Prepared for:
Berrys Ltd

Flood Risk Assessment and Surface Water Management plan for Sheepcote farm, Clifford, Herefordshire HR3 5HU

Report K0657b Rep1 Rev1

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Prepared and submitted by

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EXECUTIVE SUMMARY OF REPORT

This report documents work undertaken by Hydro-Logic Services for Berrys Ltd in care of Mr Ben Corbett in December 2018 and January 2019.

The purpose of the work was:

- To assess flood risk at this site in terms of the National Planning Policy Framework (NPPF) and, where necessary, to recommend measures to achieve compliance.
- to conceptually design the surface water management plan for a livestock cubicle, a slurry basin and a cattle milking area;
- to report the findings of this design assessment;
- to demonstrate that surface water drainage arrangements comply with the National Planning Policy Framework and Herefordshire core strategy policies SD3 and SD4.

The key outcomes of the work are:

- The surface water runoff generated from any roofs and impermeable surfaces will be released gradually to an existing watercourse. The surface water runoff will be attenuated by means of a buried attenuation tank to the East of the development.
- Any dirty waters flows resulting from operations and cleaning activities are to be pumped in the slurry lagoon;
- The slurry lagoon crest level is to be set above the 1 in 100 year + 35%CC fluvial flood level. Any loss of storage of the floodplain is to be compensated locally;

The work delivered the following outputs:

- Flood Risk Assessment;
- Surface Water Management Plan.

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Alan Corner	Project Director
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TABLE OF CONTENTS

1. Introduction

This report presents a Flood Risk Assessment (FRA) for the proposed agricultural development on land at Sheepcote Farm, Clifford HR3 5HU. It is proposed to provide a dairy unit which will comprise of a milking parlour building, livestock cubicle building, concrete yard areas and retention of a slurry lagoon. A silage which has been in place in excess of four years also forms part of the dairy unit.

The Objective of this report is to assess flood risk at the site in relation to the proposed development. The FRA will identify sources of flood hazard that apply to the development and restrictions associated with such hazards, giving design solutions which meet current regulations. The findings of this report should be used to inform future stages of the sites master planning plus design.

The proposed outline flood risk assessment and surface water drainage strategy has been prepared in accordance with the guidance and requirements set out in the following reports:

- *Strategic Flood Risk Assessment for Herefordshire Technical report, 2009;*
- *Environment Agencies 'Flood Map for Planning, 2018;*
- *National Standards for Sustainable Drainage Systems (2011) and;*
- *The CIRIA SuDS Manual (2015).*

2. Pre-development site characteristics

2.1 Location

The site of the proposed development is located within Sheepcote farm in Clifford, Herefordshire, HR3 5HU – Table 1. The site is an undeveloped field currently under agricultural use.

Table 1 - Coordinates and post code of the site

Eastings, Northings	*325716, 246715*
Nearest Post Code	*HR3 5HU*
Lat (WGS84)	*N52:06:50(52.113962)*
Long (WGS84)	*W3:04:53 (-3.081396)*
Nat Grid	*SO260467 / SO2604646734*

The proposed development comprises a silage bay, slurry basin, a livestock cubicle and a milking parlour building. The buildings have some concrete surfaces around then and gravel areas, allowing water to soak through.

The coordinates for the site are shown in Table 1 and its geographical location is shown in Figure 2-1. A layout plan and an aerial photograph are also shown in Figure 2-2 and Figure 2-3, respectively.

Figure 2-1 – Location of the site in Clifford

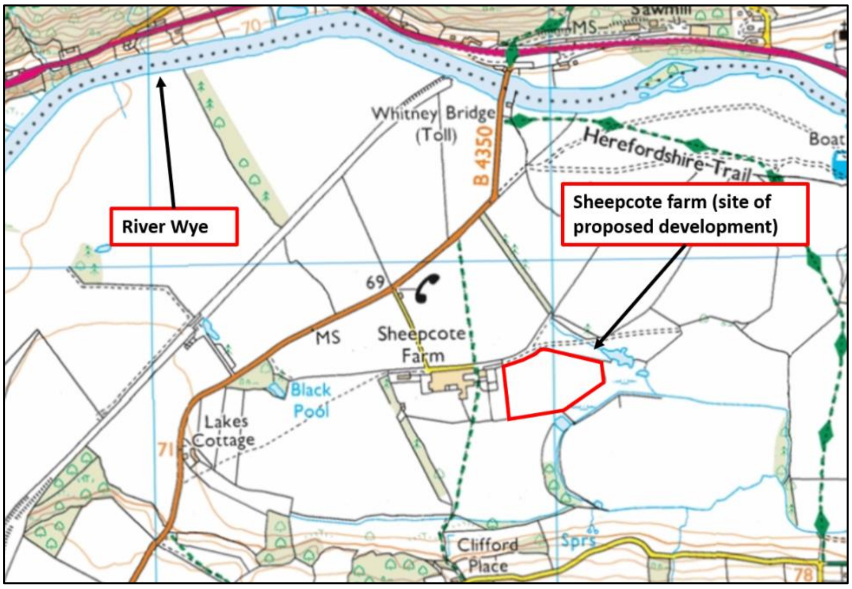
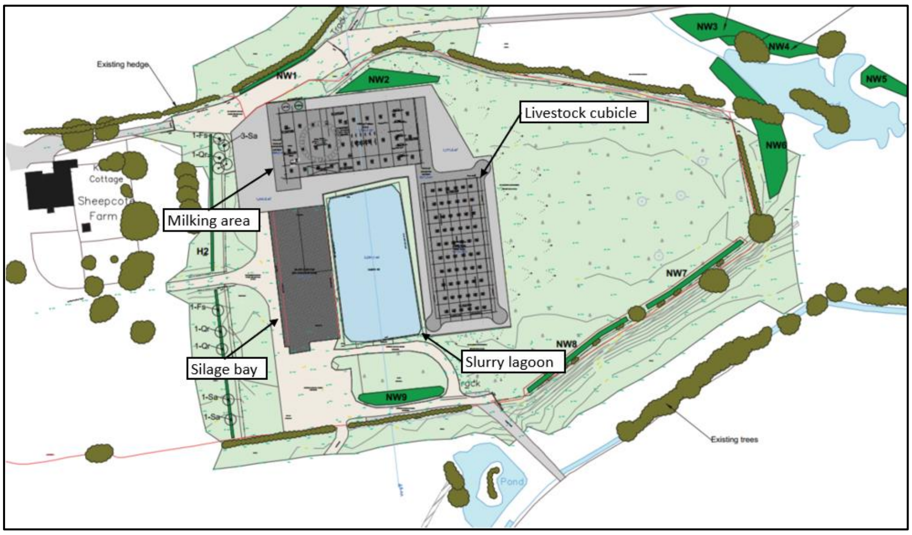


Figure 2-2 - Layout plan of the proposed development



Source: Ian Pick Associates Ltd

Figure 2-3 - Aerial photograph of the site (Site boundary in red)

Source: Google Maps

2.2 Flood risk Vulnerability

As the proposed development consists in a series of buildings with agricultural purposes, it falls within the *'less vulnerable'* classification of the NPPF, Table 2. Less vulnerable developments within Flood Zone 3a are not subject to the exception test, however these should not be permitted within Flood Zone 3b.

Table 2 – Description of flood zones

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓ *

Key:

✓ Development is appropriate

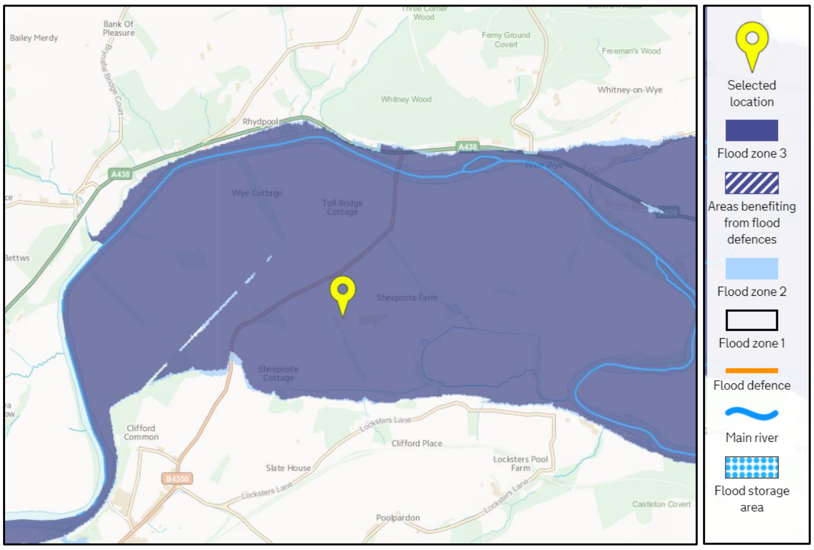
✗ Development should not be permitted.

Source: Environment Agency 'Flood risk vulnerability classification'

2.3 Flood zone and inherent risk

The Environment Agency Flood Map for planning, detailed in Figure 2-4, shows that Sheepcote farm falls well within the flood zone 3 limits, defined as "(…) having a 1 in 100 or greater annual probability of river flooding". The flood zones provided by the environment agency consider the maximum flood likely to occur from 100 years of maximum flows ***under current climate conditions,*** and therefore any further analysis will have to take into account the climate change allowances defined within the NPPF.

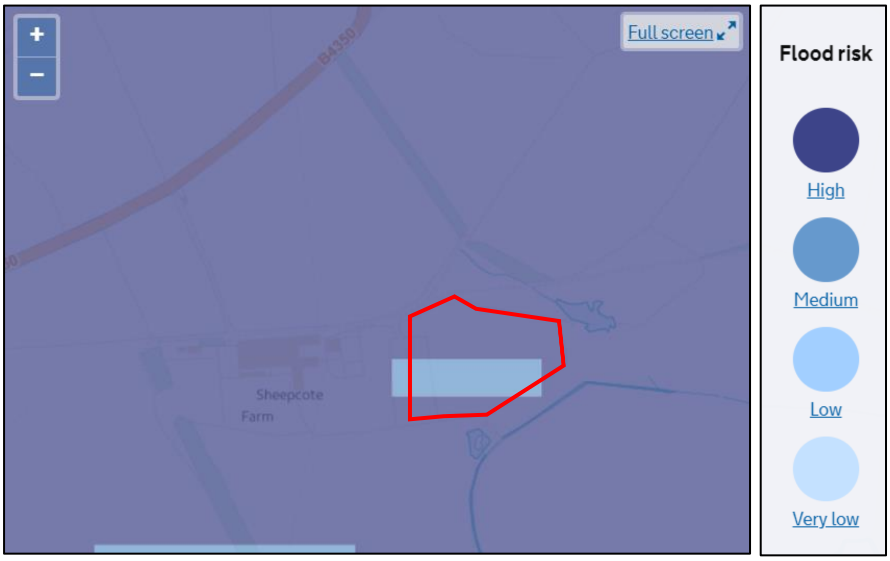
Figure 2-4 – Environment Agency flood map for planning (Location as yellow pin)



Source: Environment Agency flood map for planning

However, the flood risk map from EA (Figure 2-5) shows a *“medium risk” flooding* area – meaning a yearly chance of flooding between 1% and 3.3% – within the red boundary of the development. From this high scope analysis, it is concluded that the site may fall within Flood Zone 3a and therefore this is the main trigger for the investigations carried in the following sections. In addition to this, note that the flood maps presented by Environment Agency, show undefended flood extents only.

Figure 2-5 Flood risk map showing *medium* and *high* risk within the site.



2.4 Overall flood risk

The possible sources of surface flood risk which could affect this site are listed in Table 3.

Table 3 Sources of flooding that could affect the site

Key Sources of Flooding	***Possibility at Site***
Fluvial	*High (Flood zone 3)*
Tidal	*N/A*
Groundwater	*Very Low*
Sewers	*Low as rural agricultural development*
Surface water	*Very low*
Infrastructure failure	*Falls within flood risk zone from reservoirs**

List sourced from information in Herefordshire Council Strategic Flood Risk Assessment part 3
** Reservoirs ‘Claerwen’ and ‘Caban Coch’ lie upstream, although no loss of life from reservoir flooding in the UK since 1925.*

Table 4 – Summary of Flooding Reports by Source

Flooding Source	Number of Reports	Most reported Postcode	% of total
Fluvial	136	HR2 6, HR6 9, LD8 2, SY8 4	25%
Land Drainage	62	HR6 0, HR6 9, HR81, HR8 2, SY8 4	11%
Groundwater	2	HR7 4, LD8 2	<1%
Storm Sewers	5	HR2 6, HR4 9, HR8 1	1%
Foul Sewers	2	HR2 0, SY8 4	<1%
Highway Drainage	21	HR1 3, HR6 9, HR9 5,	4%
Culvert	8	HR3 5, HR4 8, HR6 8, HR9 7, WR6 5	2%
Unknown or “ “	237		43%
TOTAL	552		

Source: Herefordshire City Council SFRA

Information on types of flooding likely to impact the development site is detailed in Herefordshire Council Flood Risk Management Strategy – Table 4. Surface water flooding is likely to be low, as the site is out of any urban areas and currently resides on managed agricultural grassland.

From Table 4 it is concluded that 136 flood occurrences were identified due to fluvial sources. However, none of these occurrences was registered within HR3 5.

The extent of aquifers within Herefordshire is ‘somewhat limited’ therefore groundwater flooding is not expected to be a significant issue. This is in line with HCC SFRA, which shows only 2 report of flooding due to ground water, out of a grand total of 552. However, note that Herefordshire SFRA identified 8 flood occurrences due to insufficient capacity of culverts, including in the area of HR3 5.

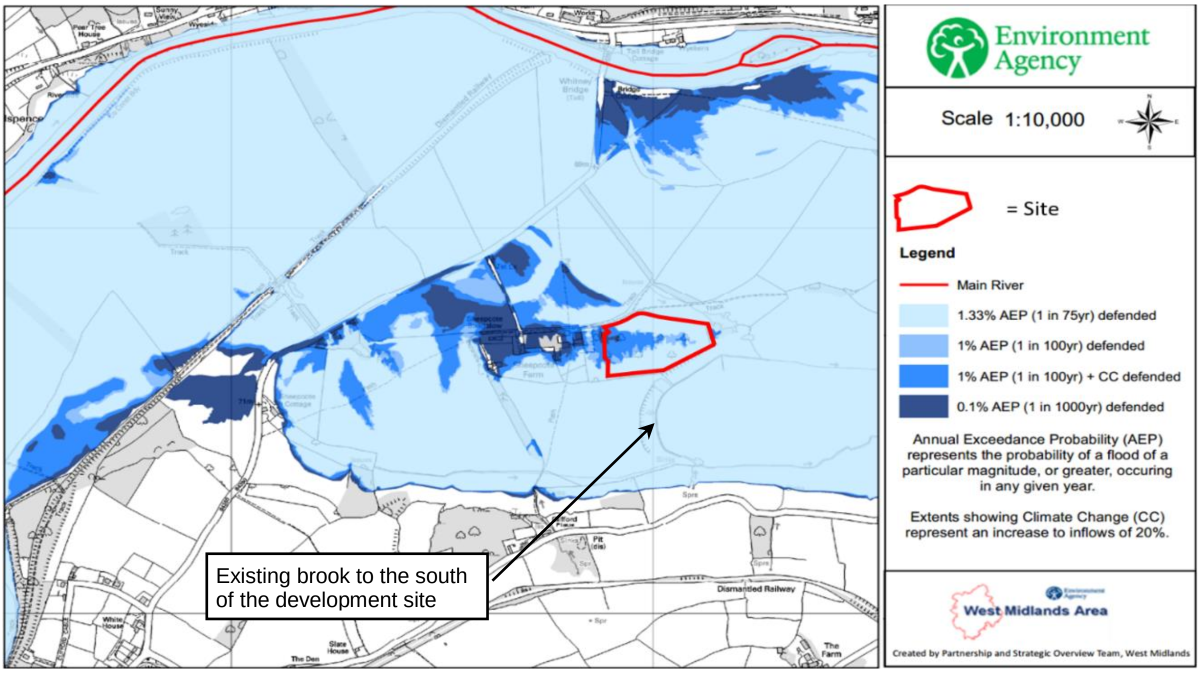
As detailed in section 3, flooding risk from fluvial sources is considered as ‘medium’ for Sheepcote farm and the proposed development. The site however is classed as ‘less vulnerable’ as agricultural developments are proposed.

2.5 Flood zone assessment

Fluvial flood risk at the site is mainly from the River Wye, which flows from west to east, to the north of the site. Apart from this, a brook located to the south of the site also increases the fluvial flood risk (Figure 2-6). Hydraulic modelling outputs provided by Environment Agency (Figure 2-6), show that the site, under the ‘defended’ modelling conditions, would still experience flooding.

The production of Environment Agency ‘Product 4’ (Figure 2-6) information on flood risk has indicated that the majority of the site falls within the 1.33% Annual Exceedance Probability (AEP), without any climate change allowance included in these extents. This means there is a 1.33% chance of the 1 in 75 year magnitude flood occurring in any given year. To the West side of the site, the ground levels increase meaning that there is a 1 in 100 AEP of flooding at this site. This indicates that the flow magnitude expected from the greatest flood event out of a 100 year time-series, would likely flood this section of the site.

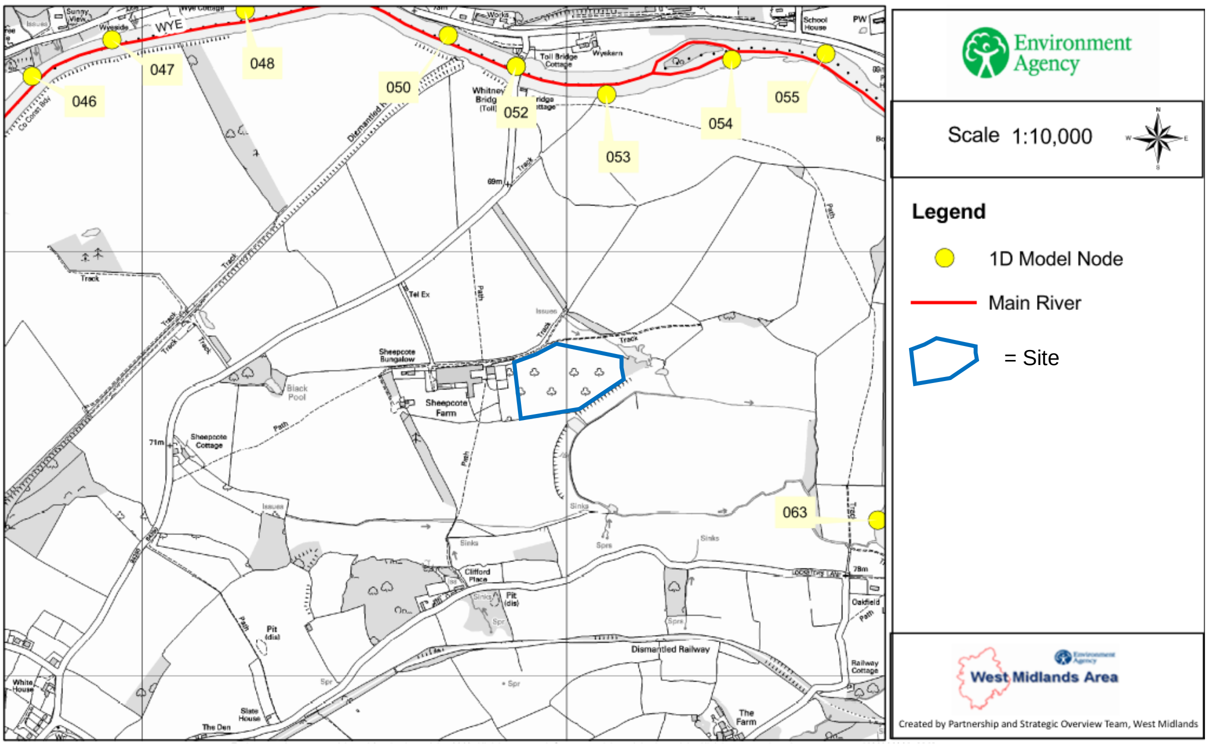
Figure 2-6 – Modelled Flood Outlines - Defended scenarios 1.33% to 0.1% AEP



Source: Environment Agency (Product 4)

The attached *Product 4* letter in Appendix D shows the 1D model node points indicating river flows and levels at each node point. The node points considered in the fluvial flooding analysis are nodes 52 and 53 (Figure 2-7). The flood levels for node 52 range between 69.09mAOD and 69.3mAOD and between 69.02mAOD and 69.06mAOD for node 53.

Figure 2-7 – Node location map



Source: Environment Agency

Since the hydraulic modelling of River Wye was conducted, the Environment Agency requirements for climate change allowances have increased from 20% (applied in the modelling) to a 35% increment to the peak flow. To meet these new requirements, the impact of a 20% climate change allowance in the river flow was estimated for Table 5. The rate of increment for a 20% climate change allowance was shown to be 12% as per Table 6 – see column *rate of increment*. The 35% rate of increment was then obtained via a linear extrapolation and shown to be around 20% – see Table 6 column *rate of increment *.* The river flows for a certain return period and taking into account a climate change allowance of 25% were then obtained by applying a *1.22* coefficient to the respective river flow

Table 5 - EA modelled fluvial flood flows for nodes 52 and 53.

			Annual Exceedance Probability - Maximum Flows (m³/s) defended									
Node Label	Easting	Northing	50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc. 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)
52	325884	247437	390.804	440.409	478.699	512.093	559.756	583.439	601.700	676.188	652.831	819.777
53	326097	247371	390.793	440.401	478.692	512.086	559.717	583.258	601.262	672.755	650.750	804.624

Source: Environment Agency (Product 4)

As an example, for node 52 the 1:100 year peak flow of 601.700m³/s increases by 74.488m³/s, once a 20% climate change allowance has been added. Assuming there's a linear relation between the climate change allowance and the river flows, a 35% climate change allowance would raise the river peak flow by 130.354 m³/s (35/20 * 74.488 m³/s). The same methodology was applied to the 1:20 year flood event and, to node label 53 obtaining the data produced in Table 10. Once evaluated the maximum flows with 35% climate change allowance, the water level for each node it has been extrapolated from the charts shown in Figure 2-8. The charts have been created plotting the water level against the river flows provided by Environment Agency 'Product 4' (Appendix D), and a regression was applied to obtain the power equation that best fits the data.

Figure 2-8 – River flow against depth for nodes 52 and 53.

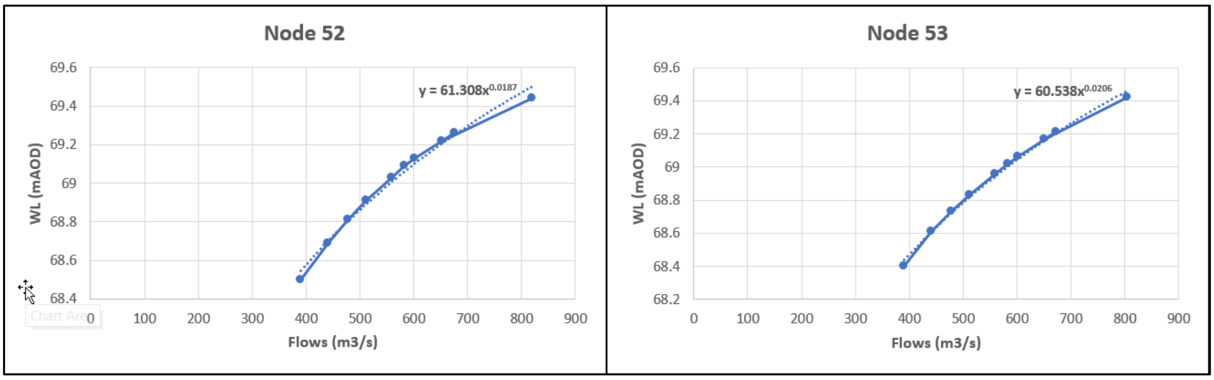


Table 6 - Extrapolated modelled flows and flood levels for the site

Annual Exceedance Probability - Maximum Flows (m³/s) and Maximum Water Levels (m AOD) defended										
Node	1% (1 in 100)	1% (1 in 100) + 20%CC	Difference between 1%+20CC and 1%	rate of increment	1% (1 in 100) + 35%CC	WL (mAOD) 1% (1 in 100) + 35%CC	rate of increment* (1:100+35%CC) /(1:100)	5% (1 in 20)	5% (1 in 20) + 35% CC*	WL (mAOD) 5% (1 in 20) + 35% CC
52	601.7	676.188	74.488	1.12	732.054	69.36	1.22	512.093	623.034	69.15
53	601.262	672.755	71.493	1.12	726.375	69.34	1.21	512.086	618.643	69.11

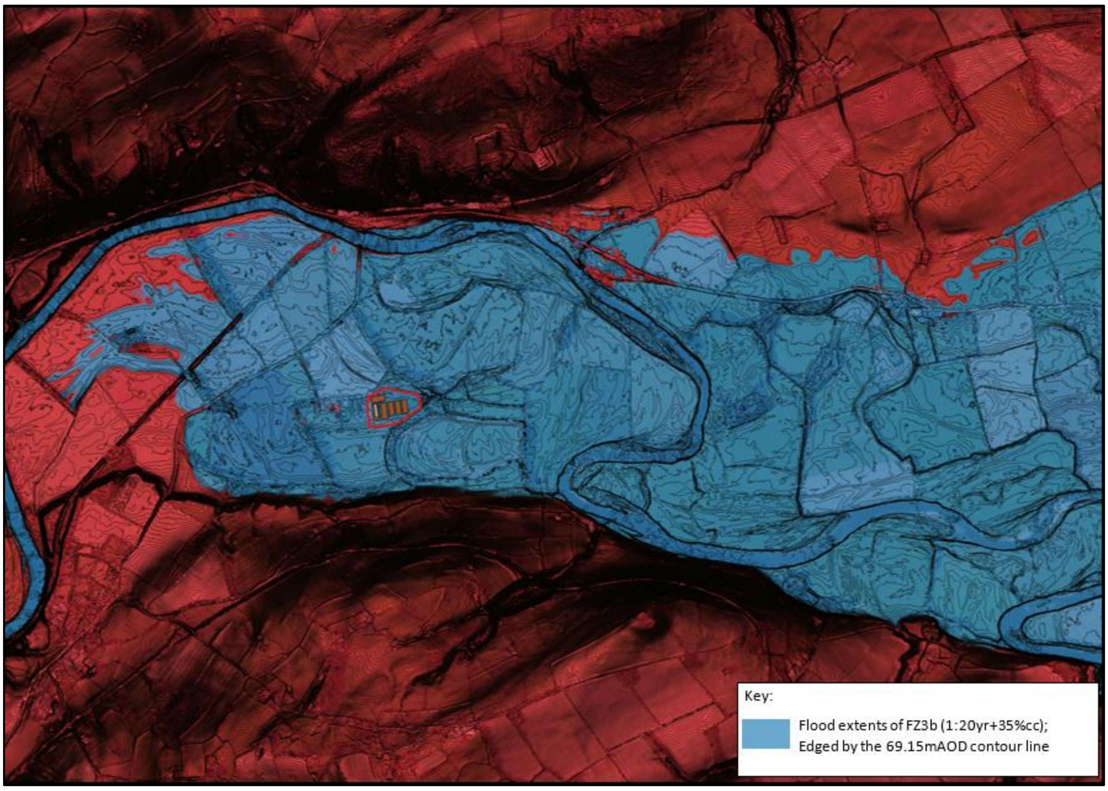
Table 10 shows estimated flood depths at the site during the 1:100 year+35%CC and during the 1:20 years+35%CC fluvial flood. The flood depths have been calculated to estimate where the border between flood zones FZ2, FZ3a and FZ3b. Results show that the 1:100

year+35%CC fluvial event on River Wye would reach a water level between 69.36mAOD and 69.34mAOD at the site and, the 1:20 year+35%CC fluvial event on River Wye would reach a water level between 69.15mAOD and 69.11mAOD at the site (Table 10). Assuming that FZ3b is bordered by the 1 in 20year +35%CC flood level, this means that the development falls within FZ3b as the ground levels vary between 68.25mAOD and 68.75mAOD (Figure 2-9).

Even though the site was found to be within Flood Zone 3b and according to NPPF no agricultural developments should take place in the area, it is believed that this can be attenuated by two main points:

1) The proposed development is an expansion of an existing development, at the date;
2) No additional people will be put at risk in a future stage of the development, as its nature is simply agricultural. Note that the development comprises a livestock cubicle, a milking yard, a sileage bay and a slurry basin.

Figure 2-9 – Modelled flood level extents for 1:20 yr+35%fluvial event



2.6 Impact in the floodplain

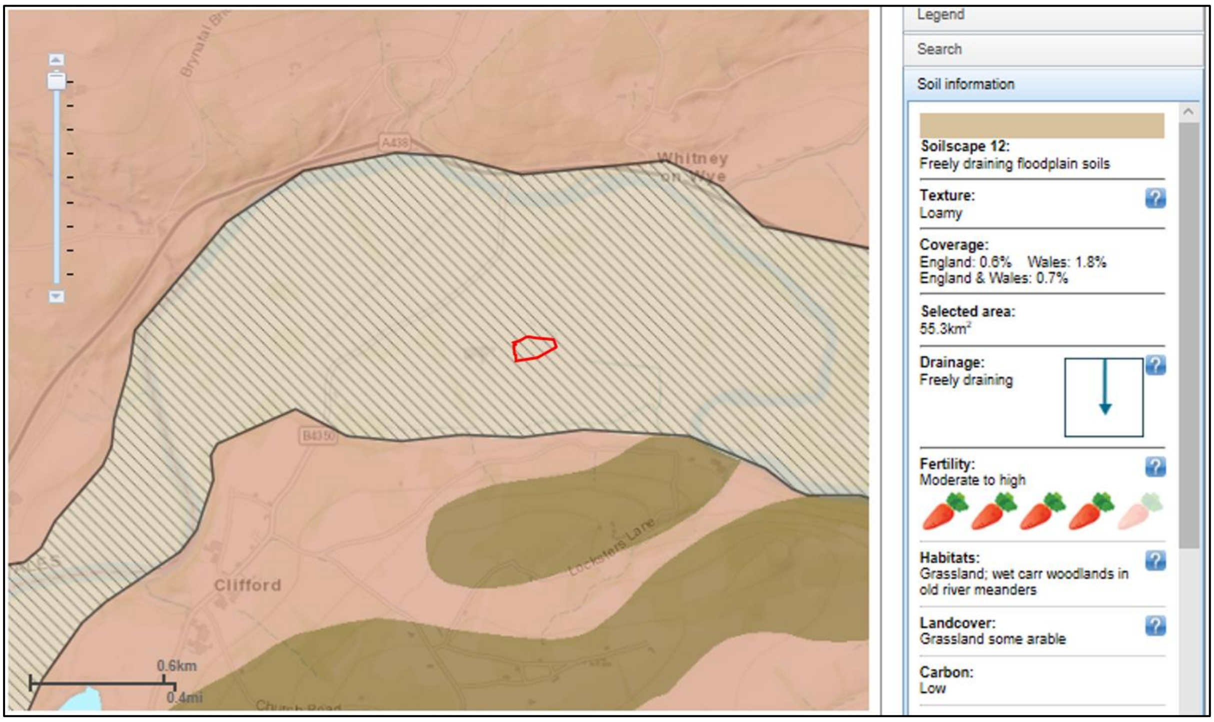
Although the development is located within Flood Zone 3, both the livestock cubicle and the milking area are considered to have an impact in the floodplain as the local ground levels – generally around 68.300mAOD are to be raised to a finish floor level of 69.300mAOD. However, note that there will be no loss of floodplain associated with the structure itself, as these are considered to be floodable.

In what concerns the slurry basin, it is proposed that such feature is built as part of an embankment, with a top level of roughly 70.9mAOD. As the surrounding soils levels range between 68.25mAOD and 68.75mAOD, this will result in a loss of the floodplain storage, meaning that level-by-level flood storage compensation will be required.

2.7 Soil Characteristics

The site is located on agricultural land comprising small amounts of previous development. Runoff rates and volumes are expected to be close to greenfield runoff rates and volumes. The Soilscapes regional soil mapping reproduced in Figure 2-10 shows that the site lies on soils characterised as "Freely draining floodplain soils".

Figure 2-10 - Soil map at the location of the site (site boundary in red)



Source: Cranfield University Soilscapes map

2.8 Infiltration rates

Infiltration tests for the site were obtained from measurements carried out for a previous project within Sheepcote farmland in 2015. Three tests were performed which found that the pits took 90 minutes to drain from 25% to 75% of the pit effective depth. This resulted in a rate of 0.08m/hr. The infiltration results suggest the site exhibits similar characteristics to that of the generalised BGS soil characteristics.

2.9 Greenfield runoff rates and volumes

The Flood Estimation Handbook (FEH) Web Service was used to retrieve the descriptors of the catchment that contains site. The retrieved catchment boundary is shown in Figure 2-11, with the site boundary shown in red. It may be seen that the retrieved catchment is significantly larger than the site, including the whole catchment of the tributary draining into the small agriculturally modified watercourse. Nevertheless, with the exception of the AREA descriptor, the retrieved catchment descriptors are considered likely to be representative of the site.

A selection of the catchment descriptors for the retrieved catchment are listed in Table 7. The percentage runoff (SPRHOST) and base flow index (BFIHOST) values of 0.5960% and 38.13 respectively are consistent with the freely draining soils at the site. The soakaway tests indicated good drainage within the site, which agree with the freely draining soils indicated by the BGS Soilscape.

Figure 2-11: FEH Catchment containing the site (site boundary in red)

Source: © Centre for Ecology & Hydrology

Table 7 - Catchment characteristics for the catchment containing the site

	Location:	**Land surrounding Sheepcote Farm, Clifford**
	NGR (catchment outlet):	326000, 246550
	NGR (catchment centroid):	SO 26000 46550
AREA	Catchment area (km^2)	0.77
ALTBAR	Base flow index (m)	70
ASPBAR	Base flow index (degrees)	142
ASPVAR	Base flow index	0.41
BFIHOST	**Base flow index**	0.5960
DPLBAR	Mean drainage path length (km)	0.84
DPSBAR	Mean drainage path slope (m/km)	1.60
FARL	Index of lakes	1
LDP	Longest drainage path (km)	1.70
PROPWET	Proportion of time soil is wet	0.49
RMED-1H	Median 1 hour rainfall (mm)	9.0
RMED-1D	Median 1 day rainfall (mm)	37.4
RMED-2D	Median 2 day rainfall (mm)	51.2
SAAR6190	SAAR for the period 1961-1990 (mm)	801
SAAR4170	SAAR for the period 1941-1970 (mm)	898
SPRHOST	**Percentage runoff**	38.13
URBEXT2000	Urban extent 2000	0

Source: © Centre for Ecology & Hydrology

The site boundary encloses an impermeable area of approximately 3,174m². Referencing a subset of the catchment descriptors reproduced in Table 7, greenfield runoff rates and volume calculations were undertaken for a range of rainfall events. The results for the peak greenfield runoff rates, and the corresponding runoff volumes, are shown in Table 8.

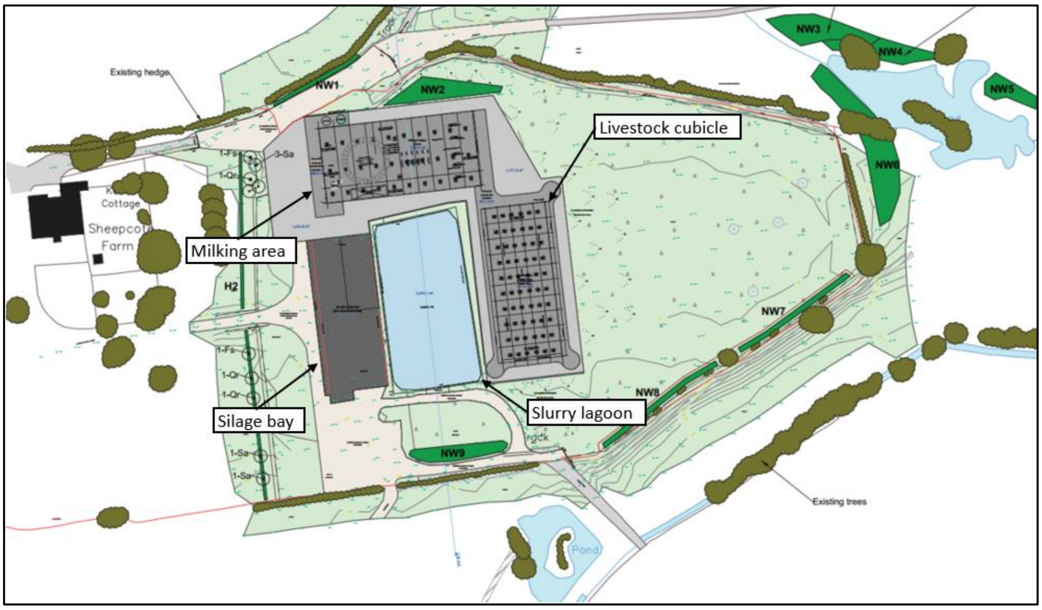
Table 8 Existing peak greenfield runoff rates and volumes for the site.

Return period (years)	***Runoff rate (l/s)***	***Runoff rate (l/s/ha)***	***Runoff volume (m^3)***
2	1.39	1.75	11.1
30	3.71	4.69	30.6
100	5.29	6.69	44.1

3. Proposed Development

As mentioned previously, the proposed development comprises four new structures – a silage bay (this has been in place for over four years), a slurry lagoon, a livestock cubicle and a milking parlour building plus some concrete yard areas around the proposed buildings – Figure 3-1.

Figure 3-1 - Proposed development layout



Source: Berrys Surveyors (Development not to scale)

The total impermeable surface generating surface water runoff to be managed within the SWMP will be 3,174m² – Table 9. This value includes both runoff from the livestock cubicle and milking parlour building roofs. Neither the slurry lagoon nor the silage bay will be included in the SWMP as it contains dirty water flows and therefore cannot be mixed with clean runoff. Also, note that any inlet features to collect the surface water runoff from the silage bay would also take fluvial waters into the surface water network and thus reduce the capacity of any storage structure to attenuate surface water runoff. Instead, the surface water runoff from the silage bay and concrete areas will be pumped into the slurry lagoon. In terms of the areas surrounding the milking area and the livestock cubicle, these will be gravel and therefore allow water runoff to soak through.

Table 9 – Impermeable surface areas to be manged by the surface water network.

Unit description	Area (m^2)
Milking parlour roof	1,760
Livestock cubicle roof	1,414
Total	**3,174**

The development is situated on a field shown as agricultural land and mainly within Flood Zone 3. Therefore, a detailed flood risk assessment and quantification of flood water volumes displaced must be carried out before any construction.

4. Surface Water Drainage Strategy

4.1 Brief Considerations

The proposed development would increase the impermeable surface area at the site, which in turn would lead to an increase in runoff rates with the potential to increase the risk of flooding away from the site.

This section outlines a surface water management plan, designed to ensure that the proposed development would not lead to an increase in flood risk elsewhere. The proposed agricultural development would include a total of 3,174m² of impermeable surface area generating surface water runoff.

Regional soil mapping shows soils at the site to be *"freely draining"* (Figure 2-10). As discussed in Section 2.8, infiltration testing was undertaken previously at the site to the BRE365 standard which produced an infiltration rate of 0.080m/hr. Taking into consideration the close proximity of the new development at Sheepcote farm to a BRE365 infiltration test location previously conducted, the infiltration rates from a previous development have been adopted.

Although the top priority according to the NPPF is to infiltrate rainfall runoff into the soil, such philosophy was not adopted in the current design in order to prevent fluvial waters from filling the tank in a flood event.

Therefore, the design philosophy was to attenuate the surface water runoff flows by means of a buried geo-cellular tank and discharge the outflows into a local brook at a greenfield runoff rate. In order to prevent high water table levels from filling the tank in fluvial flood events, the geo-cellular tank would have to be lined with an impermeable membrane.

4.2 Climate Change Allowances

The Environment Agency and NPPF require a consideration of the impacts of climate change on the flood risk for any proposed development. In February 2016, the Environment Agency updated the climate change allowances required in Flood Risk Assessments (Environment Agency, 2016); this advice updates previous climate change allowances to support the NPPF (DCLG, 2012). The Environment Agency (2016) states,

"Making an allowance for climate change in your flood risk assessment will help to minimise vulnerability and provide resilience to flooding and coastal change in the future. The climate change allowances are predictions of anticipated change for:

- *Peak river flow by river basin district*
- *Peak rainfall intensity*
- *Sea level rise*
- *Offshore wind speed and extreme wave height."*

As potential risks from flooding through sea level rise and extreme wave height do not impact this site, only allowances for peak river flows and peak rainfall intensities will be considered. For rainfall, Table 10 shows anticipated increases in peak rainfall intensity at central and upper end allowances. The Environment Agency recommends assessment of both central and upper end allowances for flood risk assessments and therefore a climate change allowance of 40% was adopted within the design.

Table 10: Allowance categories for total anticipated change for rainfall

Allowance category	Total potential change anticipated		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Source: Environment Agency 2016

As the Environment Agency classifies the development as *'less vulnerable',* allowances for climate change should consider central and higher allowances. The River Wye basin falls under the Severn basin district, which means that there is a 50% chance that river flows increase by more than 35% by 2115. Table 11 indicates the allowances which should be given to peak river flows in the Severn basin.

Table 11 – Peak Flows Allowance to climate change in the Severn basin

Allowance category	Total potential change anticipated		
	2015 to 2039	2040 to 2069	2070 to 2115
Upper end	25%	40%	70%
Higher central	15%	25%	35%
Central	10%	20%	25%

Source: Environment Agency 2016

4.3 Pre-development greenfield runoff rates

The estimation of peak rates of pre-development runoff (i.e. Greenfield runoff) has previously used the IH 124[1] (Marshall and Bayliss) method. This method uses parameters related to catchment and soil characteristics to establish a peak rate of runoff. More recently, the rainfall runoff modelling approach of ReFH version 2 (ReFH2) has been used. This method was found in work by the CEH (2015) to give a closer match to observed peak rates of runoff, and also provides a full hydrograph, rather than simply the peak flow derived by the former method. Following additional research and testing, ReFH2 was released in 2015. In particular, and with significance for the current site, ReFH2 incorporates a set of adjustments for "plot scale" conditions. These adjustments address the use of models and data for catchments to the scale of individual development plots. This is important, since such plots tend to be much smaller than topographic catchments.

ReFH2 runoff calculations reference a subset of catchment descriptors, associated with the site (SO 26046 46734) and generated by the FEH web service. In order to achieve the "plot-scale" adjustments required to generate an accurate greenfield runoff rate for the site, the AREA descriptor for the catchment was changed from approximately 0.77km² to 0.5 km², in order to calibrate several routing and base flow parameters. The AREA descriptor was then changed to 0.007918km², the total proposed impermeable surface area at the site. these adjustments enabled the generation of greenfield runoff hydrographs in l/s and the volumes in m³ fort the site.

The peak greenfield runoff rates for the proposed impermeable surface area at the site are shown in Table 8, at the 1:2, 1:30 and 1:100 year rainfall events, determined using ReFH2.

[1] IH124: Institute of Hydrology Report No. 124 Flood Estimation for Small Catchments, June 1994

4.4 Outline of the surface water management plan

As summarised before, the proposed impermeable surface area from roofs at the site is 3,174m². Runoff from this area is to be managed with a buried attenuation tank located to the east of the proposed site. Note that the drainage system in place should direct surface water runoff directly from gutters along the edges of the roofs into the geo-cellular tank, without allowing any fluvial waters to get into the system in the event of a fluvial flood.

Furthermore, any surface water runoff from rain falling on top of the silage bay and concrete areas will be pumped into the slurry lagoon to avoid any ground level inlets from conveying fluvial waters into the attenuation tank, in the event of fluvial flooding.

Analysis was undertaken in order to size the attenuation tank required to restrict outflow rates to no greater than greenfield runoff rates.

The dimensions of the attenuation structure were analysed using the Source Control module, which integrates the industry leading Micro Drainage software. The following conservative assumptions and design parameters were adopted within the Source Control module.

- Rainfall intensity was obtained using the FEH methodology and increased by 40%, the *upper end* allowance for climate change over the 60 year design life of the proposed agricultural development – as described in section 4.2 of the report;
- The proposed impermeable surface area from roofs – milking yard and livestock cubicle – is 3,174m².
- 100% of the runoff from the proposed impermeable surfaces is directed to the underground geo-cellular storage;
- A 95% void ratio was modelled, corresponding to a geo-cellular storage;
- Outflows are controlled by set of two *hydro-brake*s. The lower *hydro-brake* is supposed to work for lower return periods – typically up to the 1 in 30 year RP – and the *hydro-brake* set at a higher level is set to work for rainfall events above the 1 in 30 year RP;
- The geo-cellular attenuation structure was modelled as an *zero-infiltration* feature, in order to replicate the presence of an impermeable liner around the bottom and sides of the tank. This is to prevent fluvial water from filling the tank in case of a fluvial flood event;
- The controlled outflow from the attenuation geo-cellular tank would be discharged south into an existing stream.

Using an iterative approach to vary the attenuation geo-cellular tank area and outflow control structures, a range of attenuation designs was assessed. The software was used to analyse the response of the design to the 1 in 2, 30 and 100 year plus 40% climate change rainfall events. The design imperatives were that outflow rates should ideally be less than greenfield runoff rates scaled to the impermeable surface area, and as low as possible within the constraints of the site. Also, the outflow rates would have to be such that the *hydro-brake* outlet diameter is large enough not to put the design at risk of blockage. It was found that an attenuation geo-cellular tank with the specification summarised in Table 12, combined with a *hydro-brake* flow control with the specification summarised in Table 13 is able to cope with the surface water runoff from the site. The outflow and overflow control specifications are reproduced in Appendix C.

Table 12 – Attenuation tank specification

Structure	Stormblock Optimum
Base Area	480 m^2 (10m x 48m)
No. blocks	750
Depth	660mm

Table 13 – *Hydro-Brake* Outflow controls specification

Overall Control	Complex
Control No1	Hydro-Brake Optimum
Design head	200mm
Design flow	1.3l/s
Invert Level *	0.000mm above the bottom of the tank
Control No2	Hydro-Brake Optimum
Design head	300mm
Design flow	3.2l/s
Invert Level *	300mm above the bottom

* Above the bottom of the tank

The performance of the attenuation design and the full set of results produced by the Micro Drainage Source Control are shown in Appendix C. Furthermore, the comparison between the greenfield runoff rates and the outflows from the tank for the different return periods is show in Table 14.

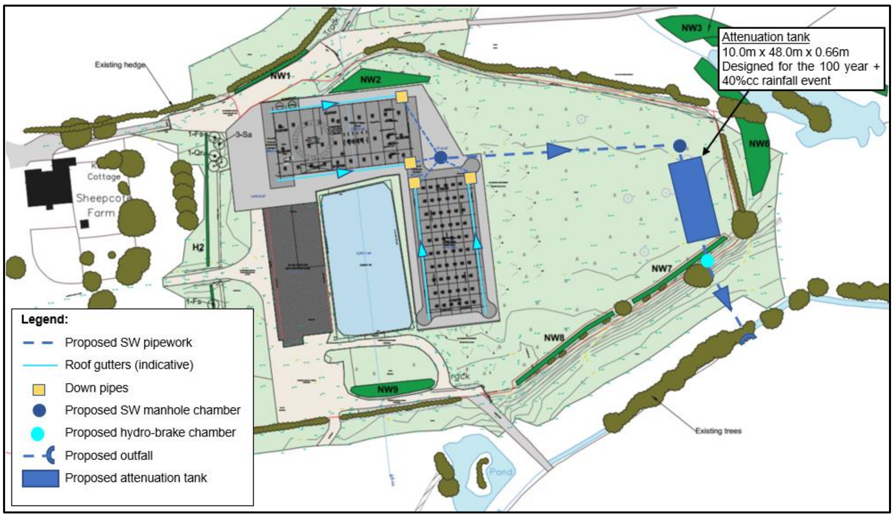
Table 14 – *Comparison between outflow runoff rates from the geo-cellular tank and the greenfield runoff rates.*

Return period (years)	***Greenfield runoff rate (l/s)***	***Post-development runoff rate discharging into the brook (l/s)***
2	1.4	1.3
30	3.7	3.5
100	5.3	5.1

The maximum water depth in the tank resulting from the 1 in 100 year plus 40% climate change design storm is 451mm, ensuring a safety freeboard of 209mm for the residual risks.

Other combinations of basin dimensions and outflow controls are of course possible, but this analysis illustrates one way in which the necessary attenuation can be achieved. A different shape is of course possible, provided the area and volume of the tank remain unchanged.

Figure 4-1 – Layout of the proposed Surface Water Management Plan



4.5 Surface water drainage of silage bay and slurry lagoon

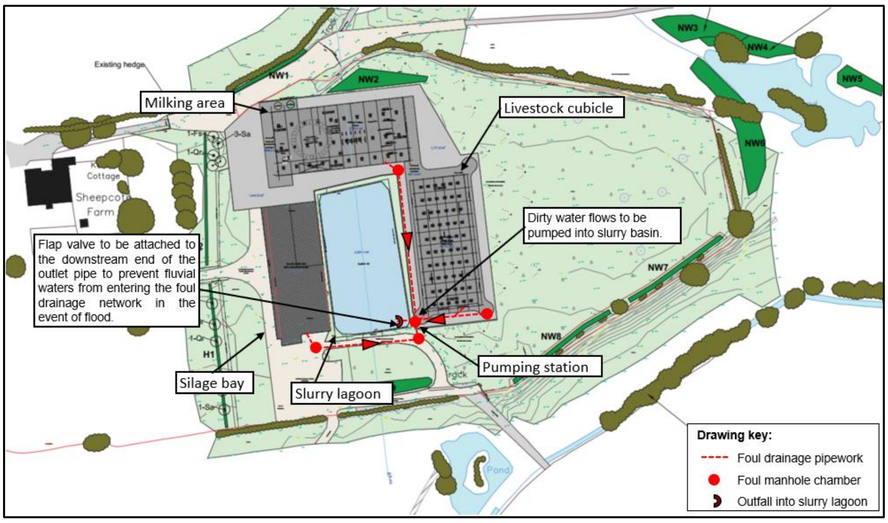
Due to the nature of operations in both the slurry lagoon and the silage bay, these features will not be covered with a roof. Therefore, the rainfall within the footprint of the lagoon will be mixed with slurry, which will in turn have to be disposed off-site.

In what concerns the silage bay, any inlet feature to take surface water runoff from the silage bay into the surface water network, would allow fluvial waters to also fill the attenuation tank. Therefore, this would reduce the attenuation tank capacity to store surface water runoff in the event of fluvial flooding. This being said, the surface water runoff generated by the silage bay will be pumped into the slurry lagoon as per The surface water runoff from the silage bay will then be mixed with any operation dirty water flows from both the milking parlour and the livestock cubicle buildings. According to Appendix E, it is estimated that a 33.0m x 65.5m slurry lagoon will suffice to store flows from 1) any livestock operations, 2) surface water runoff from rainfall from the silage bay, 3) any water from washing activities and 4) surface water from the concrete surfaces.

Figure 4-2.

The surface water runoff from the silage bay will then be mixed with any operation dirty water flows from both the milking parlour and the livestock cubicle buildings. According to Appendix E, it is estimated that a 33.0m x 65.5m slurry lagoon will suffice to store flows from 1) any livestock operations, 2) surface water runoff from rainfall from the silage bay, 3) any water from washing activities and 4) surface water from the concrete surfaces.

Figure 4-2 – Dirty water drainage from milking parlour, livestock cubicle and surface water drainage from silage bay and concrete surfaces.



4.6 Residual Risks

Residual risks for the scheme include the occurrence of rainstorms in excess of the 1 in 100 year plus 40% climate change design storm, and a blockage of the attenuation system. Blockages of the drainage system should be avoidable if appropriate maintenance procedures are followed.

The 1 in 100 year plus 40% climate change design storm would result in a maximum water level of 451mm in the attenuation structure(s). If an exceedance rainfall event occurred the capacity of the attenuation structures could be exceeded leading to surface water flooding. However, the design of the tank was tested for the 1 in 500 years plus 40% climate change storm, and the water level was shown to reach a maximum level of 550mm – see Appendix C.

Figure 4-3 provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required. The responsibility for maintaining any surface water features would be with the property owners and occupiers.

Figure 4-3 – Operation and Maintenance

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Source: CIRIA SuDS Manual 2015

5. Conclusions

This Surface Water Management Plan determined that:

- The site is shown to be in Flood Zone 3b, at risk of flooding less than 1 in 20 annual probability, within River Wye floodplain. However, it is believed that the development benefits from the fact that 1) it is an extension of the existing development and 2) no additional people will be put at risk as the development only includes agricultural buildings;
- The River Wye *Product 4* shows the site to be affected by the 1 in 20 year + 35% climate change fluvial flood event. Within this report, the original modelled flood levels have been extrapolated to determine the flood levels associated with the 35% climate change allowances, as required by Environment Agency guidelines;
- The site's elevation varies between approximately 68.5mAOD and 67.5mAOD, slightly below the 69.15mAOD contour line bordering flood zone 3b;
- The proposed surface water network will drain a total of 3,174m² – from the roof of milking parlour and livestock cubicle buildings. The remaining areas around the milking yard and livestock cubicle will be gravel and therefore allow water runoff to be soaked into the ground;
- In order to not increase flood risk elsewhere in the catchment, a geo-cellular tank, with suitable outflow controls, was designed to attenuate the post-development runoff rates from the 3,174m² impermeable areas – livestock cubicle and milking parlour roofs;
- The underground attenuation tank, with a basal area of 480m², with outflows being controlled by a set of two hydro-brake flow controls. The proposed location for the attenuation tank is the east of the proposed development. The controlled outflows from the attenuation tank would be discharged into the existing stream to the south of the site at a rate no greater than the greenfield runoff rates. The water level in the basin would reach a maximum depth of 451mm in the 1:100 year rainstorm with allowance for climate change;
- The responsibility for maintaining any surface water and dirty water features will be with the property owners and occupiers;
- Dirty water from washing down the milking parlour and cubicle buildings, rainwater from the concrete surfaces around the buildings and rainwater from the silage bay will be pumped into the slurry lagoon;
- According to CSCX design, the slurry lagoon has capacity to store 4 months' worth of slurry from up to 350 cows, wash down water from the milking parlour and cubicle buildings and surface water from the silage bay and concrete surfaces.
- The slurry lagoon crest level is set above the 1:100 year +35%CC fluvial flood level.

6. References

Author	Date	Title/Description
Centre for Ecology and Hydrology.	2018	The Flood Estimation Handbook Web Service. Available from: https://fehweb.ceh.ac.uk/
CIRIA	2015	C753, The SuDS Manual.
Cranfield University	2018	Cranfield University Soil Map. Available from: http://www.landis.org.uk/soilscapes/
DCLG	Mar 2012a	National Planning Policy Framework.
DCLG	Mar 2012b	Technical Guidance to the National Planning Policy Framework.
DEFRA	Dec 2011	National Standards for sustainable drainage systems. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/82421/suds-consult-annexa-national-standards-111221.pdf
Environment Agency	2018	Flood Risk Assessments: Climate Change Allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
Environment Agency/ UK Government	2018	Interactive Flood Maps. Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk/
Environment Agency/ UK Government	2018	Interactive Flood Map for planning. Available at: https://flood-map-for-planning.service.gov.uk/
Herefordshire Council	2009	Herefordshire Council – Strategic Flood Risk Assessment. Available at: https://www.herefordshire.gov.uk/downloads/download/180/strategic_flood_risk_assessment
Herefordshire Council	2015	Herefordshire Local Plan Core Strategy 2011 – 2031. Available at: https://www.herefordshire.gov.uk/media/5783838/core_strategy_web_version_mar_2013.pdf
Sheepcote Farm FRA	2015	FRA/SWMP for previous development at Sheepcote Farm, where infiltration test results were obtained.

Appendix A Check List for NPPF Guidance on Flood Risk[1]

1 Development description and location
1a. What type of development is proposed and where will it be located? • A location plan at an appropriate scale should be provided with the FRA, or cross referenced to the main application when it is submitted.
Section 2.1
1b. What is its vulnerability classification? • Vulnerability classifications are provided in Table 2, NPPF Technical Guide
Section 2.2
1c. Is the proposed development consistent with the Local Development Documents?
Section 2.4
1d. Please provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this development type? • Evidence is required that the Sequential Test has been used in allocating the proposed land use proposed for the site and that reference has been made to the relevant Strategic Flood Risk Assessment (SFRA) in selecting development type and design (See paragraphs 100-104, NPPF and paragraphs 3-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue. • Where use of the Exception Test is required, evidence should be provided that both elements of this test have been passed (see paragraphs 102, NPPF and paragraphs 4-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue.
Section 2.4
1e. *[Particularly relevant to minor developments (alterations & extensions) & changes of use]* Will your proposal increase overall the number of occupants and/or users of the building/land; or the nature or times of occupation or use, such that it may affect the degree of flood risk to these people?
2. Definition of the flood hazard
2a. What sources of flooding could affect the site? (see paragraph 2, NPPF Technical Guide). • This may include hazards such as the sea, reservoirs or canals, which are remote from the site itself, but which have the potential to affect flood risk (see Section 1 of the NPPF Practice Guide).
Section 2.4
2b. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available. • An appraisal of each identified source, the mechanisms that could lead to a flood occurring and the pathways that flood water would take to, and across, the site. • Inundation plans, and textural commentary, for historic flood events showing any information available on the mechanisms responsible for flooding, the depth to which the site was inundated, the velocity of the flood water, the routes taken by the flood water and the rate at which flooding occurred.
Section 2.5
2c. What are the existing surface water drainage arrangements for the site? • Details of any existing surface water management measures already in place, such as sewers and drains and their capacity.
3. Probability
3a Which flood zone is the site within? • The flood zones are defined in Table 2, NPPF Technical Guide.
Sections 2.5
3b If there is a Strategic Flood Risk Assessment covering this site, what does it show? • The planning authority can advise on the existence and status of the SFRA.

[1] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/site-specific-flood-risk-assessment-checklist/

Section 2.5
3c What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment? This may need to include • a description of how any existing flood risk management measures affect the probability of a flood occurring at the site FRA Pro-forma • supporting evidence and calculations for the derivation of flood levels for events with a range of annual probability • inundation plans of, and cross sections through, the existing site showing flood extents and levels associated with events with a range of annual probability • a plan and description of any structures which may influence the probability of a flood occurring at the site. This may include bridges, pipes/ducts crossing a watercourse, culverts, screens, embankments or walls, overgrown or collapsing channels and their likelihood to choke with debris. • details of any modelling studies completed to define the exiting degree of flood risk
Section 2.5
3d What are the existing rates and volumes of run-off generated by the site? • This should generally be accompanied by calculations of run-off rates and volumes from the existing site for a range of annual probability events (see Section 21 of the NPPF Practice Guide).
Section 2.9
4. Climate change
How is flood risk at the site likely to be affected by climate change? • Paragraphs 11-15, of the NPPF Technical Guide provide guidance on how to assess the impacts of climate change.
Section 4.2
5. Detailed development proposals
Where appropriate, are you able to demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding, including providing details of the development layout? • Reference should be made to vulnerability classification, Table 2 of the NPPF Technical Guide. • Section 4 of the NPPF Practice Guide provide guidance on how the sequential approach can be used to inform the lay-out of new development sites.
Section 3
6. Flood risk management measures
How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime? • This should show that the flood risk management hierarchy has been followed and that flood defences are a necessary solution. This should include details of any proposed flood defences, access/egress arrangements, site drainage systems (including what consideration has been given to the use of sustainable drainage systems) and how these will be accessed, inspected, operated and maintained over the lifetime of the development. This may need to include details of any modelling work undertaken in order to derive design flood levels for the development, taking into account the presence of any new infrastructure proposed.
Section 4.4
7. Off site impacts
7a How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? This should be over the lifetime of the development taking climate change into account. The assessment may need to include: • Details of the design basis for any mitigation measures (for example trash screens, compensatory flood storage works and measures to improve flood conveyance). A description of how the design quality of these measures will be assured and of how the access, operation, inspection and maintenance issues will be managed over the lifetime of the development. • Evidence that the mitigation measures will work, generally in the form of a hydrological and hydraulic modelling report. • An assessment of the potential impact of the development on the river, estuary or sea environment and fluvial/coastal geomorphology. A description of how any impacts will be mitigated and of the likely longer-term sustainability of the proposals.
Section 4.4

7b How will you prevent run-off from the completed development causing an impact elsewhere? • Evidence should be provided that drainage of the site will not result in an increase in the peak rate or in the volumes of run-off generated by the site prior to the development proceeding.
Section 4.4
8. Residual risks
8a What flood-related risks will remain after you have implemented the measures to protect the site from flooding? • Guidance on residual risks is provided in Section 14 of the NPPF Practice Guide.
Section 4.6
8b How, and by whom, will these risks be managed over the lifetime of the development? • Reference should be made to flood warning and evacuation procedures, where appropriate, and to likely above ground flow routes should sewers or other conveyance systems become blocked or overloaded. This may need to include a description of the potential economic, social and environmental consequences of a flood event occurring which exceeds the design standard of the flood risk management infrastructure proposed and of how the design has sought to minimize these – including an appraisal of health and safety issues.
Section 4.6

Appendix B - Infiltration Testing Results from Sheepcote Farm

Infiltration testing was undertaken on the site by Michael Pugh in September 2015. Infiltration testing is required to be completed to the BRE365 standard, in which trial pits are excavated, filled with water and the time taken for the pit to drain from 75% to 25% full is measured. This is required to be repeated 3 times in each pit. 1 trial pit was excavated to a depth of 3 m on site and infiltration testing was repeated 3 times (Figure B-1). Table B-1 shows the raw infiltration data from the 3 tests and the calculated infiltration rates for the site are shown in Table B-2. The infiltration rate at Sheepcote Farm was found to be 0.08 m/h which suggests that similar rates will occur at the new development, approximately 200m away. Managing surface water runoff via infiltration methods is therefore considered a viable option.

Figure A-1 Infiltration Testing at Sheepcote Farm

Table A-1 Results from Infiltration Tests 1 to 3

Trial Pit Dimensions	
Width	0.3 m
Length	2.5 m
Height	3.0 m

Test 1		**Test 2**		**Test 3**	
Start Time	7:00 am	Start Time	9:00 am	Start Time	1:00 pm
Pit Empty	10:00 am	Pit Empty	12:00am	Pit Empty	4:00 pm
Time from 25% to 75% Empty (mins)	90	Time from 25% to 75% Empty	90	Time from 25% to 75% Empty	90

Table A-2 Infiltration Rate Results for Trial Tests 1 to 3

Infiltration Test	Infiltration Rate (m/s)	Infiltration Rate (m/h)
1	2.28E-05	0.08
2	2.28E-05	0.08
3	2.28E-05	0.08

Appendix C – Micro-drainage Outputs

Surface water outputs

1 in 2 years storm plus 40% climate change

Hydrologic Services		Page 1
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 2 year Return Period (+40%)

Half Drain Time : 616 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	0.056	0.056	0.0	0.9	0.9	25.6	O K
30 min Summer	0.072	0.072	0.0	1.2	1.2	32.8	O K
60 min Summer	0.089	0.089	0.0	1.3	1.3	40.4	O K
120 min Summer	0.119	0.119	0.0	1.3	1.3	54.3	O K
180 min Summer	0.138	0.138	0.0	1.3	1.3	62.9	O K
240 min Summer	0.151	0.151	0.0	1.3	1.3	68.8	O K
360 min Summer	0.167	0.167	0.0	1.3	1.3	76.1	O K
480 min Summer	0.175	0.175	0.0	1.3	1.3	79.9	O K
600 min Summer	0.180	0.180	0.0	1.3	1.3	82.3	O K
720 min Summer	0.184	0.184	0.0	1.3	1.3	83.8	O K
960 min Summer	0.187	0.187	0.0	1.3	1.3	85.1	O K
1440 min Summer	0.186	0.186	0.0	1.3	1.3	84.8	O K
2160 min Summer	0.178	0.178	0.0	1.3	1.3	81.2	O K
2880 min Summer	0.168	0.168	0.0	1.3	1.3	76.8	O K
4320 min Summer	0.148	0.148	0.0	1.3	1.3	67.4	O K
5760 min Summer	0.130	0.130	0.0	1.3	1.3	59.4	O K
7200 min Summer	0.117	0.117	0.0	1.3	1.3	53.2	O K
8640 min Summer	0.106	0.106	0.0	1.3	1.3	48.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	43.701	0.0	21.2	19
30 min Summer	28.453	0.0	28.7	33
60 min Summer	18.029	0.0	40.2	62
120 min Summer	12.515	0.0	56.6	122
180 min Summer	9.943	0.0	67.9	182
240 min Summer	8.377	0.0	76.4	242
360 min Summer	6.489	0.0	89.0	360
480 min Summer	5.388	0.0	98.6	458
600 min Summer	4.645	0.0	106.2	512
720 min Summer	4.104	0.0	112.5	576
960 min Summer	3.354	0.0	122.3	704
1440 min Summer	2.510	0.0	136.0	980
2160 min Summer	1.870	0.0	158.3	1388
2880 min Summer	1.523	0.0	171.7	1816
4320 min Summer	1.154	0.0	194.2	2596
5760 min Summer	0.959	0.0	218.3	3344
7200 min Summer	0.840	0.0	238.8	4040
8640 min Summer	0.758	0.0	258.3	4760

Hydrologic Services		Page 2
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 2 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
10080 min Summer	0.098	0.098	0.0	1.3	1.3	44.6	O K
15 min Winter	0.063	0.063	0.0	1.1	1.1	28.6	O K
30 min Winter	0.081	0.081	0.0	1.3	1.3	36.8	O K
60 min Winter	0.100	0.100	0.0	1.3	1.3	45.5	O K
120 min Winter	0.135	0.135	0.0	1.3	1.3	61.3	O K
180 min Winter	0.156	0.156	0.0	1.3	1.3	71.3	O K
240 min Winter	0.171	0.171	0.0	1.3	1.3	78.2	O K
360 min Winter	0.189	0.189	0.0	1.3	1.3	86.3	O K
480 min Winter	0.200	0.200	0.0	1.3	1.3	91.0	O K
600 min Winter	0.205	0.205	0.0	1.3	1.3	93.5	O K
720 min Winter	0.208	0.208	0.0	1.3	1.3	94.7	O K
960 min Winter	0.210	0.210	0.0	1.3	1.3	95.7	O K
1440 min Winter	0.206	0.206	0.0	1.3	1.3	94.2	O K
2160 min Winter	0.192	0.192	0.0	1.3	1.3	87.8	O K
2880 min Winter	0.176	0.176	0.0	1.3	1.3	80.3	O K
4320 min Winter	0.141	0.141	0.0	1.3	1.3	64.2	O K
5760 min Winter	0.112	0.112	0.0	1.3	1.3	51.0	O K
7200 min Winter	0.092	0.092	0.0	1.3	1.3	41.9	O K
8640 min Winter	0.079	0.079	0.0	1.3	1.3	36.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.699	0.0	276.8	5448
15 min Winter	43.701	0.0	24.2	18
30 min Winter	28.453	0.0	32.6	33
60 min Winter	18.029	0.0	45.3	62
120 min Winter	12.515	0.0	63.7	120
180 min Winter	9.943	0.0	76.2	178
240 min Winter	8.377	0.0	85.8	236
360 min Winter	6.489	0.0	99.9	350
480 min Winter	5.388	0.0	110.6	460
600 min Winter	4.645	0.0	119.1	566
720 min Winter	4.104	0.0	126.1	658
960 min Winter	3.354	0.0	137.0	748
1440 min Winter	2.510	0.0	152.0	1054
2160 min Winter	1.870	0.0	177.5	1512
2880 min Winter	1.523	0.0	192.5	1960
4320 min Winter	1.154	0.0	217.9	2764
5760 min Winter	0.959	0.0	244.7	3464
7200 min Winter	0.840	0.0	267.6	4112
8640 min Winter	0.758	0.0	289.6	4752

Hydrologic Services		Page 3
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 2 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
10080 min Winter	0.074	0.074	0.0	1.2	1.2	33.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.699	0.0	310.6	5440

Hydrologic Services		Page 4
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 326000 246550 SO 26000 46550
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.318

Time (mins) From:	To:	Area (ha)
0	4	0.318

Hydrologic Services		Page 5
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 1.800

Cellular Storage Structure

Invert Level (m) 0.000 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	480.0	0.0	0.661	0.0	0.0
0.660	480.0	0.0			

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0064-1300-0200-1300
Design Head (m)	0.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.200	1.3	Kick-Flo®	0.160	1.2
Flush-Flo™	0.089	1.3	Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	0.800	2.4	2.000	3.7	4.000	5.2
0.200	1.3	1.000	2.7	2.200	3.9	4.500	5.5
0.300	1.6	1.200	2.9	2.400	4.0	5.000	5.9
0.400	1.8	1.400	3.1	2.600	4.2	5.500	6.1
0.500	2.0	1.600	3.3	3.000	4.5	6.000	6.4
0.600	2.1	1.800	3.5	3.500	4.9	6.500	6.7

Hydro-Brake® Optimum

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	6.9	8.000	7.4	9.000	7.9		
7.500	7.2	8.500	7.6	9.500	8.1		

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3200-0300-3200
Design Head (m)	0.300
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	0.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	3.2	Kick-Flo®	0.239	2.9
Flush-Flo™	0.136	3.2	Mean Flow over Head Range	-	2.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.1	3.000	9.4	7.000	14.3
0.200	3.1	1.400	6.5	3.500	10.1	7.500	14.8
0.300	3.2	1.600	7.0	4.000	10.8	8.000	15.3
0.400	3.7	1.800	7.4	4.500	11.4	8.500	15.7
0.500	4.0	2.000	7.7	5.000	12.0	9.000	16.2
0.600	4.4	2.200	8.1	5.500	12.6	9.500	16.6
0.800	5.0	2.400	8.4	6.000	13.2		
1.000	5.6	2.600	8.8	6.500	13.7		

Surface water outputs

1 in 30 years storm plus 40% climate change

Hydrologic Services		Page 1
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 587 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	0.143	0.143	0.0	1.3	1.3	65.0	O K
30 min Summer	0.188	0.188	0.0	1.3	1.3	85.8	O K
60 min Summer	0.237	0.237	0.0	1.4	1.4	108.1	O K
120 min Summer	0.283	0.283	0.0	1.5	1.5	128.9	O K
180 min Summer	0.308	0.308	0.0	1.6	1.6	140.4	O K
240 min Summer	0.323	0.323	0.0	1.9	1.9	147.1	O K
360 min Summer	0.334	0.334	0.0	2.2	2.2	152.4	O K
480 min Summer	0.336	0.336	0.0	2.3	2.3	153.2	O K
600 min Summer	0.336	0.336	0.0	2.3	2.3	153.2	O K
720 min Summer	0.336	0.336	0.0	2.3	2.3	153.0	O K
960 min Summer	0.334	0.334	0.0	2.2	2.2	152.3	O K
1440 min Summer	0.328	0.328	0.0	2.0	2.0	149.7	O K
2160 min Summer	0.317	0.317	0.0	1.7	1.7	144.5	O K
2880 min Summer	0.305	0.305	0.0	1.6	1.6	138.9	O K
4320 min Summer	0.282	0.282	0.0	1.5	1.5	128.4	O K
5760 min Summer	0.263	0.263	0.0	1.5	1.5	120.1	O K
7200 min Summer	0.250	0.250	0.0	1.4	1.4	113.9	O K
8640 min Summer	0.239	0.239	0.0	1.4	1.4	108.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.434	0.0	58.7	19
30 min Summer	73.253	0.0	77.6	34
60 min Summer	46.738	0.0	107.4	64
120 min Summer	28.522	0.0	131.2	124
180 min Summer	21.172	0.0	146.0	182
240 min Summer	17.053	0.0	156.7	242
360 min Summer	12.465	0.0	171.6	360
480 min Summer	9.946	0.0	182.2	458
600 min Summer	8.338	0.0	190.4	508
720 min Summer	7.213	0.0	197.0	570
960 min Summer	5.736	0.0	206.7	696
1440 min Summer	4.149	0.0	213.8	982
2160 min Summer	3.014	0.0	255.8	1428
2880 min Summer	2.418	0.0	273.1	1872
4320 min Summer	1.803	0.0	303.0	2684
5760 min Summer	1.484	0.0	338.5	3512
7200 min Summer	1.292	0.0	368.2	4320
8640 min Summer	1.163	0.0	397.2	5096

Hydrologic Services		Page 2
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
10080 min Summer	0.230	0.230	0.0	1.4	1.4	104.9	O K
15 min Winter	0.160	0.160	0.0	1.3	1.3	72.9	O K
30 min Winter	0.211	0.211	0.0	1.3	1.3	96.2	O K
60 min Winter	0.266	0.266	0.0	1.5	1.5	121.3	O K
120 min Winter	0.317	0.317	0.0	1.8	1.8	144.8	O K
180 min Winter	0.343	0.343	0.0	2.5	2.5	156.5	O K
240 min Winter	0.356	0.356	0.0	3.1	3.1	162.3	O K
360 min Winter	0.364	0.364	0.0	3.4	3.4	166.0	O K
480 min Winter	0.365	0.365	0.0	3.5	3.5	166.2	O K
600 min Winter	0.366	0.366	0.0	3.5	3.5	166.8	O K
720 min Winter	0.366	0.366	0.0	3.5	3.5	166.7	O K
960 min Winter	0.363	0.363	0.0	3.4	3.4	165.5	O K
1440 min Winter	0.354	0.354	0.0	3.0	3.0	161.4	O K
2160 min Winter	0.340	0.340	0.0	2.4	2.4	155.2	O K
2880 min Winter	0.327	0.327	0.0	2.0	2.0	149.3	O K
4320 min Winter	0.299	0.299	0.0	1.6	1.6	136.2	O K
5760 min Winter	0.269	0.269	0.0	1.5	1.5	122.5	O K
7200 min Winter	0.245	0.245	0.0	1.4	1.4	111.7	O K
8640 min Winter	0.225	0.225	0.0	1.4	1.4	102.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.071	0.0	425.3	5856
15 min Winter	110.434	0.0	65.8	19
30 min Winter	73.253	0.0	86.4	33
60 min Winter	46.738	0.0	120.4	62
120 min Winter	28.522	0.0	147.0	122
180 min Winter	21.172	0.0	163.7	178
240 min Winter	17.053	0.0	175.7	234
360 min Winter	12.465	0.0	192.5	342
480 min Winter	9.946	0.0	204.5	390
600 min Winter	8.338	0.0	213.8	462
720 min Winter	7.213	0.0	221.2	536
960 min Winter	5.736	0.0	232.1	692
1440 min Winter	4.149	0.0	239.1	998
2160 min Winter	3.014	0.0	286.7	1468
2880 min Winter	2.418	0.0	306.1	1936
4320 min Winter	1.803	0.0	338.7	2896
5760 min Winter	1.484	0.0	379.2	3744
7200 min Winter	1.292	0.0	412.6	4544
8640 min Winter	1.163	0.0	445.2	5368

Hydrologic Services		Page 3
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 30 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
10080 min Winter	0.209	0.209	0.0	1.3	1.3	95.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.071	0.0	476.9	6248

Hydrologic Services		Page 4
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 326000 246550 SO 26000 46550
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.318

Time From:	(mins) To:	Area (ha)
0	4	0.318

Hydrologic Services		Page 5
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 1.800

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	480.0	0.0	0.661	0.0	0.0
0.660	480.0	0.0			

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0064-1300-0200-1300
Design Head (m)	0.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.200	1.3	Kick-Flo®	0.160	1.2
Flush-Flo™	0.089	1.3	Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	0.800	2.4	2.000	3.7	4.000	5.2
0.200	1.3	1.000	2.7	2.200	3.9	4.500	5.5
0.300	1.6	1.200	2.9	2.400	4.0	5.000	5.9
0.400	1.8	1.400	3.1	2.600	4.2	5.500	6.1
0.500	2.0	1.600	3.3	3.000	4.5	6.000	6.4
0.600	2.1	1.800	3.5	3.500	4.9	6.500	6.7

Hydrologic Services		Page 6
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Hydro-Brake® Optimum

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	6.9	8.000	7.4	9.000	7.9		
7.500	7.2	8.500	7.6	9.500	8.1		

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3200-0300-3200
Design Head (m)	0.300
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	0.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	3.2	Kick-Flo®	0.239	2.9
Flush-Flo™	0.136	3.2	Mean Flow over Head Range	-	2.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.1	3.000	9.4	7.000	14.3
0.200	3.1	1.400	6.5	3.500	10.1	7.500	14.8
0.300	3.2	1.600	7.0	4.000	10.8	8.000	15.3
0.400	3.7	1.800	7.4	4.500	11.4	8.500	15.7
0.500	4.0	2.000	7.7	5.000	12.0	9.000	16.2
0.600	4.4	2.200	8.1	5.500	12.6	9.500	16.6
0.800	5.0	2.400	8.4	6.000	13.2		
1.000	5.6	2.600	8.8	6.500	13.7		

Surface water outputs

1 in 100 years storm plus 40% climate change

Hydrologic Services		Page 1
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

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

Half Drain Time : 546 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.195	0.195	0.0	1.3	1.3	88.9	O K
30 min Summer	0.261	0.261	0.0	1.5	1.5	119.0	O K
60 min Summer	0.331	0.331	0.0	2.1	2.1	151.1	O K
120 min Summer	0.379	0.379	0.0	4.1	4.1	173.0	O K
180 min Summer	0.396	0.396	0.0	4.7	4.7	180.4	O K
240 min Summer	0.400	0.400	0.0	4.8	4.8	182.3	O K
360 min Summer	0.399	0.399	0.0	4.8	4.8	182.0	O K
480 min Summer	0.398	0.398	0.0	4.7	4.7	181.3	O K
600 min Summer	0.395	0.395	0.0	4.6	4.6	180.2	O K
720 min Summer	0.392	0.392	0.0	4.5	4.5	178.9	O K
960 min Summer	0.386	0.386	0.0	4.3	4.3	176.0	O K
1440 min Summer	0.374	0.374	0.0	3.9	3.9	170.4	O K
2160 min Summer	0.359	0.359	0.0	3.2	3.2	163.7	O K
2880 min Summer	0.348	0.348	0.0	2.7	2.7	158.7	O K
4320 min Summer	0.332	0.332	0.0	2.1	2.1	151.4	O K
5760 min Summer	0.319	0.319	0.0	1.8	1.8	145.7	O K
7200 min Summer	0.308	0.308	0.0	1.6	1.6	140.6	O K
8640 min Summer	0.297	0.297	0.0	1.5	1.5	135.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.640	0.0	79.8	19
30 min Summer	101.360	0.0	103.3	34
60 min Summer	65.100	0.0	149.9	64
120 min Summer	38.920	0.0	179.5	122
180 min Summer	28.387	0.0	196.5	180
240 min Summer	22.540	0.0	208.1	240
360 min Summer	16.123	0.0	223.1	292
480 min Summer	12.662	0.0	233.2	354
600 min Summer	10.486	0.0	240.7	422
720 min Summer	8.983	0.0	246.7	490
960 min Summer	7.038	0.0	255.1	628
1440 min Summer	4.999	0.0	258.0	910
2160 min Summer	3.579	0.0	304.1	1336
2880 min Summer	2.847	0.0	321.9	1756
4320 min Summer	2.101	0.0	352.5	2596
5760 min Summer	1.721	0.0	392.7	3464
7200 min Summer	1.493	0.0	425.8	4320
8640 min Summer	1.342	0.0	458.6	5104

Hydrologic Services		Page 2
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

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
10080 min Summer	0.289	0.289	0.0	1.5	1.5	131.6	O K
15 min Winter	0.219	0.219	0.0	1.4	1.4	99.6	O K
30 min Winter	0.293	0.293	0.0	1.5	1.5	133.4	O K
60 min Winter	0.369	0.369	0.0	3.7	3.7	168.3	O K
120 min Winter	0.421	0.421	0.0	5.0	5.0	191.9	O K
180 min Winter	0.442	0.442	0.0	5.0	5.0	201.7	O K
240 min Winter	0.451	0.451	0.0	5.1	5.1	205.5	O K
360 min Winter	0.449	0.449	0.0	5.1	5.1	204.9	O K
480 min Winter	0.445	0.445	0.0	5.1	5.1	203.0	O K
600 min Winter	0.440	0.440	0.0	5.0	5.0	200.5	O K
720 min Winter	0.433	0.433	0.0	5.0	5.0	197.5	O K
960 min Winter	0.419	0.419	0.0	5.0	5.0	191.1	O K
1440 min Winter	0.396	0.396	0.0	4.7	4.7	180.7	O K
2160 min Winter	0.375	0.375	0.0	3.9	3.9	170.9	O K
2880 min Winter	0.360	0.360	0.0	3.3	3.3	164.4	O K
4320 min Winter	0.341	0.341	0.0	2.5	2.5	155.5	O K
5760 min Winter	0.326	0.326	0.0	2.0	2.0	148.5	O K
7200 min Winter	0.310	0.310	0.0	1.6	1.6	141.5	O K
8640 min Winter	0.291	0.291	0.0	1.5	1.5	132.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.234	0.0	490.6	5944
15 min Winter	150.640	0.0	88.7	19
30 min Winter	101.360	0.0	111.1	33
60 min Winter	65.100	0.0	168.1	62
120 min Winter	38.920	0.0	201.5	120
180 min Winter	28.387	0.0	220.5	176
240 min Winter	22.540	0.0	233.4	232
360 min Winter	16.123	0.0	250.2	332
480 min Winter	12.662	0.0	261.5	374
600 min Winter	10.486	0.0	270.0	450
720 min Winter	8.983	0.0	276.8	524
960 min Winter	7.038	0.0	286.5	668
1440 min Winter	4.999	0.0	290.3	952
2160 min Winter	3.579	0.0	340.9	1380
2880 min Winter	2.847	0.0	360.8	1816
4320 min Winter	2.101	0.0	394.3	2720
5760 min Winter	1.721	0.0	439.9	3632
7200 min Winter	1.493	0.0	477.0	4608
8640 min Winter	1.342	0.0	513.9	5448

Hydrologic Services		Page 3
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

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 (m^3)	Status
10080 min Winter	0.274	0.274	0.0	1.5	1.5	125.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
10080 min Winter	1.234	0.0	550.1	6256

Hydrologic Services		Page 4
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 326000 246550 SO 26000 46550
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.318

Time (mins) From:	To:	Area (ha)
0	4	0.318

Hydrologic Services		Page 5
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 1.800

Cellular Storage Structure

Invert Level (m) 0.000 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	480.0	0.0	0.661	0.0	0.0
0.660	480.0	0.0			

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0064-1300-0200-1300
Design Head (m)	0.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.200	1.3	Kick-Flo®	0.160	1.2
Flush-Flo™	0.089	1.3	Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	0.800	2.4	2.000	3.7	4.000	5.2
0.200	1.3	1.000	2.7	2.200	3.9	4.500	5.5
0.300	1.6	1.200	2.9	2.400	4.0	5.000	5.9
0.400	1.8	1.400	3.1	2.600	4.2	5.500	6.1
0.500	2.0	1.600	3.3	3.000	4.5	6.000	6.4
0.600	2.1	1.800	3.5	3.500	4.9	6.500	6.7

Hydrologic Services		Page 6
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File Geocellular tank 2HB.srcx	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Hydro-Brake® Optimum

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
7.000	6.9	8.000	7.4	9.000	7.9		
7.500	7.2	8.500	7.6	9.500	8.1		

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3200-0300-3200
Design Head (m)	0.300
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	0.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	0.300	3.2	Kick-Flo®	0.239	2.9
Flush-Flo™	0.136	3.2	Mean Flow over Head Range	-	2.5

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	3.0	1.200	6.1	3.000	9.4	7.000	14.3
0.200	3.1	1.400	6.5	3.500	10.1	7.500	14.8
0.300	3.2	1.600	7.0	4.000	10.8	8.000	15.3
0.400	3.7	1.800	7.4	4.500	11.4	8.500	15.7
0.500	4.0	2.000	7.7	5.000	12.0	9.000	16.2
0.600	4.4	2.200	8.1	5.500	12.6	9.500	16.6
0.800	5.0	2.400	8.4	6.000	13.2		
1.000	5.6	2.600	8.8	6.500	13.7		

Surface water outputs

1 in 100 years storm plus 40% climate change

Hydrologic Services		Page 1
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File GEOCELLULAR TANK 2HB.SRCX	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 500 year Return Period (+40%)

Half Drain Time : 697 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	0.288	0.288	0.0	1.5	1.5	131.5	O K
30 min Summer	0.389	0.389	0.0	4.4	4.4	177.4	O K
60 min Summer	0.492	0.492	0.0	5.1	5.1	224.6	O K
120 min Summer	0.554	0.554	0.0	5.1	5.1	252.5	O K
180 min Summer	0.575	0.575	0.0	5.2	5.2	262.0	O K
240 min Summer	0.579	0.579	0.0	5.2	5.2	264.1	O K
360 min Summer	0.568	0.568	0.0	5.1	5.1	258.9	O K
480 min Summer	0.552	0.552	0.0	5.1	5.1	251.9	O K
600 min Summer	0.538	0.538	0.0	5.1	5.1	245.3	O K
720 min Summer	0.524	0.524	0.0	5.1	5.1	238.9	O K
960 min Summer	0.498	0.498	0.0	5.1	5.1	227.3	O K
1440 min Summer	0.456	0.456	0.0	5.1	5.1	207.8	O K
2160 min Summer	0.413	0.413	0.0	5.0	5.0	188.2	O K
2880 min Summer	0.390	0.390	0.0	4.5	4.5	178.1	O K
4320 min Summer	0.367	0.367	0.0	3.6	3.6	167.5	O K
5760 min Summer	0.355	0.355	0.0	3.0	3.0	161.7	O K
7200 min Summer	0.346	0.346	0.0	2.7	2.7	157.9	O K
8640 min Summer	0.341	0.341	0.0	2.5	2.5	155.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	222.392	0.0	110.1	19
30 min Summer	151.865	0.0	134.5	33
60 min Summer	98.394	0.0	227.9	64
120 min Summer	57.231	0.0	265.3	122
180 min Summer	40.973	0.0	284.7	182
240 min Summer	32.082	0.0	297.0	240
360 min Summer	22.488	0.0	311.6	344
480 min Summer	17.374	0.0	320.2	396
600 min Summer	14.194	0.0	326.0	454
720 min Summer	12.020	0.0	330.2	512
960 min Summer	9.236	0.0	335.3	644
1440 min Summer	6.375	0.0	331.4	908
2160 min Summer	4.447	0.0	378.6	1296
2880 min Summer	3.478	0.0	393.9	1672
4320 min Summer	2.516	0.0	422.4	2464
5760 min Summer	2.039	0.0	465.5	3280
7200 min Summer	1.759	0.0	501.7	4040
8640 min Summer	1.575	0.0	538.7	4848

Hydrologic Services		Page 2
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File GEOCELLULAR TANK 2HB.SRCX	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 500 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
10080 min Summer	0.337	0.337	0.0	2.3	2.3	153.7	O K
15 min Winter	0.323	0.323	0.0	1.9	1.9	147.3	O K
30 min Winter	0.435	0.435	0.0	5.0	5.0	198.4	O K
60 min Winter	0.554	0.554	0.0	5.1	5.1	252.8	O K
120 min Winter	0.624	0.624	0.0	5.5	5.5	284.6	O K
180 min Winter	0.648	0.648	0.0	5.6	5.6	295.7	O K
240 min Winter	0.655	0.655	0.0	5.7	5.7	298.8	O K
360 min Winter	0.646	0.646	0.0	5.6	5.6	294.6	O K
480 min Winter	0.626	0.626	0.0	5.5	5.5	285.3	O K
600 min Winter	0.608	0.608	0.0	5.4	5.4	277.3	O K
720 min Winter	0.592	0.592	0.0	5.3	5.3	269.9	O K
960 min Winter	0.559	0.559	0.0	5.1	5.1	255.1	O K
1440 min Winter	0.497	0.497	0.0	5.1	5.1	226.4	O K
2160 min Winter	0.431	0.431	0.0	5.0	5.0	196.6	O K
2880 min Winter	0.398	0.398	0.0	4.7	4.7	181.3	O K
4320 min Winter	0.370	0.370	0.0	3.7	3.7	168.5	O K
5760 min Winter	0.355	0.355	0.0	3.0	3.0	161.7	O K
7200 min Winter	0.345	0.345	0.0	2.6	2.6	157.1	O K
8640 min Winter	0.337	0.337	0.0	2.3	2.3	153.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.447	0.0	575.9	5648
15 min Winter	222.392	0.0	116.4	19
30 min Winter	151.865	0.0	150.8	33
60 min Winter	98.394	0.0	255.5	62
120 min Winter	57.231	0.0	297.2	120
180 min Winter	40.973	0.0	318.9	178
240 min Winter	32.082	0.0	332.6	234
360 min Winter	22.488	0.0	348.8	344
480 min Winter	17.374	0.0	358.2	442
600 min Winter	14.194	0.0	364.3	472
720 min Winter	12.020	0.0	368.5	548
960 min Winter	9.236	0.0	372.7	702
1440 min Winter	6.375	0.0	370.3	982
2160 min Winter	4.447	0.0	424.3	1364
2880 min Winter	3.478	0.0	441.5	1728
4320 min Winter	2.516	0.0	472.6	2548
5760 min Winter	2.039	0.0	521.5	3352
7200 min Winter	1.759	0.0	562.0	4184
8640 min Winter	1.575	0.0	603.6	5024

Hydrologic Services		Page 3
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File GEOCELLULAR TANK 2HB.SRCX	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Summary of Results for 500 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 (m^3)	Status
10080 min Winter	0.331	0.331	0.0	2.1	2.1	150.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
10080 min Winter	1.447	0.0	645.6	5944

Hydrologic Services		Page 4
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	
Date 07/02/2019 File GEOCELLULAR TANK 2HB.SRCX	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	500
FEH Rainfall Version	2013
Site Location	GB 326000 246550 SO 26000 46550
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.318

Time (mins) From:	To:	Area (ha)
0	4	0.318

Hydrologic Services		Page 5
Unit 6, Commerce Park Brunel Way Theale RG7 4AB	Sheepcote Farm Surface Water Management Plan K0657b	Micro Drainage
Date 07/02/2019 File GEOCELLULAR TANK 2HB.SRCX	Designed by Joao Gil Checked by (self check only)	
Innovyze	Source Control 2017.1	

Model Details

Storage is Online Cover Level (m) 1.800

Cellular Storage Structure

Invert Level (m) 0.000 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	480.0	0.0	0.661	0.0	0.0
0.660	480.0	0.0			

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0064-1300-0200-1300
Design Head (m)	0.200
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.200	1.3	Kick-Flo®	0.160	1.2
Flush-Flo™	0.089	1.3	Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	0.800	2.4	2.000	3.7	4.000	5.2
0.200	1.3	1.000	2.7	2.200	3.9	4.500	5.5
0.300	1.6	1.200	2.9	2.400	4.0	5.000	5.9
0.400	1.8	1.400	3.1	2.600	4.2	5.500	6.1
0.500	2.0	1.600	3.3	3.000	4.5	6.000	6.4
0.600	2.1	1.800	3.5	3.500	4.9	6.500	6.7

Hydro-Brake® Optimum

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	6.9	8.000	7.4	9.000	7.9		
7.500	7.2	8.500	7.6	9.500	8.1		

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3200-0300-3200
Design Head (m)	0.300
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	0.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	3.2	Kick-Flo®	0.239	2.9
Flush-Flo™	0.136	3.2	Mean Flow over Head Range	-	2.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.1	3.000	9.4	7.000	14.3
0.200	3.1	1.400	6.5	3.500	10.1	7.500	14.8
0.300	3.2	1.600	7.0	4.000	10.8	8.000	15.3
0.400	3.7	1.800	7.4	4.500	11.4	8.500	15.7
0.500	4.0	2.000	7.7	5.000	12.0	9.000	16.2
0.600	4.4	2.200	8.1	5.500	12.6	9.500	16.6
0.800	5.0	2.400	8.4	6.000	13.2		
1.000	5.6	2.600	8.8	6.500	13.7		

Appendix D – Environment Agency Product 4

Environment Agency

Product 4 (Detailed Flood Risk Data) for HR3 5HU

Reference number: 103808
Date of issue: 26 October 2018

Model Information

The following information and attached maps contain a summary of the modelled information relevant to the area of interest. The information provided is based on the best available data as of the date of issue.

Model Name	Release Date
River Wye Modelling, Forecasting & Review Study	2012

Flood Map for Planning (Rivers and Sea)

The Flood Map for Planning (Rivers and Sea) indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring in any year for fluvial (river) flooding (Flood Zone 3). It also shows the extent of the Extreme Flood Outlines (Flood Zone 2) which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater. The Flood Zones refer to the land at risk of flooding and **do not** refer to individual properties. It is possible for properties to be built at a level above the floodplain but still fall within the risk area.

This Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water, sewers, road drainage, etc.

Flood zones

According to our published Flood Map for Planning (rivers and sea), the area is shown to be **within Zone 3.** The chance of flooding in any one year is greater than or equal to 1% (i.e. a 100 to 1 chance) for river flooding and greater than or equal to 0.5% (i.e. a 200 to 1 chance) for coastal and tidal flooding.

Flood Zones do not provide information on flooding from groundwater or other sources.

Areas Benefitting From Defences

Where possible we show the areas that benefit from the flood defences, in the event of flooding:

Email: Enquiries_Westmids@environment-agency.gov.uk
Website: www.gov.uk/government/organisations/environment-agency

Environment Agency

- from rivers with a 1% (1 in 100) chance in any given year, or;
- from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would flood. Please note that we do not show all areas that benefit from flood defences.

The associated Dataset is available here: https://data.gov.uk/dataset/flood-map-for-planning-rivers-and-sea-areas-benefiting-from-defences

Email: Enquiries_Westmids@environment-agency.gov.uk
Website: www.gov.uk/government/organisations/environment-agency

Node Data/ Modelled Levels

The attached flood map will show a selection of 1D model node points near to your site. The fluvial levels and flows for these node points are shown below.

Fluvial Flood Levels (m AOD)

The modelled levels are given in m AOD (N), m AOD indicates metres Above Ordnance Datum (Newlyn).

The information is taken from the model referenced above and does not include the updated climate change figures.

			Annual Exceedance Probability - Maximum Water Levels (m AOD) defended									
Node Label	Easting	Northing	50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc. 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)
46	324743	247415	69.25	69.52	69.70	69.83	70.03	70.11	70.18	70.43	70.36	70.87
47	324931	247500	69.07	69.36	69.56	69.70	69.90	70.00	70.06	70.33	70.25	70.77
48	325245	247570	69.00	69.27	69.45	69.60	69.79	69.88	69.95	70.21	70.13	70.66
50	325723	247511	68.84	69.11	69.29	69.44	69.63	69.72	69.79	70.05	69.97	70.49
52	325884	247437	68.50	68.69	68.81	68.91	69.03	69.09	69.13	69.26	69.22	69.44
53	326097	247371	68.40	68.61	68.73	68.83	68.96	69.02	69.06	69.21	69.17	69.42
54	326392	247454	68.31	68.50	68.61	68.70	68.81	68.86	68.90	69.03	68.99	69.23
55	326613	247468	68.17	68.37	68.49	68.58	68.70	68.76	68.80	68.95	68.91	69.18
63	326736	246368	67.25	67.52	67.69	67.81	68.01	68.09	68.15	68.38	68.31	68.81

Email: Enquiries_Westmids@environment-agency.gov.uk
Website: www.gov.uk/government/organisations/environment-agency

Environment Agency

Fluvial Flood Flows (m^3/s)

The fluvial flood flows for the model nodes are measured in cubic metres per second, or cumecs (m^3/s).

			Annual Exceedance Probability - Maximum Flows (m^3/s) defended										
Node Label	Easting	Northing	50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc. 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)
46	324743	247415	426.926	521.043	593.858	662.005	770.207	826.804	871.108	1045.340	991.220	1383.090
47	324931	247500	432.983	528.494	602.478	671.631	781.408	838.795	883.477	1060.450	1005.550	1402.940
48	325245	247570	408.956	484.143	542.669	598.126	687.760	734.981	771.627	916.416	871.537	1196.190
50	325723	247511	390.801	438.790	475.238	509.939	568.000	599.205	623.302	716.909	687.964	896.516
52	325884	247437	390.804	440.409	478.699	512.093	559.756	583.439	601.700	676.188	652.831	819.777
53	326097	247371	390.793	440.401	478.692	512.086	559.717	583.258	601.262	672.755	650.750	804.624
54	326392	247454	390.778	440.395	478.681	512.073	559.515	582.642	599.985	664.518	645.316	774.693
55	326613	247468	389.575	432.913	463.896	490.059	525.589	542.595	555.463	602.196	588.172	681.240
63	326736	246368	422.769	457.409	470.251	478.971	483.221	484.386	484.875	485.711	485.641	487.428

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Modelled Flood Extents

Please find attached a map showing the results of the model (referenced above) for your area. This shows modelled flood extents, not taking into account flood defences unless marked 'defended'. Climate change will increase flood risk due to overtopping of defences.

Climate Change

In February 2016 the 'Flood Risk Assessments: Climate Change Allowances' were published on GOV.UK. This is in replacement of previous climate change allowances for planning applications. The data provided in this product does not include the new allowances. You will need to consider this data and factor in the new allowances to demonstrate the development will be safe from flooding. The fluvial climate change factors are now more complex and a single uplift percentage across England cannot be justified.

The Environment Agency will incorporate the new allowances into future modelling studies. For now, it remains the applicant's responsibility to demonstrate through their proposal and flood risk assessments that new developments will be safe in flood risk terms for its lifetime.

Recorded Flood Outlines

Following an examination of our records of historical flooding we do hold records of flooding for this area, please find tabulated information below for these recorded flood events.

Flood Event Code	Flood Event Date	Source of Flooding	Cause of Flooding
3229	1947	Fluvial	Channel exceeded capacity, no raised flood defences present.

The corresponding recorded flood outline/s can be accessed here:
https://data.gov.uk/dataset/recorded-flood-outlines1

The Recorded Flood Outlines take into account the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages. Any flood extents shown do not necessarily indicate that properties were flooded internally. It is also possible that the pattern of flooding in this area has changed and that this area would now flood or not flood under different circumstances.

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Please note that our records are not comprehensive and that the map is an indicative outline of areas which have previously flooded, not all properties within this area will have flooded. It is possible that other flooding may have occurred that we do not have records for.

You may also wish to contact your Local Authority or Internal Drainage Board (where relevant), to see if they have other relevant local flood information.

Flood Defences

There are no formal flood defences owned or operated by the Environment Agency protecting this site. You may wish to contact the Local Authority to obtain further information regarding localised flooding from drains, culverts and small watercourses, and regarding existing or planned flood defence measures.

Planning development/s

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments. You can also request pre application advice:

https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Supporting Information

Surface Water

Managing the risk of flooding from surface water is the responsibility of Lead Local Flood Authorities. The 'risk of flooding from surface water' map has been produced by the Environment Agency on behalf of government, using information and input from Lead Local Flood Authorities.

You may wish to contact your Local Authority who may be able to provide further detailed information on surface water.

It is not possible to say for certain what the flood risk is but we use the best information available to provide an indication so that people can make informed choices about living with or managing the risks. The information we supply does not provide an indicator of flood risk at an individual site level. Further information can be found on the Agency's website:

https://flood-warning-information.service.gov.uk/long-term-flood-risk

Flood Risk from Reservoirs

The Flood Risk from Reservoirs map can be found on the Long Term Flood Risk Information website:

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=Reservoirs

Flood Alert & Flood Warning Area

We issue flood alert/warnings to specific areas when flooding is expected. If you receive a flood warning you should take immediate action.

You can check whether you are in a Flood Alert/Warning Area and register online using the links below:

https://www.gov.uk/check-flood-risk

https://www.gov.uk/sign-up-for-flood-warnings

If you would prefer to register by telephone, or if you need help during the registration process, please call Floodline on 0345 988 1188.

The associated dataset for flood warning areas is available here: https://data.gov.uk/dataset/flood-warning-areas3

The associated dataset for flood alert areas is available here: https://data.gov.uk/dataset/flood-alert-areas2

Flood Risk Activity Permits

We now consider applications for works, which may be Flood Risk Activities, under Environmental Permitting Regulations. This replaces the process of applying for a Flood Defence Consent. You may need an environmental Permit for flood risk activities if you want to do work:

- in, under, over or near a main river (including where the river is in a culvert)
- on or near a flood defence on a main river
- in the flood plain of a main river
- on or near a sea defence

Please go to this website to find out more about how to apply: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.
Please be aware that Bespoke and Standard Rules permits can take up to 2 months to determine and will incur a charge.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

Email: Enquiries_Westmids@environment-agency.gov.uk
Website: www.gov.uk/government/organisations/environment-agency

Appendix E – Slurry lagoon storage calculations

Calculating 2019 Slurry Storage Requirement

Slurry production per month (based on undiluted slurry)

Livestock type on slurry or part-slurry based system	No. of livestock units on slurry or part-based system		Proportion of excreta collected as slurry		Volume per livestock unit (or place) per month (m³)		Volume produced each month (m³)
Dairy cow 6000lts to 9000lts	350	x	1	x	1.59	=	556.5
Total:	350						

Total volume of slurry produced per month (m³)	A	557

Calculate the average volume of rainfall that enters your slurry store(s) each month

October Rainfall		87.1
November Rainfall		78.2
December Rainfall	=	83.9
January Rainfall		78.7
February Rainfall		55.8

Average Rainfall (mm)	B	77

Area of open slurry stores(s) plus concrete surface area (m²)		Average monthly rainfall (B)	Conversion to m³		Average volume of rainfall entering slurry store(s) per month (m³)
4934	x	77	/1000	C	379

Please note that this includes silage store area and concrete where rainwater is collected.

Calculate the volume of wash water that enters the slurry store each month

Months within the closed period	Number of dairy cows		No. of times dairy cows are milked per day		Wash water used per cow (m³)		Monthly wash water production (m³)
October	350		2		0.45		315
November	350		2		0.45		315
December	0	x	2	x	0.45	=	0
January	0		2		0.45		0
February	350		2		0.45		315
Average wash water per month in closed period						D	189

Storage Requirement

Calculate the total volume of slurry (including dilution) that is required to be stored for the closed period

Slurry produced per month (A)		Average volume of rainfall entering slurry store(s) per month (C)		Average monthly wash water (D)		Monthly slurry plus dilution (m³)
557		379		189	F	1124

Monthly slurry plus dilution (F)	Slurry Storage: 5 months if in an NVZ, 4 months if out		Total volume of slurry plus dilution to be stored (m³)
1124	4	G	4497

Slurry Storage Measurements

Ref	Earth banked store (Yes/No)	Circular Store (Yes/No)	Length (m)	Width / Diameter (m)	Working height or depth (m)	Side Run (m) (Length)	End Run (m) (Width)	Freeboard required (m)	Capacity (m³)
	Yes	No	65.5	33.0	4.8	4.8	4.8	0.75	6602
						Total Existing Capacity =			6602

Total capacity includes all deductions from the run and rise and also freeboard.

This holding has Sufficient Capacity

FACTS

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