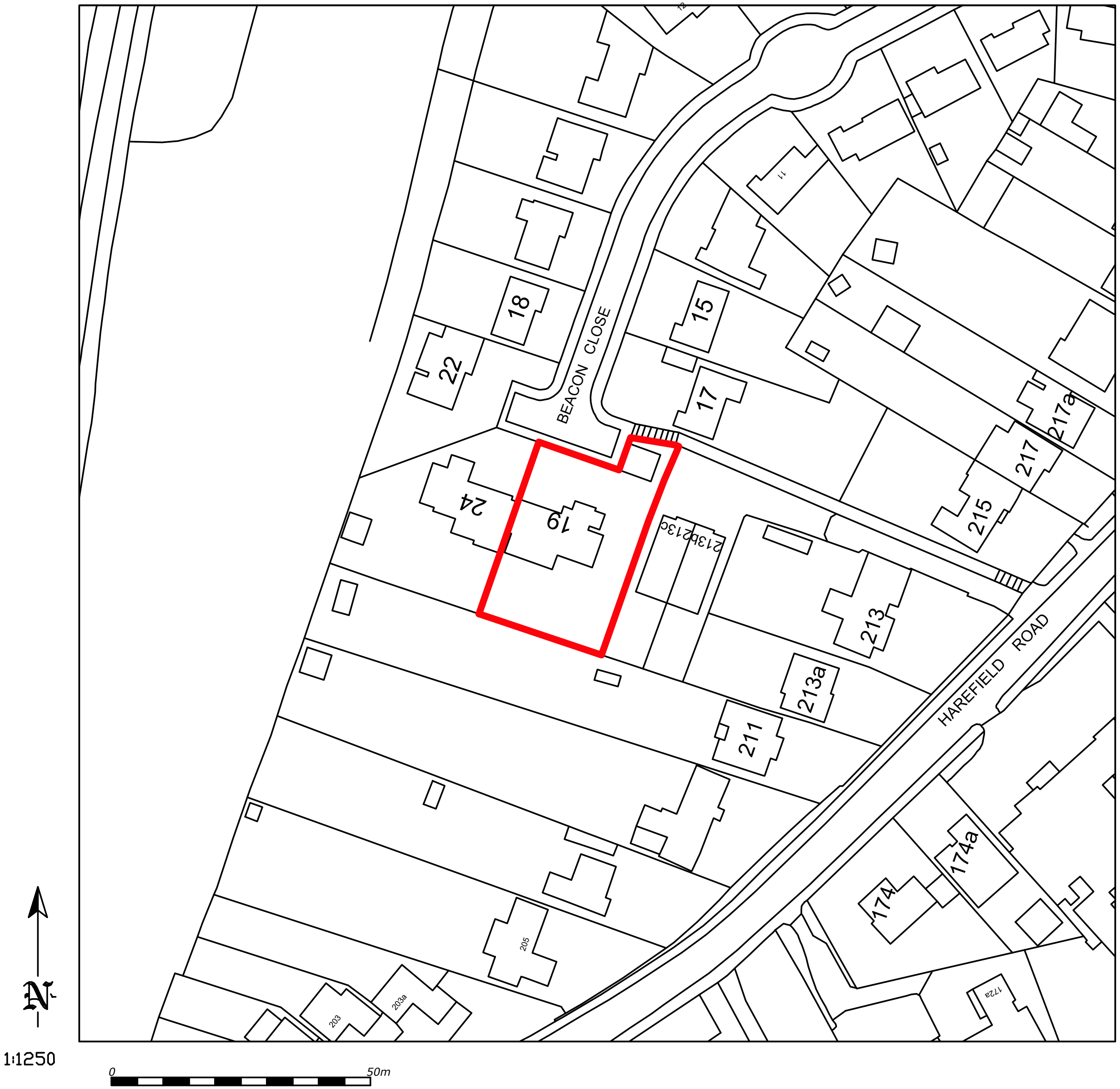
Surface water flow paths will follow existing and proposed ground topography, where surface water from the network to the front of the dwellings (north) would flow into Beacon Close and to the existing waterbodies (west), and surface water from the network to the rear of the dwellings (south) would flow across residential garden areas and to the existing waterbodies (west)

The surface water will flow away from all the proposed dwellings and will not flow into neighbouring or property prior to discharge to the waterbodies. 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 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 are greater than the pollution hazard index, and therefore suitable water quality is achieved.

Appendix A Site Location Plan


BEACON CLOSE
HAREFIELD ROAD
18
22
15
17
24
19
213b
213c
217a
217
215
213
213a
211
174a
174
205
203
203a
172a
N
1:1250
0
50m

Appendix B Topographical Survey

ST2
ST1
BEACON CLOSE
WALL
FENCE
EAVES
RIDGE
FLAT ROOF

Appendix C Proposed Site Plan

LAND AT 19 BEACON CLOSE, UXBRIDGE.

W J Macleod
ARCHITECT
70b High Street Northwood Middlesex HA6 1BL
phone 01923 840600

Drawing Number 24 / 3551 / 1	Revision
Date 19 / 3 / 24	
Scale 1:200 @ A2	

Appendix D British Geological Survey Data

BOREHOLE No. Four

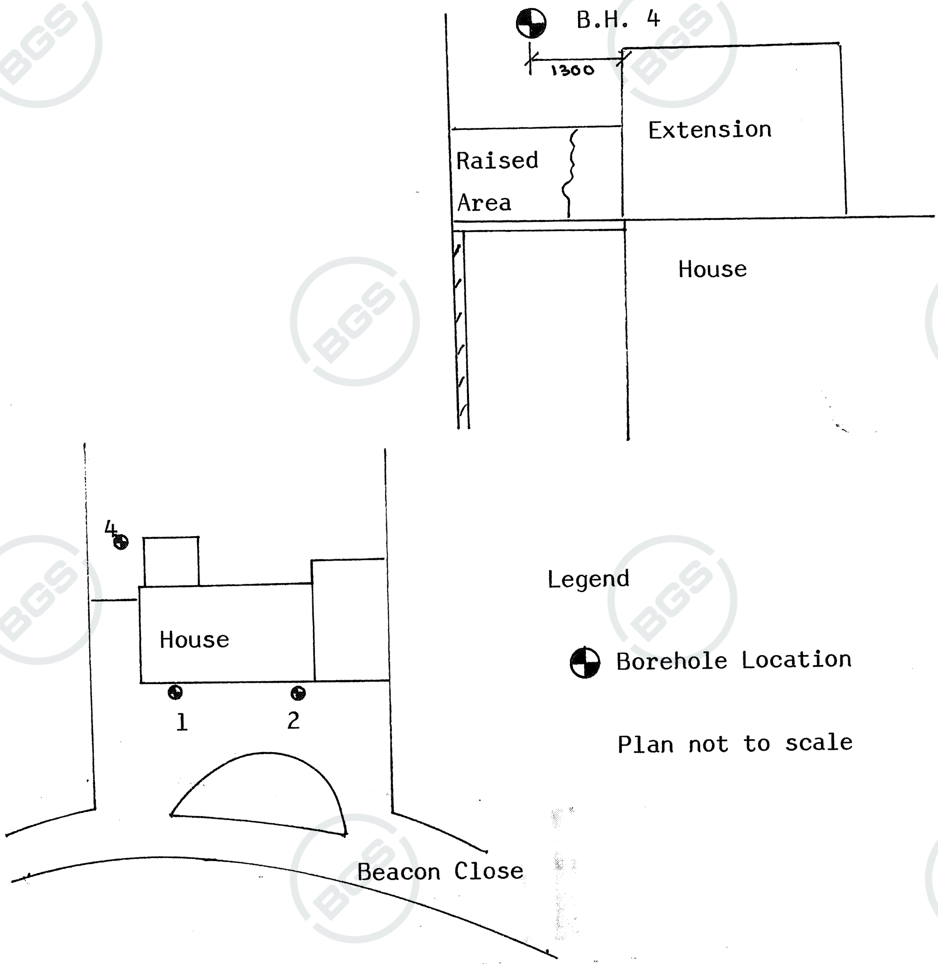
Location Beacon Close,Uxbridge,Middlesex **Date** 23.01.1981

STRATA DESCRIPTION	Strata Change: Legend	Strata Change: Depth m	Strata Change: Reduced Level m	Samples: No.	Samples: Depth m	Samples: Type	Water Level	Depth of Casing
Disturbed Soil Dark brown gravelly clay with occasional brick fragments		1.00		1	0.50	D		
LONDON CLAY Firm brown slightly gravelly CLAY		2.00		2	2.00-2.20	U		
- becoming brown,slightly grey mottled				3	2.60	D	▼ (2.70)	
- firm/stiff orange mottled with silt lenses		3.00		4	3.00-3.20			
				5	3.50-3.70	U		
		4.00						

Borehole Diameter :	200mm.	B -	Bulk Sample
Ground Level O.D. :	1330mm. below DPC	D -	Disturbed Sample
Rig :	Rotary Auger	U -	Undisturbed Sample
Scale of Legend :	2.00cm. to 1.00m.	S -	Standard Penetration Test
Weather :	Dry	W -	Water Sample
Remarks :	Seepage of water at 2.70m.		

Report No. S.295 **BOREHOLE LOG** **Date** January 1981

TYRONE



BOREHOLE LOCATION PLAN

Ground Water Conditions

Borehole no.	One		Two		Four
Date	22.01	23.01	22.01	23.01	23.01
Standing Level -m.	1.55	1.20	Dry	1.20	2.38
Remarks	Seepage of water occurred,with maximum flow at borehole one.				

BOREHOLE LOCATION SKETCH / GROUND WATER CONDITIONS

Report no. S.295 January 1981

BOREHOLE No. Two

Location Beacon Close,Uxbridge,Middlesex

Date 22.01.1981

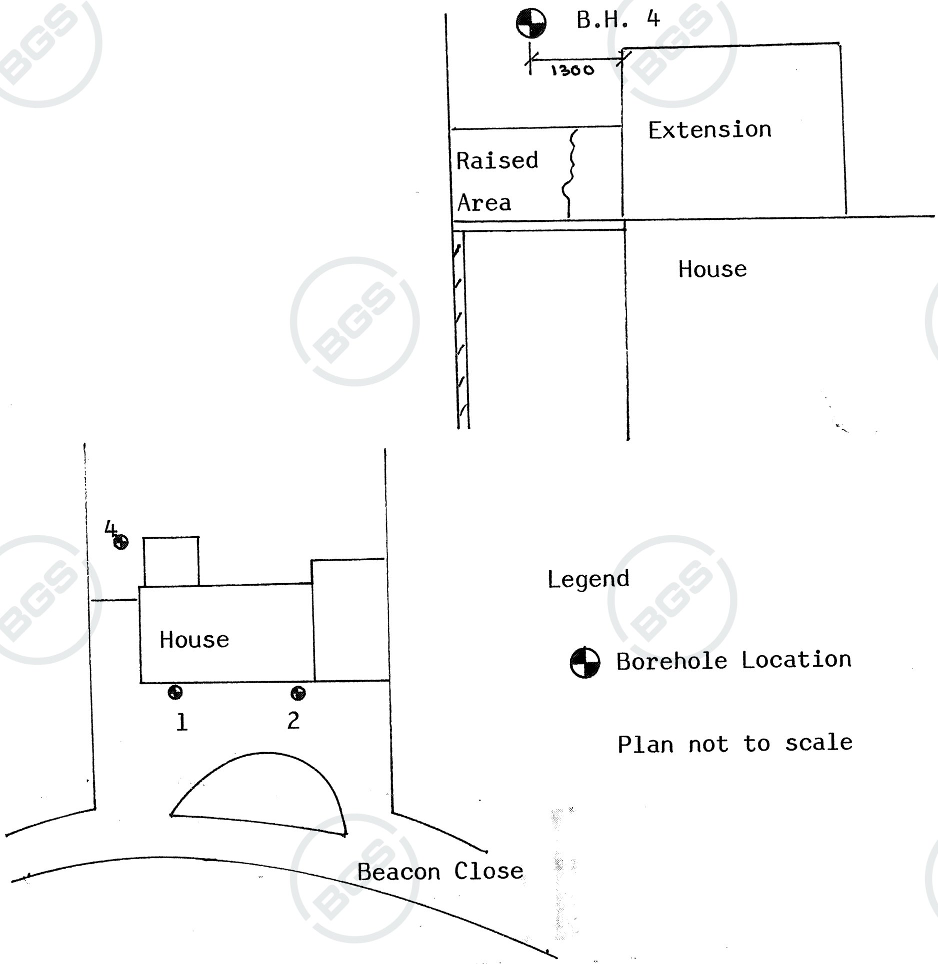
STRATA DESCRIPTION	Strata Change: Legend	Depth m	Reduced Level m	Samples: No.	Depth m	Type	Water Level	Depth of Casing
Disturbed Soil Brown silty clay with gravel particles		1.00		1	1.50	D	▼	
LONDON CLAY Firm brown slightly silty CLAY with occasional fine sandy silt lenses		2.00		2	2.60-2.80	U		
		3.00		3	3.00	D		
- becoming firm /stiff				4	3.50-3.70	U		
		4.00		5	4.00	D		
- becoming brown,slightly grey mottled		5.00		6	5.00	D		
- claystone		6.00		7	6.00	D		

Borehole Diameter : 100mm.
Ground Level O.D. : 85mm. below DPC
Rig : Rotary Auger
Scale of Legend : 2.00cm. to 1.00m.
Weather : Dry
Remarks : Borehole remained dry during drilling work.

B - Bulk Sample
D - Disturbed Sample
U - Undisturbed Sample
S - Standard Penetration Test
W - Water Sample

Report No. S.295 | BOREHOLE LOG | Date January 1981

TYRONE



BOREHOLE LOCATION PLAN

Ground Water Conditions

Borehole no.	One		Two		Four
Date	22.01	23.01	22.01	23.01	23.01
Standing Level -m.	1.55	1.20	Dry	1.20	2.38

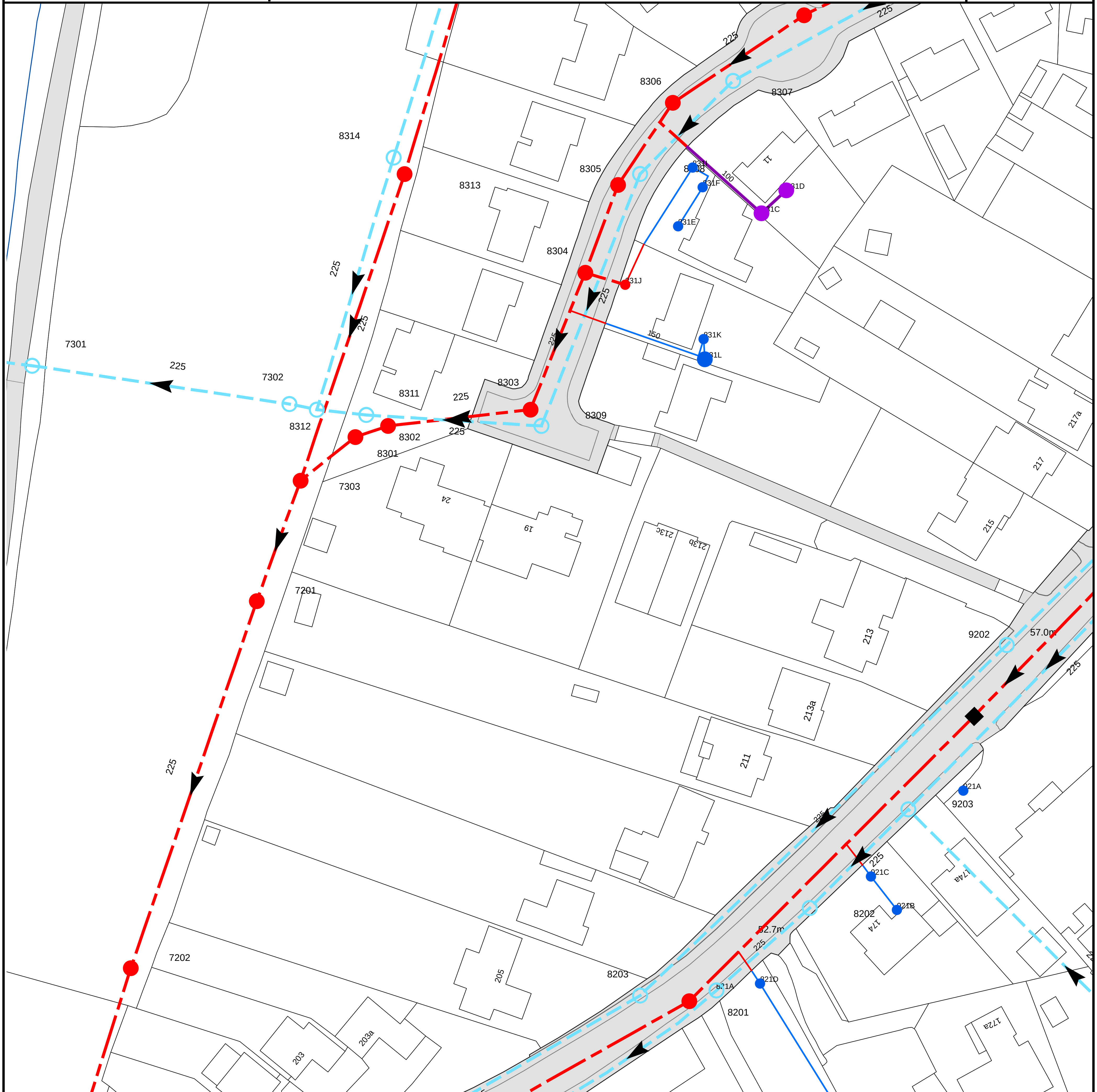
Remarks: Seepage of water occurred,with maximum flow at borehole one.

BOREHOLE LOCATION SKETCH / GROUND WATER CONDITIONS

Report no. S.295 January 1981

Appendix E Thames Water Asset Plans

Asset Location Search Sewer Map - ALS/ALS Standard/2025_5183290



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 505845,185309

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
8312	42.01	40.51
8311	43.84	42.51
8314	43.77	42.53
8313	43.74	42.43
8303	47.04	43.95
8304	47.99	46.28
8305	48.51	46.83
831J	n/a	n/a
8308	48.83	47.13
8306	49.9	47.83
831E	n/a	n/a
831I	n/a	n/a
831F	n/a	n/a
831K	n/a	n/a
831L	n/a	n/a
8307	50.39	48.79
831C	n/a	n/a
831D	n/a	n/a
8405	51.6	49.12
8202	n/a	n/a
921C	n/a	n/a
921B	n/a	n/a
9203	n/a	n/a
921A	n/a	n/a
9202	56.24	55.33
8201	51.74	49.83
8203	n/a	n/a
821A	n/a	n/a
821D	n/a	n/a
7303	41.5	40.53
8301	43.21	41.01
8302	44.16	42.19
8309	47.15	45.68
7202	n/a	n/a
7201	n/a	n/a
7302	41.35	38.85
7301	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

Foul Sewer: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water Sewer: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined Sewer: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Storm Sewer

Sludge Sewer

Foul Trunk Sewer

Surface Trunk Sewer

Combined Trunk Sewer

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Vacuum

Thames Water Proposed

Vent Pipe

Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

Sewer

Culverted Watercourse

Proposed

Decommissioned Sewer

Content of this drainage network is currently unknown

Ownership of this drainage network is currently unknown

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Meter

Dam Chase

Vent

Fitting

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Ancillary

Drop Pipe

Control Valve

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol. Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Inlet

Outfall

Undefined End

Other Symbols

Symbols used on maps which do not fall under other general categories.

Change of Characteristic Indicator

Public / Private Pumping Station

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Chamber

Operational Site

Ducts or Crossings

Casement

Ducts may contain high voltage cables. Please check with Thames Water.

Conduit Bridge

Subway

Tunnel

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.

Appendix F Greenfield Run-Off Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	2	SAAR (mm)	700	Urban	0.340
Area (ha)	50.000	Soil	0.300	Region Number	Region 6

Results	**l/s**
QBAR Rural	91.1
QBAR Urban	167.3
Q2 years	157.7
Q1 year	142.2
Q2 years	157.7
Q5 years	219.1
Q10 years	264.7
Q20 years	308.4
Q25 years	322.6
Q30 years	332.2
Q50 years	361.9
Q100 years	417.6
Q200 years	468.8
Q250 years	484.6
Q1000 years	590.6

Greenfield Runoff Volume

FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	2013
Site Location	GB 505845 185310 TQ 05845 85310
Data Type	Point
Areal Reduction Factor	1.00
Area (ha)	0.041
SAAR (mm)	700
CWI	105.000
SPR Host	47.000
URBEXT (USER)	0.3400

Results

Percentage Runoff (%)	52.10
Greenfield Runoff Volume (m^3)	15.906

Appendix G Pre-Development Run-Off Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 505845 185310 TQ 05845 85310
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	0.020	4-8	0.005	8-12	0.004	12-16	0.003

Total Area Contributing (ha) = 0.032

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 Coeffiecient	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)	100	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	1.000
Site Location	GB 505845 185310 TQ 05845 85310	Cv (Winter)	0.840
Data Type	Point	Storm Duration (mins)	30

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 505845 185310 TQ 05845 85310 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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	1	15 Summer	100	+0%					46.612	-0.038	0.000	0.40
1.001	2	15 Summer	100	+0%	100/15 Summer				46.604	0.004	0.000	1.03

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1			5.6	OK	
1.001	2			14.4	SURCHARGED	

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.020	4-8	0.005	8-12	0.004	12-16	0.003

Total Area Contributing (ha) = 0.032

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 Coeffiecient	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)	100	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	1.000
Site Location	GB 505845 185310 TQ 05845 85310	Cv (Winter)	0.840
Data Type	Point	Storm Duration (mins)	30

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 505845 185310 TQ 05845 85310	Cv (Winter)	1.000

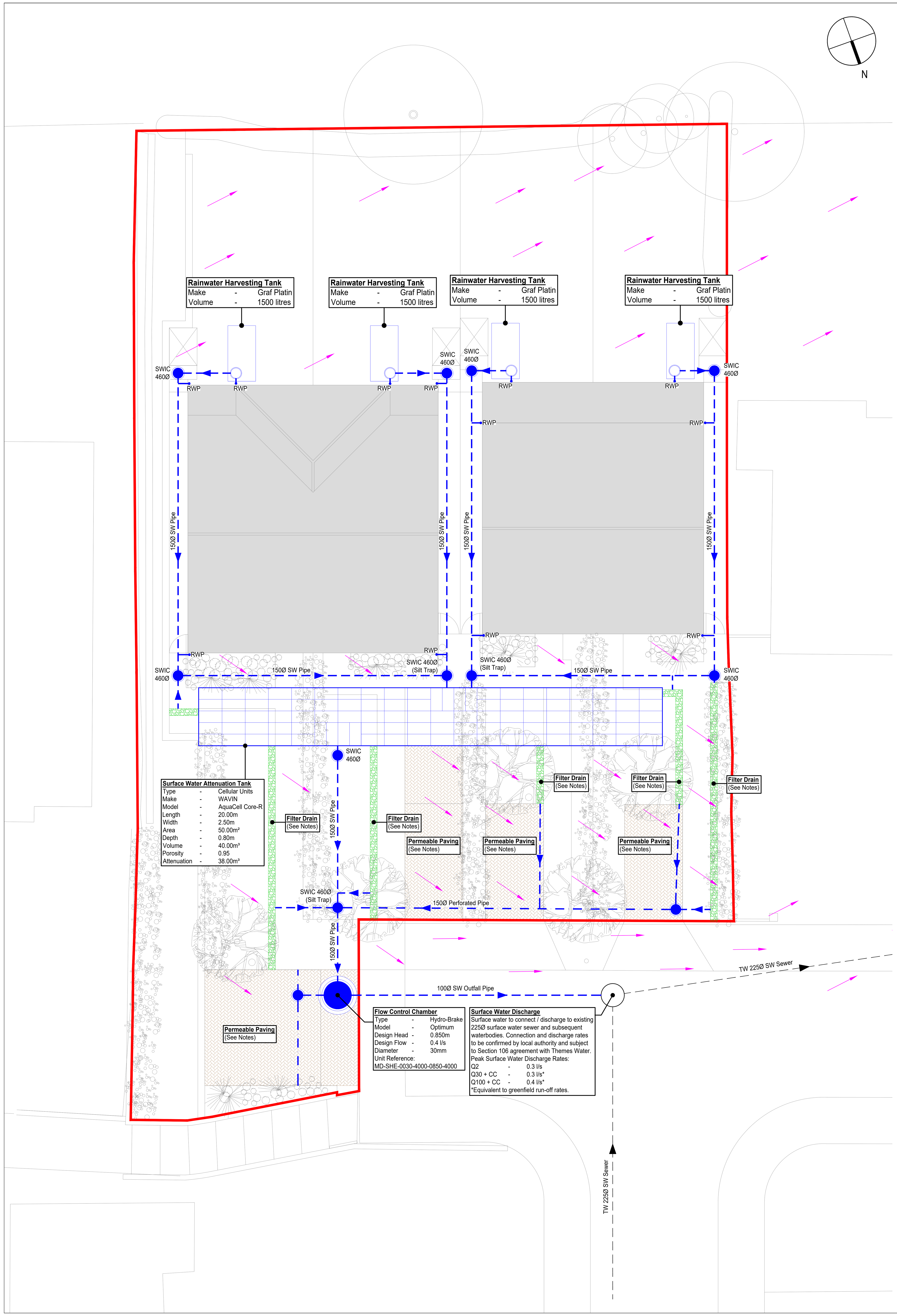
Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

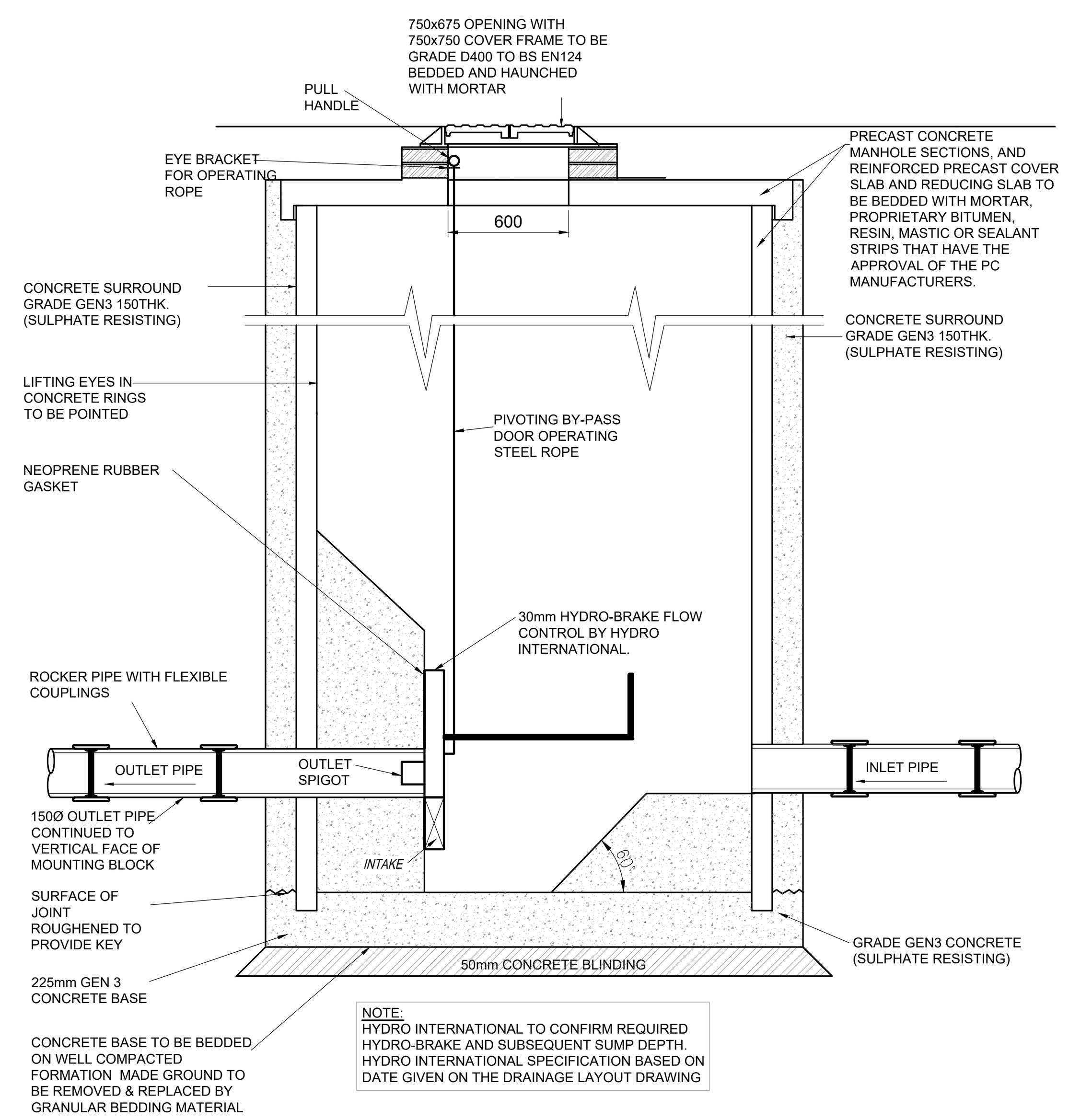
Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Discharge Vol (m³)	Half Drain Time (mins)
1.000	1	360 minute 100 year Winter I+0%	47.500	46.531	-0.119	0.000	0.10		11.915	
1.001	2	360 minute 100 year Winter I+0%	47.500	46.495	-0.105	0.000	0.20		23.837	

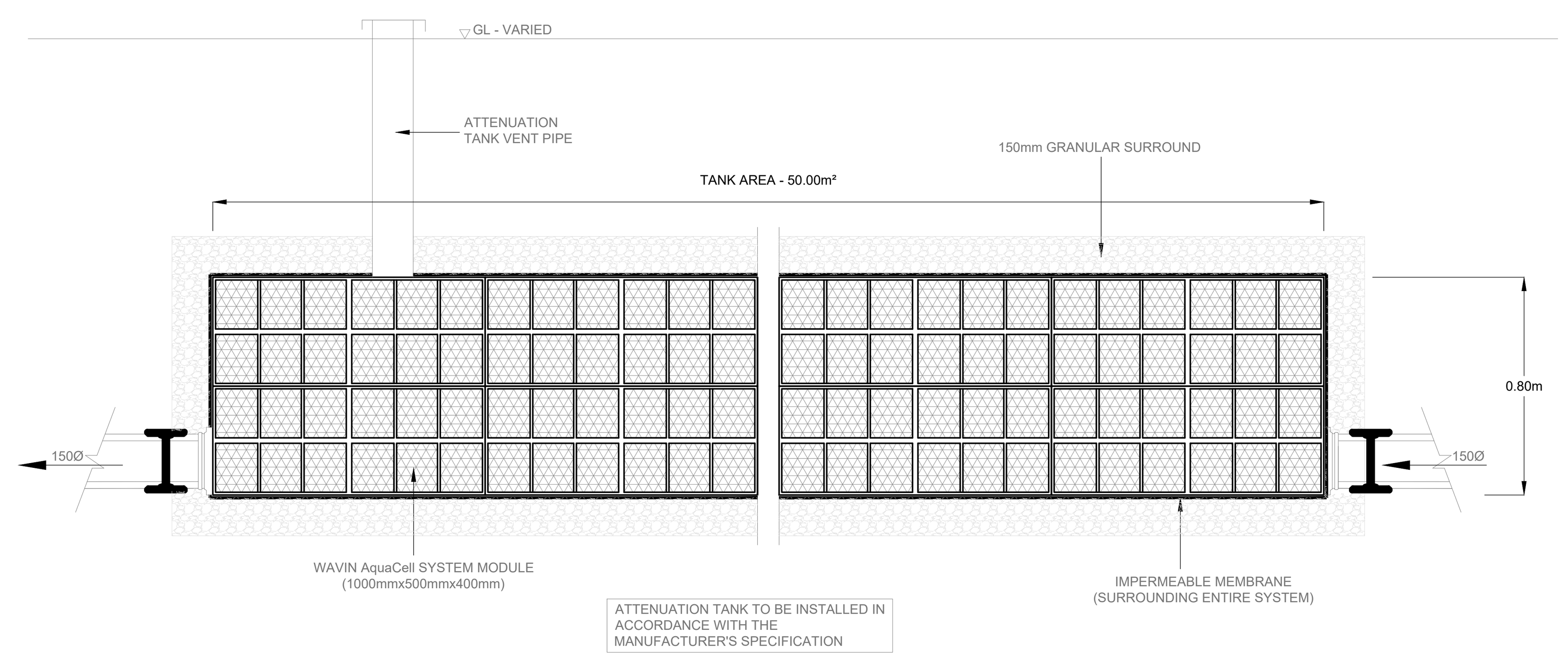
PN	US/MH Name	Pipe Flow (l/s)	Status
1.000	1	1.4	OK
1.001	2	2.8	OK

Appendix H Below Ground Drainage Layout and SuDS Details

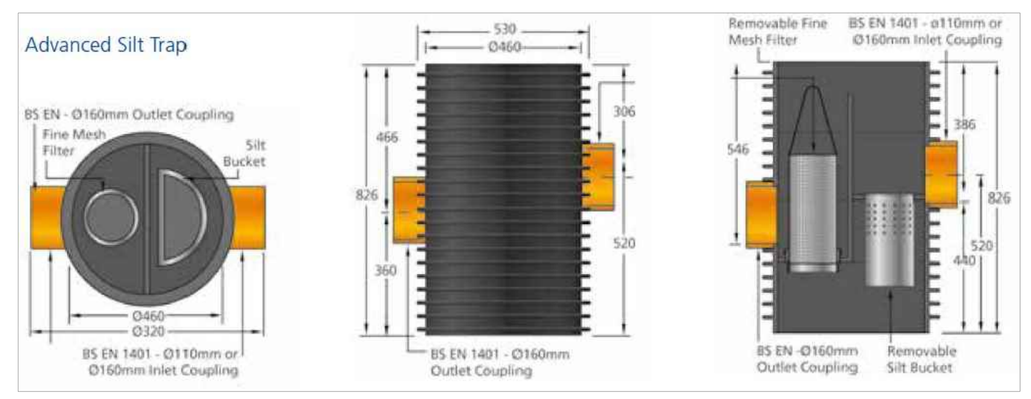




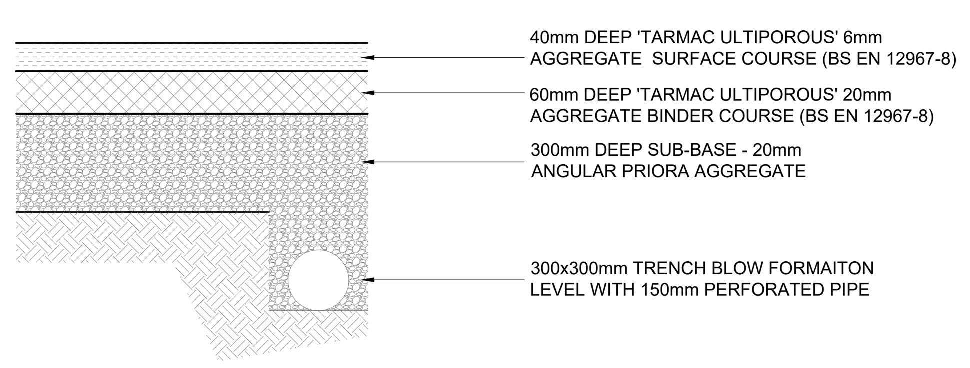
FLOW CONTROL MANHOLE DETAIL



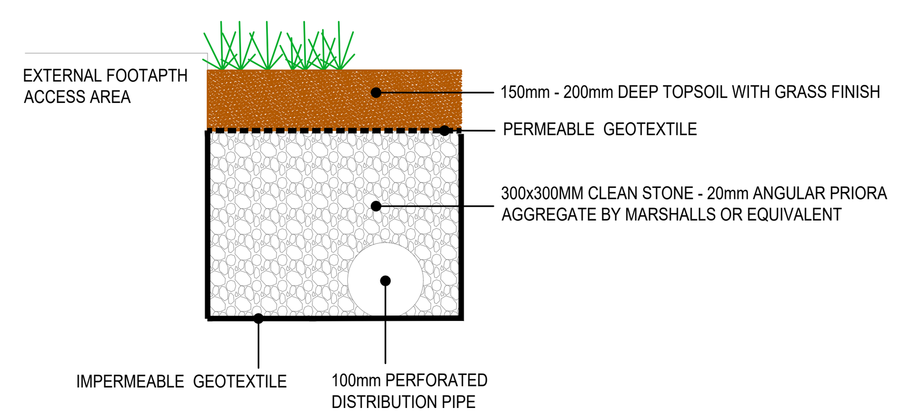
ATTENUATION TANK DETAIL



SILT TRAP CHAMBER DETAIL



POROUS SURFACING DETAIL



FILTER DRAIN DETAIL

Permeable Paving

Permeable paving to be formed over 300mm deep no fines 20mm aggregate, which is wrapped in an impermeable membrane, and houses a 100Ø perforated pipe to convey the surface water to the main drainage network.

Filter Drains

Filter drains to be formed of a 300 x 300mm trench filled with no fines 20mm aggregate, wrapped in an impermeable membrane, and is to house a perforated pipe to convey the surface water to the main drainage networkers.

Surface Water Exceedance Event

In In the event of an extreme storm event (greater than 100-year + 40% climate change) flooding of the drainage network could occur.

Surface water flow paths will follow existing and proposed ground topography, where surface water from the network to the front of the dwellings (north) would flow into Beacon Close and to the existing waterbodies (west), and surface water from the network to the rear of the dwellings (south) would flow across residential garden areas and to the existing waterbodies (west)

The surface water will flow away from all the proposed dwellings and will not flow into neighbouring or property prior to discharge to the waterbodies.

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
- 100Ø Proposed Perforated Pipe
- Existing Surface Water Sewers
- Permeable Surfacing System
- Filter Drains
- Exceedance Flow Path
- Development Boundary

Rev	Description	Drn	Chk	Date
P1	ISSUED FOR APPROVAL	MDS	NC	24.06.25

Client
RRAK PROPERTIES LTD

Project
19 BEACON CLOSE
UXBRIDGE, UB8 1PX

Drawing
SURFACE WATER MANAGEMENT LAYOUT AND SuDS DETAILS

Scale	Date	Drawn by	Checked
1:100@A1	24.06.25	MDS	NC

Status
APPROVAL

Flo

Chiltern View Studio
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Job No.	Drg. No.	Rev
1171	DR-100	P1

Appendix I Surface Water Management Calculations

Summary of Results for 2 year Return Period

Half Drain Time : 208 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	46.267	0.067	0.0	0.3	0.3	3.2	O K
30 min Summer	46.284	0.084	0.0	0.3	0.3	4.0	O K
60 min Summer	46.297	0.097	0.0	0.3	0.3	4.6	O K
120 min Summer	46.329	0.129	0.0	0.3	0.3	6.1	O K
180 min Summer	46.340	0.140	0.0	0.3	0.3	6.7	O K
240 min Summer	46.343	0.143	0.0	0.3	0.3	6.8	O K
360 min Summer	46.339	0.139	0.0	0.3	0.3	6.6	O K
480 min Summer	46.332	0.132	0.0	0.3	0.3	6.3	O K
600 min Summer	46.325	0.125	0.0	0.3	0.3	6.0	O K
720 min Summer	46.318	0.118	0.0	0.3	0.3	5.6	O K
960 min Summer	46.304	0.104	0.0	0.3	0.3	5.0	O K
1440 min Summer	46.279	0.079	0.0	0.3	0.3	3.8	O K
2160 min Summer	46.251	0.051	0.0	0.3	0.3	2.4	O K
2880 min Summer	46.231	0.031	0.0	0.3	0.3	1.5	O K
4320 min Summer	46.210	0.010	0.0	0.3	0.3	0.5	O K
5760 min Summer	46.202	0.002	0.0	0.2	0.2	0.1	O K
15 min Winter	46.267	0.067	0.0	0.3	0.3	3.2	O K
30 min Winter	46.284	0.084	0.0	0.3	0.3	4.0	O K
60 min Winter	46.298	0.098	0.0	0.3	0.3	4.6	O K
120 min Winter	46.330	0.130	0.0	0.3	0.3	6.2	O K
180 min Winter	46.342	0.142	0.0	0.3	0.3	6.8	O K
240 min Winter	46.345	0.145	0.0	0.3	0.3	6.9	O K
360 min Winter	46.338	0.138	0.0	0.3	0.3	6.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	35.221	0.0	3.6	28
30 min Summer	22.619	0.0	4.6	41
60 min Summer	13.948	0.0	5.7	68
120 min Summer	9.936	0.0	8.1	124
180 min Summer	7.800	0.0	9.6	182
240 min Summer	6.453	0.0	10.5	220
360 min Summer	4.815	0.0	11.8	284
480 min Summer	3.860	0.0	12.6	348
600 min Summer	3.235	0.0	13.2	414
720 min Summer	2.795	0.0	13.7	482
960 min Summer	2.212	0.0	14.5	616
1440 min Summer	1.589	0.0	15.6	876
2160 min Summer	1.150	0.0	16.9	1240
2880 min Summer	0.921	0.0	18.1	1592
4320 min Summer	0.687	0.0	20.3	2260
5760 min Summer	0.566	0.0	22.3	2944
15 min Winter	35.221	0.0	3.6	28
30 min Winter	22.619	0.0	4.6	41
60 min Winter	13.948	0.0	5.7	68
120 min Winter	9.936	0.0	8.1	122
180 min Winter	7.800	0.0	9.6	178
240 min Winter	6.453	0.0	10.6	232
360 min Winter	4.815	0.0	11.8	292

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	46.330	0.130	0.0	0.3	0.3	6.2	O K
600 min Winter	46.320	0.120	0.0	0.3	0.3	5.7	O K
720 min Winter	46.309	0.109	0.0	0.3	0.3	5.2	O K
960 min Winter	46.289	0.089	0.0	0.3	0.3	4.2	O K
1440 min Winter	46.255	0.055	0.0	0.3	0.3	2.6	O K
2160 min Winter	46.221	0.021	0.0	0.3	0.3	1.0	O K
2880 min Winter	46.204	0.004	0.0	0.3	0.3	0.2	O K
4320 min Winter	46.200	0.000	0.0	0.2	0.2	0.0	O K
5760 min Winter	46.200	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)
480 min Winter	3.860	0.0	12.6	366
600 min Winter	3.235	0.0	13.2	442
720 min Winter	2.795	0.0	13.7	514
960 min Winter	2.212	0.0	14.5	654
1440 min Winter	1.589	0.0	15.6	910
2160 min Winter	1.150	0.0	16.9	1256
2880 min Winter	0.921	0.0	18.1	1540
4320 min Winter	0.687	0.0	20.3	0
5760 min Winter	0.566	0.0	22.3	0

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 505845 185310 TQ 05845 85310	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.041

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.011	4	8	0.010	8	12	0.010	12	16	0.010

Model Details

Storage is Online Cover Level (m) 47.500

Cellular Storage Structure

Invert Level (m) 46.200 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	50.0	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	50.0	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	50.0	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	50.0	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	50.0	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	0.0	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	0.0	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			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0030-4000-0850-4000
Design Head (m)	0.850
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	30
Invert Level (m)	46.150
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.850	0.4	Kick-Flo®	0.264	0.2
Flush-Flo™	0.130	0.3	Mean Flow over Head Range	-	0.3

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

Summary of Results for 30 year Return Period (+35%)

Half Drain Time : 711 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	46.442	0.242	0.0	0.3	0.3	11.5	O K
30 min Summer	46.512	0.312	0.0	0.3	0.3	14.8	O K
60 min Summer	46.579	0.379	0.0	0.3	0.3	18.0	O K
120 min Summer	46.663	0.463	0.0	0.3	0.3	22.0	O K
180 min Summer	46.702	0.502	0.0	0.3	0.3	23.9	O K
240 min Summer	46.721	0.521	0.0	0.3	0.3	24.8	O K
360 min Summer	46.730	0.530	0.0	0.3	0.3	25.2	O K
480 min Summer	46.721	0.521	0.0	0.3	0.3	24.7	O K
600 min Summer	46.703	0.503	0.0	0.3	0.3	23.9	O K
720 min Summer	46.685	0.485	0.0	0.3	0.3	23.0	O K
960 min Summer	46.652	0.452	0.0	0.3	0.3	21.5	O K
1440 min Summer	46.605	0.405	0.0	0.3	0.3	19.2	O K
2160 min Summer	46.551	0.351	0.0	0.3	0.3	16.7	O K
2880 min Summer	46.508	0.308	0.0	0.3	0.3	14.7	O K
4320 min Summer	46.438	0.238	0.0	0.3	0.3	11.3	O K
5760 min Summer	46.370	0.170	0.0	0.3	0.3	8.1	O K
15 min Winter	46.442	0.242	0.0	0.3	0.3	11.5	O K
30 min Winter	46.512	0.312	0.0	0.3	0.3	14.8	O K
60 min Winter	46.579	0.379	0.0	0.3	0.3	18.0	O K
120 min Winter	46.664	0.464	0.0	0.3	0.3	22.1	O K
180 min Winter	46.705	0.505	0.0	0.3	0.3	24.0	O K
240 min Winter	46.725	0.525	0.0	0.3	0.3	24.9	O K
360 min Winter	46.735	0.535	0.0	0.3	0.3	25.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	116.748	0.0	11.9	30
30 min Summer	75.762	0.0	15.5	44
60 min Summer	46.832	0.0	19.2	74
120 min Summer	29.572	0.0	24.2	132
180 min Summer	22.104	0.0	27.2	190
240 min Summer	17.786	0.0	29.1	248
360 min Summer	12.879	0.0	31.6	364
480 min Summer	10.149	0.0	33.3	482
600 min Summer	8.405	0.0	34.4	576
720 min Summer	7.191	0.0	35.3	624
960 min Summer	5.607	0.0	36.8	748
1440 min Summer	3.944	0.0	38.8	1010
2160 min Summer	2.780	0.0	41.0	1420
2880 min Summer	2.179	0.0	42.9	1828
4320 min Summer	1.568	0.0	46.3	2644
5760 min Summer	1.255	0.0	49.4	3360
15 min Winter	116.748	0.0	11.9	30
30 min Winter	75.762	0.0	15.5	44
60 min Winter	46.832	0.0	19.2	72
120 min Winter	29.572	0.0	24.2	128
180 min Winter	22.104	0.0	27.2	186
240 min Winter	17.786	0.0	29.1	242
360 min Winter	12.879	0.0	31.6	356

Summary of Results for 30 year Return Period (+35%)

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	46.728	0.528	0.0	0.3	0.3	25.1	O K
600 min Winter	46.712	0.512	0.0	0.3	0.3	24.3	O K
720 min Winter	46.693	0.493	0.0	0.3	0.3	23.4	O K
960 min Winter	46.656	0.456	0.0	0.3	0.3	21.7	O K
1440 min Winter	46.599	0.399	0.0	0.3	0.3	18.9	O K
2160 min Winter	46.528	0.328	0.0	0.3	0.3	15.6	O K
2880 min Winter	46.467	0.267	0.0	0.3	0.3	12.7	O K
4320 min Winter	46.348	0.148	0.0	0.3	0.3	7.0	O K
5760 min Winter	46.273	0.073	0.0	0.3	0.3	3.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	10.149	0.0	33.3	468
600 min Winter	8.405	0.0	34.5	576
720 min Winter	7.191	0.0	35.4	678
960 min Winter	5.607	0.0	36.7	766
1440 min Winter	3.944	0.0	38.8	1072
2160 min Winter	2.780	0.0	41.0	1524
2880 min Winter	2.179	0.0	42.9	1968
4320 min Winter	1.568	0.0	46.3	2724
5760 min Winter	1.255	0.0	49.4	3360

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 505845 185310 TQ 05845 85310	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+35

Time Area Diagram

Total Area (ha) 0.041

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.011	4	8	0.010	8	12	0.010	12	16	0.010

Model Details

Storage is Online Cover Level (m) 47.500

Cellular Storage Structure

Invert Level (m) 46.200 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	50.0	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	50.0	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	50.0	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	50.0	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	50.0	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	0.0	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	0.0	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			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0030-4000-0850-4000
Design Head (m)	0.850
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	30
Invert Level (m)	46.150
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.850	0.4	Kick-Flo®	0.264	0.2
Flush-Flo™	0.130	0.3	Mean Flow over Head Range	-	0.3

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

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

Half Drain Time : 884 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	46.527	0.327	0.0	0.3	0.3	15.6	O K
30 min Summer	46.627	0.427	0.0	0.3	0.3	20.3	O K
60 min Summer	46.722	0.522	0.0	0.3	0.3	24.8	O K
120 min Summer	46.834	0.634	0.0	0.4	0.4	30.1	O K
180 min Summer	46.891	0.691	0.0	0.4	0.4	32.8	O K
240 min Summer	46.924	0.724	0.0	0.4	0.4	34.4	O K
360 min Summer	46.951	0.751	0.0	0.4	0.4	35.7	O K
480 min Summer	46.952	0.752	0.0	0.4	0.4	35.7	O K
600 min Summer	46.939	0.739	0.0	0.4	0.4	35.1	O K
720 min Summer	46.920	0.720	0.0	0.4	0.4	34.2	O K
960 min Summer	46.879	0.679	0.0	0.4	0.4	32.2	O K
1440 min Summer	46.809	0.609	0.0	0.4	0.4	28.9	O K
2160 min Summer	46.734	0.534	0.0	0.3	0.3	25.4	O K
2880 min Summer	46.675	0.475	0.0	0.3	0.3	22.6	O K
4320 min Summer	46.586	0.386	0.0	0.3	0.3	18.3	O K
5760 min Summer	46.516	0.316	0.0	0.3	0.3	15.0	O K
15 min Winter	46.528	0.328	0.0	0.3	0.3	15.6	O K
30 min Winter	46.627	0.427	0.0	0.3	0.3	20.3	O K
60 min Winter	46.723	0.523	0.0	0.3	0.3	24.8	O K
120 min Winter	46.836	0.636	0.0	0.4	0.4	30.2	O K
180 min Winter	46.894	0.694	0.0	0.4	0.4	33.0	O K
240 min Winter	46.928	0.728	0.0	0.4	0.4	34.6	O K
360 min Winter	46.956	0.756	0.0	0.4	0.4	35.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.520	0.0	16.0	30
30 min Summer	102.508	0.0	21.0	45
60 min Summer	63.686	0.0	26.1	74
120 min Summer	39.704	0.0	32.5	132
180 min Summer	29.624	0.0	36.4	190
240 min Summer	23.870	0.0	39.1	248
360 min Summer	17.376	0.0	42.7	366
480 min Summer	13.741	0.0	45.1	484
600 min Summer	11.397	0.0	46.7	602
720 min Summer	9.756	0.0	48.0	694
960 min Summer	7.591	0.0	49.8	800
1440 min Summer	5.310	0.0	50.5	1048
2160 min Summer	3.696	0.0	54.5	1456
2880 min Summer	2.862	0.0	56.3	1860
4320 min Summer	2.012	0.0	59.4	2684
5760 min Summer	1.580	0.0	62.2	3472
15 min Winter	156.520	0.0	16.0	30
30 min Winter	102.508	0.0	21.0	44
60 min Winter	63.686	0.0	26.1	72
120 min Winter	39.704	0.0	32.5	130
180 min Winter	29.624	0.0	36.4	186
240 min Winter	23.870	0.0	39.1	244
360 min Winter	17.376	0.0	42.7	358

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
480 min Winter	46.959	0.759	0.0	0.4	0.4	36.1	O K
600 min Winter	46.949	0.749	0.0	0.4	0.4	35.6	O K
720 min Winter	46.932	0.732	0.0	0.4	0.4	34.7	O K
960 min Winter	46.887	0.687	0.0	0.4	0.4	32.6	O K
1440 min Winter	46.811	0.611	0.0	0.4	0.4	29.0	O K
2160 min Winter	46.719	0.519	0.0	0.3	0.3	24.7	O K
2880 min Winter	46.644	0.444	0.0	0.3	0.3	21.1	O K
4320 min Winter	46.523	0.323	0.0	0.3	0.3	15.3	O K
5760 min Winter	46.415	0.215	0.0	0.3	0.3	10.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	13.741	0.0	45.1	472
600 min Winter	11.397	0.0	46.7	584
720 min Winter	9.756	0.0	48.0	692
960 min Winter	7.591	0.0	49.8	882
1440 min Winter	5.310	0.0	50.3	1100
2160 min Winter	3.696	0.0	54.5	1560
2880 min Winter	2.862	0.0	56.3	2000
4320 min Winter	2.012	0.0	59.4	2864
5760 min Winter	1.580	0.0	62.1	3752

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 505845 185310 TQ 05845 85310	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	5760
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.041

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.011	4	8	0.010	8	12	0.010	12	16	0.010

Model Details

Storage is Online Cover Level (m) 47.500

Cellular Storage Structure

Invert Level (m) 46.200 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)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	50.0	0.0	1.800	0.0	0.0	3.600	0.0	0.0
0.200	50.0	0.0	2.000	0.0	0.0	3.800	0.0	0.0
0.400	50.0	0.0	2.200	0.0	0.0	4.000	0.0	0.0
0.600	50.0	0.0	2.400	0.0	0.0	4.200	0.0	0.0
0.800	50.0	0.0	2.600	0.0	0.0	4.400	0.0	0.0
1.000	0.0	0.0	2.800	0.0	0.0	4.600	0.0	0.0
1.200	0.0	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			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0030-4000-0850-4000
Design Head (m)	0.850
Design Flow (l/s)	0.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	30
Invert Level (m)	46.150
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.850	0.4	Kick-Flo®	0.264	0.2
Flush-Flo™	0.130	0.3	Mean Flow over Head Range	-	0.3

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