Brookside, Condover, Shrewsbury, SY5 7BT

Surface and Foul Water Drainage Assessment

For Mr William Beddoes

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Project	Surface and Foul Water Drainage Assessment
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Status	Final
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EXECUTIVE SUMMARY

The purpose of this report is to assess the potential for disposing surface water. This Surface and Foul Water Drainage Assessment demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the National Planning Policy Framework (NPPF).

The development should not therefore be precluded on the grounds of flood risk or drainage.

1.0 INTRODUCTION

1.1 Background

This Surface and Foul Water Drainage Assessment has been prepared by KRS Enviro at the request of Mr William Beddoes to support a planning application for the proposed development at Brookside, Condover, Shrewsbury.

It is recognised that developments that are designed without regards to the surface water runoff are likely to result in increased impact on existing off-site service provision and may leads to an increase in flood risk.

1.2 Purpose

This Surface and Foul Water Drainage Assessment complies with the principles of SuDS presented in the new Defra non-statutory technical standards for SuDS[1], and the National Planning Policy Framework (NPPF)[2]. A Surface and Foul Water Drainage Assessment is presented with reference to the hydrological and hydrogeological context of the development.

The report findings are based upon professional judgement and are summarised below with detailed recommendations provided at the end of the report. The report includes baseline data on flood risk from the Environment Agency, rainfall data from the Flood Estimation Handbook (FEH) and hydrogeological information from the British Geological Survey (BGS). The assessment will summarise and refer to these datasets in the text.

1.3 Surface Water Management Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A SuDS Strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same net effect.

[1] Department for Environment, Food and Rural Affairs (2015) Non-statutory technical standards for SuDS (March 2015).
[2] Ministry of Housing, Communities and Local Government (2023). National Planning Policy Framework (NPPF).

1.4 What are SuDS?

A Sustainable Drainage System (SuDS) is designed to replicate, as closely as possible, the natural drainage from the site (before development) to ensure that the flood risk downstream of the site does not increase as a result of the land being developed. SuDS can also significantly improve the quality of water leaving the site and can enhance the amenity and biodiversity that a site has to offer.

There are a range of SuDS options available to provide effective surface water management that intercept and store excess run-off. The standards set out appropriate design criteria based on four main parameters:

1. Runoff Destination (in order of preference)

    a. To ground;
    b. To surface water body;
    c. To road drain or surface water sewer;
    d. To combined sewer

2. Peak flow rate and volume (pre-and post-development)

3. Water Quality (based on potential hazards arising from development and sensitivity of the runoff destination)

4. Function (design; flood risk; operation and maintenance)

These parameters are then used to develop a drainage strategy based on the following six principles;

1. Manage surface runoff at source

2. Manage on the surface

3. Utilise public space and integrate into the drainage design

4. Effective operation and maintenance

5. Account for climate change and changes in impermeable area

6. Affordability

This report aims identify the most practicable runoff destination and drainage parameters for the site and is presented with reference to the hydrological and hydrogeological context of the development.

1.5 Report Structure

This Surface and Foul Water Drainage Assessment has the following report structure:

- Section 2 details the location and the existing and proposed development;
- Section 3 outlines the proposed foul water drainage for the site;
- Section 4 details the possible surface water discharge destinations

- Section 5 outlines the surface water drainage for the site;
- Section 6 discusses water quality;
- Section 7 outlines the surface water drainage strategy; and
- Section 8 presents a summary and conclusions.

2.0 LOCATION & DEVELOPMENT DESCRIPTION

2.1 Site Location

The site is located at Brookside, Condover, Shrewsbury, Shropshire, SY5 7BT (see Figure 1). The National Grid Reference (NGR) of the site is 349738, 305503.

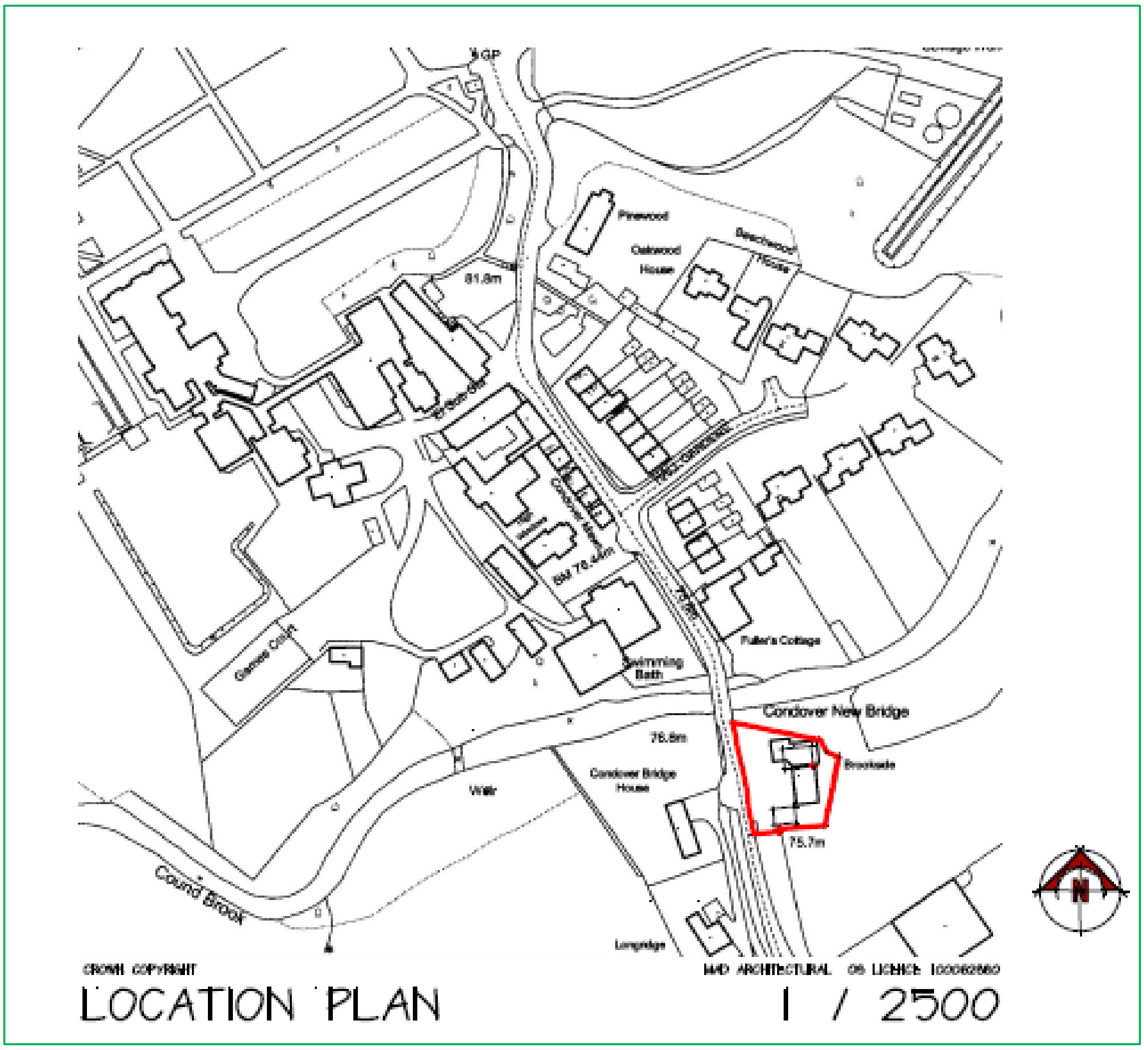

Figure 1 - Site Location

2.2 Existing Development

The existing site currently comprises a residential dwelling with a garage/workshop.

2.3 Proposed Development

The proposed development is for the demolition of the existing garage/warehouse, an extension to the residential dwelling and a new detached garage together with associated parking and landscaping (see Appendix 1). Further details with regard to the Proposed Development can be found in the accompanying information submitted with the planning application.

2.4 Ground Levels

The site is relatively flat with an approximate ground level of 80 metres Above Ordnance Datum (mAOD).

2.5 Catchment Hydrology / Drainage

The Cound Brook is located approximately 10m to the north of the site. The site is not served by public sewers.

The site is located within an area of moderate rainfall. The 1961-1990 Standard Average Annual Rainfall (SAAR) for the site as recorded in the FEH Webservice is 688 mm per annum. The UK national average is 832mm per annum.

2.6 Ground Conditions

The British Geological Survey (BGS) map shows that the bedrock deposits consist of the Salop Formation - Mudstone, sandstone and conglomerate. Sedimentary bedrock formed between 309.50 and 272.30 million years ago during the Carboniferous and Permian periods. The superficial deposits consist of Alluvium - clay, silt, sand and gravel. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period.

Information from the National Soil Resources Institute details the site area as being situated on Freely draining slightly acid loamy soils. The Wallingford Winter Rain Acceptance Potential (WRAP) map indicates that the site lies within WRAP Class 4: clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

2.7 Source Protection Zone

The site is not located within a Source Protection Zone (SPZ). SPZ's have been defined by the Environment Agency around major public water supplies with the intent to show the risk of contamination from any activities that might cause pollution in the area. Three zones are defined: SPZ 1 is the Inner Zone (highest risk); SPZ 2 is the Outer Zone (average risk); and SPZ 3 is the Total Catchment (least risk).

3.0 PROPOSED FOUL WATER DRAINAGE

3.1 Percolation Tests

Drainage field disposal should only be used when percolation tests indicate average values of Vp of between 15 and 100 and the preliminary site assessment report have been favourable. Site investigations were carried out on the 25th August 2023. The ground investigation was carried out within the proposed drainage field area at the site. A trial pit was excavated and the results of the investigation are presented in Appendix 2. The tests were abandoned after 4 hours due to very low rates of infiltration. Therefore it was not possible to calculate a Vp value.

The results indicate that the ground is not suitable for use as a drainage field for the drainage of foul water direct to the ground and therefore discharge will be to the Cound Brook which is located to the north of the site.

3.2 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The site is not served by public sewers; therefore, all foul water from the proposed residential dwelling will discharge to an adequately sized package treatment work/s with discharge to the Cound Brook to the north of the site. The proposals can be summarised as follows:

- Foul water is piped from the site with a separate foul water drainage system.
- The system discharges the maximum foul flows into a specialist unit.
- The size of the works has been chosen to cater for the development. The discharge from the site is not considered substantial.
- Following treatment, the discharge from the units is ‘clean’ water and is discharged into the drainage ditch.
- There are no moving parts.
- The treatment system will meet the standards of BS EN 12566 for small sewage treatment plants.
- The ultimate foul water discharge from the site will to be the Cound Brook to the north of the site.

Standard pollution prevention procedures have been implemented based on industry best practice and Environment Agency Pollution Prevention Guidelines (PPGs), to mitigate potential impacts on the water environment, including:

- BS 6297:2007+A1:2008: Code of practice for the design and installation of drainage fields for use in wastewater treatment.
- Part H of the Building Regulations.
- Septic tanks and treatment plants: permits and general binding rules guidance.

- Environmental Permitting (England and Wales) Regulations 2010 (as amended).

The foul drainage has been designed with the following minimum distances:

- 50m from water abstraction points.
- 15m from any building, and sufficiently distant from any other soakaway, including roof water.
- 2m from a boundary.

All foul water from the proposed residential dwelling will discharge to an adequately sized package treatment works with a discharge to the Cound Brook. Package treatment works are independently tested and certified to BS EN 12566-3 to produce a final effluent to a standard of 20mg/l Biological Oxygen Demand (BOD), 30mg/l Suspended Solids and 20mg/l Ammonia on a 95 percentile basis. The size of the package treatment work/s will be chosen to cater for the proposed development. Therefore, foul water will receive an appropriate level of treatment which will minimise the risk of pollution.

4.0 SURFACE WATER RUNOFF DESTINATION

4.1 Opportunities for Runoff of Surface Water

Possible receptors for runoff generated onsite have been assessed in line with the prioritisation set onsite out in the Defra non-statutory technical standards for SuDS. There are four possible options to discharge the surface water. The Runoff Destination is (in order of preference):

a) To ground;

b) To surface water body;

c) To road drain or surface water sewer;

d) To combined sewer

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

4.2 Discharge to Ground

In determining the future surface runoff from the site, the potential of using infiltration has been considered. BRE 365 soakaway tests were carried out on the 25th August 2023. Three soakaway trial pits were excavated at the site. The results are shown in Appendix 3.

The test in one trial pit was abandoned after 4 hours due to very low rates of infiltration. The test in one trial pit was abandoned due to groundwater seepages into the pit prior to the commencement of the test. Therefore, the ground conditions suggest infiltration would provide inception storage, but disposal of significant volumes of runoff will not be appropriate.

4.3 Discharge to surface Water Body

Should infiltration be found to be unsuitable, the next option is discharge to a surface waterbody. The Cound Brook is located approximately 10m to north of the site. Therefore, it would be possible to discharge surface water runoff from the site into a watercourse. This is the preferred option for the discharge of surface water runoff from the site.

4.4 Discharge to Road Drain or Surface Water Sewer

In the event that discharge of surface water to a surface water body is not possible, the next option is discharge to a public surface water sewer or road drain. There are no public surface water sewers in the vicinity of the site. Therefore, it will not be possible to discharge the surface water runoff to a public surface water sewer.

4.5 Discharge to a Combined Sewer

In the event that discharge of surface water to a public surface water sewer is not possible, the next option is discharge to a public combined sewer. There are no public combined sewers within the vicinity of the site. Therefore, it will not be possible to discharge the surface water runoff to a public combined sewer.

5.0 SURFACE WATER PEAK FLOW

5.1 Climate Change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the flood risk assessments: climate change allowances guidance[3].

Table 1 shows the anticipated changes in extreme rainfall intensity.

Table 1 - Peak Rainfall Intensity Allowance

Management Catchment	Rainfall Event	Allowance Category	2050s	2070s
Severn Uplands Shropshire	30	Upper End	+35%	+40%
		Central	+20%	+25%
	100	Upper End	+40%	+45%
		Central	+25%	+30%

5.2 Surface Water Runoff Rates

It is understood that the existing drainage infrastructure at the site efficiently and effectively manages surface water runoff generated at the site. As there is no history of surface water flooding at the site it is likely that the current drainage system is sufficient for the current site use. It is understood that the surface water drainage discharges from the site to the drainage ditch to the north of the site.

An estimation of surface water runoff is required to permit effective site surface water management and prevent any increase in flood risk to off-site receptors. In accordance with The SuDS Manual, the Greenfield run off from the site has been calculated using the Institute of Hydrology 124 Method (IoH124 method).

QBAR (rural) has been calculated to be 0.20 litres/second (l/s) for the total proposed impermeable area of 390m^2. Table 2 shows the IoH124 method Greenfield runoff rates for the site (see Appendix 4).

Table 2 - IoH124 method Greenfield Runoff Rates

Rainfall Event	Runoff Rate (l/s)
1	0.20
QBAR (rural)	0.20
30	0.40
100	0.50

The surface water runoff rates for the proposed impermeable areas have been calculated. The method used is derivation of the Lloyd-Davies Rational Method. This derivation includes for a

[3] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances

fixed rainfall rate of 50mm/hr and a dimensionless coefficient of 1.00 with the conversion factor of 2.78 using the impermeable area (ha) to give the equation:

$$Q\ (l/s) = 2.78 \times 50 \times A\ (ha)$$

This gives a surface water runoff rate of 5.42l/s for the proposed impermeable area.

6.0 SURFACE WATER QUALITY

6.1 Water Quality

A key requirement of any surface water drainage system is that it protects the receiving water body from the risk of pollution, and this is particularly true for surface water courses. This can be effectively managed by an appropriate “train” or sequence of components that are connected in series. The frequent and short duration rainfall events or the initial phase of longer duration events are those that are mostly loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10mm of rainfall (first flush) should be adequately treated with SuDS that are most effective in removing these potential contaminants (infiltration to the ground, filtration through a parking area sub-base, detention and sedimentation through storage in ponds and swales).

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. Systems incorporating these features are often termed SuDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

A hierarchy of techniques is identified[4]:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).

3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).

4. **Regional Control** – management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

It is generally accepted that the implementation of SuDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;

- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;

- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;

- reducing potable water demand through rainwater harvesting;

- improving amenity through the provision of public open spaces and wildlife habitat; and

[4] CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity.

The application of the SuDS Manual requires that the runoff from sites is not only restricted to meet the Greenfield runoff characteristics but also that SuDS systems are utilised to improve the quality of the runoff prior to outfall to watercourses. The SuDS Manual and Environment Agency guidance applies a sustainability hierarchy to the various types of SuDS systems, this is summarised in Table 3

Table 3 - Sustainability Hierarchy

	SuDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
Most Sustainable	Rainwater Harvesting	✓	✓	
↑	Green / Living Roofs	✓	✓	✓
	Basins and Ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter Strips and Swales	✓	✓	✓
	Infiltration Devices - Soakaways	✓	✓	
↓	Permeable Surfaces and Filter Drains - Gravelled areas - Solid paving blocks - Permeable paving	✓	✓	
Least Sustainable	Tanked Systems - Over-sized pipes / tanks - Cellular storage	✓		

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

The usual approach is to consider the 'SuDS train' where each of the above options are considered in turn until a suitable solution is found. Thus, source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds.

According to the Defra National Standards (see Table 4), the proposed development is a combination of low (roof water) to medium hazard (runoff from car parking and road).

Table 4 - Level of hazard

Hazard	Source of Hazard
Low	Roof drainage
Medium	Residential, amenity, commercial, industrial uses including car parking spaces and roads
High	Areas used for handling and storage or chemicals and fuels, handling of storage and waste (incl. scrapyards)

7.0 SURFACE WATER DRAINAGE SYSTEMS

7.1 SuDS Strategy

The objective of this SuDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. It is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. The Surface Water Drainage Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 45% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. The SuDS Strategy will take the form of:

- Underground cellular storage for attenuation storage.
- Restricted outfall to the Cound Brook to the north of the site at a restricted runoff rate of 1l/s.
- Additional soft landscaping will be incorporated within the site providing permeable areas.

For all developments, both the Building Regulations and NPPF promote a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy, infiltration is not possible. Due to the ground conditions at the site it has been concluded that soakaways and other infiltration methods (e.g. permeable paving, infiltration basin, swales etc.). will not work at the site. It would not be practical to include a pond, or lagoon within the site.

Therefore, discharge will be to the Cound Brook to the north of the site at a restricted runoff rate of 1l/s providing a betterment from the existing surface water runoff rate which is uncontrolled and unrestricted. The SuDS Strategy for the site is shown in Appendix 5.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be required via an underground cellular storage. Additional storage would be provided within the manholes, pipes and drainage gullies which will provide betterment over and above the 1 in 100 year (+45%) event.

The Microdrainage calculations for the proposed surface water drainage for the site is shown in Appendix 6. The size of the attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 45% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+45% climate change) storm event. The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground. In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The SuDS Strategy will reduce the risk of flooding to the site and off-site locations. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

7.2 Attenuation Storage Volume

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable or contaminated, SuDS methods that are designed not to infiltrate can be considered. Passive treatment systems can include a pond, wetland, tank or a basin on the lower parts of a site. These will reduce peak flows, but not the volume of runoff, and slow down flows before disposal to a surface water drainage system. These may provide a suitable SuDS solution for this site and options are therefore considered in outline below.

The provision of suitable storage on site to mitigate the flood risk resulting from the development of the site will be a key factor in the evolution of the site development layout. The provision of large volumes of attenuation, as is likely in this case, can be achieved by a number of methods; however, not all systems can be assessed in direct comparison.

The existing surface water runoff from the site discharges to the drainage ditch to the north of the site at an unrestricted runoff rate. It is proposed that the surface water runoff from the proposed site will outfall to the drainage ditch at a restricted runoff rate of 5l/s providing a substantial betterment from the existing discharge rate. Due to the site constraints, it is not practical to control the discharge rate to below 5l/s. Therefore, a value of 5l/s has been used as the limiting discharge rate before discharge to the watercourse.

Table 10 shows the volume of storage required for the proposed development for the 1 in 100 year event, with a 45% allowance for climate change (increase in peak rainfall) assuming the proposed 390m^2 of impermeable area with 1l/s used as the limiting discharge rate (see Appendix 6).

At this stage, it is proposed that underground cellular storage will be used to provide the required attenuation storage volume. Additional storage would be provided within the manholes, pipes and drainage gullies which will provide betterment over and above the 1 in 100 year (+45%) event. A conservative estimate of 100% runoff from impermeable areas has been used within the calculations.

The surface water runoff has been constrained as much as reasonably practical to the existing runoff rate and volume and to provide betterment. Restricting the surface water runoff rates further would result in a significant increase in the required attenuation storage volume, which would not be feasible. There is a lack of space taking into account the buildings and access parking requirements of the site.

Flooding will not occur on any part of the site during the 1 in 30 year event, no flooding will occur within any part of the buildings during the 1 in 100 year (+45%) event, all areas drained have been designed to accommodate the 1 in 100 year (+45%) event.

Large volumes of storage can be provided under lightly trafficked areas by using underground cellular storage systems. This will maximise the developable area of the site. These could be located underneath the roads and paved areas. There is no specific mechanism within the system designed to treat flow, but extended detention times will allow sedimentation reducing the suspended solids within the discharge. There is no creation of amenity by the installation of these types of systems, indeed by maintaining access to the system small areas may need to be reserved.

If the developable footprint is tight then these systems may be advantageous however to ensure adoptability it is recommended that the use of these systems is discussed with the adopting authority as they are not always preferred. There would be room to install cellular storage to provide the storage volume required. This will require the new drainage network to divert flow from the impermeable buildings to the underground cellular storage.

7.3 Designing for Local Drainage System Failure

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SuDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the report is therefore associated with the way the residual risk is managed.

As part of the SuDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground . The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers and lateral drains connecting the buildings and impermeable areas. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would not affect the proposed buildings because the finished floor levels are above the internal roadways of the site, ensuring any exceedance flooding would not affect the buildings. Exceedance flows would be contained within the highways adjacent to the site and within the site and would flow to the lower ground levels where the landscaped areas are located. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

In particular, the hardstanding areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+45%) event, there is safety factor, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this (i.e. within the manholes, pipes etc.). If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

7.4 Operation and Maintenance Requirements

The following maintenance schedules are based on The SuDS Manual, for standard maintenance regimes. However, planting and maintenance regimes may be changed to enhance biodiversity. In order for any surface water drainage system to operate as originally intended, it is necessary to ensure that it is adequately maintained throughout its lifetime. For residential developments, this is generally taken as 100 years. Therefore, over the lifetime of a development there is strong possibility that the system could either fail or its performance be reduced if it is not correctly maintained.

The surface water drainage scheme will be installed and fully operational before occupation of the site occurs. The surface water drainage scheme will be regularly maintained. The key maintenance requirements are regular inspection of silt traps, manholes and pipework, with removal of sediment and debris as required.

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground drainage systems. Maintenance responsibility for the system will be placed with the owner of the dwelling who will employ responsible organisations when required. Specific maintenance needs of the system will be monitored, and maintenance schedules adjusted to suit requirements.

Preventative measures will be taken rather than corrective measures. Preventative maintenance ensures both the condition monitoring and life-extending tasks are carried out at scheduled regular intervals, ensuring failure and regular repair of the system is avoided.

Underground Cellular Storage

Underground cellular storage systems which are designed to provide attenuation and storage of surface water. Table 5 provides details of the maintenance requirements.

Table 5 - Underground Cellular Storage

General Requirements	Frequency
Inspect and identify any areas not operating correctly, if necessary, take remedial action	Monthly for 3 months, then annually
Remove debris from the catchment surface	Monthly
Remove sediment from pre-treatment areas	Annually (or as required)
Occasional Tasks	**Frequency**
Inspect/check all inlets, outlets, overflows and vents to ensure they are in good condition and operating as designed	As required, based on inspection
Survey inside tank for sediment build-up and remove if necessary.	Every 5 years or as required

Remedial Work	Frequency
Repair/rehabilitate inlets, outlets, overflows and vents	As required

Inlet Structures and Inspection Chambers

Inlet structures such as rainwater downpipes, road gullies and channel drains. They should be free from obstruction at all times to allow free flow through the system. Inspection chambers and rodding eyes are used on bends or where pipes come together. They allow access and cleaning to the system if necessary. Table 6 provides details of the maintenance requirements.

Table 6 - Inlet Structures and Inspection Chambers

General Requirements	Frequency
Inspect rainwater downpipes, channel drains and road gullies, removing obstructions and silt, as necessary, check there is no physical damage	Monthly
Strim vegetation 1m minimum surrounding structures and keep area free from silt and debris	Monthly
Remove cover and inspect, ensuring that the water is flowing freely and that the exit route for water is unobstructed, removed debris and silt	Annually
Occasional Tasks	**Frequency**
Check topsoil levels are 20mm above edges of chambers to avoid mower damage	As required
Remedial Work	**Frequency**
Repair physical damage if necessary	As required

Below Ground Drainage Pipes

Below ground drainage pipes convey water to the SuDS system. They should be free from obstruction at all times to allow free flow. Table 7 provides details of the maintenance requirements.

Table 7 - Below Ground Drainage Pipes

General Requirements	Frequency
Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for first 3 months then annually
Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
Remove sediment from pre-treatment inlet structures and inspection chambers	Annually or as required
Maintain vegetation to designed limits within vicinity of below ground drainage pipes and tanks to avoid damage to system	Annually or as required
Occasional Tasks	**Frequency**
Inspect all inlets, outlets, and vents to ensure that they are in good condition and operating as designed	Annually
Remedial Work	**Frequency**
Repair physical damage if necessary	As required
Survey inside of pipe runs for sediment build up and remove if necessary	Every 5 years or as required

Flow Control Device

A flow control device controls the flow of water leaving the site. Table 8 provides details of the maintenance requirements.

Table 8 - Flow Control Device

General Requirements	Frequency
Inspect and identify any areas that are not operating correctly and clear out any debris from chamber	Monthly for 3 months, then every 6 months
Occasional Tasks	**Frequency**
Inspect all inlets, outlets, and vents to ensure that they are in good condition and operating as designed	Annually
Remedial Work	**Frequency**
Repair physical damage if necessary	As required

8.0 SUMMARY AND CONCLUSIONS

8.1 Introduction

This report presents a Surface and Foul Water Drainage Assessment for the proposed development at Brookside, Condover, Shrewsbury, SY5 7BT.

8.2 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The site is not served by public sewers; therefore, all foul water from the proposed residential dwellings will discharge to an adequately sized package treatment works with discharge to the Cound Brook to the north of the site.

The size of the package treatment work/s will be chosen to cater for the proposed development. Therefore, foul water will receive an appropriate level of treatment which will minimise the risk of pollution.

8.3 SuDS Strategy

This SuDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. It is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. The Surface Water Drainage Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 45% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. The SuDS Strategy will take the form of:

- Underground cellular storage with an attenuation storage volume.
- Restricted outfall to the Cound Brook to the north of the site at a restricted runoff rate of 1l/s.
- Additional soft landscaping will be incorporated within the site providing permeable areas.

For all developments, both the Building Regulations and NPPF promote a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy, infiltration is not possible. Due to the ground conditions at the site it has been concluded that soakaways and other infiltration methods (e.g. permeable paving, infiltration basin, swales etc.). will not work at the site. It would not be practical to include a pond, or lagoon within the site.

Therefore, discharge will be to the drainage ditch to the north of the site at a restricted runoff rate of 1l/s providing a betterment from the existing surface water runoff rate which is uncontrolled and not restricted.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be required via an underground cellular storage. Additional storage would be provided within the manholes, pipes and drainage gullies which will provide betterment over and above the 1 in 100 year (+45%) event.

The size of the attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 45% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+45% climate change) storm event. The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground. In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The SuDS Strategy will reduce the risk of flooding to the site and off-site locations. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

8.4 Conclusion

This Surface Water Drainage Assessment demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF.

The development should not therefore be precluded on the grounds of flood risk or drainage.

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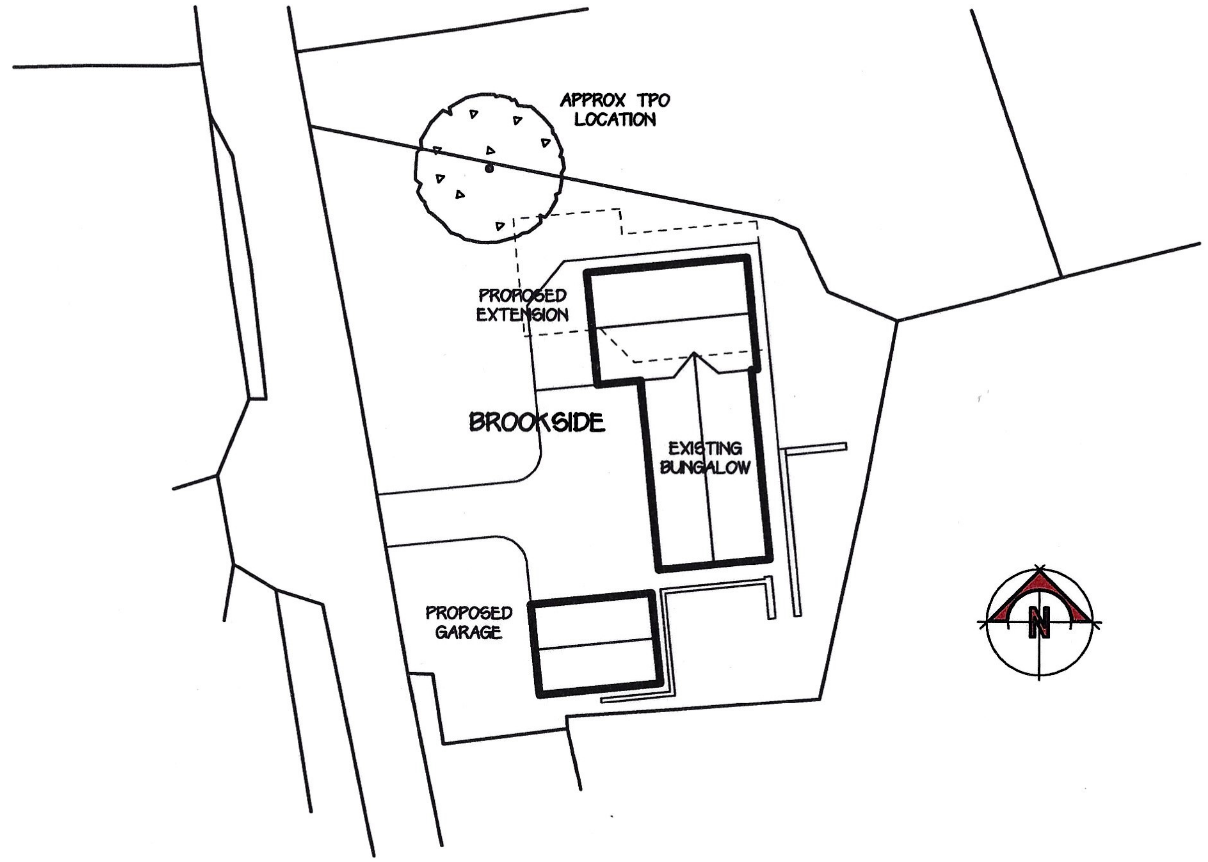
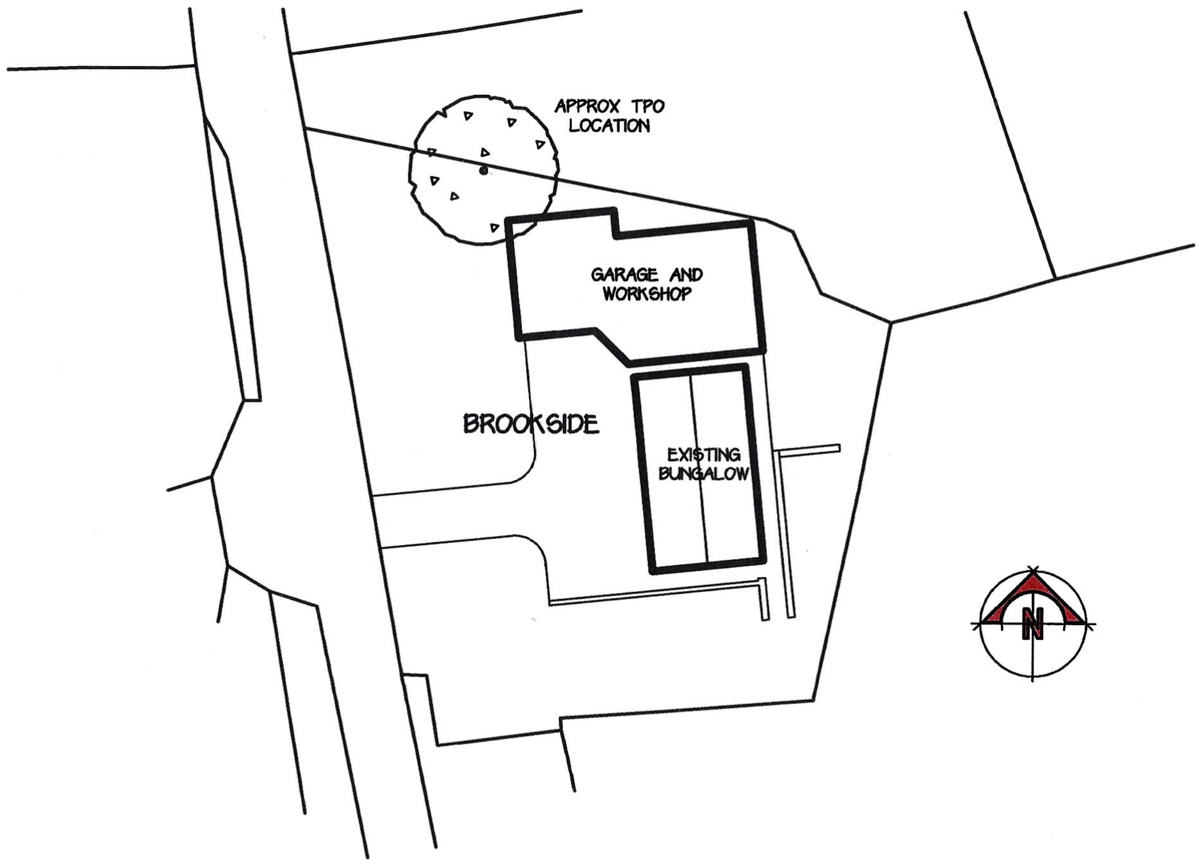
APPENDICES

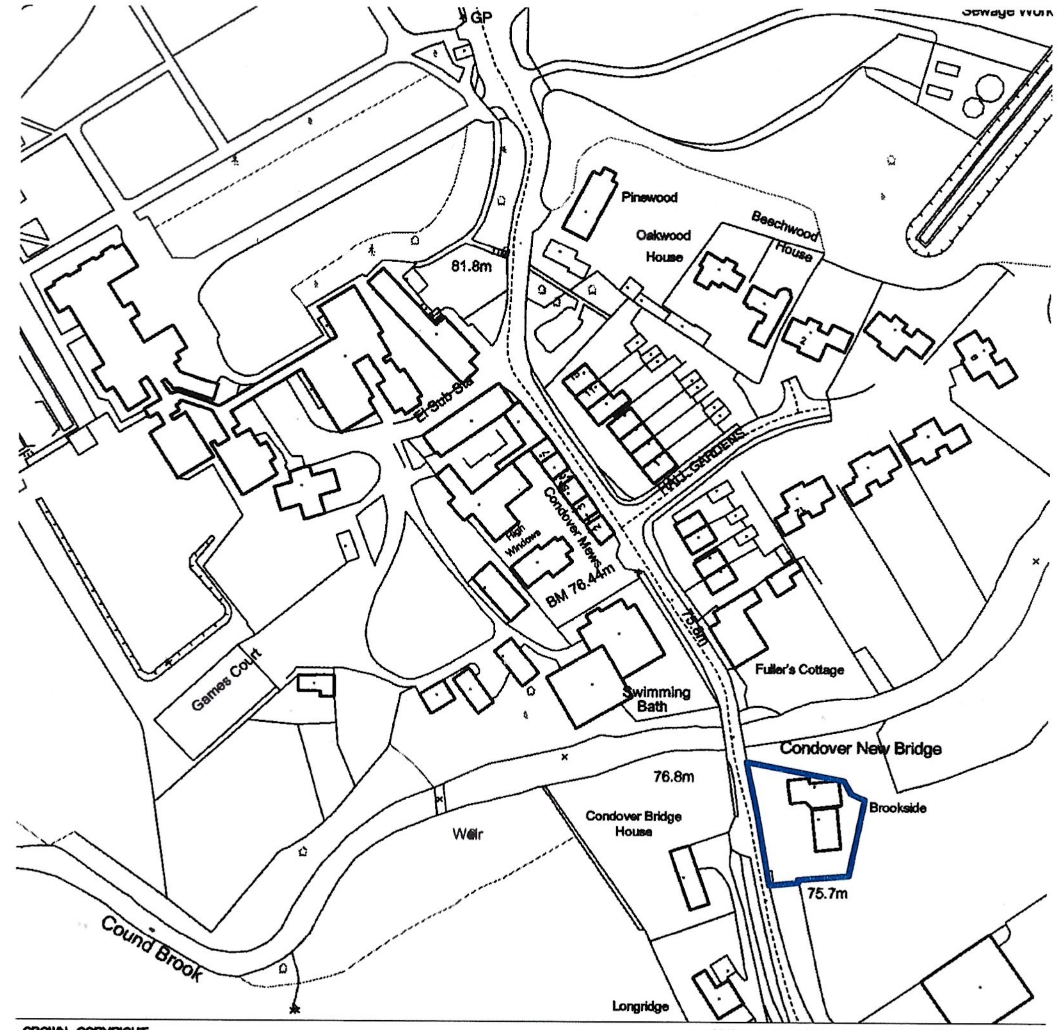
APPENDIX 1 – Proposed Site Layout



PROPOSED BLOCK PLAN 1 / 500



EXISTING BLOCK PLAN 1 / 500



 MAD ARCHITECTURAL OS LICENCE 100062660

LOCATION PLAN 1 / 2500

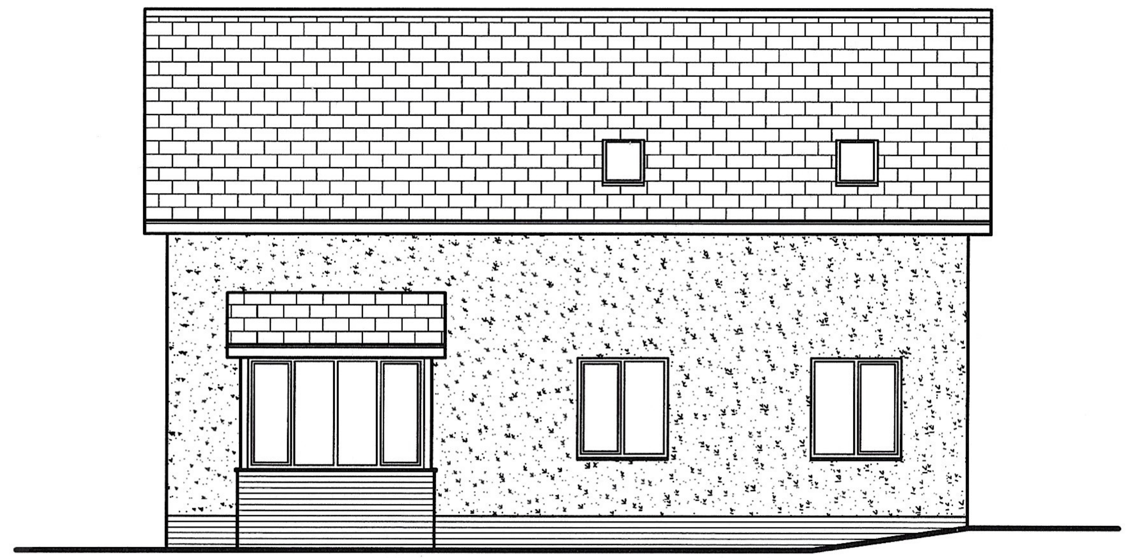
Date	Ref	Revision

Client: Mr W BEDDOES		Project: BROOKSIDE CONDOVER SHREWSBURY SY5 7BT	MAD Architectural
Date: 07.05.2022	Scale: AS SHOWN at A3		11 DOL LAS, ABERMULE, MONTGOMERY, POWYS. SY15 6JT
Project - Drawing Number - Amend: 00020522 - 001 -	Drawn: SKM	Subject: PROPOSED EXTENSION LOCATION & SITE PLAN	T: 01686 630676 M: 07896 608083 E: info@mad-architectural.co.uk
CAD - BROOKSIDE\EXTN\BSC_EXIST_LP_SP			COPYRIGHT This drawing / design is the copyright of MAD Architectural and must not be reproduced without written consent.

PROPOSED WEST ELEVATION (FRONT)

PROPOSED SOUTH ELEVATION (SIDE)

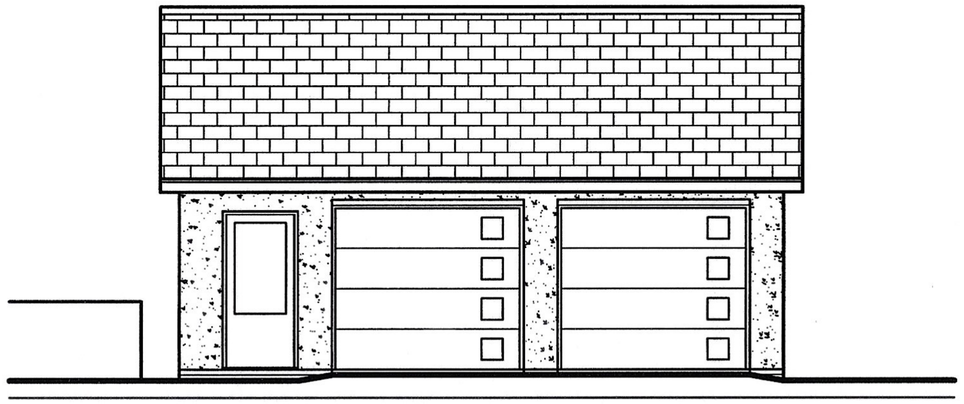
PROPOSED EAST ELEVATION (REAR)



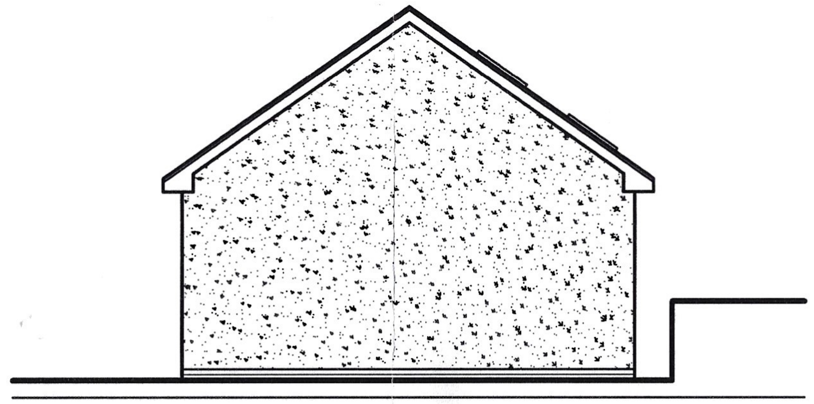
PROPOSED NORTH ELEVATION (END)

OPTION B

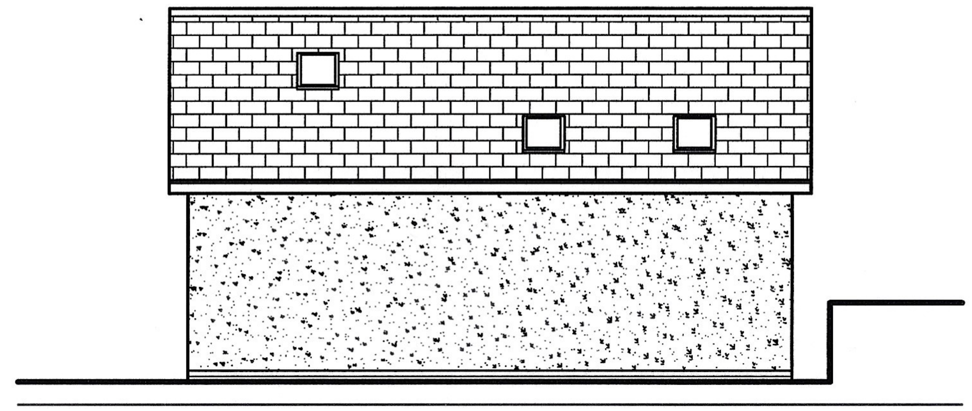
Client: W BEDDOES	Project: BROOKSIDE CONDOVER SHREWSBURY SY5 7BT	Date | Ref | Revision
Date: 13.05.2022 | Scale: 1 / 100 at A3		MAD Architectural 11 DOL LAS, ABERMULE, MONTGOMERY, POWYS. SY15 6JT T: 01686 630676 M: 07896 608083 E: info@mad-architectural.co.uk
Project - Drawing Number - Amend: 00020522 - 003 - | Drawn: SKM	Subject: PROPOSED EXTENSION PROPOSED LAYOUT/SECTION	
CAD - MAD\BROOKSIDE\BSC_PROP_LAY		



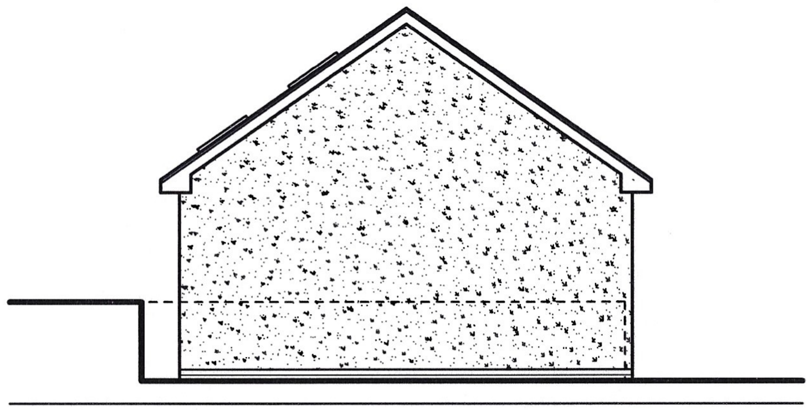
PROPOSED NORTH ELEVATION (FRONT)



PROPOSED WEST ELEVATION (SIDE)



PROPOSED SOUTH ELEVATION (REAR)



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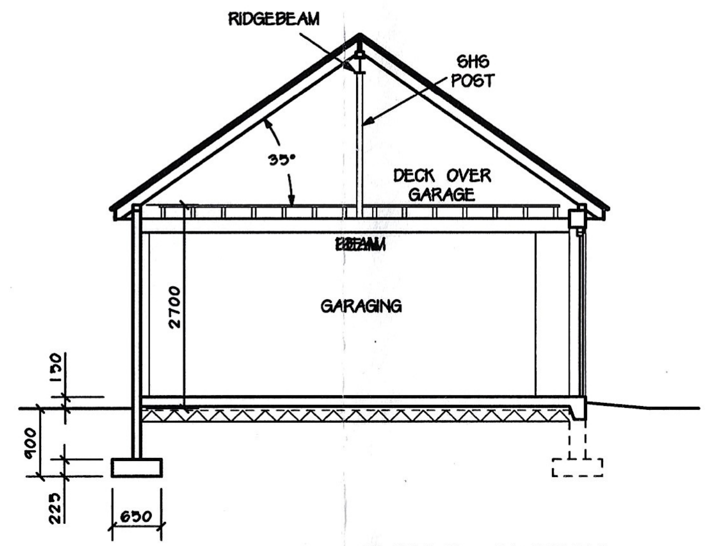
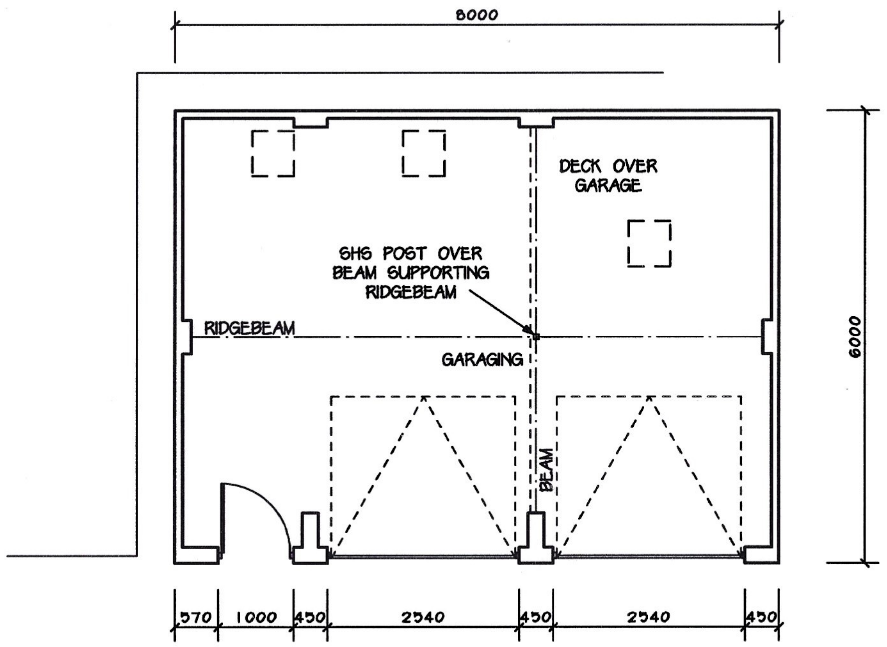


TYPICAL SECTION



PROPOSED LAYOUT

Date | Ref | Revision

Client
W BEDDOES

Date
13.05.2022

Scale
1 / 100 at A3

Project - Drawing Number - Amend
00020522 - 005 -

Drawn
SKM

CAD - MAD\BROOKSIDE\BSC_PROP_GAR

Project
BROOKSIDE CONDOVER
SHREWSBURY SY5 7BT

Subject
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PROPOSED GARAGE

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APPENDIX 2 – Percolation Test Results

Percolation Tests - Brookside			

TP1	Test 1	Test 2	Test 3
Total time minutes for water to drop from 75% to 25% full	68	210	340
Total Time seconds	4080	12600	20400
Vp	27.2	84	136
Average Vp	82.4		

APPENDIX 3 – Soakaway Test Results

TP1

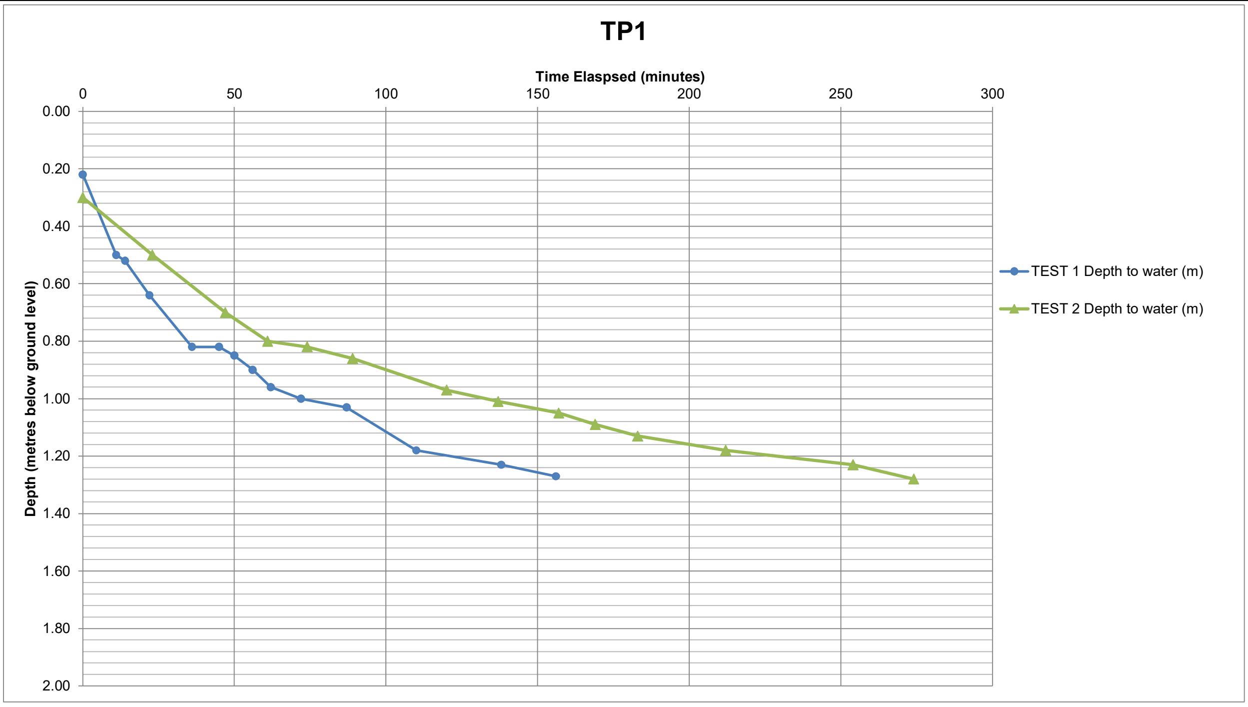
		Length (m)	1.50	KRS Environmental
Date	25/08/2023	Width (m)	0.40	
Site	Brookside, Condover	Depth (m)	1.60	SOIL INFILTRATION RATE TEST
Job Number	KRS.0750.001	Groundwater Level (mbgl)	Dry	See B.R.E. Digest 365, 2016, Soakaway Design.

Remarks -

No groundwater seepages were observed to enter the trial pit.

TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
0	0.22	0	0.30		
11	0.50	23	0.50		
14	0.52	47	0.70		
22	0.64	61	0.80		
36	0.82	74	0.82		
45	0.82	89	0.86		
50	0.85	120	0.97		
56	0.90	137	1.01		
62	0.96	157	1.05		
72	1.00	169	1.09		
87	1.03	183	1.13		
110	1.18	212	1.18		
138	1.23	254	1.23		
156	1.27	274	1.28		

		TEST 1	TEST 2	TEST 3
Effective Storage Depth	m	1.38	1.30	
75% Effective Storage Depth	m	1.04	0.98	
(i.e. depth below GL)	m	0.57	0.63	
25% Effective Storage Depth	m	0.35	0.33	
(i.e. depth below GL)	m	1.26	1.28	
Effective Storage Depth 75%-25%	m	0.69	0.65	
Time to fall to 75% effective depth	mins	18	7	
Time to fall to 25% effective depth	mins	150	274	
V (75%-25%)	m3	0.4140	0.3900	
a (50%)	m2	3.2220	3.0700	
t (75%-25%)	mins	132.0000	267.0000	
SOIL INFILTRATION RATE	m/s	**1.62E-05**	**7.93E-06**	**N/A**
DESIGN SOIL INFILTRATION RATE, f	m/s	**7.93E-06**		



TP2

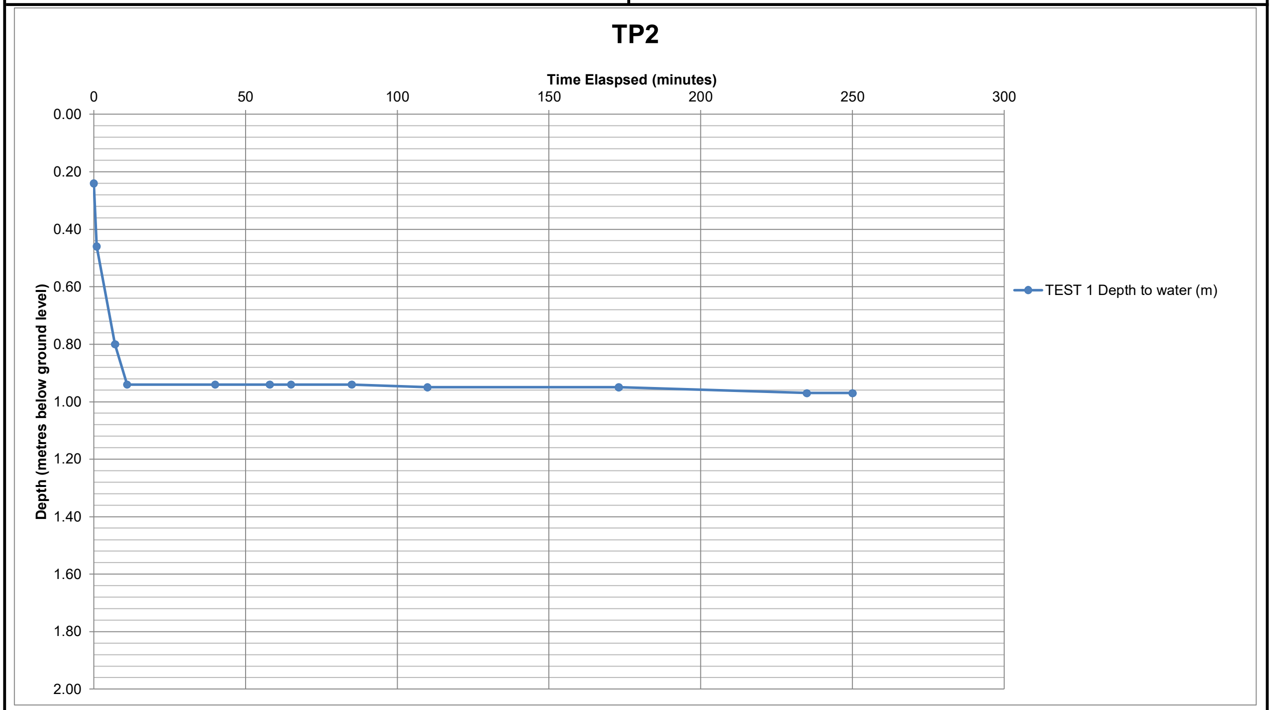
Date	25.08.2023	**Length (m)**	1.50	
Site	Brookside, Condover	**Width (m)**	0.40	
Job Number	KRS.0750.001	**Depth (m)**	1.60	**SOIL INFILTRATION RATE TEST**
		Groundwater Level (mbgl)	Dry	See B.R.E. Digest 365, 2016, Soakaway Design.

Remarks -

No groundwater seepages were observed to enter the trial pit.

TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)
0	0.24				
1	0.46				
7	0.80				
11	0.94				
40	0.94				
58	0.94				
65	0.94				
85	0.94				
110	0.95				
173	0.95				
235	0.97				
250	0.97				

		TEST 1	TEST 2	TEST 3
Effective Storage Depth	**m**	1.36		
75% Effective Storage Depth	**m**	1.02		
(i.e. depth below GL)	**m**	0.58		
25% Effective Storage Depth	**m**	0.34		
(i.e. depth below GL)	**m**	1.26		
Effective Storage Depth 75%-25%	**m**	0.68		
Time to fall to 75% effective depth	**mins**	4		
Time to fall to 25% effective depth	**mins**	N/A		
V (75%-25%)	**m3**	0.4080		
a (50%)	**m2**	3.1840		
t (75%-25%)	**mins**	#VALUE!		
SOIL INFILTRATION RATE	**m/s**	**#VALUE!**		
DESIGN SOIL INFILTRATION RATE, f	**m/s**	**#VALUE!**		



TP3

Date	07.09.2023	Width (m)	0.60
Site	Severnleigh, Leighton	Depth (m)	1.40
Job Number	KRS.0561.002	Groundwater Level (mbgl)	Wet
		Length (m)	1.20

SOIL INFILTRATION RATE TEST

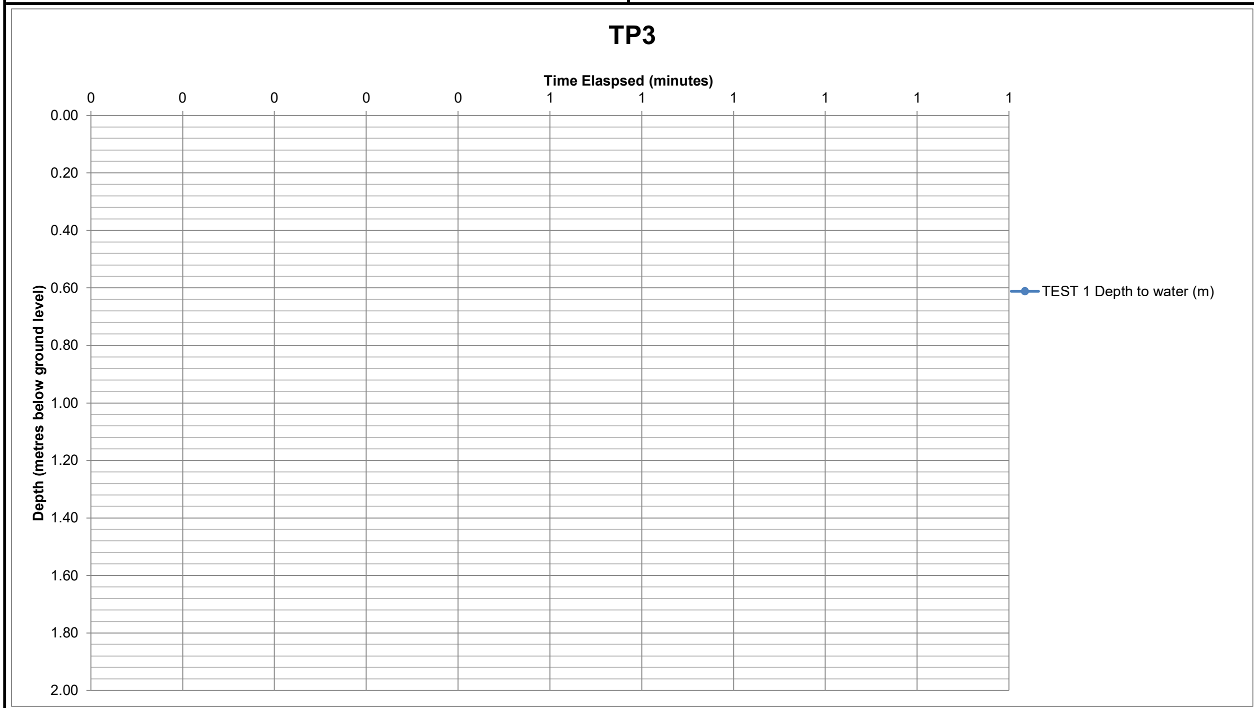
See B.R.E. Digest 365, 2007, Soakaway Design.

Remarks -

Test abandoned as groundwater seepages were observed to enter the trial pit.

TEST 1		TEST 2		TEST 3	
Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)	Time(min)	Depth to Water (m)

		TEST 1	TEST 2	TEST 3
Effective Storage Depth	m	1.40		
75% Effective Storage Depth	m	1.05		
(i.e. depth below GL)	m	0.35		
25% Effective Storage Depth	m	0.35		
(i.e. depth below GL)	m	1.05		
Effective Storage Depth 75%-25%	m	0.70		
Time to fall to 75% effective depth	mins	N/A		
Time to fall to 25% effective depth	mins	N/A		
V (75%-25%)	m3	0.5040		
a (50%)	m2	3.2400		
t (75%-25%)	mins	#VALUE!		
SOIL INFILTRATION RATE	**m/s**	**#VALUE!**		
DESIGN SOIL INFILTRATION RATE, f	**m/s**	**#VALUE!**		



APPENDIX 4 – IoH124 Method Greenfield Runoff Rates

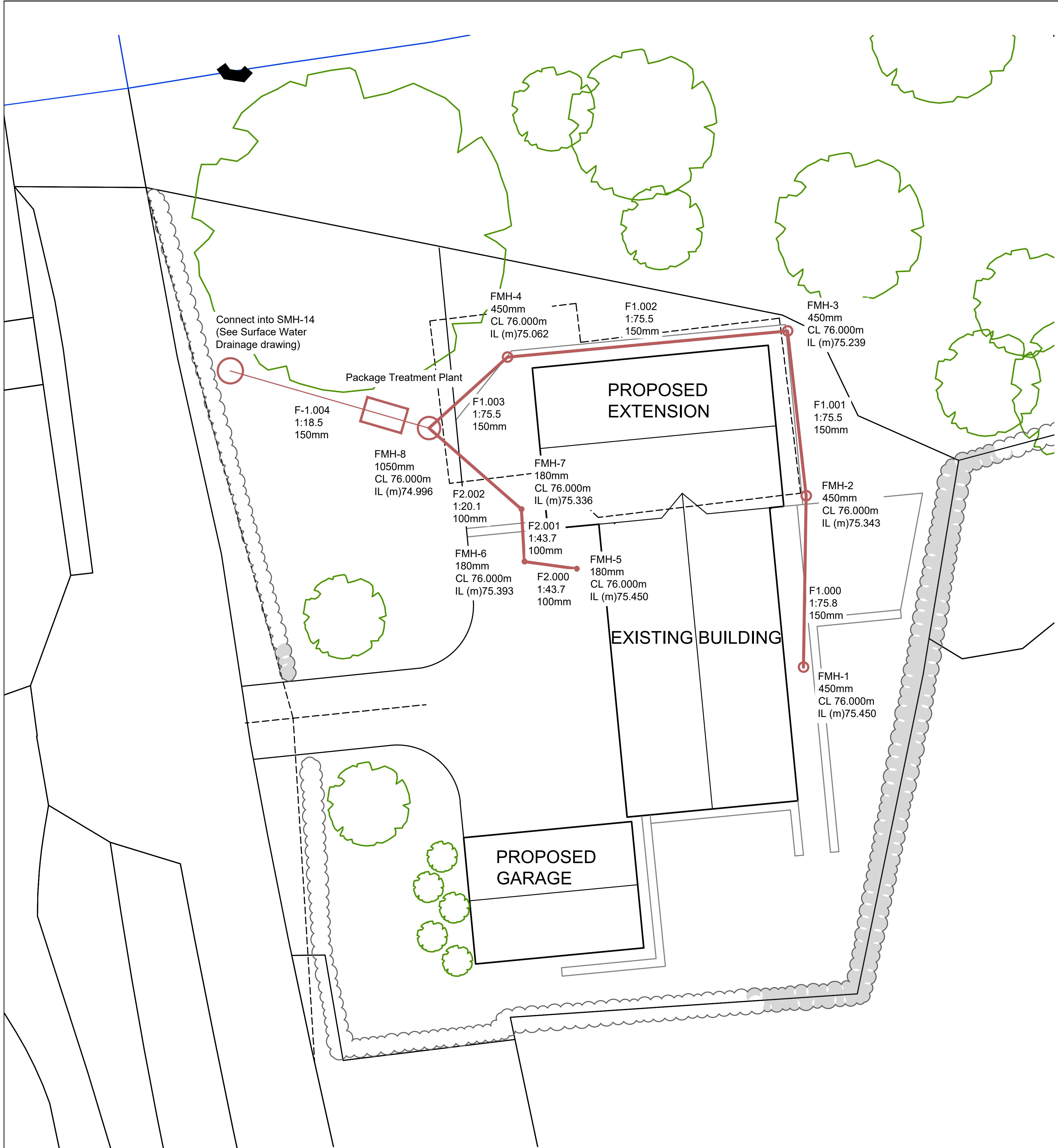
ICP SUDS Mean Annual Flood

Input

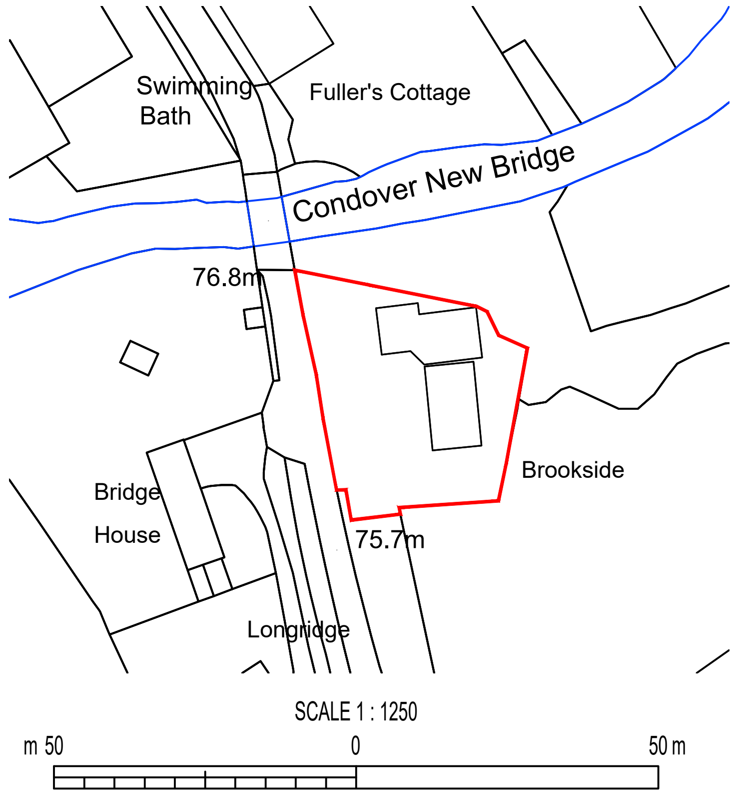
Return Period (years)	100	Soil	0.450
Area (ha)	0.039	Urban	0.000
SAAR (mm)	759	Region Number	Region 4

Results	**l/s**
QBAR Rural	0.2
QBAR Urban	0.2
Q100 years	0.5
Q1 year	0.2
Q30 years	0.4
Q100 years	0.5

APPENDIX 5 – SuDS Strategy



PROPOSED FOUL WATER LAYOUT 1:200



SITE LOCATION PLAN 1:1250

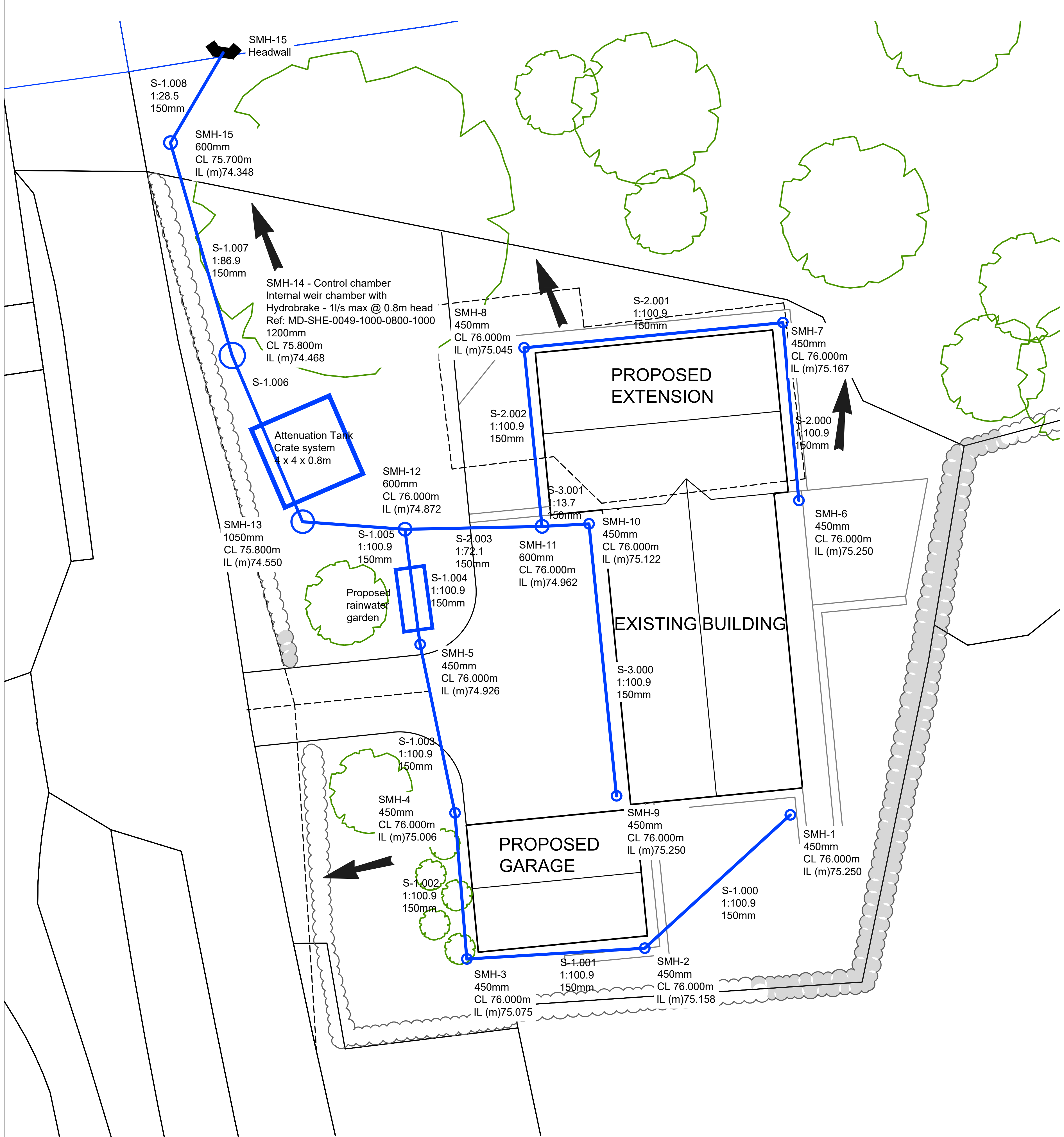
OS LICENCE NUMBER 100030835

Rev.	Date:	Notes:	By:
B	14-12-23	NOTE AMENDED	AP
A	01-12-23	DRAINAGE LAYOUT AMENDED	AP

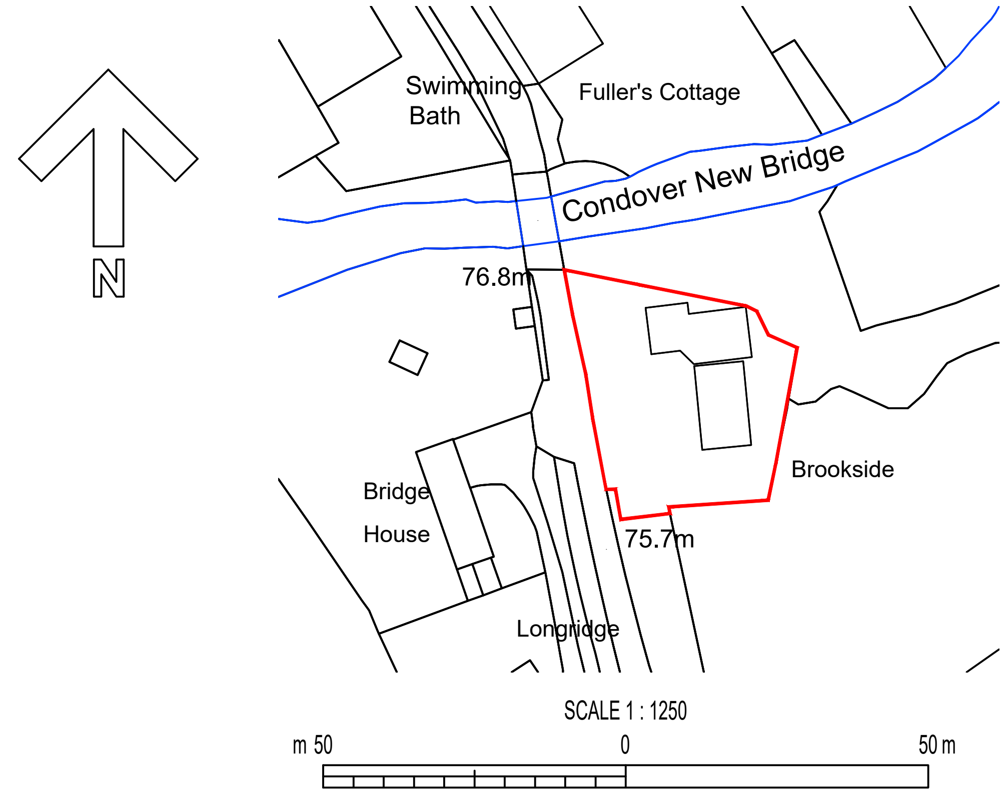
KRS ENVIRONMENTAL

TEL: 01484 437420 MOBILE: 07857264376
3 PRINCES SQUARE PRINCES STREET
MONTGOMERY POWYS SY15 6PZ

Job:	BROOKSIDE, CONDOVER, SHREWSBURY
Client:	MR COLIN BEDDOES
Drawing Title:	PROPOSED FOUL WATER DRAINAGE LAYOUT
Date:	SEPTEMBER 2023
Drawing No:	KRS.0750.001.001 revision: B
Scale:	AS NOTED @ A3
Drawn:	AP
Status:	FOR COMMENT



PROPOSED SURFACE WATER LAYOUT 1:200



SITE LOCATION PLAN 1:1250

OS LICENCE NUMBER 100030835

A	01-12-23	DRAINAGE LAYOUT AMENDED	AP
Rev.	Date:	Notes:	By:

KRS ENVIRONMENTAL

TEL: 01484 437420 MOBILE: 07857264376
3 PRINCES SQUARE PRINCES STREET
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Job:	BROOKSIDE, CONDOVER, SHREWSBURY
Client:	MR COLIN BEDDOES
Drawing Title:	PROPOSED SURFACE WATER DRAINAGE LAYOUT
Date:	SEPTEMBER 2023
Drawing No:	KRS.0750.001.002 revision: A
Scale:	AS NOTED @ A3
Drawn:	AP
Status:	FOR COMMENT

APPENDIX 6 – Attenuation Storage Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes SLS-1 Manhole Sizes SLS450mm

FSR Rainfall Model - England and Wales

Return Period (years)	2	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	18.000	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	0.600
Ratio R	0.391	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.500		

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.000	9.296	0.092	100.9	0.003	4.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.001	8.387	0.083	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.002	6.892	0.068	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.003	8.104	0.080	100.9	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.000	50.00	4.15	75.250	0.003	0.0	0.0	0.0	1.00	17.7	0.4
S-1.001	50.00	4.29	75.158	0.004	0.0	0.0	0.0	1.00	17.7	0.5
S-1.002	50.00	4.41	75.075	0.005	0.0	0.0	0.0	1.00	17.7	0.7
S-1.003	50.00	4.54	75.006	0.008	0.0	0.0	0.0	1.00	17.7	1.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.004	5.465	0.054	100.9	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.000	8.412	0.083	100.9	0.005	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.001	12.239	0.121	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.002	8.456	0.084	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.000	12.871	0.128	100.9	0.007	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.001	2.211	0.161	13.7	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.003	6.457	0.090	72.1	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.005	4.830	0.322	15.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.006	8.498	0.082	103.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.004	50.00	4.64	74.926	0.014	0.0	0.0	0.0	1.00	17.7	1.8
S-2.000	50.00	4.14	75.250	0.005	0.0	0.0	0.0	1.00	17.7	0.6
S-2.001	50.00	4.34	75.167	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-2.002	50.00	4.49	75.045	0.009	0.0	0.0	0.0	1.00	17.7	1.2
S-3.000	50.00	4.21	75.250	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-3.001	50.00	4.23	75.122	0.015	0.0	0.0	0.0	2.73	48.3	2.0
S-2.003	50.00	4.58	74.962	0.025	0.0	0.0	0.0	1.19	20.9	3.4
S-1.005	50.00	4.67	74.872	0.039	0.0	0.0	0.0	2.61	46.2	5.3
S-1.006	50.00	4.81	74.550	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.007	10.430	0.120	86.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.008	4.909	0.172	28.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.009	14.726	0.142	103.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.007	50.00	4.97	74.468	0.039	0.0	0.0	0.0	1.08	19.1	5.3
S-1.008	50.00	5.01	74.348	0.039	0.0	0.0	0.0	1.89	33.4	5.3
S-1.009	50.00	5.26	74.176	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SMH-1	76.000	0.750	Open Manhole	450	S-1.000	75.250	150				
SMH-2	76.000	0.842	Open Manhole	450	S-1.001	75.158	150	S-1.000	75.158	150	
SMH-3	76.000	0.925	Open Manhole	450	S-1.002	75.075	150	S-1.001	75.075	150	
SMH-4	76.000	0.994	Open Manhole	450	S-1.003	75.006	150	S-1.002	75.006	150	
SMH-5	76.000	1.074	Open Manhole	450	S-1.004	74.926	150	S-1.003	74.926	150	
SMH-6	76.000	0.750	Open Manhole	450	S-2.000	75.250	150				
SMH-7	76.000	0.833	Open Manhole	450	S-2.001	75.167	150	S-2.000	75.167	150	
SMH-8	76.000	0.955	Open Manhole	450	S-2.002	75.045	150	S-2.001	75.045	150	
SMH-9	76.000	0.750	Open Manhole	450	S-3.000	75.250	150				
SMH-10	76.000	0.878	Open Manhole	450	S-3.001	75.122	150	S-3.000	75.122	150	
SMH-11	76.000	1.038	Open Manhole	600	S-2.003	74.962	150	S-2.002	74.962	150	
								S-3.001	74.962	150	
SMH-12	76.000	1.128	Open Manhole	600	S-1.005	74.872	150	S-1.004	74.872	150	
								S-2.003	74.872	150	
SMH-13	75.800	1.250	Open Manhole	1050	S-1.006	74.550	150	S-1.005	74.550	150	
SMH-14	75.800	1.332	Open Manhole	1200	S-1.007	74.468	150	S-1.006	74.468	150	
SMH-15	75.700	1.352	Open Manhole	600	S-1.008	74.348	150	S-1.007	74.348	150	
SMH-Headwall	75.200	1.024	Open Manhole	1000	S-1.009	74.176	150	S-1.008	74.176	150	
SMH-dummy	75.000	0.966	Open Manhole	1000		OUTFALL		S-1.009	74.034	150	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-1	349744.831	305491.838	349744.831	305491.838	Required	
SMH-2	349737.980	305485.556	349737.980	305485.556	Required	
SMH-3	349729.607	305485.054	349729.607	305485.054	Required	
SMH-4	349729.047	305491.923	349729.047	305491.923	Required	
SMH-5	349727.406	305499.859	349727.406	305499.859	Required	
SMH-6	349745.237	305506.632	349745.237	305506.632	Required	
SMH-7	349744.482	305515.010	349744.482	305515.010	Required	
SMH-8	349732.300	305513.826	349732.300	305513.826	Required	
SMH-9	349736.653	305492.730	349736.653	305492.730	Required	
SMH-10	349735.357	305505.536	349735.357	305505.536	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-11	349733.149	305505.413	349733.149	305505.413	Required	
SMH-12	349726.693	305505.278	349726.693	305505.278	Required	
SMH-13	349721.876	305505.635	349721.876	305505.635	Required	
SMH-14	349718.555	305513.456	349718.555	305513.456	Required	
SMH-15	349715.650	305523.474	349715.650	305523.474	Required	
SMH-Headwall	349718.130	305527.710	349718.130	305527.710	Required	
SMH-dummy	349732.359	305531.502			No Entry	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	o	150	SMH-1	76.000	75.250	0.600	Open Manhole	450
S-1.001	o	150	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.002	o	150	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.003	o	150	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.004	o	150	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-2.000	o	150	SMH-6	76.000	75.250	0.600	Open Manhole	450
S-2.001	o	150	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.002	o	150	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-3.000	o	150	SMH-9	76.000	75.250	0.600	Open Manhole	450
S-3.001	o	150	SMH-10	76.000	75.122	0.728	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	9.296	100.9	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.001	8.387	100.9	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.002	6.892	100.9	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.003	8.104	100.9	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-1.004	5.465	100.9	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-2.000	8.412	100.9	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.001	12.239	100.9	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-2.002	8.456	100.9	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-3.000	12.871	100.9	SMH-10	76.000	75.122	0.728	Open Manhole	450
S-3.001	2.211	13.7	SMH-11	76.000	74.962	0.888	Open Manhole	600

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	o	150	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-1.005	o	150	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.006	o	150	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.007	o	150	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.008	o	150	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.009	o	150	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	6.457	72.1	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.005	4.830	15.0	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.006	8.498	103.6	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.007	10.430	86.9	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.008	4.909	28.5	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000
S-1.009	14.726	103.7	SMH-dummy	75.000	74.034	0.816	Open Manhole	1000

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.003	0.003	0.003
1.001	User	-	100	0.001	0.001	0.001
1.002	User	-	100	0.001	0.001	0.001
1.003	User	-	100	0.001	0.001	0.001
	User	-	100	0.002	0.002	0.003
1.004	User	-	100	0.005	0.005	0.005
2.000	User	-	100	0.005	0.005	0.005
2.001	User	-	100	0.002	0.002	0.002
2.002	User	-	100	0.002	0.002	0.002
3.000	User	-	100	0.001	0.001	0.001
	User	-	100	0.003	0.003	0.004
	User	-	100	0.003	0.003	0.007
3.001	User	-	100	0.005	0.005	0.005
	User	-	100	0.003	0.003	0.008
2.003	User	-	100	0.001	0.001	0.001
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.039	0.039	0.039

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Offline Controls	1	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	18.000	Cv (Summer)	0.750
Return Period (years)	2	Ratio R	0.391	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SMH-14, DS/PN: S-1.007, Volume (m^3): 1.6

Unit Reference	MD-SHE-0049-1000-0800-1000	Sump Available	Yes
Design Head (m)	0.800	Diameter (mm)	49
Design Flow (l/s)	1.0	Invert Level (m)	74.468
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0	Kick-Flo®	0.437	0.8
Flush-Flo™	0.215	0.9	Mean Flow over Head Range	-	0.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	0.600	0.9	1.600	1.4	2.600	1.7	5.000	2.3	7.500	2.8
0.200	0.9	0.800	1.0	1.800	1.4	3.000	1.8	5.500	2.4	8.000	2.9
0.300	0.9	1.000	1.1	2.000	1.5	3.500	1.9	6.000	2.5	8.500	2.9
0.400	0.8	1.200	1.2	2.200	1.6	4.000	2.1	6.500	2.6	9.000	3.0
0.500	0.8	1.400	1.3	2.400	1.6	4.500	2.2	7.000	2.7	9.500	3.1

Offline Controls for Storm

Weir Manhole: SMH-14, DS/PN: S-1.007, Loop to PN: S-1.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 75.268

Storage Structures for Storm

Cellular Storage Manhole: SMH-14, DS/PN: S-1.007

Invert Level (m) 74.468 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	16.0	16.0	0.800	16.0	28.8	0.900	0.0	28.8

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.391 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1
Climate Change (%) 45

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.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S-1.000	SMH-1	15 Winter	1	+45%					75.268	-0.132	0.000	0.04			0.6	OK
S-1.001	SMH-2	15 Winter	1	+45%					75.179	-0.129	0.000	0.05			0.7	OK
S-1.002	SMH-3	15 Winter	1	+45%					75.099	-0.126	0.000	0.06			0.9	OK
S-1.003	SMH-4	15 Winter	1	+45%					75.037	-0.120	0.000	0.09			1.4	OK
S-1.004	SMH-5	15 Winter	1	+45%					74.965	-0.111	0.000	0.15			2.2	OK
S-2.000	SMH-6	15 Winter	1	+45%					75.273	-0.127	0.000	0.06			0.9	OK
S-2.001	SMH-7	15 Winter	1	+45%					75.194	-0.123	0.000	0.07			1.2	OK
S-2.002	SMH-8	15 Winter	1	+45%					75.077	-0.118	0.000	0.10			1.5	OK

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
S-1.000	SMH-1	
S-1.001	SMH-2	
S-1.002	SMH-3	
S-1.003	SMH-4	
S-1.004	SMH-5	
S-2.000	SMH-6	
S-2.001	SMH-7	
S-2.002	SMH-8	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

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.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S-3.000	SMH-9	15 Winter	1	+45%					75.278	-0.122	0.000	0.08			1.3
S-3.001	SMH-10	15 Winter	1	+45%					75.154	-0.118	0.000	0.10			2.5
S-2.003	SMH-11	15 Winter	1	+45%					75.012	-0.100	0.000	0.24			4.3
S-1.005	SMH-12	15 Winter	1	+45%					74.915	-0.107	0.000	0.18			6.5
S-1.006	SMH-13	60 Winter	1	+45%					74.662	-0.038	0.000	0.23			3.5
S-1.007	SMH-14	60 Winter	1	+45%	1/15 Winter			0	74.659	0.041	0.000	0.05	0.0	44	0.9
S-1.008	SMH-15	60 Winter	1	+45%					74.366	-0.132	0.000	0.04			0.9
S-1.009	SMH-Headwall	60 Winter	1	+45%					74.199	-0.127	0.000	0.06			0.9

PN	US/MH Name	Status	Level Exceeded
S-3.000	SMH-9	OK	
S-3.001	SMH-10	OK	
S-2.003	SMH-11	OK	
S-1.005	SMH-12	OK	
S-1.006	SMH-13	OK	
S-1.007	SMH-14	SURCHARGED	
S-1.008	SMH-15	OK	
S-1.009	SMH-Headwall	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes SLS-1 Manhole Sizes SLS450mm

FSR Rainfall Model - England and Wales

Return Period (years)	2	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	18.000	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	0.600
Ratio R	0.391	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.500		

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.000	9.296	0.092	100.9	0.003	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.001	8.387	0.083	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.002	6.892	0.068	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.003	8.104	0.080	100.9	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.000	50.00	4.15	75.250	0.003	0.0	0.0	0.0	1.00	17.7	0.4
S-1.001	50.00	4.29	75.158	0.004	0.0	0.0	0.0	1.00	17.7	0.5
S-1.002	50.00	4.41	75.075	0.005	0.0	0.0	0.0	1.00	17.7	0.7
S-1.003	50.00	4.54	75.006	0.008	0.0	0.0	0.0	1.00	17.7	1.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.004	5.465	0.054	100.9	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.000	8.412	0.083	100.9	0.005	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.001	12.239	0.121	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.002	8.456	0.084	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.000	12.871	0.128	100.9	0.007	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.001	2.211	0.161	13.7	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.003	6.457	0.090	72.1	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.005	4.830	0.322	15.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.006	8.498	0.082	103.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.004	50.00	4.64	74.926	0.014	0.0	0.0	0.0	1.00	17.7	1.8
S-2.000	50.00	4.14	75.250	0.005	0.0	0.0	0.0	1.00	17.7	0.6
S-2.001	50.00	4.34	75.167	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-2.002	50.00	4.49	75.045	0.009	0.0	0.0	0.0	1.00	17.7	1.2
S-3.000	50.00	4.21	75.250	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-3.001	50.00	4.23	75.122	0.015	0.0	0.0	0.0	2.73	48.3	2.0
S-2.003	50.00	4.58	74.962	0.025	0.0	0.0	0.0	1.19	20.9	3.4
S-1.005	50.00	4.67	74.872	0.039	0.0	0.0	0.0	2.61	46.2	5.3
S-1.006	50.00	4.81	74.550	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.007	10.430	0.120	86.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.008	4.909	0.172	28.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.009	14.726	0.142	103.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.007	50.00	4.97	74.468	0.039	0.0	0.0	0.0	1.08	19.1	5.3
S-1.008	50.00	5.01	74.348	0.039	0.0	0.0	0.0	1.89	33.4	5.3
S-1.009	50.00	5.26	74.176	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SMH-1	76.000	0.750	Open Manhole	450	S-1.000	75.250	150				
SMH-2	76.000	0.842	Open Manhole	450	S-1.001	75.158	150	S-1.000	75.158	150	
SMH-3	76.000	0.925	Open Manhole	450	S-1.002	75.075	150	S-1.001	75.075	150	
SMH-4	76.000	0.994	Open Manhole	450	S-1.003	75.006	150	S-1.002	75.006	150	
SMH-5	76.000	1.074	Open Manhole	450	S-1.004	74.926	150	S-1.003	74.926	150	
SMH-6	76.000	0.750	Open Manhole	450	S-2.000	75.250	150				
SMH-7	76.000	0.833	Open Manhole	450	S-2.001	75.167	150	S-2.000	75.167	150	
SMH-8	76.000	0.955	Open Manhole	450	S-2.002	75.045	150	S-2.001	75.045	150	
SMH-9	76.000	0.750	Open Manhole	450	S-3.000	75.250	150				
SMH-10	76.000	0.878	Open Manhole	450	S-3.001	75.122	150	S-3.000	75.122	150	
SMH-11	76.000	1.038	Open Manhole	600	S-2.003	74.962	150	S-2.002	74.962	150	
								S-3.001	74.962	150	
SMH-12	76.000	1.128	Open Manhole	600	S-1.005	74.872	150	S-1.004	74.872	150	
								S-2.003	74.872	150	
SMH-13	75.800	1.250	Open Manhole	1050	S-1.006	74.550	150	S-1.005	74.550	150	
SMH-14	75.800	1.332	Open Manhole	1200	S-1.007	74.468	150	S-1.006	74.468	150	
SMH-15	75.700	1.352	Open Manhole	600	S-1.008	74.348	150	S-1.007	74.348	150	
SMH-Headwall	75.200	1.024	Open Manhole	1000	S-1.009	74.176	150	S-1.008	74.176	150	
SMH-dummy	75.000	0.966	Open Manhole	1000		OUTFALL		S-1.009	74.034	150	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-1	349744.831	305491.838	349744.831	305491.838	Required	
SMH-2	349737.980	305485.556	349737.980	305485.556	Required	
SMH-3	349729.607	305485.054	349729.607	305485.054	Required	
SMH-4	349729.047	305491.923	349729.047	305491.923	Required	
SMH-5	349727.406	305499.859	349727.406	305499.859	Required	
SMH-6	349745.237	305506.632	349745.237	305506.632	Required	
SMH-7	349744.482	305515.010	349744.482	305515.010	Required	
SMH-8	349732.300	305513.826	349732.300	305513.826	Required	
SMH-9	349736.653	305492.730	349736.653	305492.730	Required	
SMH-10	349735.357	305505.536	349735.357	305505.536	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-11	349733.149	305505.413	349733.149	305505.413	Required	
SMH-12	349726.693	305505.278	349726.693	305505.278	Required	
SMH-13	349721.876	305505.635	349721.876	305505.635	Required	
SMH-14	349718.555	305513.456	349718.555	305513.456	Required	
SMH-15	349715.650	305523.474	349715.650	305523.474	Required	
SMH-Headwall	349718.130	305527.710	349718.130	305527.710	Required	
SMH-dummy	349732.359	305531.502			No Entry	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	o	150	SMH-1	76.000	75.250	0.600	Open Manhole	450
S-1.001	o	150	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.002	o	150	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.003	o	150	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.004	o	150	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-2.000	o	150	SMH-6	76.000	75.250	0.600	Open Manhole	450
S-2.001	o	150	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.002	o	150	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-3.000	o	150	SMH-9	76.000	75.250	0.600	Open Manhole	450
S-3.001	o	150	SMH-10	76.000	75.122	0.728	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	9.296	100.9	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.001	8.387	100.9	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.002	6.892	100.9	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.003	8.104	100.9	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-1.004	5.465	100.9	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-2.000	8.412	100.9	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.001	12.239	100.9	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-2.002	8.456	100.9	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-3.000	12.871	100.9	SMH-10	76.000	75.122	0.728	Open Manhole	450
S-3.001	2.211	13.7	SMH-11	76.000	74.962	0.888	Open Manhole	600

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	o	150	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-1.005	o	150	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.006	o	150	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.007	o	150	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.008	o	150	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.009	o	150	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	6.457	72.1	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.005	4.830	15.0	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.006	8.498	103.6	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.007	10.430	86.9	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.008	4.909	28.5	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000
S-1.009	14.726	103.7	SMH-dummy	75.000	74.034	0.816	Open Manhole	1000

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.003	0.003	0.003
1.001	User	-	100	0.001	0.001	0.001
1.002	User	-	100	0.001	0.001	0.001
1.003	User	-	100	0.001	0.001	0.001
	User	-	100	0.002	0.002	0.003
1.004	User	-	100	0.005	0.005	0.005
2.000	User	-	100	0.005	0.005	0.005
2.001	User	-	100	0.002	0.002	0.002
2.002	User	-	100	0.002	0.002	0.002
3.000	User	-	100	0.001	0.001	0.001
	User	-	100	0.003	0.003	0.004
	User	-	100	0.003	0.003	0.007
3.001	User	-	100	0.005	0.005	0.005
	User	-	100	0.003	0.003	0.008
2.003	User	-	100	0.001	0.001	0.001
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.039	0.039	0.039

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Offline Controls	1	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	18.000	Cv (Summer)	0.750
Return Period (years)	2	Ratio R	0.391	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SMH-14, DS/PN: S-1.007, Volume (m^3): 1.6

Unit Reference	MD-SHE-0049-1000-0800-1000	Sump Available	Yes
Design Head (m)	0.800	Diameter (mm)	49
Design Flow (l/s)	1.0	Invert Level (m)	74.468
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0	Kick-Flo®	0.437	0.8
Flush-Flo™	0.215	0.9	Mean Flow over Head Range	-	0.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	0.600	0.9	1.600	1.4	2.600	1.7	5.000	2.3	7.500	2.8
0.200	0.9	0.800	1.0	1.800	1.4	3.000	1.8	5.500	2.4	8.000	2.9
0.300	0.9	1.000	1.1	2.000	1.5	3.500	1.9	6.000	2.5	8.500	2.9
0.400	0.8	1.200	1.2	2.200	1.6	4.000	2.1	6.500	2.6	9.000	3.0
0.500	0.8	1.400	1.3	2.400	1.6	4.500	2.2	7.000	2.7	9.500	3.1

Offline Controls for Storm

Weir Manhole: SMH-14, DS/PN: S-1.007, Loop to PN: S-1.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 75.268

Storage Structures for Storm

Cellular Storage Manhole: SMH-14, DS/PN: S-1.007

Invert Level (m) 74.468 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	16.0	16.0	0.800	16.0	28.8	0.900	0.0	28.8

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.391 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
Climate Change (%) 45

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.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S-1.000	SMH-1	15 Winter	30	+45%					75.280	-0.120	0.000	0.09			1.4	OK
S-1.001	SMH-2	15 Summer	30	+45%					75.193	-0.115	0.000	0.12			1.9	OK
S-1.002	SMH-3	15 Summer	30	+45%					75.116	-0.109	0.000	0.17			2.5	OK
S-1.003	SMH-4	120 Winter	30	+45%					75.074	-0.082	0.000	0.08			1.2	OK
S-1.004	SMH-5	120 Winter	30	+45%					75.074	-0.003	0.000	0.13			1.9	OK
S-2.000	SMH-6	15 Winter	30	+45%					75.287	-0.113	0.000	0.14			2.2	OK
S-2.001	SMH-7	15 Winter	30	+45%					75.212	-0.105	0.000	0.20			3.1	OK
S-2.002	SMH-8	15 Summer	30	+45%					75.099	-0.097	0.000	0.27			4.2	OK

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
S-1.000	SMH-1	
S-1.001	SMH-2	
S-1.002	SMH-3	
S-1.003	SMH-4	
S-1.004	SMH-5	
S-2.000	SMH-6	
S-2.001	SMH-7	
S-2.002	SMH-8	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

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 (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S-3.000	SMH-9	15 Winter	30	+45%					75.294	-0.106	0.000	0.19			3.1
S-3.001	SMH-10	15 Winter	30	+45%					75.176	-0.096	0.000	0.28			7.0
S-2.003	SMH-11	120 Winter	30	+45%					75.074	-0.037	0.000	0.20			3.6
S-1.005	SMH-12	120 Winter	30	+45%	30/60 Winter				75.073	0.051	0.000	0.15			5.5
S-1.006	SMH-13	120 Winter	30	+45%	30/15 Summer				75.071	0.371	0.000	0.34			5.2
S-1.007	SMH-14	120 Winter	30	+45%	30/15 Summer			0	75.069	0.451	0.000	0.05	0.0	128	0.9
S-1.008	SMH-15	360 Summer	30	+45%					74.366	-0.132	0.000	0.04			0.9
S-1.009	SMH-Headwall	30 Winter	30	+45%					74.199	-0.127	0.000	0.06			0.9

PN	US/MH Name	Status	Level Exceeded
S-3.000	SMH-9	OK	
S-3.001	SMH-10	OK	
S-2.003	SMH-11	OK	
S-1.005	SMH-12	SURCHARGED	
S-1.006	SMH-13	SURCHARGED	
S-1.007	SMH-14	SURCHARGED	
S-1.008	SMH-15	OK	
S-1.009	SMH-Headwall	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes SLS-1 Manhole Sizes SLS450mm

FSR Rainfall Model - England and Wales

Return Period (years)	2	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	18.000	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	0.600
Ratio R	0.391	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.500		

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.000	9.296	0.092	100.9	0.003	4.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.001	8.387	0.083	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.002	6.892	0.068	100.9	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S-1.003	8.104	0.080	100.9	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.000	50.00	4.15	75.250	0.003	0.0	0.0	0.0	1.00	17.7	0.4
S-1.001	50.00	4.29	75.158	0.004	0.0	0.0	0.0	1.00	17.7	0.5
S-1.002	50.00	4.41	75.075	0.005	0.0	0.0	0.0	1.00	17.7	0.7
S-1.003	50.00	4.54	75.006	0.008	0.0	0.0	0.0	1.00	17.7	1.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.004	5.465	0.054	100.9	0.005	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.000	8.412	0.083	100.9	0.005	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.001	12.239	0.121	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.002	8.456	0.084	100.9	0.002	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.000	12.871	0.128	100.9	0.007	4.00	0.0	0.600	o	150	Pipe/Conduit	
S-3.001	2.211	0.161	13.7	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-2.003	6.457	0.090	72.1	0.001	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.005	4.830	0.322	15.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.006	8.498	0.082	103.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.004	50.00	4.64	74.926	0.014	0.0	0.0	0.0	1.00	17.7	1.8
S-2.000	50.00	4.14	75.250	0.005	0.0	0.0	0.0	1.00	17.7	0.6
S-2.001	50.00	4.34	75.167	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-2.002	50.00	4.49	75.045	0.009	0.0	0.0	0.0	1.00	17.7	1.2
S-3.000	50.00	4.21	75.250	0.007	0.0	0.0	0.0	1.00	17.7	0.9
S-3.001	50.00	4.23	75.122	0.015	0.0	0.0	0.0	2.73	48.3	2.0
S-2.003	50.00	4.58	74.962	0.025	0.0	0.0	0.0	1.19	20.9	3.4
S-1.005	50.00	4.67	74.872	0.039	0.0	0.0	0.0	2.61	46.2	5.3
S-1.006	50.00	4.81	74.550	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S-1.007	10.430	0.120	86.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.008	4.909	0.172	28.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S-1.009	14.726	0.142	103.7	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S-1.007	50.00	4.97	74.468	0.039	0.0	0.0	0.0	1.08	19.1	5.3
S-1.008	50.00	5.01	74.348	0.039	0.0	0.0	0.0	1.89	33.4	5.3
S-1.009	50.00	5.26	74.176	0.039	0.0	0.0	0.0	0.99	17.4	5.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SMH-1	76.000	0.750	Open Manhole	450	S-1.000	75.250	150				
SMH-2	76.000	0.842	Open Manhole	450	S-1.001	75.158	150	S-1.000	75.158	150	
SMH-3	76.000	0.925	Open Manhole	450	S-1.002	75.075	150	S-1.001	75.075	150	
SMH-4	76.000	0.994	Open Manhole	450	S-1.003	75.006	150	S-1.002	75.006	150	
SMH-5	76.000	1.074	Open Manhole	450	S-1.004	74.926	150	S-1.003	74.926	150	
SMH-6	76.000	0.750	Open Manhole	450	S-2.000	75.250	150				
SMH-7	76.000	0.833	Open Manhole	450	S-2.001	75.167	150	S-2.000	75.167	150	
SMH-8	76.000	0.955	Open Manhole	450	S-2.002	75.045	150	S-2.001	75.045	150	
SMH-9	76.000	0.750	Open Manhole	450	S-3.000	75.250	150				
SMH-10	76.000	0.878	Open Manhole	450	S-3.001	75.122	150	S-3.000	75.122	150	
SMH-11	76.000	1.038	Open Manhole	600	S-2.003	74.962	150	S-2.002	74.962	150	
								S-3.001	74.962	150	
SMH-12	76.000	1.128	Open Manhole	600	S-1.005	74.872	150	S-1.004	74.872	150	
								S-2.003	74.872	150	
SMH-13	75.800	1.250	Open Manhole	1050	S-1.006	74.550	150	S-1.005	74.550	150	
SMH-14	75.800	1.332	Open Manhole	1200	S-1.007	74.468	150	S-1.006	74.468	150	
SMH-15	75.700	1.352	Open Manhole	600	S-1.008	74.348	150	S-1.007	74.348	150	
SMH-Headwall	75.200	1.024	Open Manhole	1000	S-1.009	74.176	150	S-1.008	74.176	150	
SMH-dummy	75.000	0.966	Open Manhole	1000		OUTFALL		S-1.009	74.034	150	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-1	349744.831	305491.838	349744.831	305491.838	Required	
SMH-2	349737.980	305485.556	349737.980	305485.556	Required	
SMH-3	349729.607	305485.054	349729.607	305485.054	Required	
SMH-4	349729.047	305491.923	349729.047	305491.923	Required	
SMH-5	349727.406	305499.859	349727.406	305499.859	Required	
SMH-6	349745.237	305506.632	349745.237	305506.632	Required	
SMH-7	349744.482	305515.010	349744.482	305515.010	Required	
SMH-8	349732.300	305513.826	349732.300	305513.826	Required	
SMH-9	349736.653	305492.730	349736.653	305492.730	Required	
SMH-10	349735.357	305505.536	349735.357	305505.536	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH-11	349733.149	305505.413	349733.149	305505.413	Required	
SMH-12	349726.693	305505.278	349726.693	305505.278	Required	
SMH-13	349721.876	305505.635	349721.876	305505.635	Required	
SMH-14	349718.555	305513.456	349718.555	305513.456	Required	
SMH-15	349715.650	305523.474	349715.650	305523.474	Required	
SMH-Headwall	349718.130	305527.710	349718.130	305527.710	Required	
SMH-dummy	349732.359	305531.502			No Entry	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	o	150	SMH-1	76.000	75.250	0.600	Open Manhole	450
S-1.001	o	150	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.002	o	150	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.003	o	150	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.004	o	150	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-2.000	o	150	SMH-6	76.000	75.250	0.600	Open Manhole	450
S-2.001	o	150	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.002	o	150	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-3.000	o	150	SMH-9	76.000	75.250	0.600	Open Manhole	450
S-3.001	o	150	SMH-10	76.000	75.122	0.728	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-1.000	9.296	100.9	SMH-2	76.000	75.158	0.692	Open Manhole	450
S-1.001	8.387	100.9	SMH-3	76.000	75.075	0.775	Open Manhole	450
S-1.002	6.892	100.9	SMH-4	76.000	75.006	0.844	Open Manhole	450
S-1.003	8.104	100.9	SMH-5	76.000	74.926	0.924	Open Manhole	450
S-1.004	5.465	100.9	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-2.000	8.412	100.9	SMH-7	76.000	75.167	0.683	Open Manhole	450
S-2.001	12.239	100.9	SMH-8	76.000	75.045	0.805	Open Manhole	450
S-2.002	8.456	100.9	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-3.000	12.871	100.9	SMH-10	76.000	75.122	0.728	Open Manhole	450
S-3.001	2.211	13.7	SMH-11	76.000	74.962	0.888	Open Manhole	600

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	o	150	SMH-11	76.000	74.962	0.888	Open Manhole	600
S-1.005	o	150	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.006	o	150	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.007	o	150	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.008	o	150	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.009	o	150	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S-2.003	6.457	72.1	SMH-12	76.000	74.872	0.978	Open Manhole	600
S-1.005	4.830	15.0	SMH-13	75.800	74.550	1.100	Open Manhole	1050
S-1.006	8.498	103.6	SMH-14	75.800	74.468	1.182	Open Manhole	1200
S-1.007	10.430	86.9	SMH-15	75.700	74.348	1.202	Open Manhole	600
S-1.008	4.909	28.5	SMH-Headwall	75.200	74.176	0.874	Open Manhole	1000
S-1.009	14.726	103.7	SMH-dummy	75.000	74.034	0.816	Open Manhole	1000

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.003	0.003	0.003
1.001	User	-	100	0.001	0.001	0.001
1.002	User	-	100	0.001	0.001	0.001
1.003	User	-	100	0.001	0.001	0.001
	User	-	100	0.002	0.002	0.003
1.004	User	-	100	0.005	0.005	0.005
2.000	User	-	100	0.005	0.005	0.005
2.001	User	-	100	0.002	0.002	0.002
2.002	User	-	100	0.002	0.002	0.002
3.000	User	-	100	0.001	0.001	0.001
	User	-	100	0.003	0.003	0.004
	User	-	100	0.003	0.003	0.007
3.001	User	-	100	0.005	0.005	0.005
	User	-	100	0.003	0.003	0.008
2.003	User	-	100	0.001	0.001	0.001
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.039	0.039	0.039

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Offline Controls	1	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	18.000	Cv (Summer)	0.750
Return Period (years)	2	Ratio R	0.391	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SMH-14, DS/PN: S-1.007, Volume (m^3): 1.6

Unit Reference	MD-SHE-0049-1000-0800-1000	Sump Available	Yes
Design Head (m)	0.800	Diameter (mm)	49
Design Flow (l/s)	1.0	Invert Level (m)	74.468
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0	Kick-Flo®	0.437	0.8
Flush-Flo™	0.215	0.9	Mean Flow over Head Range	-	0.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	0.600	0.9	1.600	1.4	2.600	1.7	5.000	2.3	7.500	2.8
0.200	0.9	0.800	1.0	1.800	1.4	3.000	1.8	5.500	2.4	8.000	2.9
0.300	0.9	1.000	1.1	2.000	1.5	3.500	1.9	6.000	2.5	8.500	2.9
0.400	0.8	1.200	1.2	2.200	1.6	4.000	2.1	6.500	2.6	9.000	3.0
0.500	0.8	1.400	1.3	2.400	1.6	4.500	2.2	7.000	2.7	9.500	3.1

Offline Controls for Storm

Weir Manhole: SMH-14, DS/PN: S-1.007, Loop to PN: S-1.009

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 75.268

Storage Structures for Storm

Cellular Storage Manhole: SMH-14, DS/PN: S-1.007

Invert Level (m) 74.468 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	16.0	16.0	0.800	16.0	28.8	0.900	0.0	28.8

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.391 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 100
Climate Change (%) 45

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.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S-1.000	SMH-1	15 Winter	100	+45%					75.283	-0.117	0.000	0.11			1.7
S-1.001	SMH-2	120 Winter	100	+45%					75.271	-0.037	0.000	0.05			0.8
S-1.002	SMH-3	120 Winter	100	+45%	100/60 Winter				75.271	0.046	0.000	0.07			1.0
S-1.003	SMH-4	120 Winter	100	+45%	100/60 Winter				75.270	0.114	0.000	0.10			1.5
S-1.004	SMH-5	120 Winter	100	+45%	100/30 Winter				75.270	0.193	0.000	0.17			2.5
S-2.000	SMH-6	15 Winter	100	+45%					75.293	-0.107	0.000	0.18			2.8
S-2.001	SMH-7	120 Winter	100	+45%					75.272	-0.044	0.000	0.08			1.2
S-2.002	SMH-8	120 Winter	100	+45%	100/60 Winter				75.271	0.076	0.000	0.11			1.7

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S-1.000	SMH-1	OK	
S-1.001	SMH-2	OK	
S-1.002	SMH-3	SURCHARGED	
S-1.003	SMH-4	SURCHARGED	
S-1.004	SMH-5	SURCHARGED	
S-2.000	SMH-6	OK	
S-2.001	SMH-7	OK	
S-2.002	SMH-8	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

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.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S-3.000	SMH-9	15 Winter	100	+45%					75.301	-0.099	0.000	0.25			4.0
S-3.001	SMH-10	120 Winter	100	+45%					75.271	-0.001	0.000	0.11			2.8
S-2.003	SMH-11	120 Winter	100	+45%	100/30 Winter				75.271	0.159	0.000	0.26			4.7
S-1.005	SMH-12	120 Winter	100	+45%	100/15 Winter				75.269	0.247	0.000	0.20			7.0
S-1.006	SMH-13	120 Winter	100	+45%	100/15 Summer				75.267	0.567	0.000	0.43			6.6
S-1.007	SMH-14	120 Winter	100	+45%	100/15 Summer			0	75.264	0.646	0.000	0.06	0.0	172	1.0
S-1.008	SMH-15	120 Winter	100	+45%					74.367	-0.131	0.000	0.04			1.0
S-1.009	SMH-Headwall	120 Winter	100	+45%					74.200	-0.126	0.000	0.06			1.0

PN	US/MH Name	Status	Level Exceeded
S-3.000	SMH-9	OK	
S-3.001	SMH-10	OK	
S-2.003	SMH-11	SURCHARGED	
S-1.005	SMH-12	SURCHARGED	
S-1.006	SMH-13	SURCHARGED	
S-1.007	SMH-14	SURCHARGED	
S-1.008	SMH-15	OK	
S-1.009	SMH-Headwall	OK	

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Main

Pipe Sizes Foul1 Manhole Sizes Foul-MH1

Industrial Flow (l/s/ha)	0.00	Domestic (l/s/ha)	0.00	Maximum Backdrop Height (m)	1.500
Industrial Peak Flow Factor	0.00	Domestic Peak Flow Factor	6.00	Min Design Depth for Optimisation (m)	0.450
Flow Per Person (l/per/day)	222.00	Add Flow / Climate Change (%)	0	Min Vel for Auto Design only (m/s)	1.00
Persons per House	3.00	Minimum Backdrop Height (m)	0.200	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F-1.000	8.115	0.107	75.8	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
F-1.001	7.852	0.104	75.5	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F-1.002	13.318	0.176	75.5	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F-1.003	5.004	0.066	75.5	0.000	0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F-1.000	75.450	0.000	0.0	1	0.0	6	0.20	1.01	17.8	0.0
F-1.001	75.343	0.000	0.0	1	0.0	6	0.20	1.01	17.8	0.0
F-1.002	75.239	0.000	0.0	1	0.0	6	0.20	1.01	17.8	0.0
F-1.003	75.062	0.000	0.0	1	0.0	6	0.20	1.01	17.8	0.0

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F-2.000	2.500	0.057	43.7	0.000	1	0.0	1.500	o	100	Pipe/Conduit	
F-2.001	2.481	0.057	43.7	0.000	0	0.0	1.500	o	100	Pipe/Conduit	
F-2.002	5.816	0.290	20.1	0.000	0	0.0	1.500	o	100	Pipe/Conduit	
F-1.004	4.593	0.061	75.3	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F-1.005	4.489	0.060	74.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F-2.000	75.450	0.000	0.0	1	0.0	6	0.25	1.01	7.9	0.0
F-2.001	75.393	0.000	0.0	1	0.0	6	0.25	1.01	7.9	0.0
F-2.002	75.336	0.000	0.0	1	0.0	5	0.33	1.49	11.7	0.0
F-1.004	74.996	0.000	0.0	2	0.0	8	0.25	1.01	17.9	0.1
F-1.005	74.935	0.000	0.0	2	0.0	8	0.25	1.01	17.9	0.1

Manhole Schedules for Foul - Main

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
FMH-1	76.000	0.550	Open Manhole	450	F-1.000	75.450	150				
FMH-2	76.000	0.657	Open Manhole	450	F-1.001	75.343	150	F-1.000	75.343	150	
FMH-3	76.000	0.761	Open Manhole	450	F-1.002	75.239	150	F-1.001	75.239	150	
FMH-4	76.000	0.938	Open Manhole	450	F-1.003	75.062	150	F-1.002	75.062	150	
FMH-5	76.000	0.550	Open Manhole	180	F-2.000	75.450	100				
FMH-6	76.000	0.607	Open Manhole	180	F-2.001	75.393	100	F-2.000	75.393	100	
FMH-7	76.000	0.664	Open Manhole	180	F-2.002	75.336	100	F-2.001	75.336	100	
FMH-8	76.000	1.004	Open Manhole	1050	F-1.004	74.996	150	F-1.003	74.996	150	
								F-2.002	75.046	100	
FMH-9	75.800	0.865	Open Manhole	450	F-1.005	74.935	150	F-1.004	74.935	150	
FMH-	0.000		Open Manhole	0		OUTFALL		F-1.005	74.875	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FMH-1	349745.669	305499.422	349745.669	305499.422	Required	
FMH-2	349745.797	305507.536	349745.797	305507.536	Required	
FMH-3	349744.913	305515.338	349744.913	305515.338	Required	

Manhole Schedules for Foul - Main

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FMH-4	349731.653	305514.095	349731.653	305514.095	Required	
FMH-5	349734.936	305504.084	349734.936	305504.084	Required	
FMH-6	349732.459	305504.424	349732.459	305504.424	Required	
FMH-7	349732.313	305506.901	349732.313	305506.901	Required	
FMH-8	349727.942	305510.738	349727.942	305510.738	Required	
FMH-9	349724.106	305513.263	349724.106	305513.263	Required	
FMH-	349719.637	305513.701			No Entry	

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F-1.000	o	150	FMH-1	76.000	75.450	0.400	Open Manhole	450
F-1.001	o	150	FMH-2	76.000	75.343	0.507	Open Manhole	450
F-1.002	o	150	FMH-3	76.000	75.239	0.611	Open Manhole	450
F-1.003	o	150	FMH-4	76.000	75.062	0.788	Open Manhole	450
F-2.000	o	100	FMH-5	76.000	75.450	0.450	Open Manhole	180
F-2.001	o	100	FMH-6	76.000	75.393	0.507	Open Manhole	180
F-2.002	o	100	FMH-7	76.000	75.336	0.564	Open Manhole	180
F-1.004	o	150	FMH-8	76.000	74.996	0.854	Open Manhole	1050
F-1.005	o	150	FMH-9	75.800	74.935	0.715	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F-1.000	8.115	75.8	FMH-2	76.000	75.343	0.507	Open Manhole	450
F-1.001	7.852	75.5	FMH-3	76.000	75.239	0.611	Open Manhole	450
F-1.002	13.318	75.5	FMH-4	76.000	75.062	0.788	Open Manhole	450
F-1.003	5.004	75.5	FMH-8	76.000	74.996	0.854	Open Manhole	1050
F-2.000	2.500	43.7	FMH-6	76.000	75.393	0.507	Open Manhole	180
F-2.001	2.481	43.7	FMH-7	76.000	75.336	0.564	Open Manhole	180
F-2.002	5.816	20.1	FMH-8	76.000	75.046	0.854	Open Manhole	1050
F-1.004	4.593	75.3	FMH-9	75.800	74.935	0.715	Open Manhole	450
F-1.005	4.489	74.8	FMH-	0.000	74.875		Open Manhole	0

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