Site of White's Bakery, Worsborough, S70 5AF

Surface and Foul Water Drainage Assessment

For A & E White

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November 2020

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Site of White's Bakery, Worsborough, S70 5AF	
Project	Surface and Foul Water Drainage Assessment
Client	A & E White
Status	Final
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EXECUTIVE SUMMARY

The purpose of this report is to assess the potential for disposing of foul and 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 NPPF. The proposed development will considerably reduce the flood risk posed to the site and to off-site locations due to the adoption of a SUDS Strategy.

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 Environmental Limited at the request of A & E White to support a planning application for the proposed development at Site of White's Bakery, Worsborough, S70 5AF.

It is recognised that developments that are designed without regards to the surface and foul 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 & Local Government (2019) 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 runoff. 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 each site. A surface water drainage assessment 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 & development description;
- Sections 3 details the possible foul water discharge destinations;
- 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 SuDS Strategy: and
- Section 8 presents a summary and conclusions.

2.0 LOCATION & DEVELOPMENT DESCRIPTION

2.1 Site Location

The site is located at White's Bakery, Worsborough, S70 5AF (see Figure 1).

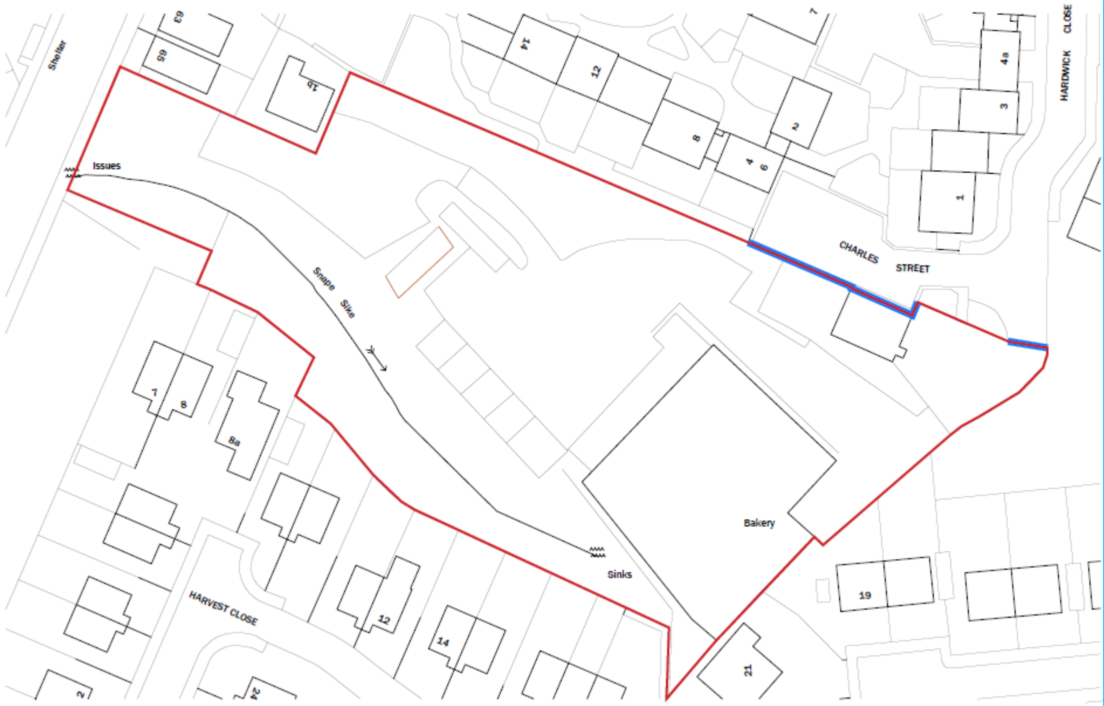


Figure 1 - Site Location

2.2 Existing Development

The site is currently a bakery and scrub land. The existing impermeable areas covers 2,744m^2.

2.3 Proposed Development

The site proposals are for the erection of 14 dwellings with associated car parking and amenity space (see Appendix 1). The proposed impermeable areas will cover approximately 2,300m^2. Further details with regard to the proposed development can be found in the accompanying information submitted with the planning application.

2.4 Catchment Hydrology

The Snape Sike runs through the southern portion of the site from west to east, Snape Sike is located well below the ground levels of the proposed dwellings. 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 CD-ROM (v3) is 743mm per annum. The UK national average is 832mm per annum.

The catchment is very heavily urbanised. The catchment is predominantly impermeable with a large proportion of the rainfall contributing to direct runoff rather than being stored. The catchment is responsive to rainfall with the majority of baseflow being rainfall derived. It would be expected that the catchment has a rapid, flashy response to a rainfall event.

2.5 Public Sewers

The Yorkshire Water public sewer plan is shown in Figure 2. Yorkshire Water have confirmed the following (see Appendix 2):

- There is a 375 mm diameter public surface water sewer recorded crossing the north eastern part of the site. No buildings, or other obstructions, are to be erected within 3 (three) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer.

- The site shall be developed with separate systems of drainage for foul and surface water on and off site (in the interest of satisfactory and sustainable drainage.

- Foul water domestic waste should discharge to the combined sewer network.

- No development shall take place until details of the proposed means of disposal of surface water drainage, including details of any balancing works and off-site works, have been submitted to and approved by the Local Planning Authority.

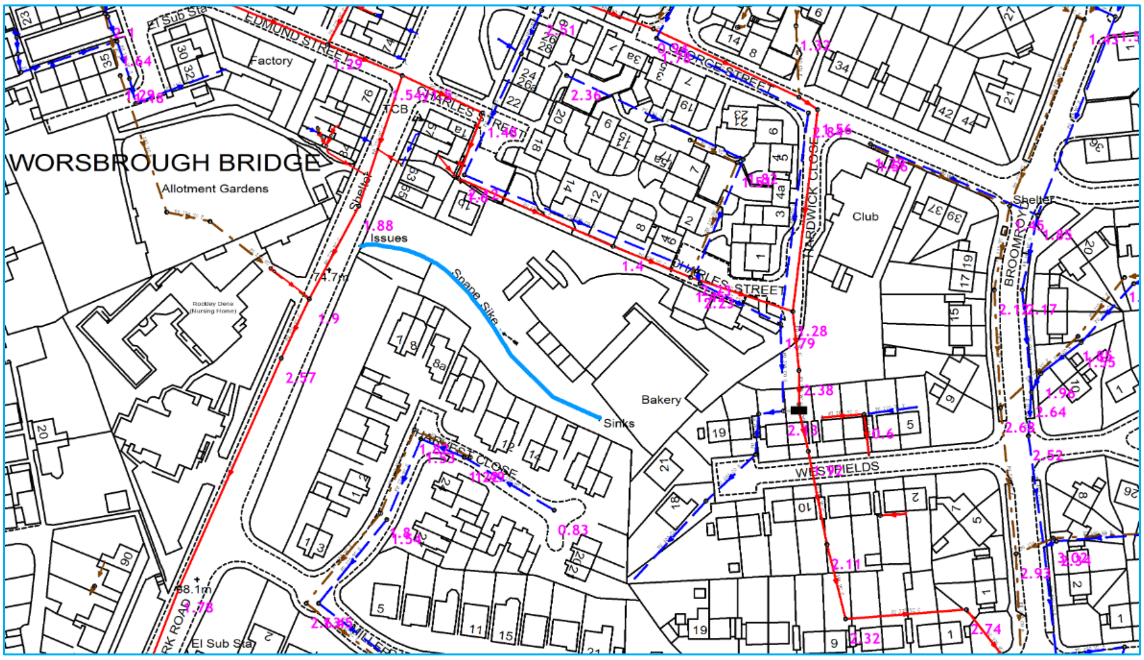


Figure 2 - Yorkshire Public Sewers

2.6 Geology

The British Geological Survey (BGS) Map indicates that no superficial deposits underlay the site. It is anticipated that Made Ground artificial deposits may underlays the site. The bedrock deposits consist of the Pennine Middle Coal Measures Formation - mudstone, siltstone and sandstone. Sedimentary Bedrock formed approximately 310 to 318 million years ago in the Carboniferous Period in a local environment previously dominated by swamps, estuaries and deltas.

2.7 Groundwater

No BGS borehole records are held for positions located within the site. Groundwater is likely to be more than 3.00m below the ground surface and confirms that the groundwater is not expected to be especially vulnerable to contamination. Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.

2.8 Source Protection Zone

The site is not located within an Environment Agency Source Protection Zone. 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); SPZ 3 is the Total Catchment (least risk).

2.9 Soil

Information from the National Soil Resources Institute details the site area as being situated on slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage.

2.10 Contaminated Land

We are not aware of any historical industrial land use. Further investigation would be required to confirm this. The client has not provided information to suggest the potential for contamination within the site boundary from past land uses.

2.11 Ground stability

Dissolution, sand liquefaction and landslides could be enhanced by SUDS infiltration and lead to unstable ground. Dissolution risk is low since the site does not appear to be directly underlain by chalk or other soluble rocks. Sand liquefaction risk is low since the site is not located on unconsolidated superficial sand deposits. Landslide risk is low since there are no records of landslides close to the site according to the BGS.

The BGS data does not indicate any very significant geological hazards (soluble rock; landslide hazard; shallow mining; or made ground) within the site. Increased infiltration is unlikely to result in increased geological hazards.

2.12 Permeability/Infiltration Rate

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. An overview of the general ground conditions may be used to gauge if there is potential for their application. The general ground conditions suggest that the permeability and infiltration rate of the site will be low and infiltration devices such as soakaways may not work at the site.

If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations. Such work is beyond the scope of this report, but should be undertaken to inform the detailed drainage strategy for the site.

3.0 FOUL WATER DRAINAGE

3.1 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. Foul water domestic waste should discharge to the combined sewer network.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

3.2 Conditions

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage can be connected/discharged to the public sewer.

At a last resort, highway drainage may be accepted under certain circumstances. If SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharge to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with Yorkshire Water under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

Foul water from kitchens and/or food preparation areas of any restaurants and/or canteens etc. must pass through a fat and grease trap of adequate design before any discharge to the public sewer network.

3.3 Application to make connections

The developer will write to Yorkshire Water requesting an application form that will be duly completed and returned. No works on the public sewer will be carried out until a letter of consent is received from Yorkshire Water.

3.4 Adoption Agreements

Prospective adoptable sewers and pumping stations will be designed and in constructed in accordance with 'Sewers for Adoption' 7th Edition as supplemented by Yorkshire Water requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site.

3.5 Easements

An easement (an area over and to either side of the sewer on which no buildings or other permanent structures are permitted) is required where sewers are laid in land other than highway. The minimum dimension of a sewer easement is 6 metres (3 metres either side of the centre line of the sewer), but may be more depending on the size and depth of the sewer. No information has been provided by Yorkshire Water on the depth of sewers within the vicinity of the site. Easements are not required where the sewers are in the public highway. If sewers are shown as being present on the site this will be discussed further with Yorkshire Water.

4.0 SURFACE WATER RUNOFF DESTINATION

4.1 Opportunities for Discharge of Surface Water

Possible receptors for run-off 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

The ground conditions suggest infiltration SuDS techniques such as soakaways may not work and may not provide a suitable option at the site.

4.3 Discharge to Surface Water Body

Should infiltration be found to be unsuitable, the next option is discharge to a surface water body. The Snape Sike runs through the southern portion of the site from west to east. There are no other watercourses evident either on, or within the vicinity of the site. The surface water runoff from the site would be attenuated on-site before being discharged to the Snape Sike at greenfield runoff rates. Any attenuated and controlled surface water discharge to the Snape Sike would have minimal effect on the water levels of Snape Sike. Therefore, discharge to a water body will not be possible.

4.4 Discharge to Road Drain or Surface Water Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to a public surface water sewer will be possible. There is a 375 mm diameter public surface water sewer recorded crossing the north eastern part of the site. Discharge to the public surface water sewer would be at existing or greenfield runoff rates.

It would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer. A gravity connection to the sewers would be made at a location/s adjacent to the site. If required, it should be confirmed with Yorkshire Water if they have the capacity to accept any discharge of surface water from the site. If so, it would be possible to discharge to the public sewers, at a point adjacent to the site. This option should be explored further.

4.5 Discharge to a Combined Sewer

This option will not be required.

5.0 SURFACE WATER PEAK FLOW AND VOLUME

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 SuDS Strategies. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF[3].

Table 1 shows the anticipated changes in extreme rainfall intensity in small and urban catchments.

Table 1 - Peak Rainfall Intensity Allowance in Small and Urban Catchment (use 1961 to 1990 baseline)

Parameter	2010 to 2039	2040 to 2059	2060 to 2115
Upper end	+ 10%	+ 20%	+ 40%
Central	+ 5%	+ 10%	+ 20%

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. The existing impermeable areas covers 2,744m^2 and the proposed impermeable areas will cover approximately 2,300m^2.

An estimation of surface water runoff is required to permit effective site 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 IoH124 method. QBAR (rural) has been calculated to be 0.40l/s for the proposed impermeable area of 2,300m^2. Table 2 shows the IoH 124 method Greenfield runoff rates for the site (see Appendix 3).

The method used for calculating the runoff complies with the NPPF, as well as the new Defra non-statutory technical standards for SuDS, and assumes that the excess runoff associated with the proposed development (plus an allowance for future climate change) will need to be managed by the proposed SuDS scheme.

Table 2 - IoH124 method Greenfield Runoff Rates

Rainfall Event	Runoff Rate (l/s)
1	0.34
QBAR (rural)	0.40
30	0.67
100	0.84

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

6.0 SURFACE WATER QUALITY

6.1 SuDS and Water Quality

A key requirement of any SuDS 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 SuDS 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).

Proposed SUDS must account for a sufficient number of treatment stages to protect the receiving waterbody. The minimum number of treatment stages will depend of the sensitivity of the receiving groundwater body and the potential hazard associated with the proposed development.

Current guidance promotes sustainable water management through the use of SuDS. SuDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

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 bio-diversity. 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;

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

- 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
- 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

Most Sustainable ↕ Least Sustainable	SuDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
	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	✓	✓	
	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 Draft 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. scrap-yards).

Table 5 has been extrapolated from the Defra Draft National Standards and indicates in green the stages of treatment suggested for the different runoff waters identified for the proposed development. It is noted that if the site is on clay and does not discharge to the aquifer then less treatment is required.

Table 5 - Minimum number of treatment stages for groundwater

<table>
<tr><th rowspan="2">Sensitivity of the groundwater below the site</th><th colspan="3">Hazard</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td>SPZ 1; within 50 m of an existing well, a spring or a borehole that supplies potable water</td><td>1</td><td>3</td><td rowspan="4">Consult with the Environment Agency</td></tr>
<tr><td>Discharge into or immediately adjacent to a sensitive receptor that could be influenced by infiltrated water. Includes designated nature conservation, heritage and landscape sites – including Biodiversity Action Plan (BAP) habitats and Protected Species</td><td>1</td><td>3</td></tr>
<tr><td>SPZ 2 or SPZ 3 or Principal Aquifer</td><td>1</td><td>3</td></tr>
<tr><td>Secondary Aquifer</td><td>1</td><td>2</td></tr>
</table>

6.2 Source Control

(i) Soakaways

Soakaways are buried rings or tanks filled with rubble or stone and allow gradual infiltration of collected runoff from impermeable areas into the surrounding soil. They require relatively permeable strata below a site to allow percolation and the reduction in runoff is achieved by the volume of percolation and the available storage volume. An assessment of their suitability requires the characteristics of the sub-soils or the geology to confirm the infiltration rate or vertical permeability.

The depth of any soakaway should not normally exceed 2.00m and will not intersect the water table. A minimum of 1.00m unsaturated zone will be maintained between the base of any soakaway and the maximum seasonal water table. Whilst the permeability and infiltration rate of the site should ideally be confirmed by a site investigation into the hydrogeology of the site, the ground conditions suggest infiltration techniques such as soakaways may not work and may not provide a suitable option at the site.

(ii) Permeable Paving

The use of permeable paving can often be considered for pedestrian or car parking areas but not for heavy traffic areas such as roadways where the heavy loading could damage the paving infrastructure. It is also possible to provide plot-by-plot systems connecting in to a site wide system. There may be scope to apply these features on a plot-by-plot basis as the layout develops further. These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the run-off.

Permeable paving also depends on having permeable underlying strata. The permeable paving can either discharge via infiltration or discharge to cellular storage. Land take is reduced as storage is located under car parks and access roads. However, maintenance is potentially a long-term issue and the possibility of the paving being damaged, dug up and not properly reinstated or not regularly swept could lead to compromising the future capacity of the system.

This system will negate the need for a separate collection system such as kerbs and gullies. It will also assist in reducing the flood profile of the site by significantly attenuating the run-off from the development within the sub base material. There is no specific amenity provided by the system other than enabling other areas to be utilised for development rather than potentially sterilizing areas with an easement for a sewer or stand-off for a basin.

Permeable paving will provide storage for the first 5mm (interception storage) as a minimum. It is should be noted that any permeable paving system to be installed by a developer must have an infiltration rate of at least 30mm/hr (0.03m/hr) to avoid ponding on the surface before it reaches the natural soil (permeable paving systems generally would have an infiltration rate in excess of 30mm/hr).

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the runoff. Treatment processes that occur within the surface structure and the geotextile layers include:

- Filtration
- Absorption
- Biodegradation
- Sedimentation

Whilst the permeability and infiltration rate of the site should ideally be confirmed by a site investigation into the hydrogeology of the site, the ground conditions suggest infiltration techniques such as permeable paving may not work and may not provide a suitable option at the site. However, permeable paving which discharges to cellular storage could be used within the site, permeable paving would provide treatment processes with attenuation storage within the below ground cellular storage.

(iii) Rainwater Harvesting

The reuse of water from roofed areas to provide grey (non-potable) water for flushing WCs within buildings can reduce storm runoff without the need for treatment or oil separators since the risk of spillage or contamination is low. Such a facility could be practical depending on the available water volumes. Rain water is held in off-line storage tanks at or about roof level from where a gravity feed is used to supplement the standard water supply. This would not include the hardstanding areas at ground level such as roads and car parking areas which would require a pumped system to return water to roof level and this is considered impractical. Over the course of a year a grey water system will reduce the volume of water entering the storm water disposal system and could be considered.

Such a system would require one or more tanks at roof level and under optimum conditions these would be kept as near as full as possible to ensure a reliable water supply. For the purposes of a worst-case design scenario it is assumed that the tanks would be full at the start of an extreme rainfall event and hence all storm rainfall would enter the surface water drainage system rather than grey water storage. Whilst there may be merit in including such a scheme in the overall designs these are not considered appropriate in the SuDS assessment.

(iv) Water Butts

Water butts are the most common means of harvesting rainwater for garden use. They are small, off-line storage devices that are designed to capture and store roof runoff. They are a simple water conservation technique that can contribute to sustainable water management for developed areas. In general water butts, do not provide water quality treatment.

A water butt collects rainwater from roofs via an inlet that is connected to the roof down-pipe. Water butts are manufactured in a wide variety of sizes and can consist of inter-connectable units. During wet periods, water butts are often full, resulting in little or no attenuation or reduction in outflow rates or volumes. However, water butts can be designed to attenuate runoff by using a throttled overflow system with excess water discharge to the drainage system or soakaway.

Water butts will be used to provide betterment but not as the primary system and have therefore not been included within any storage volume calculations. Normal sized water butts can provide between $0.20m^3$ and $0.35m^3$ of water storage.

(iv) Green Roofs/Brown Roofs

A green/brown roof is a multi-layered system that covers the top of a building with soil and vegetation and which can provide a degree of rain storm attenuation and a reduction in site runoff. These can either be extensive roofs which are low maintenance with a 25-125mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which impose a greater load on the roof structure but are more suitable in certain circumstances. Green/brown roofs can be used to reduce the volume and rate of runoff so that other SuDS techniques in the scheme can be significantly reduced in size.

The application of green roofs in a domestic scenario is limited due to on-going cost, maintenance and access requirements of any system therefore, this is not a practical option and is therefore not considered further.

6.3 Site Control - Permeable Conveyance Systems

Permeable conveyance systems can take the form of infiltration trenches, swales or filter strips at road margins where surface runoff from roads, car parking areas and also roof drainage can be directed. Other options include canals and rills. Used to collect water directly from linear systems, percolate the flow, attenuate and then discharge the flow to either a traditional system or a secondary SuDS device.

The use of these systems is more suited to linear applications such as roads as the typical cross section is relatively small and longer runs are required to provide attenuation volume. Land take can be relatively small in comparison to other systems and both types perform well in improving water quality. They are also ideally suited for disposal of water via secondary infiltration. Due to the small size of the site it has been concluded that these are not a practical option and is therefore not considered further.

6.4 Passive Treatment Systems

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 principle applied in the design of storage is to limit the discharge rate of surface water runoff from the developed site for events of similar frequency of occurrence to the same peak rate of runoff as that which takes place from a greenfield site prior to development. QBAR (rural) has been calculated to be 0.40l/s. Using a complex control device and practical minimum pipe sizes it is not practical to control the discharge rate to below 5.00l/s. Therefore, a value of 5.00l/s has been used as the limiting discharge rate before discharge to the Snake Sike

Table 6 shows the volume of storage required for the proposed development estimated using the Masterdrain Drainage Software for the 1 in 100 year event, with a 40% allowance for climate change (increase in peak rainfall) assuming the proposed 2,300m^2 of impermeable area with 5.00l/s used as the limiting discharge rate (see Appendix 4). Therefore, the surface water runoff from the developed site will be no greater than existing.

Table 6 - Attenuation Storage Volume with No Infiltration

Return Period (years)	Limiting Discharge Rate (l/s)	Volume (m^3)
100 +40%	5.00	139

This volume may be reduced by implementing a complex control at the outfall which would increase the rate of discharge from the site for events above the 1 in 30 year event in accordance with the Interim Code of Practice for SuDS. This should be explored at detailed design stage and agreed with the Local Planning Authority, Lead Local Flood Authority, Yorkshire Water and the Environment Agency. This volume of attenuation storage could be provided by a variety of means these are discussed below.

(i) Ponds and Basins

The nature of these systems is such that the runoff from the development can be treated by biological action and stilling to significantly improve the quality of water discharged from the system.

Basins also provide large areas of open space that can be developed for recreational uses or as new habitats for wildlife. Both systems do, however, take up significant amounts of developable land and have residual maintenance and liability issues attached to their implementation. Due to the lack of open space within the site it would not be possible to integrate these into the site layout.

(ii) Storage Tanks

Hard engineered tank storage systems have traditionally been used for attenuation structures for the past decade and are often specified where large volumes of storage are required (>200m^3) and available space is an issue. These could be located underneath the roads and paved areas.

These systems have no inherent water treatment properties bar potential sedimentation of the attenuated flow and offer no additional amenity benefits. In some cases, the easement to the tank or culvert is such that a significant portion of land area is sterilized from development and certain planting.

There are also significant costs associated with these systems in production, transportation and installation. However, once installed the long-term maintenance of the system is relatively low. With a proven record of successful installation, tanks and culverts are regularly adopted by water authorities across the country, albeit with a large associated easement that will sterilise that portion of the site.

In this case, the site conditions would permit the use of these systems with careful integration. The site layout allows for 139m^3 of storage tanks under the car parking areas located on the site. The oversized drainage network would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(iii) Oversized Drainage Network

A further option on storage and attenuation would be the use of an oversized drainage network designed to act as inline storage, rather than a tank or pond, to provide the required storage volume underground. These could be located underneath the roads and paved areas.

As the diameter of larger pipes readily available is limited the applicability of these types of systems is more suited to <200m^3 of attenuation. Above this volume, the length of pipe required is excessive and difficult to suitably fit into a normal site layout. There is no intrinsic amenity provided by the use of this system neither is there any specific level of run-off treatment over and above that of a standard pipe and gully system.

However, due to their traditional nature, the adoption of these types of systems by water authorities is straightforward and does not require any specialist input. The pipes are generally available direct from suppliers with little or no lead in time and the satisfactory long-term performance of these systems is well documented.

In this case, the site conditions would permit the use of these systems with careful integration. The site layout allows for 139m^3 of oversized drainage networks under the car parking areas located on the site. The oversized drainage network would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(iv) Cellular Storage

Large volumes of storage can be provided under grassed and lightly trafficked areas by using proprietary plastic cellular 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 building to this cellular storage facility. This option could also be drained via permeable pavement surfaces.

The site layout allows for cellular storage under the highways located on the site. The site layout allows for 139m^3 of cellular storage under the car parking areas located on the site. Cellular storage would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(v) Surface Storage

The use of roads, public areas and even landscaped areas as additional storage is becoming a widely-accepted form of attenuation. Water spilling from drainage systems can be collected via roads and kerbs and channelled to lower lying areas where it would be stored until the capacity in the existing system returns.

These systems have the advantage of requiring little additional infrastructure merely detailing of the proposed roads and grassed areas. As these systems, will only be used in extreme events when the adopted drainage system is exceeded (>1 in 30 years), they provide a very efficient way of catering for these events rather than providing permanent capacity. There is no inherent water treatment capability in this system or any particular increase in amenity; however, the costs associated with this provision are relatively small.

7.0 SUSTAINABLE 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. The proposed SuDS Strategy is designed to attenuate surface water runoff up to and including the 1 in 100 year (+40%) event. The SuDS 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 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy with infiltration being utilised wherever possible. If discharge via infiltration is not possible the surface water will discharge to a public combined sewer.

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. It is therefore recommended that the site provides its own attenuation. The SuDS Strategy would take the form of:

- Discharge to the Snake Sike at a restricted runoff rate of 5.00l/s.
- Water Butts for each building.
- Permeable paving of driveways, patios, footpaths and car parking areas.
- Storage tanks, oversized drainage network or cellular storage below the permeable paving with an attenuation storage volume of 139m^3.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The precise nature and form of the SUDS system will be influenced by the type of the site layout, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made.

If ground permeability is poor then surface features such as filter strips, canals and rills, swales etc. would be required for conveying surface water runoff. Some pipework would invariably be required for road crossings and flow control purposes.

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 40% 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 (+40%) storm event. This restriction will provide significant flood mitigation benefits to existing third-party property and land downstream of the site that may be potentially at risk from flooding.

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, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 165m^3 of attenuation storage will be incorporated into the site layout with discharge limited to 5.00l/s for all events up to and including the 1 in 100 year (+40%) rainfall event before discharge to the public combined sewers. Therefore, the surface water runoff from the developed site will be no greater than existing.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, 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.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a SuDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the LPA, the LLFA, Yorkshire Water and the Environment Agency.

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 Designing for Local Drainage System Failure/Design Exceedance

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 ground5.

The attenuation requirements have been designed to accommodate the 1 in 100 year storm event plus climate change (+40%). 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 properties to the underground storage 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 level will be raised above surrounding ground levels, ensuring any exceedance flooding

[5] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

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 public open space is 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 landscaped 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 (+40%) event, there is safety, 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, pipework 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.

7.3 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 bio-diversity. 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. This is even more important when SuDS form part of the SuDS Strategy compared to traditional piped networks.

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, pipework and pre-treatment devices, with removal of sediment and debris as required.

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance responsibility for the system will be placed with the owner of the dwellings 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.

The operational and maintenance requirements are shown in Table 7.

Table 7 - Operational and maintenance requirements

Maintenance Schedule	Required action	Frequency
Permeable Paving		
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole pavement)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturers recommendations – pay particular attention to areas where water runs onto permeable surface from adjacent impermeable areas as this area is most likely to collect most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weed	As required – once per year on less frequency used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users	As required
	Rehabilitation of surface and upper sub-structure	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	3 monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually
Underground Attenuation Storage		
Regular maintenance	Inspect and identify any areas that are not operating correctly, if required take remedial action	Monthly for three months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface or filter for blockage by sediment, algae or	Annually

	other matter, remove and replace surface infiltration medium as necessary	
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlets, overflows and vents	As required
Monitoring	Inspect all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or 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 Site of White's Bakery, Worsborough, S70 5AF.

8.2 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. Foul water domestic waste should discharge to the combined sewer network.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

8.3 SuDS Strategy

The 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. The proposed SuDS Strategy is designed to attenuate surface water runoff up to and including the 1 in 100 year (+40%) event. The SuDS 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 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy with infiltration being utilised wherever possible. If discharge via infiltration is not possible the surface water will discharge to a public combined sewer.

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. It is therefore recommended that the site provides its own attenuation. The SuDS Strategy would take the form of:

- Discharge to the Snake Sike at a restricted runoff rate of 5.00l/s.
- Water Butts for each building.
- Permeable paving of driveways, patios, footpaths and car parking areas.
- Storage tanks, oversized drainage network or cellular storage below the permeable paving with an attenuation storage volume of 139m^3.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The precise nature and form of the SuDS system will be influenced by the type of the site layout, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made.

If ground permeability is poor then surface features such as filter strips, canals and rills, swales etc. would be required for conveying surface water runoff. Some pipework would invariably be required for road crossings and flow control purposes.

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 40% 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 (+40%) storm event. This restriction will provide significant flood mitigation benefits to existing third-party property and land downstream of the site that may be potentially at risk from flooding.

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, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 165m^3 of attenuation storage will be incorporated into the site layout with discharge limited to 5.00l/s for all events up to and including the 1 in 100 year (+40%) rainfall event before discharge to the public combined sewers. Therefore, the surface water runoff from the developed site will be no greater than existing.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, 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.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a SUDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the LPA, the LLFA, Yorkshire Water and the Environment Agency.

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 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 NPPF. The proposed development will considerably reduce the flood risk posed to the site and to off-site locations due to the adoption of a SuDS Strategy.

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

APPENDICES

APPENDIX 1 – Proposed Site Layout

White Agus PARTNERSHIP

ARCHITECTURAL SERVICES

OFFICE ONE
34 VICTORIA ROAD
BARNSLEY.
S70 2BU

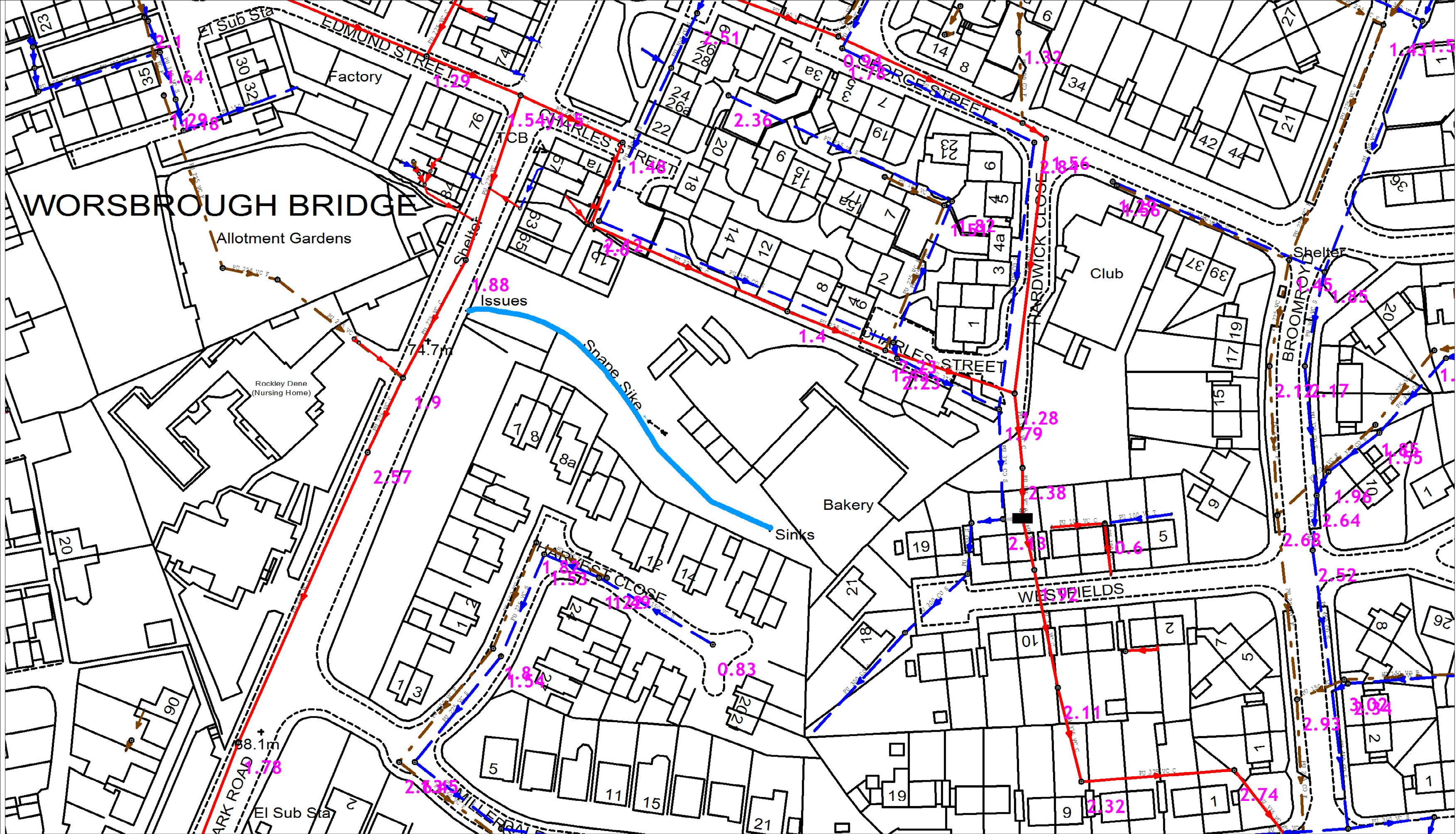
Phone: 01226 208482

Email: info@whiteaguspartnership.co.uk
Web: www.whiteaguspartnership.co.uk

Project. RESIDENTIAL DEVELOPMENT AT WHITES BAKERY BARNSLEY	Client. MR DAVID WHITE
Drawing Title. SITE PLAN	Date. NOV 2020 / Scale. 1:500 @ A2 / Ref. 20-137 / Dwg. No. 01 / Rev.

Date	Suffix	Description	Date	Suffix	Description

APPENDIX 2 – Yorkshire Water Correspondence



435154 : 403716	Map Name : SE3503NW	Title	Partial Key	This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.

YorkshireWater

Yorkshire Water,
PO Box 500,
Halifax Road,
Bradford BD6 2LZ
Contact Name :
YorMap Advisor C ROBERTS
Contact Tel : 87 2582

Notes

Foul Sewer = F
Combined Sewer = C
Surface Water Sewer = SW
Trade Sewer = TD
Partially Separate = PS

Date Req : 03/02/2019, 13:01:16

Date Gen : 03/02/2019, 13:02:35

Source : Sewer Network Enquiry

UPN: Undefined
Originator: C ROBERTS, YorMap, 87 2582

YorkshireWater

K Serjeant
KRS Environmental Ltd
3 Pronces Square
Princes Street
Montgomery
Powys
SY15 6UR

Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0345 120 8482
Fax: (01274) 372 834

Email:
Technical.Sewerage@yorkshirewater.co.uk

For telephone enquiries ring:
Chris Roberts on 0345 120 8482

Your Ref:
Our Ref: V001623

3rd February 2019

Dear K Serjeant,

Whites Bakery, Worsborough, Sheffield, S70 5AF - Pre-Planning Enquiry on T287569

Thank you for your recent enquiry and remittance. Our official VAT receipt has been sent to you under separate cover. Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records.

The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months.

Existing Infrastructure

There is a 375 mm diameter public surface water sewer recorded crossing the north eastern part of the site. No buildings, or other obstructions, are to be erected within 3 (three) metres, nor trees planted within 5 (five) metres of this public sewer. It may not be acceptable to raise or lower ground levels over the sewer, nor to restrict access to the manholes on the sewer. If you wish to have this sewer diverted under Section 185 of the Water Industry Act 1991 an application should be made in writing. To discuss this matter, please telephone 0345 120 84 82.

Foul Water

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul water domestic waste should discharge to the combined sewer network.

Surface Water

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

YorkshireWater

It is understood that Snape Sike is located through the site. This appears to be the obvious place for surface water disposal (if SuDS are not viable).

If other methods of surface water disposal are not viable and subject to providing satisfactory evidence as to why they have been discounted, curtilage surface water discharges to the public sewer will be restricted to the level of run-off - i.e. same rate of discharge - to that from the existing use of the site less a 30% reduction in the existing discharge. Any discharge of surface water from the site should discharge to similar points of connection to that of the existing use of the site. You will need to demonstrate positive drainage, based on a 1 in 1 year storm, to the public sewer to Yorkshire Water by means of investigation and calculation carried out at your expense.

To do this, Yorkshire Water requires to see existing and proposed drainage layouts with pipe sizes, gradients and connection points, measured impermeable areas of the present and proposed use of the site, along with the calculations that show the existing and proposed discharge rate from the site to the public sewer.

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority/Internal Drainage Board, with regard to surface water disposal from the site.

Other Observations

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may apply on line or obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

An off-site foul and surface water sewer may be required which may be provided by the developer and considered for adoption under Section 104 of the Water Industry Act 1991. Please telephone 0345 120 84 82 for advice on sewer adoptions. Alternatively, the developer may in certain circumstances be able to requisition off-site sewers under Section 98 of the Water Industry Act 1991 for which an application must be made in writing. For further information, please telephone 0345 120 84 82.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith. Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

Ch Roberts

Chris Roberts
Sewerage Technician
Developer Services

YorkshireWater

APPENDIX 3 – IoH Method Greenfield Runoff Rates

Hydrological Data:-

FSR Hydrology:-

Location	= BARNSLEY (W.YORKS)	Grid reference	= SE3406
M5-60 (mm)	= 18.8	r	= 0.36
Soil runoff	= 0.30	SAAR (mm/yr)	= 675
WRAP	= 2	Area	= England & Wales
Hydrological area	= 3	Hydrological zone	= 8

Soil classification for WRAP type 2

i) Very permeable soils with shallow ground water;

ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. The layer is low in organic matter, mottled and slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).

iii) Moderately permeable soils, some with slowly permeable subsoils.

Design data:-

Area = 0.0023 Km^2 - 0.23 Ha - 2300 m^2

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(rural)} = 0.00108\ AREA^{0.89}\ .\ SAAR^{1.17}\ .\ SOIL^{2.17}$$

where

- AREA = Site area in Km^2
- SAAR = Standard Average Annual Rainfall (mm/yr)
- SOIL = Soil value derived from Winter Rainfall Acceptance Potential
- $Q_{BAR(rural)}$ = Runoff (cumecs)

$Q_{BAR(rural)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.005

Mean Annual Peak Flow $Q_{BAR(rural)}$ = 0.40 l/s

KRS Environmental Limited. www.krsenvironmental.com	3 Princes Square, Princes Street, Montgomery Powys, SY15 6PZ Tel: 01686 668957 Mob: 07857 264 376 email: keelan@krsenvironmental.com	Job No. Sheet no. 2 Date 17/11/20
Project Site of White's Bakery, Worsborough, S70 5AF		By / Checked / Reviewed
Title IoH 124 Runoff Calculations		

MasterDrain
HY 11.0

Values for $Q_{BAR(rural)}$

Ret. per.	m^3/hr	l/s	l/s/ha	Ret. per.	m^3/hr	l/s	l/s/ha
1yr	1.229	0.341	1.485	100yr+20%	3.644	1.012	4.401
2yr	1.359	0.378	1.642	100yr+30%	3.948	1.097	4.768
5yr	1.750	0.486	2.113	100yr+40%	4.252	1.181	5.135
10yr	2.097	0.582	2.532	200yr	3.471	0.964	4.192
30yr	2.429	0.675	2.934	200yr + 30%	4.512	1.253	5.449
50yr	2.748	0.763	3.318	500yr	3.948	1.097	4.768
100yr	3.037	0.844	3.668	1000yr	4.396	1.221	5.309

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.94	1.21	1.45	1.68	1.90	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124
to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.

APPENDIX 4 – Attenuation Storage Volumes

Data:-

Location = BARNSLEY (W.YORKS)
M5-60 (mm) = 18.8
Soil index = 0.30
Return period = 100
UCWI = 0.0

Grid reference = SE3406
r = 0.36
SAAR (mm/yr) = 675
WRAP = 2
Climate change = +40%

i) Very permeable soils with shallow ground water;
ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; The layer is low in organic matter, mottled and (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. Slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).
iii) Moderately permeable soils, some with slowly permeable subsoils.

Percentage runoff = 100.0% (manual setting)

Imperv. area = 2300 m²
Total area = 2300 m²
Total runoff = 198.9 m³

Pervious area = 0 m²
Equiv area = 2300 m² (Tot. area x % runoff).
Discharge rate = 5.000 l/s

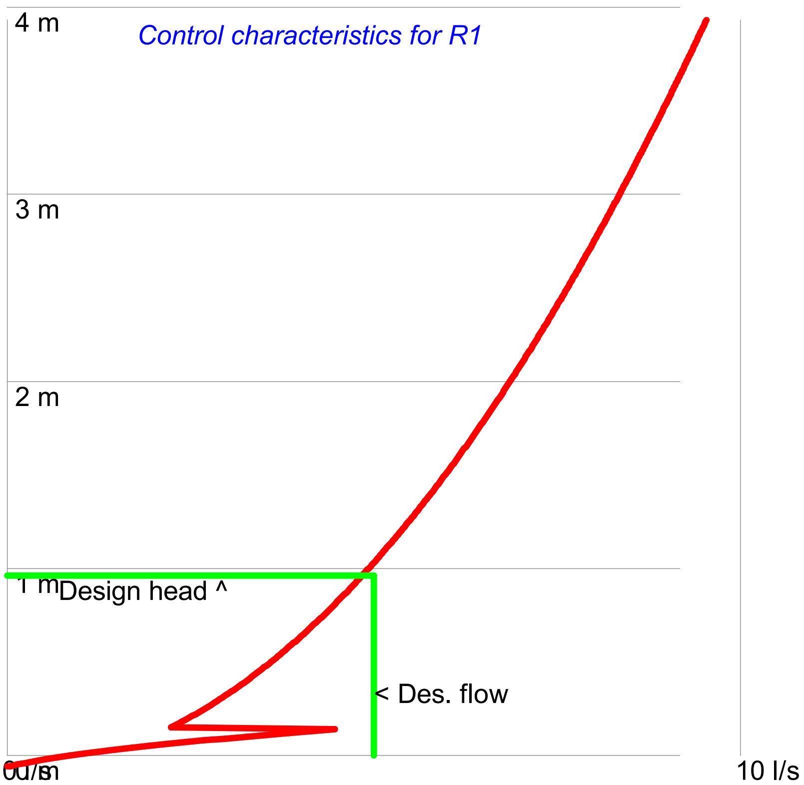
Design Head = 1.1m
Control device = R1
Max. calc. depth = 1.04 m

Peak flow = 4.86 l/s
Orifice diam = 88.7 mm
Available depth = 0.0 m³

Pipeline storage = 0.0 m³
Offline storage = 0.0 m³
Total storage = 139.0 m³

Available MH storage = 0.0 m³

Peak input flow =23.02 l/s



Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.01	0.05	2.01	6.76
0.05	0.52	2.05	6.83
0.10	1.47	2.10	6.91
0.15	2.70	2.15	6.99
0.20	4.15	2.20	7.07
0.25	2.38	2.25	7.15
0.30	2.61	2.30	7.23
0.35	2.82	2.35	7.31
0.40	3.02	2.40	7.39
0.45	3.20	2.45	7.46
0.50	3.37	2.50	7.54
0.55	3.54	2.55	7.61
0.60	3.69	2.60	7.69
0.65	3.84	2.65	7.76
0.70	3.99	2.70	7.83
0.75	4.13	2.75	7.91
0.80	4.26	2.80	7.98
0.85	4.40	2.85	8.05
0.90	4.52	2.90	8.12
0.95	4.65	2.95	8.19
1.00	4.77	3.00	8.26
1.05	4.89	3.05	8.33
1.10	5.00	3.10	8.39
1.15	5.11	3.15	8.46
1.20	5.22	3.20	8.53
1.25	5.33	3.25	8.59
1.30	5.44	3.30	8.66
1.35	5.54	3.35	8.73
1.40	5.64	3.40	8.79
1.45	5.74	3.45	8.85
1.50	5.84	3.50	8.92
1.55	5.94	3.55	8.98
1.60	6.03	3.60	9.05
1.65	6.12	3.65	9.11
1.70	6.22	3.70	9.17
1.75	6.31	3.75	9.23
1.80	6.40	3.80	9.29
1.85	6.48	3.85	9.35
1.90	6.57	3.90	9.41
1.95	6.66	3.95	9.47
2.00	6.74	4.00	9.53

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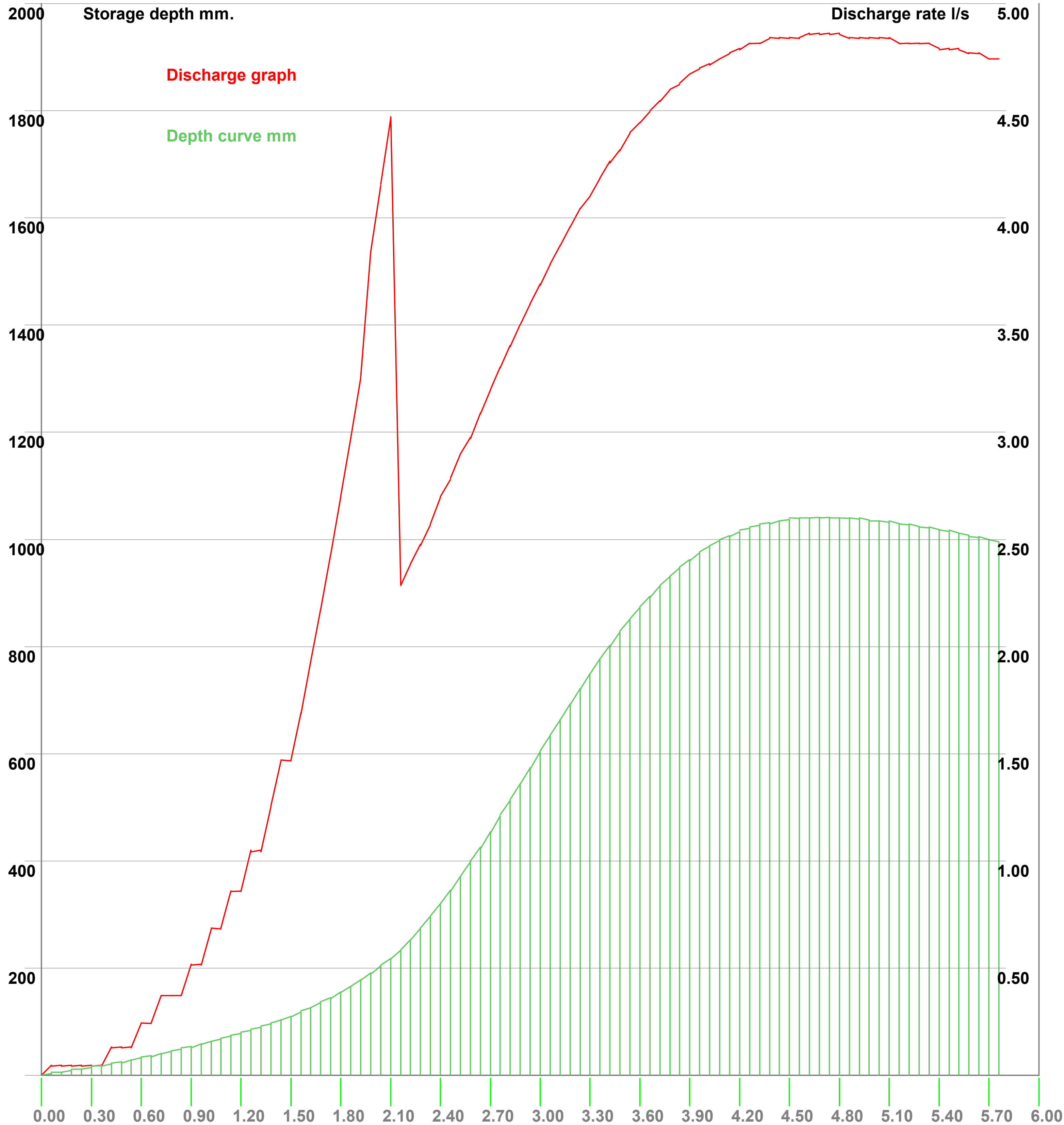
			Sheet no. 2		
			Date 17/11/20		
	Project Site of White's Bakery, Worsborough, S70 5AF		By	Checked	Reviewed
	Title Attenuation Storage Calculations				

Storage curves for a 6 hours storm.



Incremental rainfall figures.

Storm Mins	Storage Depth mm	Control Flow l/s	Storm Mins	Storage Depth mm	Control Flow l/s
3.6	2.9	0.05	183.6	633.7	3.78
7.2	5.7	0.05	187.2	663.5	3.87
10.8	8.6	0.05	190.8	692.9	3.96
14.4	11.5	0.05	194.4	721.7	4.05
18.0	14.6	0.05	198.0	749.6	4.10
21.6	17.8	0.05	201.6	776.6	4.18
25.2	21.2	0.13	205.2	802.4	4.26
28.8	24.7	0.13	208.8	827.1	4.32
32.4	28.4	0.13	212.4	850.8	4.40
36.0	32.3	0.24	216.0	873.1	4.45
39.6	36.4	0.24	219.6	894.0	4.50
43.2	40.6	0.37	223.2	913.2	4.55
46.8	44.7	0.37	226.8	930.9	4.60
50.4	49.0	0.37	230.4	947.2	4.62
54.0	53.6	0.52	234.0	962.0	4.67
57.6	58.2	0.52	237.6	975.2	4.70
61.2	63.0	0.68	241.2	987.3	4.72
64.8	67.6	0.68	244.8	997.8	4.74
68.4	72.6	0.86	248.4	1006.8	4.77
72.0	77.7	0.86	252.0	1014.4	4.79
75.6	83.4	1.05	255.6	1021.0	4.81
79.2	89.3	1.05	259.2	1026.5	4.81
82.8	95.8	1.25	262.8	1031.0	4.84
86.4	102.8	1.47	266.4	1034.5	4.84
90.0	109.9	1.47	270.0	1037.2	4.84
93.6	117.8	1.69	273.6	1039.1	4.84
97.2	126.2	1.93	277.2	1040.4	4.86
100.8	135.2	2.17	280.8	1041.0	4.86
104.4	144.9	2.43	284.4	1041.1	4.86
108.0	155.1	2.70	288.0	1040.5	4.86
111.6	166.0	2.97	291.6	1039.4	4.84
115.2	177.6	3.25	295.2	1037.9	4.84
118.8	190.5	3.84	298.8	1036.1	4.84
122.4	203.8	4.15	302.4	1034.2	4.84
126.0	217.8	4.47	306.0	1032.1	4.84
129.6	232.9	2.29	309.6	1029.7	4.81
133.2	252.9	2.38	313.2	1027.1	4.81
136.8	273.9	2.48	316.8	1024.4	4.81
140.4	296.2	2.57	320.4	1021.5	4.81
144.0	320.0	2.70	324.0	1018.4	4.79
147.6	345.0	2.78	327.6	1015.1	4.79
151.2	371.0	2.90	331.2	1011.5	4.79
154.8	397.9	2.98	334.8	1007.8	4.77
158.4	425.6	3.09	338.4	1003.8	4.77
162.0	454.1	3.20	342.0	999.7	4.74
165.6	483.3	3.30	345.6	995.5	4.74
169.2	513.1	3.40	349.2	991.1	4.74
172.8	543.3	3.50	352.8	986.8	4.72
176.4	573.5	3.60	356.4	982.3	4.72
180.0	603.7	3.69	360.0	977.8	4.70

Using the Get Max button causes the program to step through a series of storm durations until a maximum volume is obtained.
Each duration is sampled 600 times and the results recorded. The storm durations (hrs) are:-

0.25, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 18, 20, 24, 30, 36, 42, 48, 54, 60, 66, 72, 84, 96, 120, 150, 175, 200, 250, 300, 375, 500, 750, 1000, 1250, 1500, 1570, 2000, 2500, 3000, 3500, 4000

It should be noted that the six hour storm frequently requested rarely demonstrates the worst case for storage.

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Sheet no.	4	
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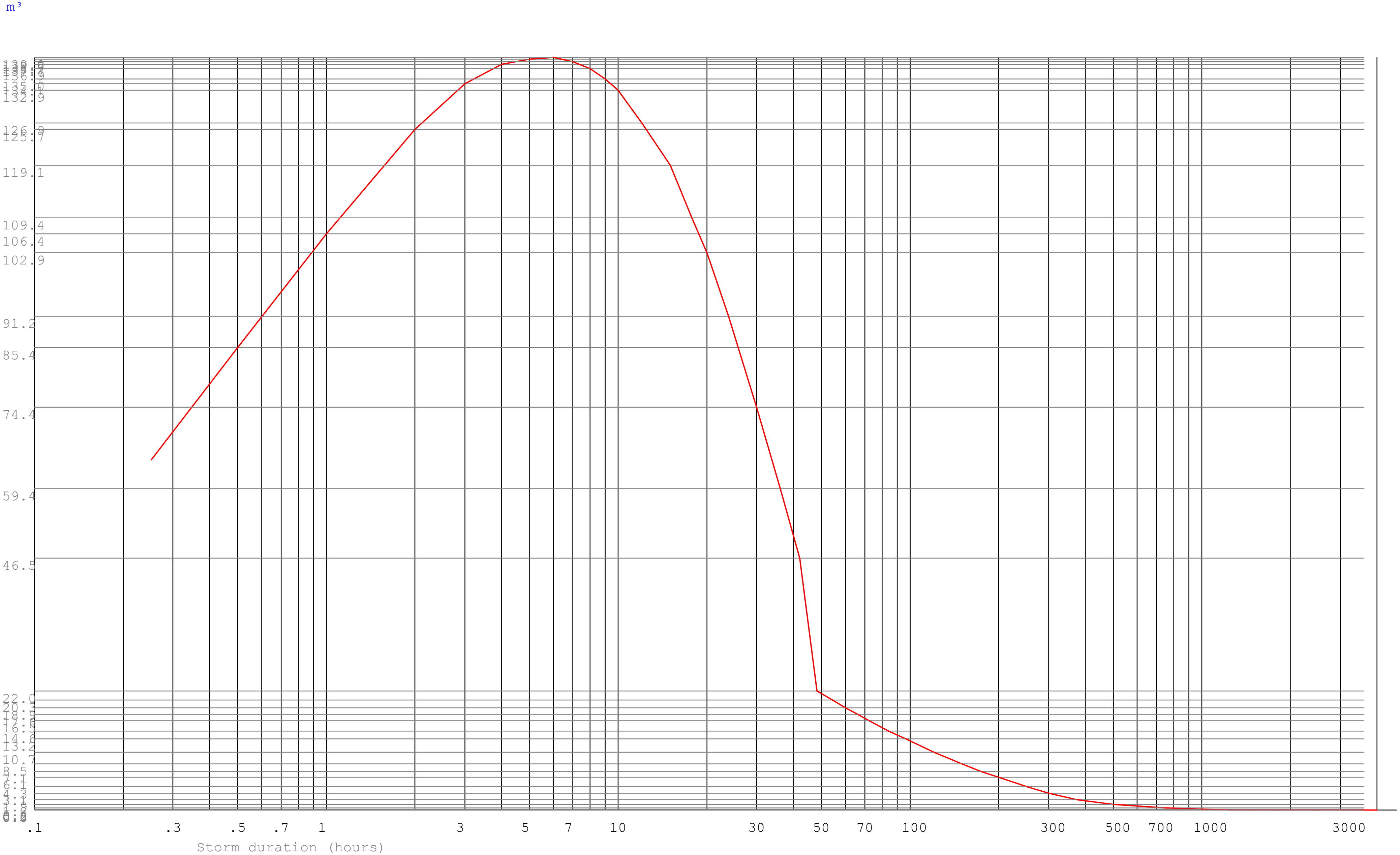
Project **Site of White's Bakery, Worsborough, S70 5AF**

Title **Attenuation Storage Calculations**

Sequential storage volume at specific storm durations.



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Sheet no.	5
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Project **Site of White's Bakery, Worsborough, S70 5AF**

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By	Checked	Reviewed

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