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Flood Risk Assessment

Startifants Farm, Longridge Road, Chipping

Report Ref: 18073/CR/01

Prepared For:
J Hadfield
Engineering/Surveying

Date:
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Executive Summary

Paul Waite Associates Ltd has been appointed by Johnathan Hadfield of J Hadfield Engineering/Surveying, to provide a Flood Risk Assessment in support of a planning application for a development at the former Startifants Farm, Longridge Road, Chipping, Lancashire.

The site is shown to be situated within Flood Zone 3 of the Environment Agency Flood Map and therefore it is considered as having a high risk of fluvial flooding.

An initial assessment indicates that the primary flood risk at the proposed development is from the fluvial source Chipping Brook, that traverses through the centre of the site and surface water flow routes from the north.

The redline boundary comprises of a farm house, associated farm outbuildings, grassed areas and access roads.

The topographical survey provided shows that the site ranges in level from approximately 99.00m AOD at the north of the site, down to 97.00m AOD at the south of the site.

Vehicular access is from the west of the site, and provides a link to Longridge Road at the north and west of the site.

The development area to the east side of Chipping Brook is currently accessible via a track from Longridge Road over a bridge that spans Chipping Brook.

The planning application incorporates the following:

- Demolish existing farmhouse and rebuild
- Change if use of agricultural barn to 2No dwellings
- Change of use of mono-pitch farm building to a garage for the barn conversion
- Demolish 4No farm buildings
- Dismantle and rebuild one timber framed agricultural building in new location on the site
- Reorientation of one steel framed agricultural building

For flood risk evaluation purposes each building has been referenced A to E (as listed below). The average ground level where the footprint of each building is to be located has been taken from the topographical survey, these are identified below:

A. Replacement Dwelling 98.72m AOD
B. Barn Conversion 98.02m AOD
C. Garage Building 98.11m AOD
D. Steel Framed Building 97.85m AOD
E. Large Timer Framed Building 97.50m AOD

The mechanism of flooding at the site via 2No sources i.e. overland flow routes and direct overtopping of the banks and walls along Chipping Brook through the site. The flooding from each mechanism are described in the details provided below.

Pluvial: Overland Flow

Surface Water Flood Maps show that there is a flow route passing through the site from the north boundary on Longridge Road.

It is evident that a small unnamed watercourse which flows through the west of the site and Chipping Brook located centrally within the site contribute to surface water flooding.

Once the capacity of the watercourse's are exceeded, flows then overtop the banks flowing overland through low lying topography, resulting in varying depths and velocities throughout the site.

In conclusion surface water flow routes through the site are present even during the high probability event i.e. most frequent, with a hazard rating increasing for the less frequent events.

High Probability Event – 30 Year Event

- Source of flooding = Chipping Brook via Longridge Road to the north
- Depth = Less than 300mm confined to the west of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Low

Medium Probability Event – 100 Year Event

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from north west via Longridge Road
- Depth = Less than 300mm confined to the west of the site, increasing compared to high probability event.
- Velocity = In excess of 0.25m/s
- Flood Hazard = Moderate

Low Probability Event – 1000 Year Event

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from the west via Longridge Road
- Depth = Between 300mm-900mm large proportion of west extent, with a new flow routes passing out of east of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Significant

Suitable mitigation should be incorporated into the development proposals to provide protection to people and property from this source.

Providing that finished floor levels incorporated into the proposed development are set at a level in accordance with NFFP Guidance and flood resilience/resistance measures as outlined within Section 7.0 of this report, the risk associated with pluvial flooding can be suitably managed

Fluvial: Chipping Brook

Chipping Brook traverses through the centre of the application site in a southerly direction. Entering through the north boundary, it flows under 3No structures: Startifants Bridge, UU WWTW bridge and a small footbridge, before flowing out of the south boundary.

The topographical survey identifies that walls are presents along the west banks of Chipping Brook with stepped access down to the watercourse, there are no walls present along the east banks.

The site is located within Flood Zone 3, and therefore a comparison of flood levels against existing site levels has been undertaken.

The flood levels taken from the Jacobs WWTW Modelling Report show that the site floods to a considerable depth during the 100 year and 100 year + climate change events. Undertaking hazard calculations indicates a 'danger for all'.

Sites A and B are the only developments to be of a habitable nature i.e. 'more vulnerable', sites C, D and E are indicated to be non-habitable 'less vulnerable'. Providing that suitable mitigation is incorporated into the development plan the risk from fluvial flooding can be suitably managed.

Drainage

The site is currently developed comprising of 8No farm buildings. The site has an overall area of approximately 0.642 Hectares, of which approximately 0.191 Hectares (84%) comprises of roof or hardstanding and is considered impermeable.

At present no CCTV Survey has been undertaken, however engineering judgement suggests that surface water flows are collected via a positive drainage network and ultimately directed to Chipping Brook within the centre of the site.

Existing runoff rates have been divided into the west and east extent of the site, due to the fact that they will require 2No separate systems.

West

- Total Area = 0.297Ha
- Total Impermeable Area = 4%

East

- Total Area = 0.345Ha
- Total Impermeable Area = 51%

The ICP SUDS Method has been utilised to derive existing runoff rates for a range of return periods, with the application of 4% and 51% impermeable to account for roof and hardstanding, these are identified within Section 6.4.3.

The hierarchy for disposal of surface water from new developments is outlined within the Building Regulations Approved Document H and specifies the following methods in order of preference:

- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public surface water sewer
- Discharge to public combined sewer

Infiltration

Following a non-intrusive desk top study infiltration at the site is not considered to be feasible, a review of Soilscape maps identifies the site to be located on land which is considered to be *'Slowly permeable seasonally wet acid loamy and clayey soils'*.

Furthermore, local borehole logs identify that the underlying ground comprises of clay down to a considerable depth.

Although the underlying ground seems to be unsuitable, the statutory authorities may require evidence in the form of on-site percolation tests taken in accordance with BRE Digest 365 prior to any outfall into the watercourse.
Watercourse

Chipping Brook traverses through the centre of the application site. At the time of writing no CCTV Survey was available and the topographical survey does not indicate the location of any drainage outfalls to the watercourse. However, engineering judgment suggests that the existing site already directs surface water flows to watercourse.

Therefore, it is recommended that surface water flows from the proposed development discharge into Chipping Brook, where possible reutilising the existing network to facilitate an outfall/s.

Undertaking an assessment using the SUDS Planner Module within MicroDrainage Windes revealed that a number of different methods could be used within the development. A summary of the results determined that on/offline tanks where most appropriate within this scenario.

The application site is considered as greenfield with a percentage urban to account for the roof and hardstanding, proposed discharge rates should be restricted to existing runoff by means of flow control devices.

Post development the impermeable areas within the west extent of the site increase slightly, whilst the impermeable areas in the east are reduced dramatically. Overall there will be a reduction in impermeable area compared to the existing situation from 55%, down to 36% of the total site area.

Indicative attenuation volumes have been estimated based on the proposed impermeable areas, restricted to existing greenfield runoff rates for a range of return periods, these are shown within Section 6.4.8.

West Extent

It is estimated that only a small amount of attenuation is required for the west extent of the site and it may be possible that volumes could be retained within a traditional piped network, with flows restricted to greenfield runoff via an orifice plate, without the need for a formal attenuation structure.

East Extent

Flows from the east side of the site will require formal on/offline attenuation. This could be in the form Geo-cellular crates systems located within an area that allows for a gravity connection into the watercourse, with flows restricted via a flow control device prior to disposal.

To demonstrate the feasibility of this a Geo-cellular tank has been modelled which attenuates flows up to and including the 100 year plus 40% climate change event with no surface flooding. The dimensions of the tank are as follows:

Geo-Cellular Tank Dimensions

- Area = 30m^2
- Depth of Crate = 0.8m
- Depth to Invert of Tank = 2.0m

Where possible it would be best to reutilise the existing outfall/s which would negate any requirement to undertake works within the watercourse.

It is recommended that foul flows from the site are to be directed to the existing public combined system at the south of the site, which ultimately flows into the UU Waste Water Treatment Works approximately 100m south of the site, following consultation with United Utilities.

Where possible the existing foul drainage network that serves the site should be reutilised.

Mitigation Measures

- Finished floor levels of habitable buildings set 600mm above 100 year + climate change event. Building A = 100.140m AOD, Building B = 99.840m AOD
- Finished floor levels of non-habitable buildings set to exiting ground levels if necessary.
- Building E will require structural design for flooding in excess of 0.9m in depth.
- Flood Alarm incorporated into final design, site located outside of EA Flood Warning/Alert coverage area.
- Residents to evacuate north up Longridge Road on receipt of flood alarm.
- Boundary treatments should be passive with no new walls along banks of watercourse permitted.

Contents

Appendices

1.0 Introduction

1.1 Terms of Reference

Paul Waite Associates Ltd has been appointed by Johnathan Hadfield of J Hadfield Engineering/Surveying, to provide a Flood Risk Assessment in support of a planning application for a development at the former Startifants Farm, Longridge Road, Chipping, Lancashire.

The site is shown to be situated within Flood Zone 3 of the Environment Agency Flood Map and therefore has a high risk of fluvial flooding.

It is usual for the Environment Agency to raise an objection to development applications within the floodplain, or Zones 2 and 3 of the flood map, until the issue of flood risk has been properly evaluated. The Agency will also object to developments where the total site area is in excess of 1 Hectare until suitable consideration has been given to the management of surface water runoff.

1.2 Objectives

The objective of this assessment is to evaluate the following issues in regard to flood risk at the application site.

- Suitability of the proposed development in accordance with current planning policy.
- Identify the risk to both the proposed development and people from all forms of flooding.
- Provide a preliminary assessment of foul and surface water management.
- Increasing the risk of flooding elsewhere e.g. surface water flows and flood routing.
- Recommendation of appropriate measures to mitigate against flooding both within the proposed development, and neighbouring land and property.

1.3 Data Sources

This assessment is based on desk-top study of information from the following sources:

- National Planning Policy Framework (2018)
- Planning Practice Guidance at www.gov.uk
- Building Regulations Approved Document H
- Environment Agency Flood Mapping
- Ribble Valley Strategic Flood Risk Assessment May 2010
- British Geological Society – Historic Borehole Logs
- Cranfield University's Soilscape Viewer
- CIRIA C697 The SUDS Manual
- Chronology of British Hydrological Events (Dundee University)
- R&D Technical Report FD2320/TR2 (2005)

2.0 Planning Policy Context

2.1 Approach to the Assessment

An initial assessment indicates that the primary flood risk at the proposed development is from the fluvial source Chipping Brook, that traverses through the centre of the site and surface water flow routes from the north.

Consideration has also been given to the site flooding from secondary sources such as groundwater; artificial water bodies; infrastructure failure and ponding.

The requirements for flood risk assessments are generally as set out in the 'Technical Guidance to the National Planning Policy Framework', updated in July 2018; and in more detail from the Environment Agency's 'Standing Advice on Flood Risk' available from www.gov.uk.

2.2 National Planning Policy Framework (NPPF)

The information provided in the flood risk assessment should be credible and fit for purpose.

Site-specific flood risk assessments should always be proportionate to the degree of flood risk and make optimum use of information already available, including information in a Strategic Flood Risk Assessment for the area, and the interactive flood risk maps available on the Environment Agency's website.

A flood risk assessment should also be appropriate to the scale, nature and location of the development.

2.2.1 Sources of Flooding

- **Rivers (fluvial):** Flooding occurs when flow within river channels exceeds capacity; and the type of flood event experienced e.g. flash flooding; depends upon the characteristics of the river catchment.
- **The Sea (tidal):** Flooding at low lying coastline and tidal estuaries is caused by storm surges and high tides; with overtopping and breach failure of sea defences possible during extreme storm events.
- **Pluvial (surface flooding or overland flows):** Heavy rainfall, which is unable to soak away via infiltration or enter drainage systems can flow overland, resulting in localised flooding. Topography generally influences the direction and depth of flooding caused by this mechanism.
- **Groundwater:** Caused when ground water levels rise to the surface; and is most likely to occur in low lying areas underlain by aquifers.
- **Sewers and drains:** Generally occurs in more urban areas; where sewers and drains are overwhelmed by heavy rainfall or blocked pipes and gullies.
- **Artificial Sources (reservoirs, canals, lakes and ponds):** Reservoir and canal flooding may occur as a result of capacity exceedance or structural failure.

Figure 2.1: The Environment Agency Flood Map

Source: www.gov.uk

2.2.2 Flood Zones

- **Flood Zone 1:** Low probability (less than 1 in 1000 year (<0.1% AEP) annual probability of river or sea flooding in any year.
- **Flood Zone 2:** Medium probability (between 1 in 100 year (1.0% AEP) and 1 in 1000 year (0.1% AEP) annual probability of river flooding; or between 1 in 200 year (0.2% AEP) and 1 in 1000 year (0.1% AEP) annual probability of sea flooding in any year).
- **Flood Zone 3a:** High probability (1 in 100 year (1.0% AEP) or greater annual probability of river flooding in any year or 1 in 200 year (0.5% AEP) or greater annual probability of sea flooding in any year).
- **Flood Zone 3b:** This zone comprises land where water has to flow or be stored in times of flood. Land which would flood with an annual probability of 1 in 20 (5% AEP), or is designed to flood in an extreme flood (0.1%) should provide a starting point for discussions to identify functional floodplain.

2.2.3 Vulnerability of Different Development Types

- **Essential Infrastructure:** Transport infrastructure (railways and motorways etc...); utility infrastructure (primary sub-stations, water treatment facilities; power stations; and wind turbines).
- **Water Compatible Development:** Flood control infrastructure; water and sewage infrastructure; navigation facilities.
- **Highly Vulnerable:** Emergency services; basement dwellings; mobile home parks; industrial or other facilities requiring hazardous substance consent.
- **More Vulnerable:** Hospitals; residential dwellings; educational facilities; landfill sites caravan and camping sites.
- **Less Vulnerable:** Commercial premises; emergency services not required during a flood; agricultural land.

2.2.4 Sequential & Exceptions Test

As set out in the National Planning Policy Framework, the aim of the Sequential Test is to steer new development to areas at the lowest probability of flooding.

The Flood Zones are the starting point for the sequential approach.

The Environment Agency Flood Map shows the development site to be located within Flood Zone 3.

In accordance with Table 2 'Flood Risk Vulnerability Classification' of the Technical Guidance to the National Planning Policy Framework, residential developments are defined as 'More Vulnerable' developments.

Taking this into account if any new developments/buildings, the site it will have to pass both a Sequential Test and the Exceptions Test in order for the site to be deemed suitable.

Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility'[1]

Flood Risk Vulnerability Classification		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓

[1] Extracted from Table 3 of the Technical Guidance to the National Planning Policy Framework Document (March 2012)

	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b	Exception Test required	✓	×	×	×

✓ Development is appropriate
× Development should not be permitted

2.2.5 Climate Change

The NPPF requires the application of climate change over the lifetime of a development.

Following the nationwide floods which occurred on Boxing Day (26th December) 2015, the Technical Guidance for NPPF was updated to provide revised climate change allowances based on the river basin district. These updates were published on 24th July 2018.

Chipping is located within the North West River Basin District; and the climate change allowances for this district are therefore tabulated below:

Table 2: North West Basin Climate Change Allowances[2]

Parameter	Allowance Category	2010 - 2039	2040 - 2059	2060 - 2069	2070 - 2115
Peak Rainfall Intensity	Upper end	+ 10%	+ 20%	+ 40%	
	Central	+ 5%	+ 10%	+ 20%	
Peak River Flow	Upper end	+ 20%	+ 35%		+ 70%
	Higher Central	+ 20%	+ 30%		+ 35%
	Central	+ 15%	+ 25%		+ 30%

The selection of climate change allowance should be chosen appropriate to the expected lifespan of the proposed development.

Residential development is anticipated to have a lifespan approximating 100 years; and as such an additional 40% should be applied to peak rainfall intensities to assess the range of impact for this development.

Due to the development being located mainly within Flood Zone 3 an allowance of 70% - 35% to should be applied to peak river flow.

[2] Extracted from Tables 1-4 of the Technical Guidance for flood risk assessments: Climate change allowances Document (February 2016)

3.0 Details of the Site

3.1 Site Details

Table 3: Development Location

Site Name:	Startifants Farm, Longridge Road
Purpose of Development:	Residential/Agricultural
Existing Land Use:	Farm
OS NGR:	SD624426
Country:	England
County:	Lancashire
Local Planning Authority:	Ribble Valley Borough Council
Internal Drainage Board:	Not Applicable
Other Authority (e.g. British Waterways/ Harbour Authority)	Not Applicable

Location Plan:

Source: Street Map

3.2 Site Description

The application site is located east of Longridge Road within the southern extent of the village of Chipping in Lancashire.

The redline boundary comprises of a mixture of a farm house, associated farm outbuildings, grassed areas and access roads.

Table 4: Boundaries

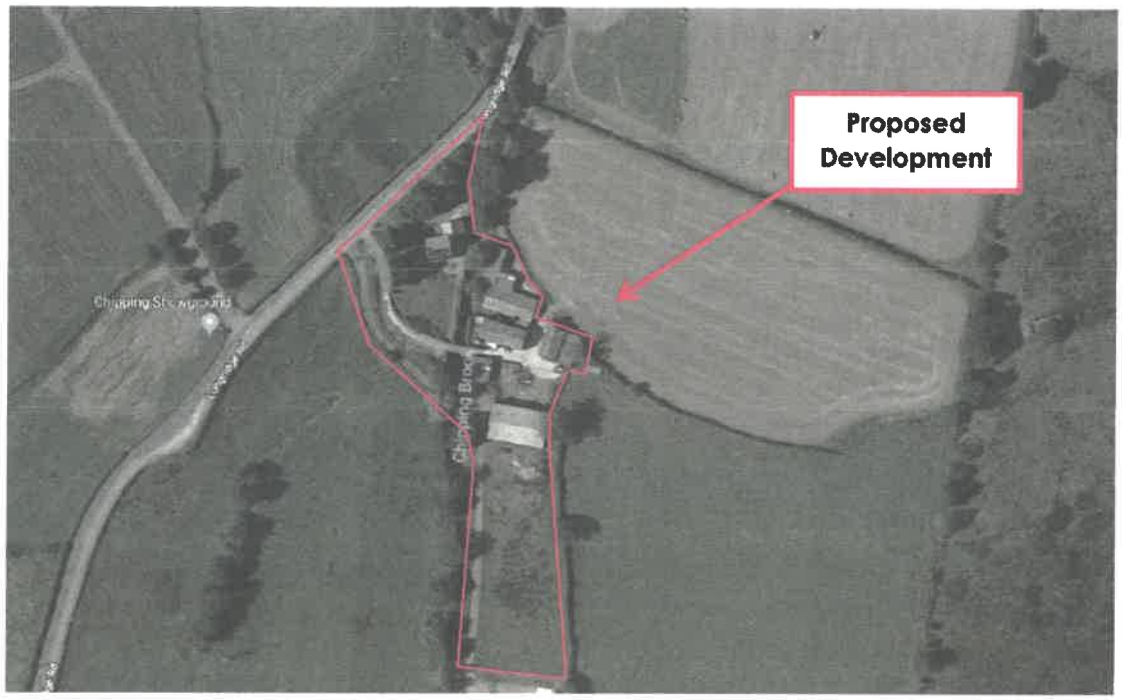
North	Directly north of the site is Longridge Road, then the southern extent of the village of Chipping, beyond which is a vast expanse of agricultural land.
East	Directly east of the site is Longridge Road, beyond which is a vast expanse of agricultural land.
South	Directly south of the site is Chipping Waste Water Treatment Plant, beyond which is a vast expanse of agricultural land.
West	Directly west of the site are agricultural fields, beyond which is a vast expanse of agricultural land.

The topographical survey provided shows that the site ranges from approximately 99.00m AOD at the north of the site, down to 97.00m AOD at the south of the site.

Vehicular access to the west proportion of the site can be accessed from Longridge Road at the north of the site and west of the site.

The site on the east banks of Chipping Brook is currently available via a track from Longridge Road over a wooden bridge that spans Chipping Brook.

Figure 3.1: Aerial View



Source: Google Earth

3.3 Proposed Development Details

The planning application involves the following:

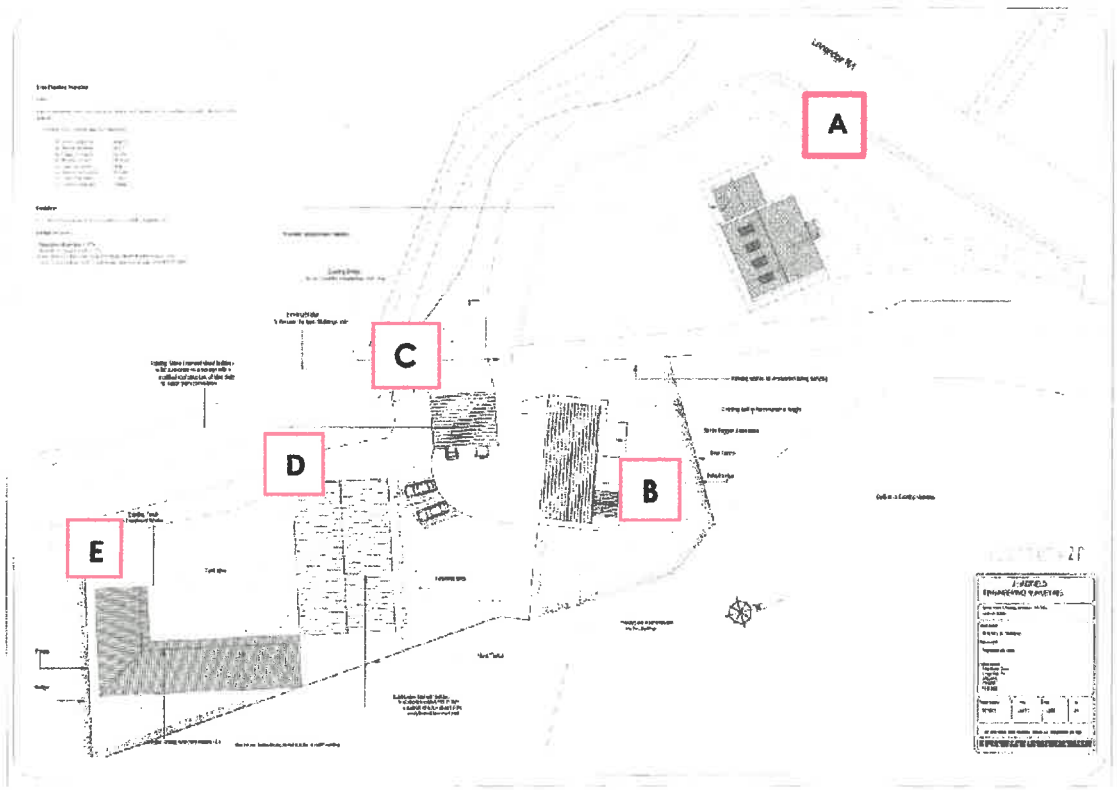
- Demolish existing farmhouse and rebuild
- Change if use of agricultural barn to 2No dwellings
- Change of use of mono-pitch farm building to a garage for the barn conversion
- Demolish 4No farm buildings
- Dismantle and rebuild one timber framed agricultural building in new location on the site (end use unspecified).
- Reorientation of one steel framed agricultural building

For flood risk evaluation purposes each building has been given a label ranging from A to E. The average ground level where the footprint of each building is to be sited has been taken from the topographical survey, these are identified below:

F. 98.72m AOD
G. 98.02m AOD
H. 98.11m AOD
I. 97.85m AOD

J. 97.50m AOD

Figure 3.2: Development Proposals



Source: J Hadfield

4.0 Historic Flooding

4.1 Internet Search

An internet search for historic flooding within the area of Chipping in Lancashire resulted in the following incidents:

- September 2015 – Lancashire Telegraph - River Ribble burst its banks

'The water is threatening homes in Sawley, near Clitheroe, although there are no reports of any flooded properties at the moment.

Elsewhere, fire crews were called out to a man trapped in a silver BMW in Chipping Road, east of Chipping. The vehicle was submerged in three feet of water and the man was trapped.'

- January 2008 – Longridge and Ribble Valley News – Torrential rain

'TORRENTIAL rain brought chaos to the Longridge area on Monday as homes flooded, roads were blocked and schools and businesses were forced to close. Although conditions - following 24 hours of relentless rain - were some of the worst in recent memory, police praised the public response and said most people, particularly motorists, had 'acted sensibly'.

In Chipping, villagers reported never having seen anything like the floods. Brooks were at bursting point and water was cascading down the hilly streets. The Cobbled Corner cafe and St Mary's and Brabin's schools were forced to close at lunchtime.'

4.2 Ribble Valley Borough Council SFRA May 2010

The Strategic Flood Risk Assessment (SFRA) was completed by Ribble Valley Borough Council in May 2010.

Section 4.3 Historic Flooding does not specifically identify any historic flood events within the vicinity of the proposed development.

5.0 Initial Evaluation of Flood Risk

5.1 The Environment Agency Flood Map

The Environment Agency Flood Map illustrated within Figure 2.1, confirms that proposed development site is located in Flood Zone 3.

The definition for each of the flood zones highlighted above is provided for reference within Section 2.2.2 of this report.

5.2 Sources of Flooding

Table 5: Possible Flooding Mechanisms

Source/Pathway	Significant?	Comment/Reason
Fluvial	Yes	Flood Zone 3 (Chipping Brook)
Canal	No	Not Applicable
Tidal/Coastal	No	Not Applicable
Reservoir	No	EA Map shows that the site is not affected by reservoir flooding
Pluvial (urban drainage)	Yes	Site will require positive drainage strategy
Groundwater	No	SFRA states low risk of groundwater flooding
Surface Water Flooding	Yes	Site is located within an area that has a high risk of flooding
Overland Flow	Yes	Surface water flow route passes through the site
Blockage	No	Possibility of blockage at the access bridge
Infrastructure failure	No	Possible capacity issues if connecting to United Utilities sewers
Rainfall Ponding	No	No existing pond systems or depressed area where ponding could occur identified within the site.

From the initial assessment it is concluded that the primary source of flood risk will be from the fluvial source Chipping Brook and a surface water flow route that passes through the site from the north/west boundary.

Fluvial:

Chipping Brook emanates from approximately 4km north west of the site within the heights of Fair Snape Fell.

The watercourse is predominantly open channel along its length flowing in a southerly direction centrally through the site, entering at the north boundary and exiting through the south boundary.

Downstream of the application site the watercourse flows south east for approximately 1km, where it confluences with the River Loud, which ultimately discharges into the River Hodder east.

A small unnamed watercourse flows along the access road into the site, then out of the west boundary, the watercourse ultimately flows into Chipping Brook approximately 780m south east of the applications site.
Due to the proposed development site being located within Flood Zone 3, the risk associated with fluvial flooding is considered to be high and therefore requires further evaluation.

Groundwater

Section 4.2.5 of the Ribble Valley Borough Councils states the following in relation to groundwater flooding within the borough:

'Following consultation with the EA, no evidence of groundwater flooding in the area has been identified. While no risk has been demonstrated, this is not to say that unrecorded groundwater flooding events may have taken place or that groundwater flooding may not occur in the future, but using the best available information they are not considered to be a significant risk at this time.'

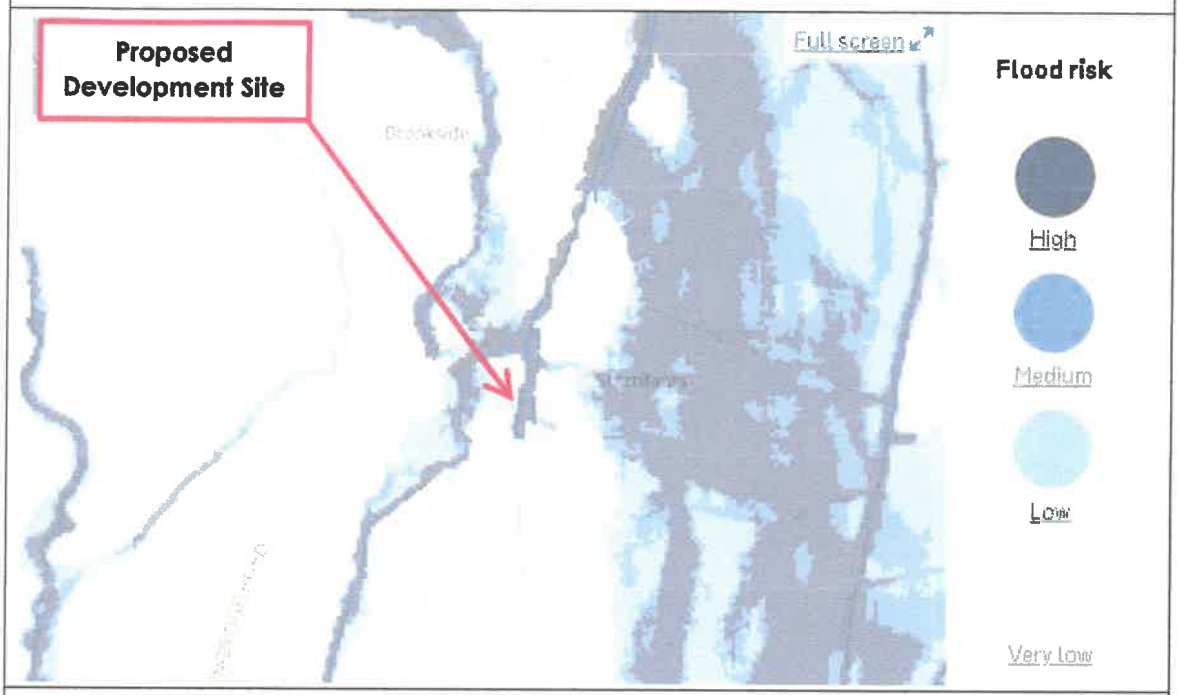
A review of local borehole logs using the BGS online service found one approximately 300m south east of the site, which states that water was struck 21m BGL.

Taking the above information into account the risk associated with groundwater flooding at the site is considered to be low.

Surface Water Flooding and Overland Flow

The Environment Agency's Surface Water Flood Map identifies that the proposed development site has a high surface water flood risk, as is identified within the figure below:

Figure 5.1: Environment Agency Surface Water Flood Map



Source: www.gov.uk

The Environment Agency's definition of high risk is provided below for reference:

'High risk means that each year this area has a chance of flooding of greater than 3.3%. Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.'
Due to the proposed development site having a high risk of surface water flooding, as a result of overland flow routes, flooding from this mechanism requires further evaluation.

Pluvial: Exceedance and Local System Failure (Sewer Flooding)

The following text has been extracted from CIRIA 2906 'Managing Extreme Events by Designing for Exceedance January 2013':

'Climate change and urbanisation is already contributing to increased surface water flooding, where the capacity of the existing drainage systems are overwhelmed (or exceeded).

The traditional approach to fixing the problem is to build bigger pipes or provide underground storage. Ofwat, the Environment Agency and others believe that this approach is unsustainable and unaffordable and are encouraging sewerage undertakers, Lead Local Flood Authorities and highway authorities to look at different approaches to managing sewer and surface water flooding.
One approach being promoted is "designing for exceedance".

Designing for exceedance is an approach to manage flood risk (particularly from extreme events) by planning, designing and retrofitting drainage schemes that can safely accommodate rainfall and flooding that exceeds their design capacity (normally a 1 in 30 rainfall event). This is often achieved by considering flood pathways (such as managing runoff on highways) or providing additional storage (preferably on the surface through car parks, or multifunctional detention basins).

In England and Wales Sewers for Adoption and the National Planning Policy Framework encourage the consideration of drainage exceedance, it is a flexible approach to manage extreme events that can be used to reduce the need for more traditional, expensive underground approaches to manage surface water and often complement sustainable drainage and other local urban design initiatives.'

The impact of extreme rainfall events and/or local system failure will therefore need to be assessed as part of the overall surface water management strategy for the proposed development.

6.0 Quantitative Flood Risk Assessment

6.1 National Planning Policy Framework

6.1.1 Site Specific Flood Risk Assessment Checklist

The following checklist has been extracted from Paragraph 068 from the Flood Risk & Coastal Change Section of the NPPF Guidance available from www.gov.uk , updated in July 2018.

1. Development site and location

Provide a description of the site you are proposing to develop, including, or making reference to, a location map which clearly indicates the development site.

a. Where is the development site located? (e.g. postal address or national grid reference)
b. What is the current use of the site? (e.g. undeveloped land, housing, shops, offices)
c. Which Flood Zone (for river or sea flooding) is the site within? (i.e. Flood Zone 1, Flood Zone 2, Flood Zone 3). Check the Flood Map for Planning (Rivers and Sea) and the Strategic Flood Risk Assessment for the area available from the local planning authority.

2. Development proposals

Provide a general summary of the development proposals, including, or making reference to, an existing block plan and a proposed block plan, where appropriate.

a. What are the development proposal(s) for this site? Will this involve a change of use of the site and, if so, what will that change be?
b. In terms of vulnerability to flooding, what is the vulnerability classification of the proposed development?
c. What is the expected or estimated lifetime of the proposed development likely to be? (E.g. less than 20 years, 20-50 years, 50-100 years?).

3. Sequential test
For developments in flood zones 2 or 3 only.
(If the development site is wholly within flood zone 1, this section can be skipped - go to section 4).

Describe how the sequential test has been applied to the development (if required, and as set out in paragraphs 101-104 of the National Planning Policy Framework); and provide the evidence to demonstrate how the requirements of the test have been met.

See paragraph 033 of the NPPF guidance for further information. (It is recommended that the Developer or Agent contacts the LPA to confirm whether the sequential test should be applied and to ensure the appropriate level of information is provided).

a. What other locations with a lower risk of flooding have you considered for the proposed development?
b. If you have not considered any other locations, what are the reasons for this?

c. Explain why you consider the development cannot reasonably be located within an area with the lowest probability of flooding (flood zone 1); and, if your chosen site is within flood zone 3, explain why you consider the development cannot reasonably be located in flood zone 2.
d. As well as flood risk from rivers or the sea, have you taken account of the risk from any other sources of flooding in selecting the location for the development?

4. Climate Change

How is flood risk at the site likely to be affected by climate change? (The local planning authority's Strategic Flood Risk Assessment should have taken this into account). Further advice on how to take account of the impacts of climate change in flood risk assessments is available from the Environment Agency.

5. Site specific flood risk

Describe the risk of flooding to and from the proposed development over its expected lifetime, including appropriate allowances for the impacts of climate change. It would be helpful to include any evidence, such as maps and level surveys of the site, flood datasets (e.g. flood levels, depths and/or velocities) and any other relevant data, which can be acquired through consultation with the Environment Agency, the lead local flood authority for the area, or any other relevant flood risk management authority. Alternatively, you may consider undertaking or commissioning your own assessment of flood risk, using methods such as computer flood modelling.

a. What is/ are the main source(s) of flood risk to the site? (E.g. tidal/sea, fluvial or rivers, surface water, groundwater, other?). You should consider the flood mapping available from the Environment Agency, the Strategic Flood Risk Assessment for the area, historic flooding records and any other relevant and available information.
b. What is the probability of the site flooding, taking account of the maps of flood risk available from the Environment Agency, the local planning authority's Strategic Flood Risk Assessment and any further flood risk information?
c. Are you aware of any other sources of flooding that may affect the site?
d. What is the expected depth and level for the design flood? See paragraph 055 of the NPPF guidance for information on what is meant by a "design flood". If possible, flood levels should be presented in metres above Ordnance Datum (i.e., the height above average sea level).
e. Are properties expected to flood internally in the design flood and to what depth? Internal flood depths should be provided in metres.
f. How will the development be made safe from flooding and the impacts of climate change, for its lifetime? Further information can be found in paragraphs 054 and 059 (including on the use of flood resilience and resistance measures) of the NPPF guidance.
g. How will you ensure that the development and any measures to protect the site from flooding will not cause any increase in flood risk off-site and elsewhere? Have you taken into account the impacts of climate change, over the expected lifetime of the development? (e.g. providing compensatory flood storage which has been agreed with the Environment Agency).
h. Are there any opportunities offered by the development to reduce the causes and impacts of flooding?

6. Surface water management*

Describe the existing and proposed surface water management arrangements at the site using sustainable drainage systems wherever appropriate, to ensure there is no increase in flood risk to others off-site.

a. What are the existing surface water drainage arrangements for the site?
b. If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?
c. What are the proposals for managing and discharging surface water from the site, including any measures for restricting discharge rates? For major developments (e.g. of ten or more homes or major commercial developments), and for all developments in areas at risk of flooding, sustainable drainage systems should be used, unless demonstrated to be inappropriate.
d. How will you prevent run-off from the completed development causing an impact elsewhere?
e. Where applicable, what are the plans for the ongoing operation and/or maintenance of the surface water drainage systems?

7. Occupants and users of the development

Provide a summary of the numbers of future occupants and users of the new development; the likely future pattern of occupancy and use; and proposed measures for protecting more vulnerable people from flooding.

a. Will the development proposals increase the overall number of occupants and/or people using the building or land, compared with the current use? If this is the case, by approximately how many will the number(s) increase?
b. Will the proposals change the nature or times of occupation or use, such that it may affect the degree of flood risk to these people? If this is the case, describe the extent of the change.
c. Where appropriate, are you able to demonstrate how the occupants and users that may be more vulnerable to the impact of flooding (e.g., residents who will sleep in the building; people with health or mobility issues; etc.,) will be located primarily in the parts of the building and site that are at lowest risk of flooding? If not, are there any overriding reasons why this approach is not being followed?

8. Exception test

Provide the evidence to support certain development proposals in flood zones 2 or 3 if, following application of the sequential test, it is appropriate to apply the exception test, as set out in paragraphs 102-104 of the National Planning Policy Framework.

It is advisable to contact the local planning authority to confirm whether the exception test needs to be applied and to ensure the appropriate level of information is provided.

a. Would the proposed development provide wider sustainability benefits to the community? If so, could these benefits be considered to outweigh the flood risk to and from the proposed development?

b. How can it be demonstrated that the proposed development will remain safe over its lifetime without increasing flood risk elsewhere?
c. Will it be possible to for the development to reduce flood risk overall (e.g. through the provision of improved drainage)?

8. Residual risk

Describe any residual risks that remain after the flood risk management and mitigation measures are implemented, and to explain how these risks can be managed to keep the users of the development safe over its lifetime.

a. What flood related risks will remain after the flood risk management and mitigation measures have been implemented?
b. How, and by whom, will these risks be managed over the lifetime of the development? (e.g., putting in place flood warning and evacuation plans).

9. Flood risk assessment credentials

Provide details of the author and date of the flood risk assessment.

a. Who has undertaken the flood risk assessment?
b. When was the flood risk assessment completed?

Other considerations

*** Managing surface water**

The site-specific flood risk assessment will need to show how surface water runoff generated by the developed site will be managed. In some cases, it may be advisable to detail the surface water management for the proposed development in a separate drainage strategy or plan. You may like to discuss this approach with the lead local flood authority.

Surface water drainage elements of major planning applications (e.g., of ten or more homes) are reviewed by the lead local flood authority for the area. As a result, there may be specific issues or local policies, for example the Local Flood Risk Management Strategy or Surface Water Management Plan, that will need to be considered when assessing and managing surface water matters.

It is advisable to contact the appropriate lead local flood authority prior to completing the surface water drainage section of the flood risk assessment, to ensure that the relevant matters are covered in sufficient detail.

Proximity to Main Rivers

If the development of the site involves any activity within specified distances of main rivers, a flood risk activity permit may be required in addition to planning permission.

For non-tidal main rivers, a flood risk activity permit may be required if the development of the site is within 8 metres of a river, flood defence structure or culvert.

For tidal main rivers, a flood risk activity permit may be required if the development of the site is within 16 metres of a river, flood defence structure or culvert.

Details on obtaining a Flood Risk Activity Permit are available from the Environment Agency.

6.2 Pluvial Flood Risk

6.2.1 Long Term Flood Risk Map

Surface Water Flood Maps available from the www.gov.uk website indicate that there is a flow route passing through the site from the north boundary on Longridge Road.

It is evident that a small unnamed watercourse which flows through the west of the site and Chipping Brook located centrally within the site contribute to surface water flooding.

Once the capacity of the watercourses is exceeded, flows then overtop the banks flowing overland through low lying topography, resulting in varying depths and velocities throughout the site.

Mapping illustrates the chance of occurrence, potential depths, velocities and direction of flow for surface water flood routes. The definitions for varying probability events are provided below:

- High - Chance of flooding is greater than 1 in 30 in any one year (3.3% AEP).
- Medium - Chance of flooding is between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP) in any one year.
- Low - Chance of flooding is between 1 in 1000 (0.1% AEP) and 1 in 100 (1% AEP in any one year).
- Very Low - Chance of flooding of less than 1 in 1000 (0.1% AEP) in any one year.

6.2.2 High Probability Event

During the high probability event Chipping Brook overtops onto Longridge Road approximately 30m north of the site, then flows south where it enters site through the access road along the north boundary.

The proposed development site experiences flooding within the north west proportion.

Overland flow from the unnamed watercourse to the west does not pass over the crest of Longridge Road.

The flood depth during the high probability event is considered to be below 300mm with a velocity of over 0.25m/s.

6.2.3 Medium Probability Event

During the medium probability event the flood route associated with Chipping Brook is more prominent, furthermore the flow route associated with the unnamed watercourse now flows over Longridge Road and contributes to surface water flooding at the west site.

The flood depth during the medium probability event is considered to be overall below 300mm with a velocity of over 0.25m/s.

6.2.4 Low Probability Event

During the low probability event the flow routes north from Chipping Brook and from the west associated with the unnamed watercourse increases in magnitude.
During this event flooding associated with the unnamed watercourse to the east increases considerably, this combined with the flow route from the north results in extensive flooding within the west of the site.

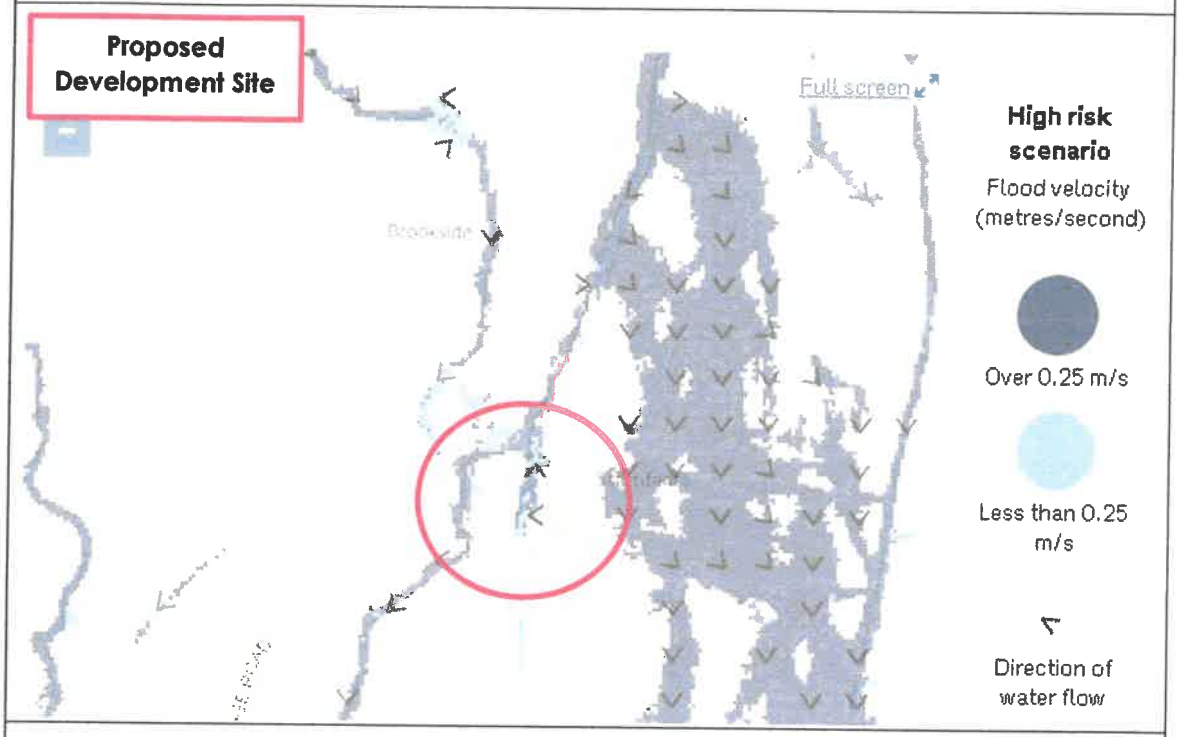
Furthermore, Chipping Brook overtops the east bank within the centre of the site creating a new flow route flowing in an easterly direction.

The flood depth during the low probability event in low lying areas is considered to be between 300mm-900mm with a velocity of over 0.25m/s.

Figure 6.1: Surface Water Depth – High Probability Event Depth

Source: www.gov.uk

Figure 6.2: Surface Water Depth – High Probability Event Velocity

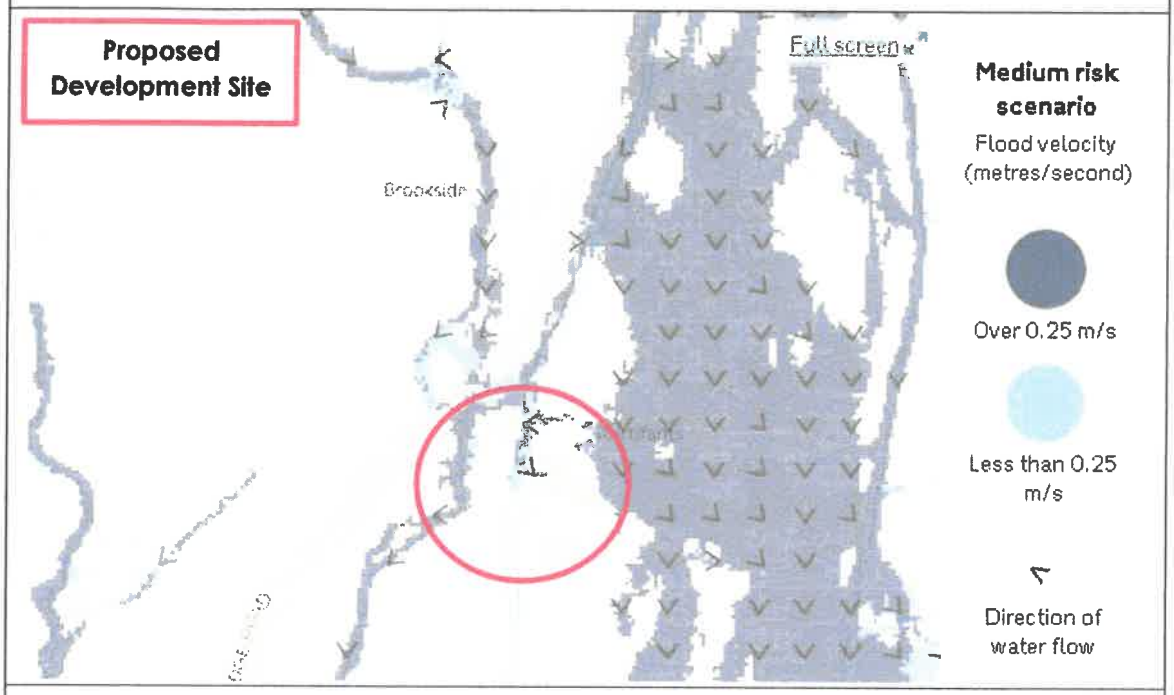


Source: www.gov.uk

Figure 6.3: Surface Water Depth – Medium Probability Event Depth

Source: www.gov.uk

Figure 6.4: Surface Water Depth – Medium Probability Event Velocity

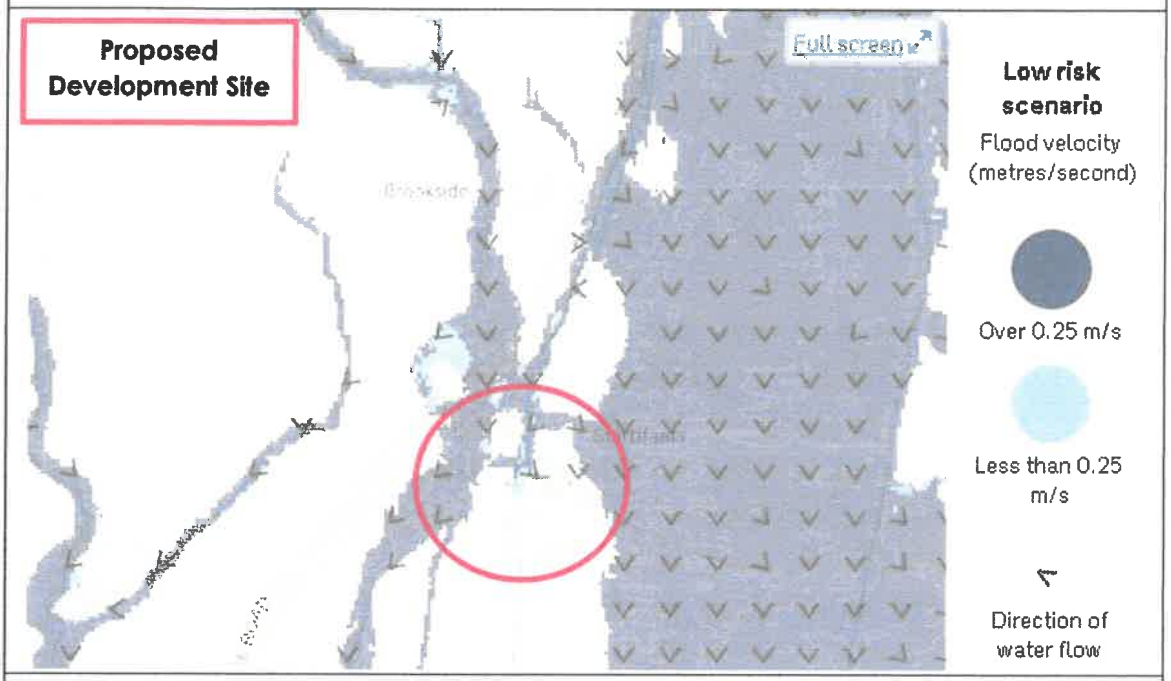


Source: www.gov.uk

Figure 6.5: Surface Water Depth – Low Probability Event Depth

Source: www.gov.uk

Figure 6.6: Surface Water Depth – Low Probability Event Velocity



Source: www.gov.uk

6.2.5 Flood Hazard Rating

The risk to people has been evaluated below using the methodology within the document FD2321/TR2 published by Defra and the Environment Agency.

Where Hazard Rating = Depth x (Velocity + 0.5) + Debris Factor

For flood depths <300mm, the Debris Factor = 0.5, and

For flood depths >300mm, the Debris Factor = 1.0

Therefore, using the map information, the hazard rating for each probability event is as follows:

High Probability:

Flood Depth: <300mm
Velocity: >0.25 (0.3m/s used for calculation purposes)
Debris Factor: 0.5

High Probability Hazard Rating = 0.3 x (0.3 + 0.5) + 0.5 = **0. 74 (low)**

Medium Probability:

Flood Depth: <300mm

Velocity: >0.25 (0.5m/s used for calculation purposes)
Debris Factor: 0.5

Medium Probability Hazard Rating = 0.3 x (0.5 + 0.5) + 0.5 = **0.80 (moderate)**

Low Probability:

Flood Depth: 300mm-900mm
Velocity: >0.25 (1.0m/s used for calculation purposes)
Debris Factor: 1.0

Medium Probability Hazard Rating = 0.9 x (1.0 + 0.5) + 0.5 = **1.85 (significant)**

Table 6: Velocity, Depth and Flood Hazard Matrix

Velocity (m/s)	Depth (m)									
	DF = 0.5			DF = 1.0						
	0.1	0.2	0.25	0.5	0.75	1.00	1.25	1.50	1.75	2.00
0.00	0.55	0.60	0.625	1.25	1.00	1.50	1.63	1.75	1.88	2.00
0.50	0.60	0.70	0.75	1.50	1.37	2.00	2.25	2.50	2.75	3.00
1.00	0.65	0.80	0.88	1.75	2.12	2.50	2.88	3.25	3.63	4.00
1.50	0.70	0.90	1.00	2.00	2.50	3.00	3.50	4.00	4.50	5.00
2.00	0.75	1.00	1.13	2.25	2.88	3.50	4.13	4.75	5.38	6.00
2.50	0.80	1.11	1.25	2.50	3.25	4.00	4.75	5.50	6.25	7.00

	<0.75	Low flood hazard (caution is required)
Class 1	0.75 – 1.25	Moderate hazard - Danger for some (children, the elderly & infirm)
Class 2	1.25 – 2.00	Significant hazard - Danger for most (the general public)
Class 3	>2.00	Extreme hazard - Danger for all (includes the emergency services)

6.2.6 Pluvial: Conclusion

In conclusion surface water flow routes through the site are present even during the high probability event i.e. most frequent, with a hazard rating increasing for the less frequent events.

High Probability Event

- Source of flooding = Chipping Brook via Longridge Road to the north
- Depth = Less than 300mm confined to the west of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Low

Medium Probability Event

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from north west via Longridge Road
- Depth = Less than 300mm confined to the west of the site, increasing compared to high probability event.
- Velocity = In excess of 0.25m/s
- Flood Hazard = Moderate

Low Probability Event

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from the west via Longridge Road
- Depth = Between 300mm-900mm large proportion of west extent, with a new flow routes passing out of east of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Significant

Providing that finished floor levels incorporated into the proposed development are set at a level in accordance with NFFP Guidance and flood resilience/resistance measures as outlined within Section 7.0 of this report, the risk associated with pluvial flooding can be suitably managed

6.3 Fluvial: Chipping Brook

6.3.1 General

Chipping Brook traverses through the centre of the application site in a southerly direction, entering through the north boundary, it flows under 3No structures: Startifants Bridge, UU WWTW bridge and a small footbridge, before flowing out of the south boundary.

The topographical survey identifies that walls are located along the west banks of Chipping Brook with stepped access down to the watercourse, there are no walls present along the east banks.

The site is located within Flood Zone 3, and therefore a comparison of flood levels against existing site levels has been undertaken.

6.3.2 Modelled Flood Levels

Modelled flood levels have been taken from the Chipping WWTW Maintenance, United Utilities Hydraulic Modelling Report, D02 | V01 January 2016 (Jacobs).

The scope of the model extends upstream of the WWTW into Startifants Farm, nodes along the route of the watercourse that are associated with the site are identified below.

The flood nodes are referenced within the report as follows:

- CH01-1071 = Startifants Site North
- CH01-1010u = Startifants Bridge
- CH01-1007 = Intersection

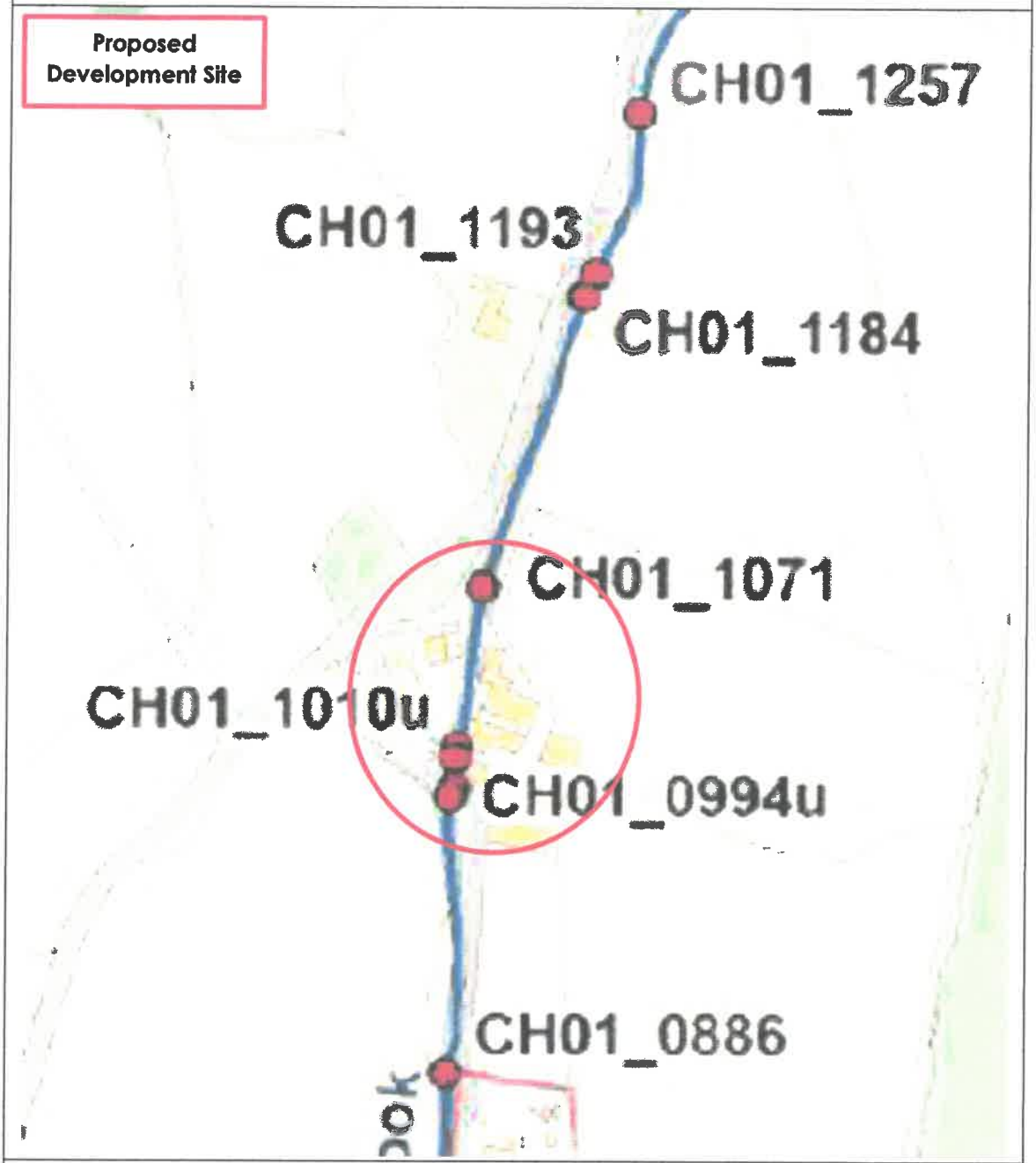
- CH01-0994u = WWTW Bridge

Table 7: Chipping Brook Flood Levels

Node Ref	100 Year Event (m AOD)	100 Year + 20% CC Event (m AOD)
CH01-1071	99.52	99.54
CH01-101u	99.21	99.24
CH01-1007	98.79	98.80
CH01-0994u	98.72	98.73

The location of the nodes is identified within the figure overleaf which is extracted from the Jacobs Modelling Report.

Figure 6.7: Jacobs Modelling Report Node Location Map



Source: UU WWTW Flood Model Report

6.3.3 1 in 100-year Flood Event (Flood Zone 3)

The table below identifies the flood level and depth in relation to the chosen nodes for each building during the 100 year event:

Table 8: 100 Year Flood Level/Depth for Each Building

Building Ref	Node Ref	100 Year Event (m AOD)	Existing Ground Level (m AOD)	Flood Depth (m)
A	CH01-1071	99.52	98.72	0.80
B	CH01-101u	99.21	98.02	1.19
C	CH01-1007	98.79	98.11	0.68
D	CH01-0994u	98.72	97.85	0.87
E	CH01-0994u	98.72	97.50	1.22

6.3.4 1 in 100-year Flood Event + 20% Climate Change Event

The table below identifies the flood level and depth in relation to the chosen nodes for each building during the 100 year + Climate Change event:

Table 9: 100 Year + Climate Change Flood Level/Depth for Each Building

Building Ref	Node Ref	100 Year + Climate Change Event (m AOD)	Existing Ground Level (m AOD)	Flood Depth (m)
A	CH01-1071	99.54	98.72	0.82
B	CH01-101u	99.24	98.02	1.22
C	CH01-1007	98.80	98.11	0.69
D	CH01-0994u	98.73	97.85	0.88
E	CH01-0994u	98.73	97.50	1.23

6.3.5 Danger from Overtopping

Using Table 4.3 from DEFRA/EA Document Flood Risk to People, the distance and depth associated with overtopping during the 1 in 100-year + climate change flood risk event is considered to present a 'Danger for All'.

Table 10: Danger to People from Overtopping Relevant to Distance

Distance from Breach (m)	Head Above Crest Level (m)			
	0.5	1	2	3
100			✓	
250				
500				
1000				
1500				
2000				

	Danger for none
	Danger for some e.g. elderly, infirm, and small children
	Danger for most e.g. the general public
	Danger for all e.g. the public and emergency services

6.3.6 Fluvial: Conclusion

The flood levels taken from the Jacobs WWTW Modelling Report show that the site floods to a considerable depth during the 100 year and 100 year + climate change events and is considered danger for all.

Sites A and B are the only developments to be of a habitable nature i.e. 'more vulnerable', sites C, D and E are considered to be non-habitable 'less vulnerable'.

Providing that mitigation measures as described within Section 7.0 of this report are incorporated into the final design of the buildings the risk from fluvial flooding can be suitably managed.

6.4 Surface Water Runoff

6.4.1 General

At present the site is developed comprising of 8No farm buildings. The site has an overall area of approximately 0.642 Hectares, of which approximately 0.191 Hectares (84%) comprises of roof or hardstanding and is considered impermeable.

6.4.2 Existing On-site Drainage Regime

At present no CCTV Survey has been undertaken, however engineering judgement suggests that surface water flows are collected via a positive drainage network and ultimately directed to Chipping Brook within the centre of the site.

United Utilities sewer records identify that a public combined sewer is located within the access road in a southerly direction to the UU Waste Water Treatment Works approximately 100m south.

6.4.3 Existing Runoff Rates

Existing runoff rates have been divided into the west and east extent of the site, due to the fact that they will require 2No separate systems.

West

- Total Area = 0.297Ha
- Total Impermeable Area = 4%

East

- Total Area = 0.345Ha
- Total Impermeable Area = 51%

The ICP SUDS Method has been utilised to derive existing runoff rates for a range of return periods, with the application of 4% and 51% impermeable to account for roof and hardstanding, these are shown below:

Table 11: Existing Surface Water Runoff

Return Period	West Discharge Rate l/s	East Discharge Rate l/s
1 Year	2.3	4.6
30 Year	4.4	7.9
100 Year	5.3	8.9

6.4.4 Surface Water Drainage Hierarchy

The hierarchy for disposal of surface water from new developments is outlined within the Building Regulations Approved Document H and specifies the following methods in order of preference:

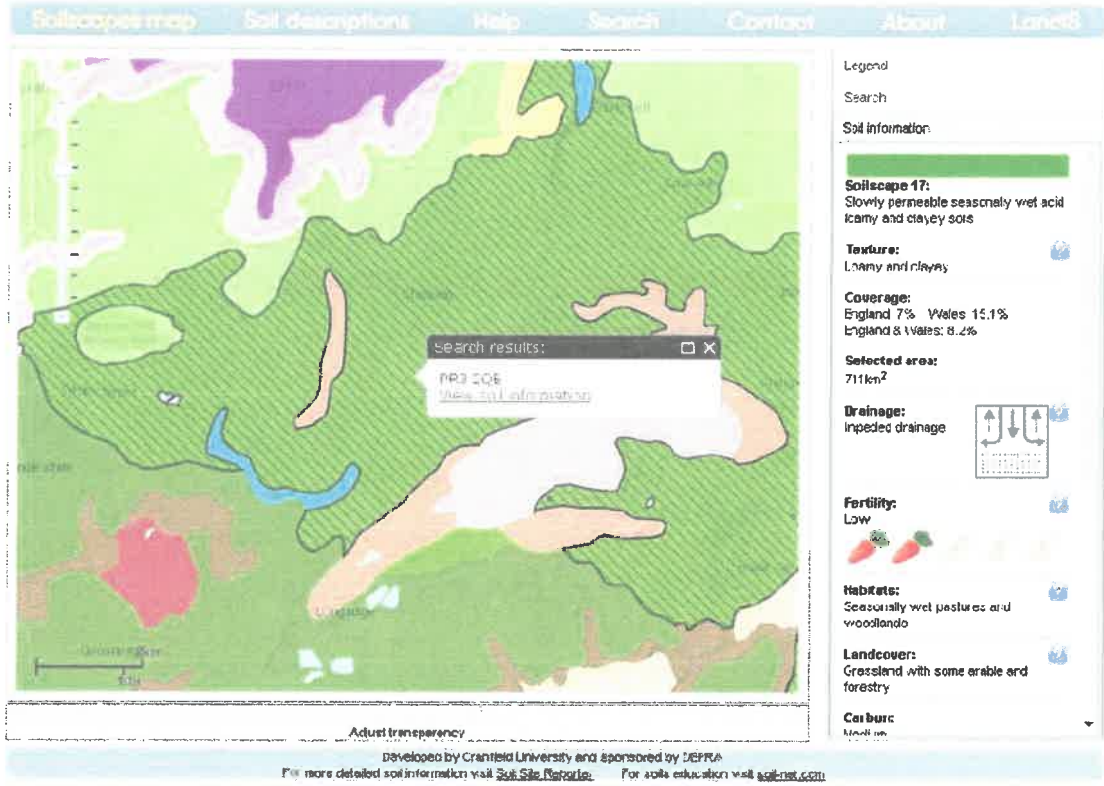
- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public surface water sewer
- Discharge to public combined sewer

Infiltration

Following a non-intrusive desk top study infiltration at the site is not considered to be feasible, a review of Soilscape maps identifies the site to be located on land which is considered to be *'Slowly permeable seasonally wet acid loamy and clayey soils'.*

Furthermore, local borehole logs identify that the underlying ground comprises of clay down to a considerable depth.

Figure 6.8: Soilscape Map



Source: Soilscape

Although the underlying ground seems to be unsuitable, the statutory authorities may require evidence in the form of on-site percolation tests taken in accordance with BRE Digest 365 prior to any outfall into the watercourse.

Watercourse

Chipping Brook traverses through the centre of the application site. At the time of writing no CCTV Survey was available, however engineering judgment suggests that the existing site already directs surface water flows to watercourse.

Therefore, it is recommended that surface water flows from the proposed development discharge into Chipping Brook, where possible reutilising the existing network to facilitate an outfall/s.

6.4.5 Sustainable Urban Drainage Systems (SUDS)

SUDS act to reduce the impact of surface water runoff from the development by limiting runoff volumes and rates from leaving the site.

Undertaking an assessment using the SUDS Planner Module within MicroDrainage Windes revealed that a number of different methods could be used within the development. A summary of the results is tabulated below:

Table 12: SUDS Planner

SUDS Criteria	Rank 1	Rank 2	Rank 3
Hydrological	Permeable Pavements	Infiltration Trench/Soakaway	Infiltration Basin
Land Use	Infiltration Trench/Soakaway	Bioretention Area	Infiltration Basin
Site Features	Permeable Pavements	Green Roofs	Filtration Techniques
Community & Environment	Bioretention Area	Grassed Filter Strips	Stormwater Wetlands
Economics & Maintenance	Wet Ponds	Grassed Filter Strips	Dry Detention
Total	**Online/Offline Storage**	**Permeable Pavements**	**Green Roofs**

1. Source Control

The inclusion of source control in SUDS schemes is one of the more important principles of SUDS design, and source control components should be upstream of any pond, wetland or other SUDS component.

Source control can help provide interception storage which can handle and treat some of the more frequent but smaller, polluting events (at least 5mm).

Most source control components will be located within the private properties or highway areas. Their purpose is to manage rainfall close to where it falls, not allowing it to become a problem elsewhere.

The main types of source control include:

- Green roofs
- Rainwater harvesting
- Permeable paving
- Other permeable surfaces

Source control methods look to maximize permeability within a site to promote attenuation, treatment and infiltration, thereby reducing the need for off-site conveyance.

a) Green Roofs

Green roof solutions generally comprise of a multi-layered system that covers the roof of a building with vegetation cover, and/or landscaping over a drainage layer, designed to intercept and retain rainfall.

The incorporation of green roofs is to be decided by the architect/developers during the final design stage and is largely dependent on the final building design.

The likelihood of green roofs being utilised is considered to be low due to the increase in structural cost of the development.

b) Rainwater Harvesting

Rainwater harvesting provides a source of non-potable water, for purposes such as car washing; and landscaped area irrigation etc... and can be used for some industrial processes to reduce consumption of water from conventional supplies.

This SUDS solution, like green roof technology, is also designed to provide interception storage i.e. acts to reduce the volume of surface water leaving the proposed development; thereby helping to alleviate the current pressures on the receiving watercourse.

Rainwater harvesting can be installed at relatively low costs dependant on the chosen structure providing that the development site has scope.

c) Permeable Paving

Pervious surfaces can be either porous or permeable. The important distinction between the two is:

Porous surfacing is a surface that infiltrates water across the entire surface. Permeable surfacing is formed of material that is itself impervious to water but, by virtue of voids formed through the surface, allows infiltration through the pattern of voids.

Pervious surfaces provide a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into underlying layers.

The water can be temporarily stored before infiltration to the ground, reused, or discharged to a watercourse or other drainage system. Surfaces with an aggregate sub-base can provide good water quality treatment.

*Due to the proposed development being located within Flood Zone 3 and the risk of siltation incorporating permeable paving is not recommended.

2. On/Offline Storage

This is a traditional form of surface water attenuation and may be provided via online or offline structures such as oversized pipes; or shallow attenuation structures such as geo-cellular crate systems

e.g. Hydro-International's Stormcell System or similar. These structures may be easily placed within either hardstanding or landscaped areas to provide ease of access for maintenance purposes.

6.4.6 Restricted Discharge Rates

Due to the application site being considered as greenfield with a percentage urban, proposed discharge rates should be restricted to existing runoff by means of flow control devices.

6.4.7 Proposed Areas

The development proposals show that the impermeable areas within the west extent of the site rise slightly, whilst the impermeable areas in the east fall dramatically.

overall there will be a reduction in impermeable area compared to the existing situation from 55%, down to 36% of the total site area. This is broken down further into the west and east extents as follows:

West

- Existing Impermeable Area = 4%
- Proposed Impermeable Area = 6%

East

- Existing Impermeable Area = 51%
- Proposed Impermeable Area = 30%

6.4.8 Indicative Attenuation Volumes

Indicative attenuation volumes have been estimated based on the proposed impermeable areas, restricted to existing greenfield runoff rates for a range of return periods, these are shown within the table below:

Table 13: Indicative Attenuation Volumes

Return Period	West Indicative Attenuation Volumes (m^3)	East Indicative Attenuation Volumes (m^3)
1 Year	0.0 - 0.3	1.4 - 6.3
30 Year	0.0 - 1.2	6.4 - 18.0
100 Year +40% Climate Change	0.1- 3.5	20.0 - 43.0

6.4.9 Drainage Strategy

At the time of writing a desk top study has revealed that infiltration at the proposed site is not considered to be suitable, as such it is recommended that proposed surface water flows as a result of the development are directed to Chipping Brook.

West Extent

Due to the small amount of attenuation required for the west extent of the site, it may be possible that volumes could be retained within a traditional piped network, with flows restricted to greenfield runoff via an orifice plate, without the need for a formal attenuation structure.

East Extent

Flows from the east extent of the site will require formal on/offline attenuation, this could be in the form Geo-cellular crates located within an area that allows for a gravity connection into the watercourse, with flows restricted via a flow control device prior to disposal.

A Geo-cellular tank has been modelled which attenuates flows up to and including the 100 year plus 40% climate change event with no surface flooding, the dimensions of the tank are as follows:

Geo-Cellular Tank Dimensions

- Area = 30m^2
- Depth of Crate = 0.8m
- Depth to Invert of Tank = 2.0m

Where possible it would be best to reutilise the existing outfall/s which would negate any requirement to undertake works within the watercourse.

*Furthermore, the tank needs to be designed to prevent floatation during a flood event.

6.4.10 Residual Flood Risk

The proposed drainage system should be designed such that attenuation will be provided to accommodate surface water runoff for storms with a return period of up to the 1 in 30 year event incorporating an additional 40% to accommodate climate change over the lifetime of the development; in accordance with the EA's and LPAs requirements.

The 1 in 100 year plus climate change event is allowed to flood at surface level within the development. However, it is highlighted that the resulting flood water must be retained within the site; and will not be allowed to inundate property within the development; or migrate beyond the boundary of the site, thereby increasing flood risk elsewhere.

Following modelling of the drainage network there is no surface flooding during the 1 year and 30 year and 100 year plus 10%, 20%, 30% and 40% climate change events

As such the flood risk to properties both on and off the site during the 100 year + climate change event is considered to be low.

6.4.11 Maintenance

It is anticipated that the proposed drainage network will remain private and therefore a private maintenance contract should be formed covering all the drainage elements, this is ultimately the responsibility of the developer.

6.5 Foul

It is recommended that foul flows from the site are to be directed to the existing public combined system at the south of the site, which ultimately flows into the UU Waste Water Treatment Works approximately 100m south of the site, following consultation with United Utilities.

Where possible the existing foul drainage network that serves the site should be reutilised.

7.0 Development Constraints & Flood Mitigation

7.1 Residential Development Finished Floor Levels

In accordance with the NPPF, finished floor levels for habitable buildings should be set to no less than 600mm above the 100 year plus climate change event.

As such the finished floor level for sites A and B should be set to no less than the following:

A. 99.54m AOD + 0.600m = **100.140m AOD**
B. 99.24m AOD + 0.600m = **99.840m AOD**

To achieve the finished floor levels as identified above non-habitable space should be provided at ground floor level, an example of this is provided below.

Figure 7.1: Example Houses with Non-habitable space at Ground Floor

7.2 Non-Habitable Development Constraints Finished Floor Levels

Any building that is not considered to be habitable may have level access, however if the flood depth is in excess of 0.9m during the 100 year + climate change event, it should be suitably designed by a structural engineer to withstand flooding of this magnitude.

Therefore, sites C, D and E may set floor levels matching existing ground levels if required.

Site E will require a structural assessment as the flood depth during the 100 year + climate change event is 1.23m.

7.3 Flood Resistance/Resilience Measures

Habitable dwellings should incorporate wet proofing measures at ground floor level and dry proofing measures for anything on first floor level up to 0.6m above finished floor levels.

A. Wet Proofing at Ground Floor Level, Dry Proofing up to a level of 99.92m AOD
B. Wet Proofing at Ground Floor Level, Dry Proofing up to a level of 99.22m AOD

Due to the depth of flooding associated with the non-habitable buildings, it is recommended that wet proofing measures are incorporated at ground floor level up to a level of 0.6m above the 100 year plus climate change flood level.

C. Wet Proofing up to a level of 98.71m AOD
D. Wet Proofing up to a level of 97.85m AOD
E. Wet Proofing up to a level of 98.10m AOD

Flood proofing is a technique by which buildings are designed to withstand the effects of flooding. There are two main categories of flood proofing, which are dry proofing and wet proofing.

Dry proofing methods are designed to keep water out of the building, and wet proofing methods are designed to improve the ability of the property to withstand effects of flooding once the water has entered the building.

Where wet proofing is required it is important that a flood warning and an evacuation plan should be prepared and practised regularly, so that persons on-site, along with any irreplaceable contents of the building, can be moved to areas above the predicted flood level if required.

In addition, fixtures and fittings should be built to withstand immersion in water or designed to be easily replaced.

The differential pressures across load bearing walls and the flotation effect that will occur during flood events should be taken into account when considering dry proofing techniques.

For most existing properties this means that dry flood proofing should only be considered if the expected flood depth is under 0.9m.

The table below summarises recommendations for flood proofing measures which can be incorporated within the design for the proposed redevelopment works. Such measures are put forward in accordance with 'Development and Flood Risk Guidance for the Construction Industry' CIRIA C624, London 2004.

It would be preferable to avoid external doors as this would remove a potential point of flood inflows. However, since free access and egress into the building will be required, flood resistant doors and/or the use of flood resistant stop logs or flood boards should be considered.

Full details of manufacturer's or suppliers of flood protection equipment may be obtained from the Flood Protection Association (website: www.thefpa.org.uk).

Table 14: Typical Flood Proofing Measures

Feature	Considerations to Improve Flood Proofing
External Doors	The use of flood proof doors provide an effective way of ensuring that flood water cannot enter through the thresholds of the property at all times of the day, weather residents are at home or not.
External Walls	Careful consideration of materials: use low permeability materials to limit water penetration if dry proofing required. Avoid using timber frame and cavity walls. Consider applying a water resistant coating. Provide fitting for flood boards or other temporary barriers across openings in the walls.
Internal Walls	Avoid use of gypsum plaster and plasterboards; use more flood resistant linings (e.g. hydraulic lime, ceramic tiles). Avoid use of stud partition walls.
Floors	Avoid use of chipboard floors. Use concrete floors with integrated and continuous damp proof membrane and damp proof course. Solid concrete floors are preferable; if a suspended floor is to be used, provide facility for drainage of sub-floor void. Use solid insulation materials.
Fitting, Fixtures and Services	If possible, locate all fittings, fixtures and services above design floor level. Avoid chipboard and MDF. Consider use of removable plastic fittings. Use solid doors treated with waterproof coatings. Avoid using double-glazed window units that may fill with flood water. Use solid wood staircases. Avoid fitted carpets. Locate electrical, gas and telephone equipment and systems above flood level. Fit anti-flooding devices to drainage systems.
Source: www.floodsense.co.uk	

7.4 Displacement of Flood Storage

Due to the site being located within Flood Zone 3 flood waters are not allowed to be displaced by buildings or elevation of site levels, as this could result an increase of flood risk off site.

In this scenario the proposed footprints of the buildings is less than that of the existing scenario i.e.

- Existing Footprints of Buildings = 950m^2
- Proposed Footprints of Buildings = 800m^2

Due to the net decrease in footprints of 150m^2 there is no requirement to provide flood storage compensation.

7.5 Flood Alarm

The application site is not covered by the Environment Agency's Flood Warning Service.

Therefore, in order to give advanced warning to residents about the onset of flooding it is advised that a proprietary flood alarm system is incorporated into the development proposals, allowing residents to remove valuables and/or evacuate the site well in advance of any flooding onsite.

An example of a typical flood alarm system is depicted overleaf:

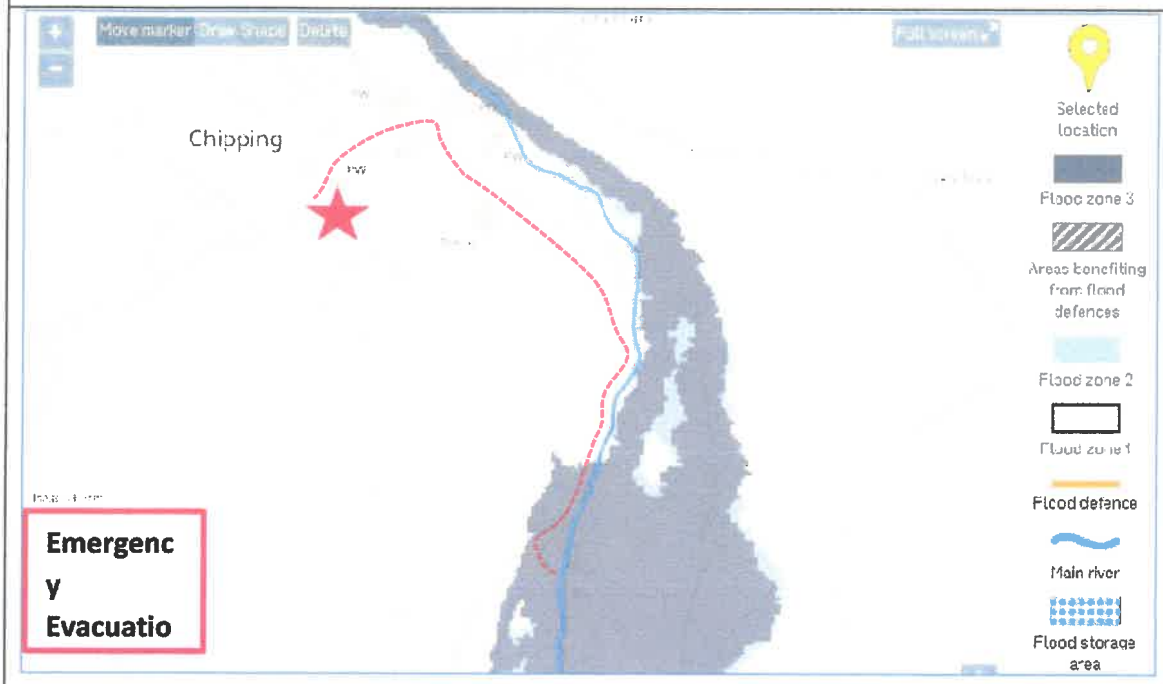
Figure 7.2: Typical Flood Alarm

Source: Flood Safe

7.6 Safe Access and Egress

Dry access and egress will not be available at the application site at all times, furthermore due to the considerable flood depths throughout the site, it is highly recommended that all residents must evacuate the site well in advance of the on-set of flooding.

Figure 7.3: Preferred Access Route North of the Site



Source: www.gov.uk

Upon receipt of the flood alarm residents must exit the site via the west boundary onto Longridge Road where they should head north, then west on Club Lane into Flood Zone 1.

An appropriate Muster Point would be Chipping Congressional Church which is located on Club Lane, approximately 900m north west of the application site.

Residents should not enter back into the property until flooding has fully subsided and the flood alarm is no longer active.

7.7 Fencing/Walls

During the design phase boundary treatments should consider that existing flood flow routes should not be obstructed from their existing course, if this happens it has the potential to displace volumes which may result in flooding of properties downstream of the application site which can increase flood risk to the wider area.

As such it is recommended that boundary treatments comprise of vegetation/hedging and/or open style fencing.

*Furthermore, any new solid walls along the banks of the watercourse are not permitted for the above reasons.

7.8 Evacuation Plan

Once a development plan has been developed and access routes established a robust evacuation plan should be formalised to ensure that all residents can evacuate the property well in advance of the onset of flooding.

Guidance on developing a Flood Plan has been attached within the appendix.

7.9 Easement's

Any United Utilities sewers that pass through the site will require easements of generally 4m at either side of the sewer, however this will have to be determined by UU once a pipe size has been confirmed.

Furthermore, no buildings or structures are allowed within 8m of a Main River, this is to allow access for maintenance purposes.

7.10 Environmental Permit

Any works within 8m of the watercourse will require an Environmental Permit, this will also include any new drainage outfalls that will require works to the banks of Chipping Brook.

8.0 Conclusions & Recommendations

The site is shown to be situated within Flood Zone 3 of the Environment Agency Flood Map and therefore has a high risk of fluvial flooding.

An initial assessment indicates that the primary flood risk at the proposed development is from the fluvial source Chipping Brook, that traverses through the centre of the site and surface water flow routes from the north.

Pluvial: Overland Flow

Surface Water Flood Maps available from the www.gov.uk website indicate that there is a flow route passing through the site from the north boundary on Longridge Road.

It is evident that a small unnamed watercourse which flows through the west of the site and Chipping Brook located centrally within the site contribute to surface water flooding.

Once the capacity of the watercourses is exceeded, flows then overtop the banks flowing overland through low lying topography, resulting in varying depths and velocities throughout the site.

In conclusion surface water flow routes through the site are present even during the high probability event i.e. most frequent, with a hazard rating increasing for the less frequent events.

High Probability Event - 30 Year

- Source of flooding = Chipping Brook via Longridge Road to the north
- Depth = Less than 300mm confined to the west of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Low

Medium Probability Event – 100 Year

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from north west via Longridge Road
- Depth = Less than 300mm confined to the west of the site, increasing compared to high probability event.
- Velocity = In excess of 0.25m/s
- Flood Hazard = Moderate

Low Probability Event – 1000 Year

- Source of flooding = Chipping Brook via Longridge Road to the north & unnamed watercourse from the west via Longridge Road
- Depth = Between 300mm-900mm large proportion of west extent, with a new flow routes passing out of east of the site
- Velocity = In excess of 0.25m/s
- Flood Hazard = Significant

Providing that finished floor levels incorporated into the proposed development are set at a level in accordance with NFFP Guidance and flood resilience/resistance measures as outlined within Section 7.0 of this report, the risk associated with pluvial flooding can be suitably managed

Fluvial: Chipping Brook

Chipping Brook traverses through the centre of the application site in a southerly direction, entering through the north boundary, it flows under 3No structures: Startifants Bridge, UU WWTW bridge and a small footbridge, before flowing out of the south boundary.

The topographical survey identifies that walls are presents along the west banks of Chipping Brook with stepped access down to the watercourse, there are no walls present along the east banks.

The site is located within Flood Zone 3, and therefore a comparison of flood levels against existing site levels has been undertaken.

The flood levels taken from the Jacobs WWTW Modelling Report show that the site floods to a considerable depth during the 100 year and 100 year + climate change events and is considered danger for all.

Sites A and B are the only developments to be of a habitable nature i.e. 'more vulnerable', sites C, D and E are considered to be non-habitable 'less vulnerable'. Providing that mitigation measures as described within Section 7.0 of this report are incorporated into the final design of the buildings the risk from fluvial flooding can be suitably managed.

Drainage

Chipping Brook traverses through the centre of the application site. At the time of writing no CCTV Survey was available, however engineering judgment suggests that the existing site already directs surface water flows to watercourse.

Therefore, it is recommended that surface water flows from the proposed development discharge into Chipping Brook, where possible reutilising the existing network to facilitate an outfall/s.

West Extent

Due to the small amount of attenuation required for the west extent of the site, it may be possible that volumes could be retained within a traditional piped network, with flows restricted to greenfield runoff via an orifice plate, without the need for a formal attenuation structure.

East Extent

Flows from the east extent of the site will require formal on/offline attenuation, this could be in the form Geo-cellular crates located within an area that allows for a gravity connection into the watercourse, with flows restricted via a flow control device prior to disposal.

A Geo-cellular tank has been modelled which attenuates flows up to and including the 100 year plus 40% climate change event with no surface flooding, the dimensions of the tank are as follows:

Geo-Cellular Tank Dimensions

- Area = $30m^2$
- Depth of Crate = 0.8m
- Depth to Invert of Tank = 2.0m

Where possible it would be best to reutilise the existing outfall/s which would negate any requirement to undertake works within the watercourse.
It is recommended that foul flows from the site are to be directed to the existing public combined system at the south of the site, which ultimately flows into the UU Waste Water Treatment Works approximately 100m south of the site, following consultation with United Utilities.

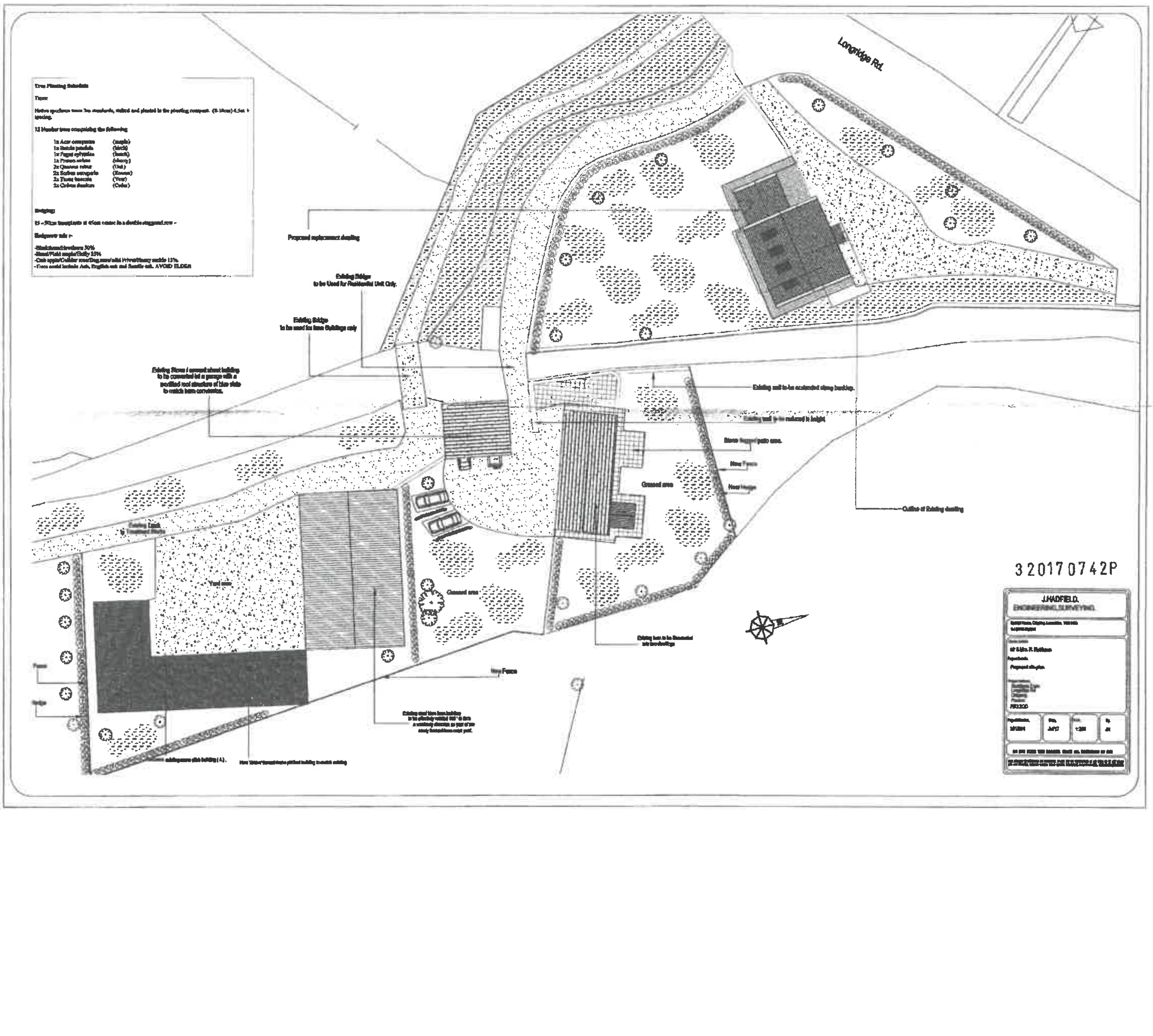
Where possible the existing foul drainage network that serves the site should be reutilised.

Mitigation Measures

- Finished floor levels of habitable buildings set 600mm above 100 year + climate change event. Building A = 100.140m AOD, Building B = 99.840m AOD
- Finished floor levels of non-habitable buildings set to exiting ground levels if necessary.
- Building E will require structural design for flooding in excess of 0.9m in depth.
- Flood Alarm incorporated into final design, site located outside of EA Flood Warning/Alert coverage area.
- Residents to evacuate north up Longridge Road on receipt of flood alarm.
- Boundary treatments should be passive with no new walls along banks of watercourse permitted.

Appendix A
Topographical Survey

Appendix B
Proposed Development


Longridge Rd.
Proposed replacement dwelling
Existing Bridge
to be Used for Residential Unit Only.
Existing Bridge
to be used for farm Buildings only
Stone flagged patio area.
New Fence
New Hedge
Grassed area
Yard area
Grassed area
Outline of Existing dwelling
New Fence
Fence
Hedge
J.HADFIELD.
ENGINEERING,SURVEYING.

3 2 0 1 7 0 7 4 2 P

Appendix C
Borehole Logs & Soilscape Maps

ACC NO 46602 ACC NO 46621

British Geological Survey

HYDROGEOLOGY RESEARCH GROUP

SD64/69

Form WR-38 (BGS)

BOREHOLE RECORD

NORTH WEST 68.

SD64 SW/14

A SITE DETAILS		
Borehole drilled for	TOBY OLLERTON	
Location	POLE FARM, CHIPPING, PRESTON.	
NGR (8 fig.)	SD 6271 4200	Please attach site plan
Ground Level (if known)		
Drilling Company	DALES WATER SERVICES LTD	
Date of Drilling	Commenced 9 9 2000	Completed 14 9 2000

B CONSTRUCTION DETAILS

Borehole Datum (if not ground level) _____ above / m below GL

(point from which all measurements of depth are taken e.g. flange, edge of chamber, etc.)

Borehole drilled diameter	150	mm from	GL	to	63 m/depth
	_____	mm from	_____	to	_____ m/depth
	_____	mm from	_____	to	_____ m/depth
Casing material and type (e.g. if plain steel, plastic slotted) PLAIN STEEL diameter	150	mm from	GL	to	19.50 m/depth
_____ diameter	_____	mm from	_____	to	_____ m/depth
_____ diameter	_____	mm from	_____	to	_____ m/depth
_____ diameter	_____	mm from	_____	to	_____ m/depth

Grouting details _____

Water struck at 21 m (depth below datum — mbd)

45 m (depth below datum — mbd)

Rest water level on completion _____ mbd

C TEST PUMPING SUMMARY (Please supply full details on Forms WR-39)

Test Pumping Datum (if different from borehole datum)	_____ m	above / below borehole datum (mbd)
Pump Suction depth	35 mbd	
Water Level (Start of Test)	_____ mbd	
Water Level (End of Test)	_____ mbd	
Pumping rate	_____ m^3/d:l/s	
for	_____ days/hours	
Recovery to (from end of pumping)	_____ mbd in	mins: hrs: days
Date(s) of measurements	_____	

Please supply chemical Analysis if available.

D STRATA LOG SD 64/69

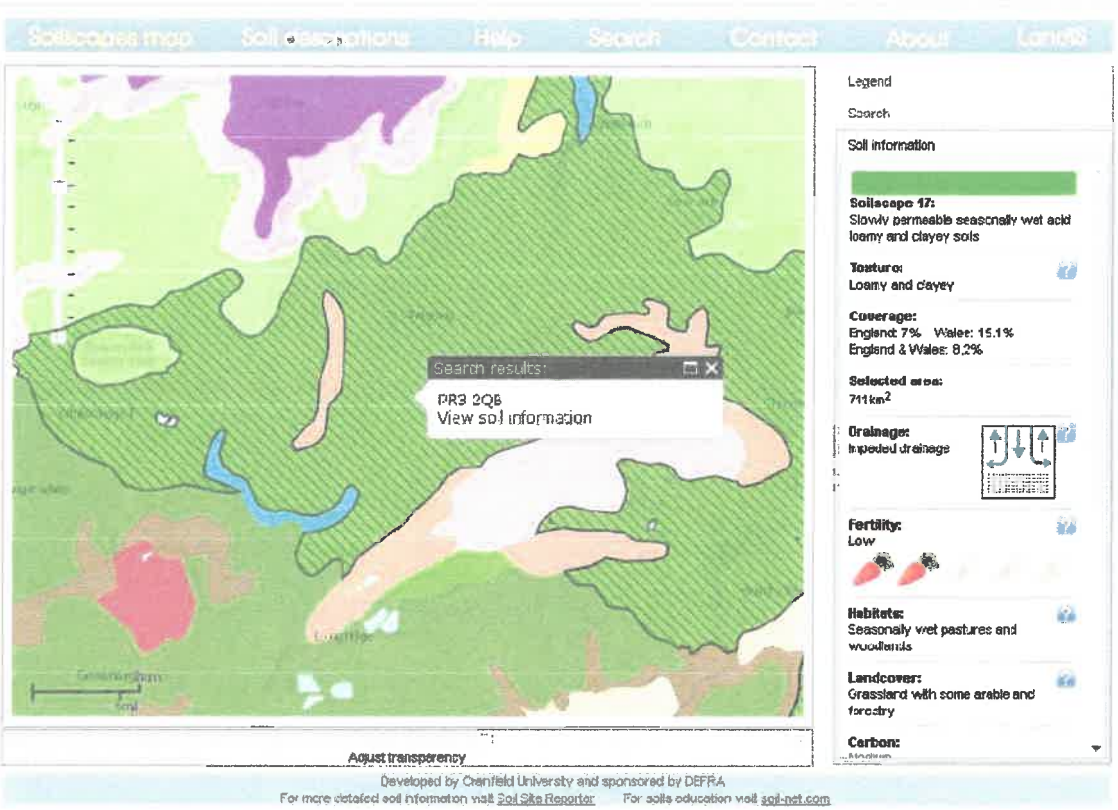
Geological Classification (BGS only)	Description of strata	Thickness m	Depth m
	SAND & SILTY CLAY	6 · 00	6 · 00
	BOULDER CLAY	9 · 00	15 · 00
	MILLSTONE GRIT	48 · 00	63 · 00

(continue on separate page if necessary

Other comments (e.g. gas encountered, saline water intercepted, etc.)

FOR OFFICIAL USE ONLY

FILE	CONSENT NO.	NGS REF NO.
LIC NO.	PURPOSE	NRA REF NO.
DATE REC:	COPY TO:	ENTERED BY:


Soilscapes map
Soil descriptions
Help
Search
Contact
About
Login
Search results:
PR3 2QB
View soil information
Legend
Search
Soil information
Soilscape 17:
Slowly permeable seasonally wet acid loamy and clayey soils
Texture:
Loamy and clayey
Coverage:
England: 7% Wales: 15.1%
England & Wales: 8.2%
Selected area:
711 km2
Drainage:
Impeded drainage
Fertility:
Low
Habitats:
Seasonaly wet pastures and woodlands
Landcover:
Grassland with some arable and forestry
Carbon:
Adjust transparency
Developed by Cranfield University and sponsored by DEFRA
For more detailed soil information visit Soil Site Reporter
For soils education visit soil-net.com

Appendix D
United Utilities Sewer Maps

United Utilities
helping life flow smoothly

How to contact us:

United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Telephone: 0370 7510101

E-mail: propertysearches@uuplc.co.uk

Paul Waite Associates Ltd
□
Summit House
Riparian Way
Cross Hills
Keighley
BD20 7BW□

FAO:

Your Ref: DM009
Our Ref: UUPS-ORD-54279
Date: 06/09/2018

Dear Sirs

Location: Startifants Startifants Longridge Road, Chipping, PR3 2QB

I acknowledge with thanks your request dated 04/09/2018 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. http://www.unitedutilities.com/work-near-asset.aspx .

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please contact us .

Yours Faithfully,

Karen McCormack
Property Searches Manager

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

TERMS AND CONDITIONS - WASTERWATER AND WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

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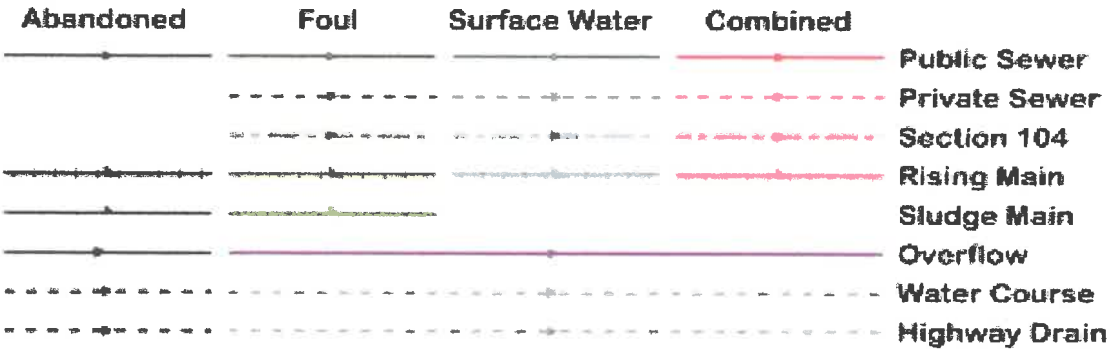
Wastewater Symbology



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

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

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SEWER RECORDS

Address or Site Reference

Startifants Startifants Longridge Road,
Chipping,
PR3 2QB

Scale: 1:5000
Date: 06/09/2018

Printed by: Property Searches

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

Appendix E
Existing Runoff Rates

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	0.297	Urban	0.040
SAAR (mm)	1203	Region Number	Region 10

Results l/s

QBAR Rural	2.5
QBAR Urban	2.6
Q1 year	2.3
Q1 year	2.3
Q30 years	4.4
Q100 years	5.3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	0.345	Urban	0.510
SAAR (mm)	1203	Region Number	Region 10

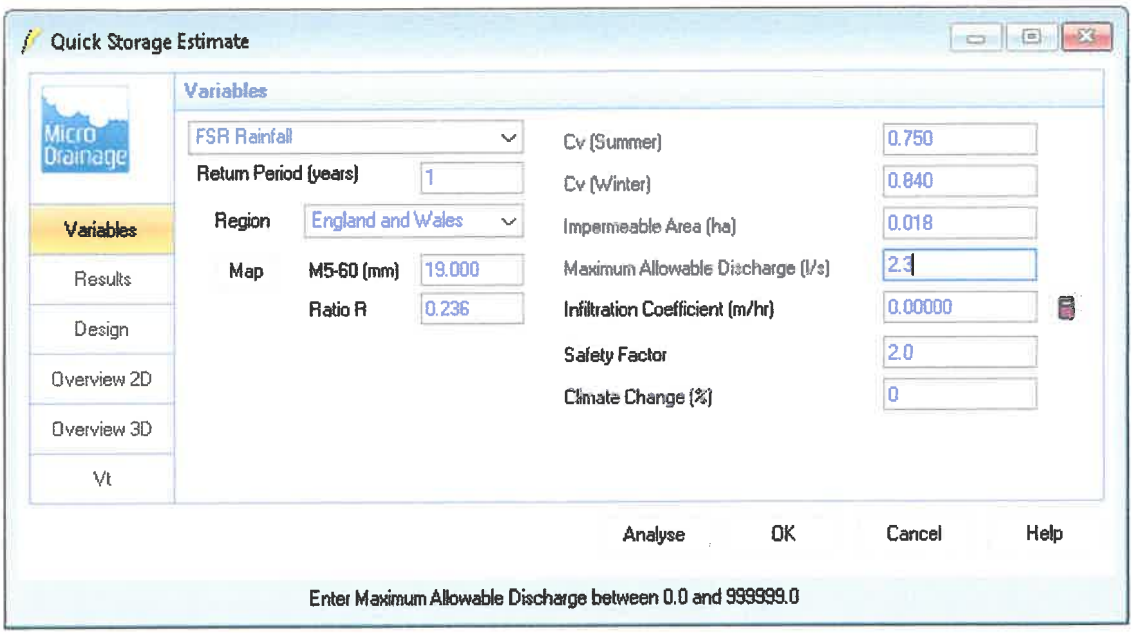
Results 1/s

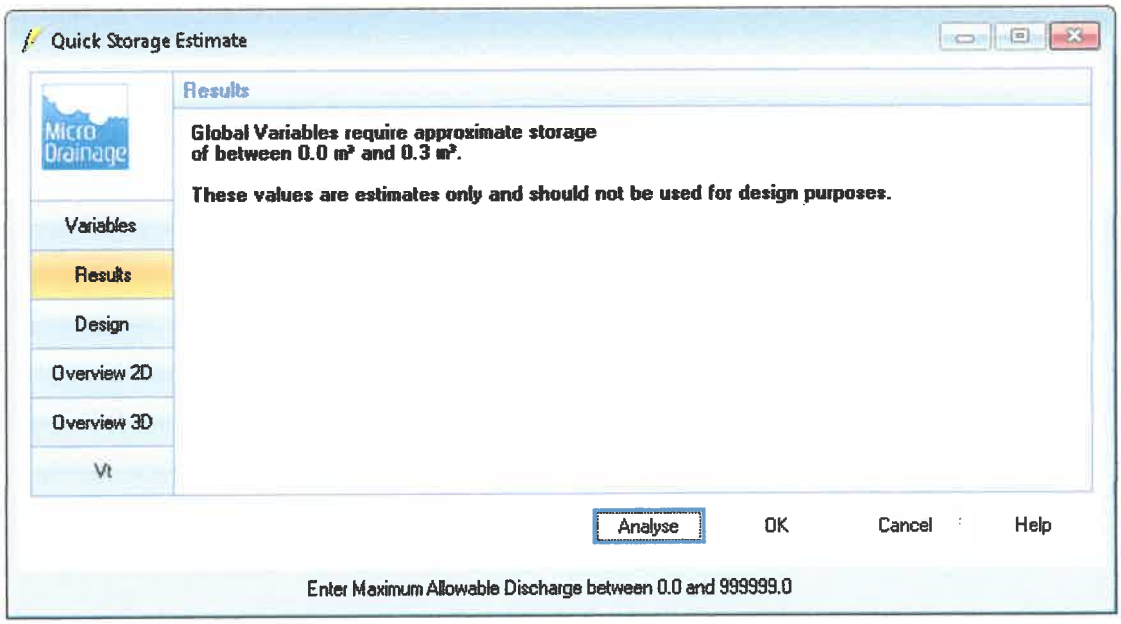
QBAR Rural	2.9
QBAR Urban	5.2
Q1 year	4.6
Q1 year	4.6
Q30 years	7.9
Q100 years	8.9

Appendix F
Indicative Attenuation Volumes

WEST EXTENT
INDICATIVE ATTENUATION VOLUMES

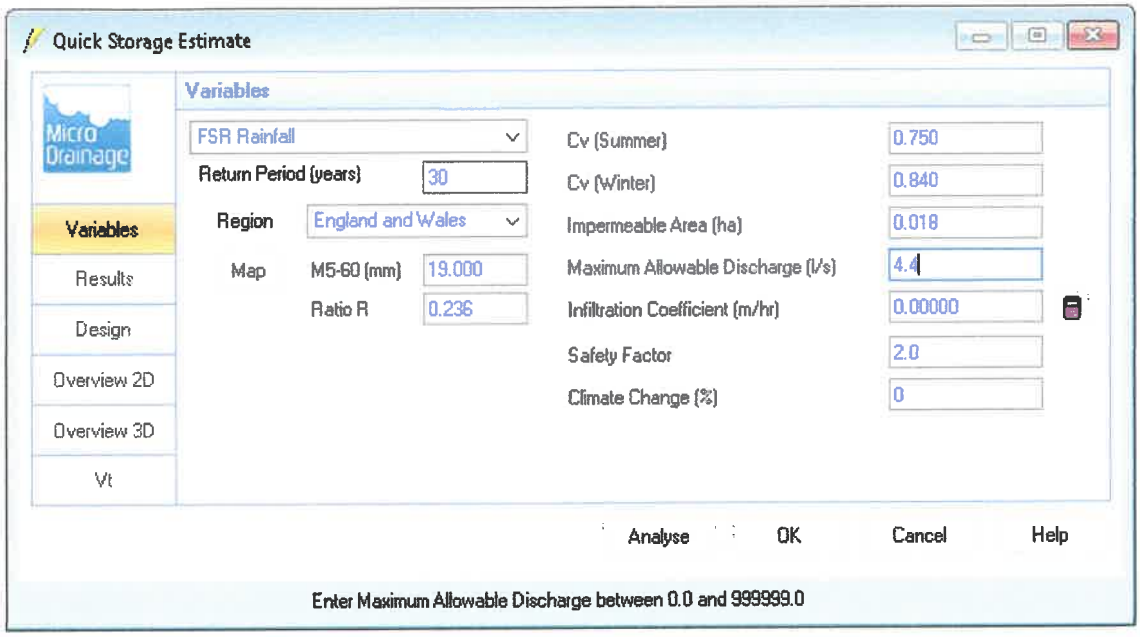
1 YEAR

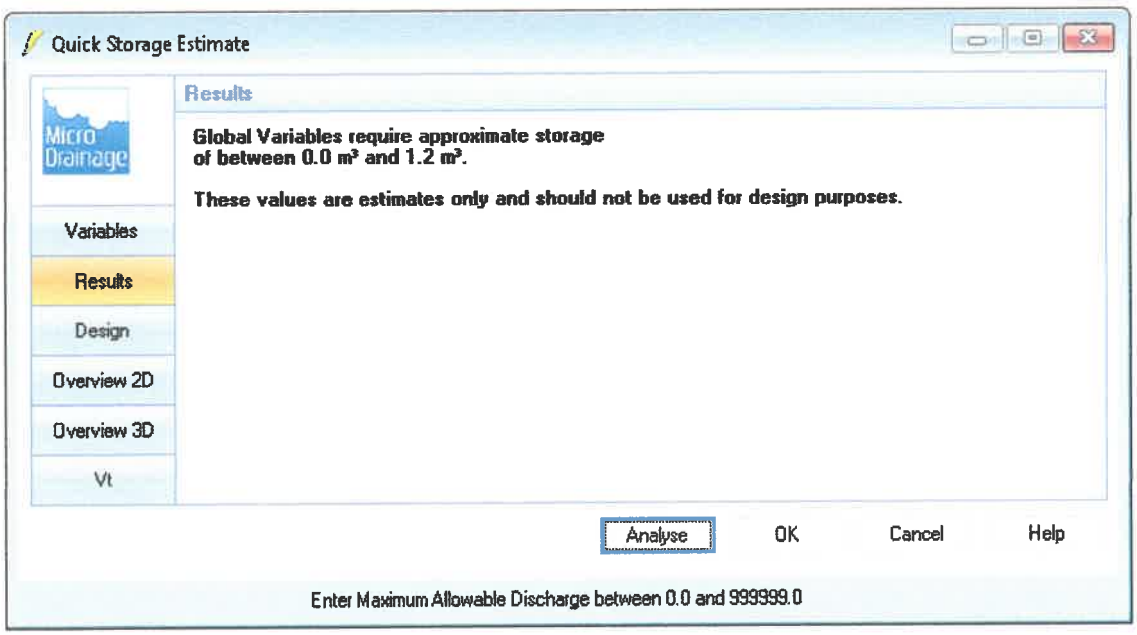




WEST EXTENT
INDICATIVE ATTENUATION VOLUMES

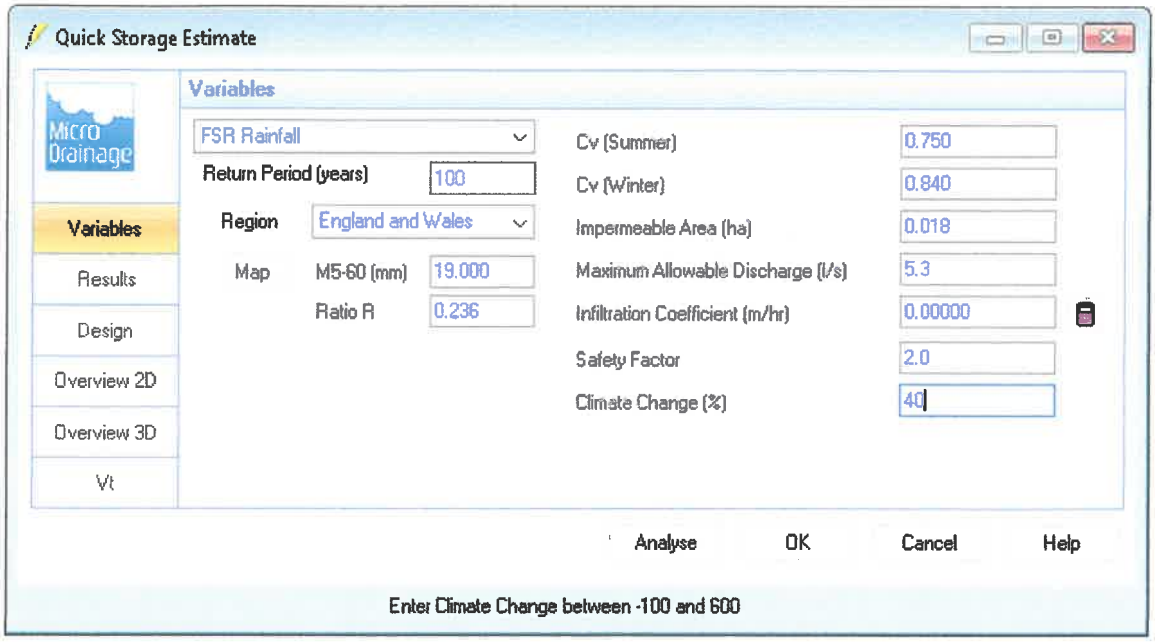
30 YEAR

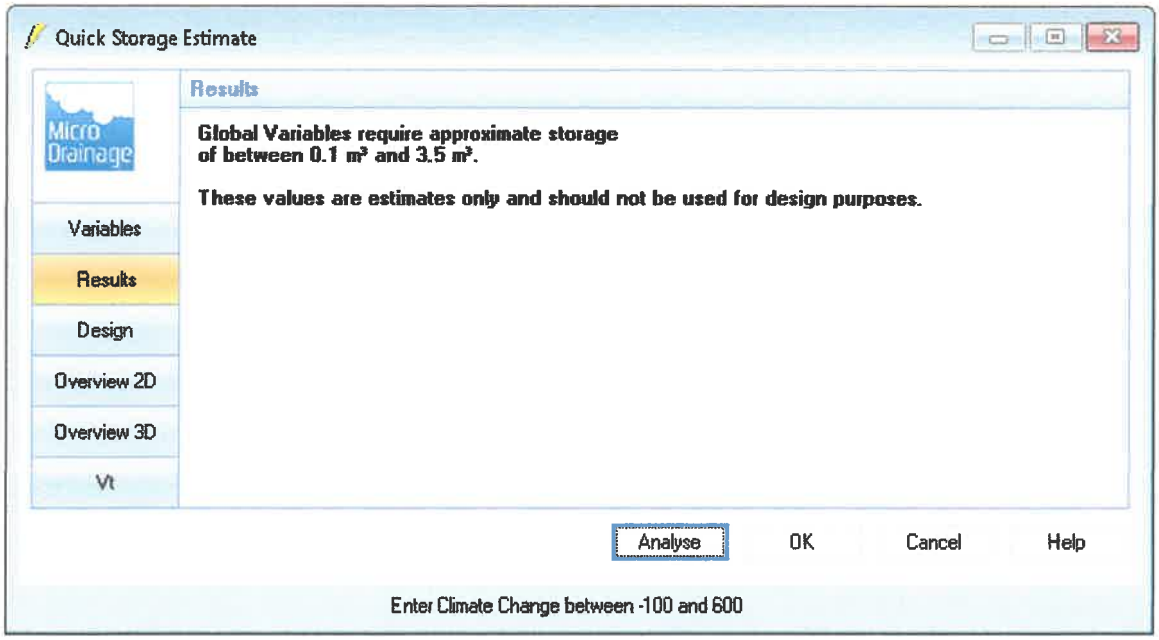




WEST EXTENT
INDICATIVE ATTENUATION VOLUMES

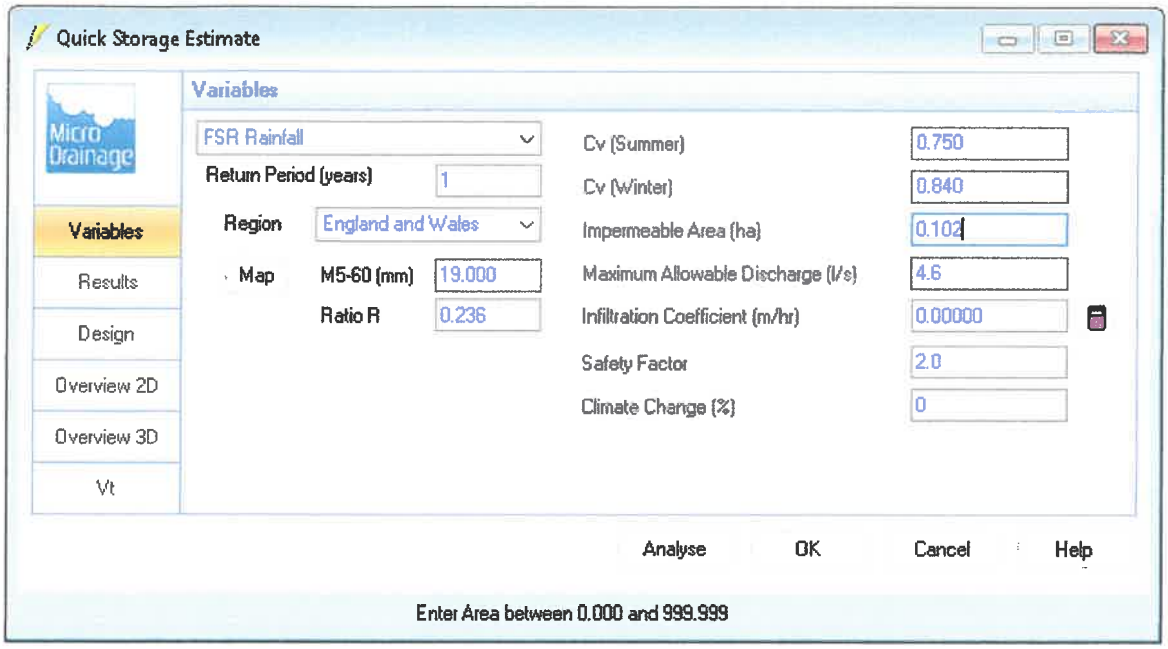
100 YEAR + 40% CLIMATE CHANGE

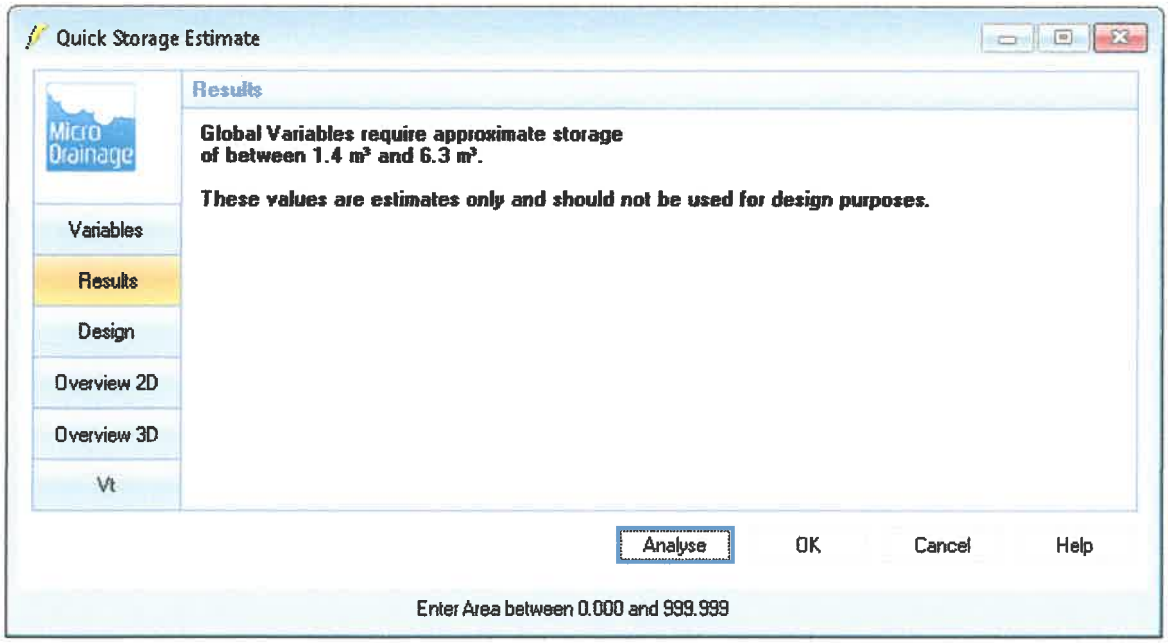




EAST EXTENT
INDICATIVE ATTENUATION VOLUMES

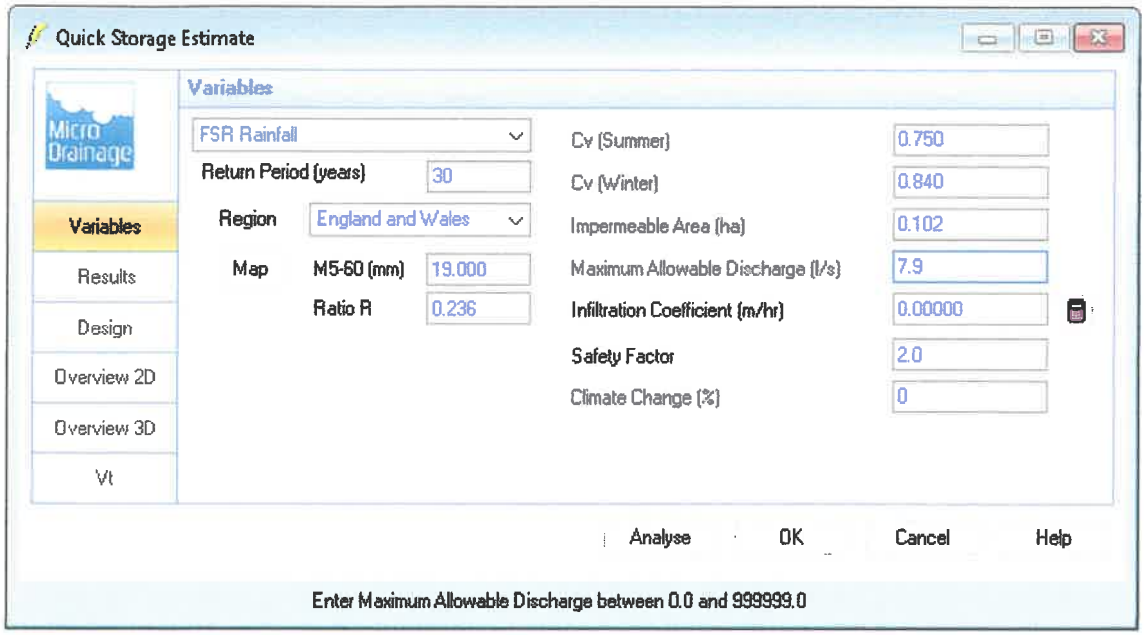
1 YEAR

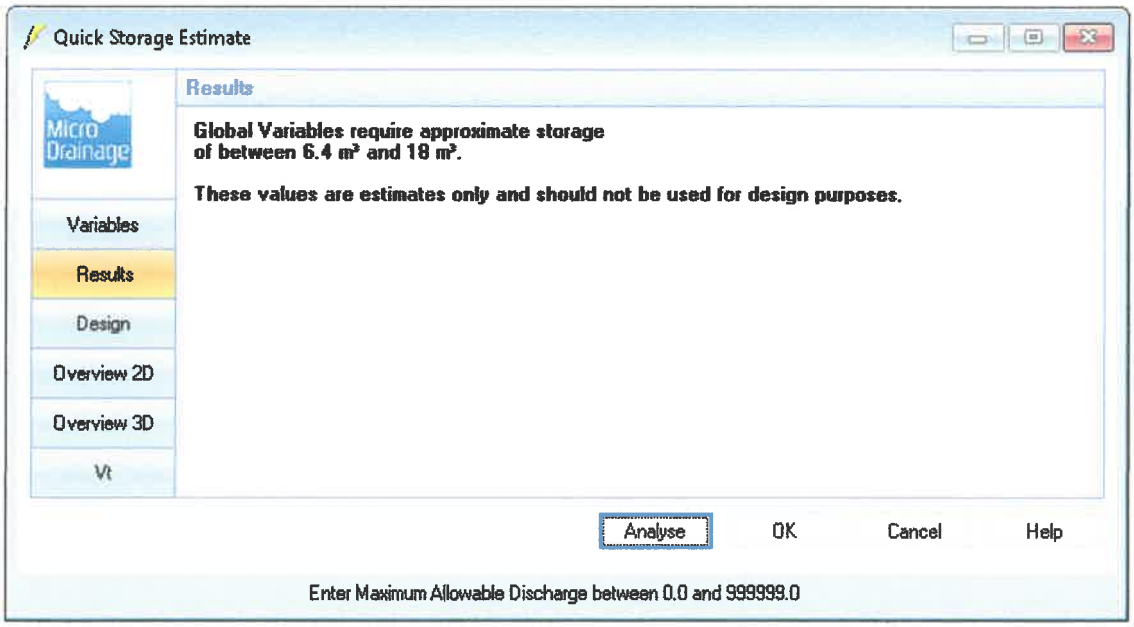




EAST EXTENT
INDICATIVE ATTENUATION VOLUMES

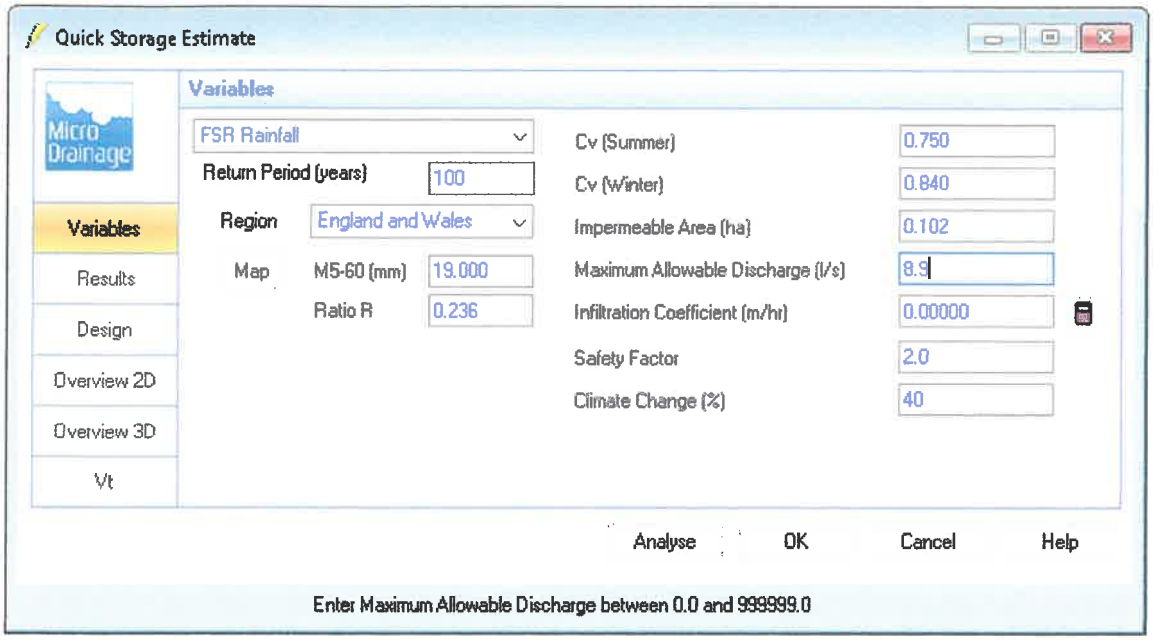
30 YEAR

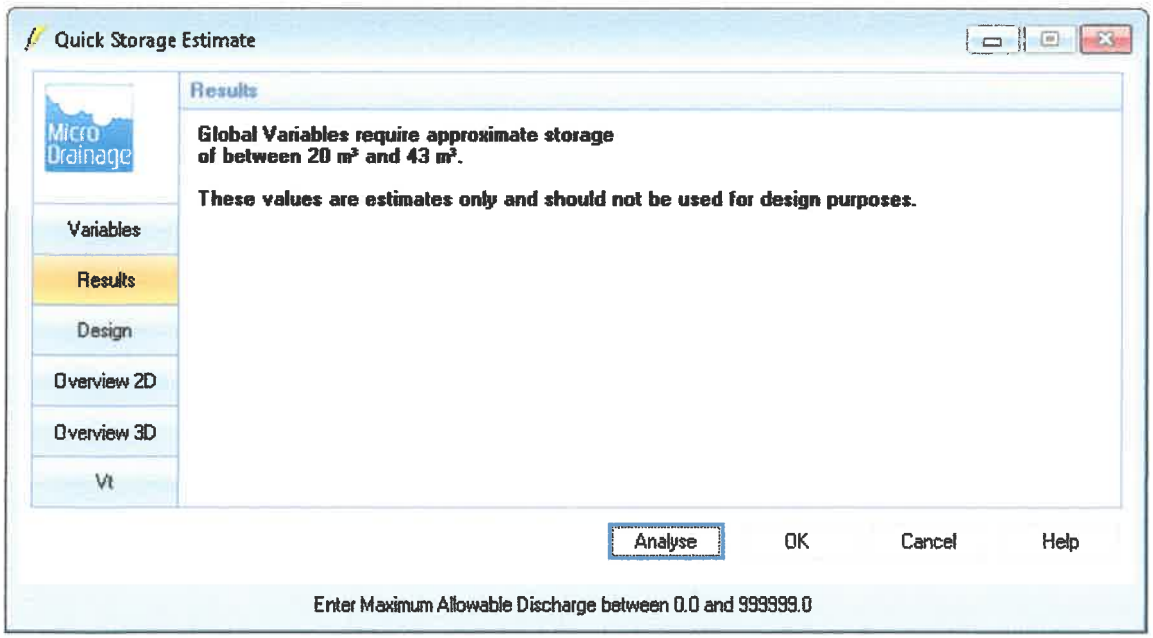




EAST EXTENT
INDICATIVE ATTENUATION VOLUMES

100 YEAR + 40% CLIMATE CHANGE





Appendix G
Geo-cellular Tank East Proportion Calcs

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

Half Drain Time : 26 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.484	0.484	0.0	8.5	8.5	13.8	O K
30 min Summer	98.659	0.659	0.0	8.5	8.5	18.8	O K
60 min Summer	98.767	0.767	0.0	8.5	8.5	21.9	O K
120 min Summer	98.775	0.775	0.0	8.5	8.5	22.1	O K
180 min Summer	98.703	0.703	0.0	8.5	8.5	20.0	O K
240 min Summer	98.621	0.621	0.0	8.5	8.5	17.7	O K
360 min Summer	98.473	0.473	0.0	8.5	8.5	13.5	O K
480 min Summer	98.361	0.361	0.0	8.3	8.3	10.3	O K
600 min Summer	98.282	0.282	0.0	7.9	7.9	8.0	O K
720 min Summer	98.226	0.226	0.0	7.5	7.5	6.5	O K
960 min Summer	98.160	0.160	0.0	6.8	6.8	4.6	O K
1440 min Summer	98.119	0.119	0.0	5.4	5.4	3.4	O K
2160 min Summer	98.094	0.094	0.0	4.1	4.1	2.7	O K
2880 min Summer	98.083	0.083	0.0	3.3	3.3	2.4	O K
4320 min Summer	98.069	0.069	0.0	2.5	2.5	2.0	O K
5760 min Summer	98.062	0.062	0.0	2.0	2.0	1.8	O K
7200 min Summer	98.056	0.056	0.0	1.7	1.7	1.6	O K
8640 min Summer	98.053	0.053	0.0	1.5	1.5	1.5	O K
10080 min Summer	98.050	0.050	0.0	1.4	1.4	1.4	O K
15 min Winter	98.557	0.557	0.0	8.5	8.5	15.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	108.566	0.0	20.7	21
30 min Summer	78.035	0.0	29.8	31
60 min Summer	53.779	0.0	41.1	48
120 min Summer	35.568	0.0	54.4	84
180 min Summer	27.257	0.0	62.5	116
240 min Summer	22.503	0.0	68.8	148
360 min Summer	17.125	0.0	78.6	208
480 min Summer	14.072	0.0	86.1	268
600 min Summer	12.066	0.0	92.3	326
720 min Summer	10.632	0.0	97.6	382
960 min Summer	8.693	0.0	106.4	498
1440 min Summer	6.521	0.0	119.7	736
2160 min Summer	4.876	0.0	134.3	1100
2880 min Summer	3.974	0.0	145.9	1456
4320 min Summer	2.982	0.0	164.2	2192
5760 min Summer	2.437	0.0	179.0	2880
7200 min Summer	2.089	0.0	191.7	3672
8640 min Summer	1.845	0.0	203.2	4336
10080 min Summer	1.664	0.0	213.9	5096
15 min Winter	108.566	0.0	23.2	21

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	98.761	0.761	0.0	8.5	8.5	21.7	O K
60 min Winter	98.912	0.912	0.0	8.5	8.5	25.2	O K
120 min Winter	98.858	0.858	0.0	8.5	8.5	24.2	O K
180 min Winter	98.711	0.711	0.0	8.5	8.5	20.3	O K
240 min Winter	98.574	0.574	0.0	8.5	8.5	16.4	O K
360 min Winter	98.363	0.363	0.0	8.3	8.3	10.3	O K
480 min Winter	98.240	0.240	0.0	7.6	7.6	6.8	O K
600 min Winter	98.171	0.171	0.0	6.9	6.9	4.9	O K
720 min Winter	98.140	0.140	0.0	6.3	6.3	4.0	O K
960 min Winter	98.115	0.115	0.0	5.2	5.2	3.3	O K
1440 min Winter	98.092	0.092	0.0	3.9	3.9	2.6	O K
2160 min Winter	98.077	0.077	0.0	3.0	3.0	2.2	O K
2880 min Winter	98.068	0.068	0.0	2.4	2.4	1.9	O K
4320 min Winter	98.057	0.057	0.0	1.8	1.8	1.6	O K
5760 min Winter	98.051	0.051	0.0	1.5	1.5	1.5	O K
7200 min Winter	98.047	0.047	0.0	1.3	1.3	1.3	O K
8640 min Winter	98.044	0.044	0.0	1.1	1.1	1.3	O K
10080 min Winter	98.042	0.042	0.0	1.0	1.0	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	78.035	0.0	33.4	32
60 min Winter	53.779	0.0	46.1	52
120 min Winter	35.568	0.0	60.9	90
180 min Winter	27.257	0.0	70.0	124
240 min Winter	22.503	0.0	77.1	156
360 min Winter	17.125	0.0	88.0	214
480 min Winter	14.072	0.0	96.4	270
600 min Winter	12.066	0.0	103.4	324
720 min Winter	10.632	0.0	109.3	376
960 min Winter	8.693	0.0	119.2	492
1440 min Winter	6.521	0.0	134.1	726
2160 min Winter	4.876	0.0	150.4	1096
2880 min Winter	3.974	0.0	163.4	1468
4320 min Winter	2.982	0.0	183.9	2204
5760 min Winter	2.437	0.0	200.5	2864
7200 min Winter	2.089	0.0	214.7	3624
8640 min Winter	1.845	0.0	227.6	4384
10080 min Winter	1.664	0.0	239.5	4968

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.236	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.102

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.034	4	8	0.034	8	12	0.034

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 98.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	30.0	30.0	5.200	0.0	51.9
0.400	30.0	38.8	5.600	0.0	51.9
0.800	30.0	47.5	6.000	0.0	51.9
1.200	0.0	51.9	6.400	0.0	51.9
1.600	0.0	51.9	6.800	0.0	51.9
2.000	0.0	51.9	7.200	0.0	51.9
2.400	0.0	51.9	7.600	0.0	51.9
2.800	0.0	51.9	8.000	0.0	51.9
3.200	0.0	51.9	8.400	0.0	51.9
3.600	0.0	51.9	8.800	0.0	51.9
4.000	0.0	51.9	9.200	0.0	51.9
4.400	0.0	51.9	9.600	0.0	51.9
4.800	0.0	51.9	10.000	0.0	51.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0123-8900-2000-8900
Design Head (m)	2.000
Design Flow (l/s)	8.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	123
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	8.9
Flush-Flo™	0.536	8.5
Kick-Flo®	1.101	6.7
Mean Flow over Head Range	-	7.6

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.4	1.200	7.0	3.000	10.8	7.000	16.1
0.200	7.3	1.400	7.5	3.500	11.6	7.500	16.7
0.300	8.0	1.600	8.0	4.000	12.4	8.000	17.2
0.400	8.4	1.800	8.5	4.500	13.1	8.500	17.7
0.500	8.5	2.000	8.9	5.000	13.7	9.000	18.2
0.600	8.5	2.200	9.3	5.500	14.4	9.500	18.7
0.800	8.2	2.400	9.7	6.000	15.0		
1.000	7.5	2.600	10.1	6.500	15.6		

Appendix H
Flood Evacuation Guidance

Personal flood plan

Name

Environment Agency

Are you signed up to receive flood warnings? If not call Floodline on 0345 988 1188 to see if your area receives free flood warnings.

Let us know when you've completed your flood plan by calling Floodline on **0345 988 1188.** This will help us learn more about how people are preparing for flooding.

General contact list	Company name	Contact name	Telephone
Floodline	Environment Agency		0345 988 1188
Electricity provider			
Gas provider			
Water company			
Telephone provider			
Insurance company and policy number			
Local council			
Local radio station			
Travel/weather info			

Key locations

Service cut-off	Description of location
Electricity	
Gas	
Water	

Who can help/who can you help?

Relationship	Name	Contact details	How can they/you help?
Relative			
Friend or neighbour			

Be prepared for flooding. Act now

Personal flood plan

What can I do NOW?

Environment Agency

- Put important documents out of flood risk and protect in polythene ☐
- Check your insurance covers you for flooding ☐
- Look at the best way of stopping floodwater entering your property ☐
- Make a flood plan and prepare a flood kit ☐
- Find out where you can get sandbags ☐
- Identify who can help you/ who you can help ☐
- Identify what you would need to take with you if you had to leave your home ☐
- Understand the flood warning codes ☐

What can you do if a flood is expected in your area?

Actions	Location
Home	
• Move furniture and electrical items to safety	
• Put flood boards, polythene and sandbags in place	
• Make a list now of what you can move away from the risk	
• Turn off electricity, water and gas supplies	
• Roll up carpets and rugs	
• Unless you have time to remove them hang curtains over rods	
• Move sentimental items to safety	
• Put important documents in polythene bags and move to safety	
Garden and outside	
• Move your car out of the flood risk area	
• Move any large or loose items or weigh them down	
Business	
• Move important documents, computers and stock	
• Alert staff and request their help	
• Farmers move animals and livestock to safety	
Evacuation - Prepare a flood kit in advance	
• Inform your family or friends that you may need to leave your home	
• Get your flood kit together and include a torch, warm and waterproof clothing, water, food, medication, toys for children and pets, rubber gloves and wellingtons	

There are a range of flood protection products on the market to help you protect your property from flood damage. A directory of these is available from the **National Flood Forum** at **www.bluepages.org.uk**

Be prepared for flooding. Act now

GEHO0709BQPU-E-E

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