



Development • Planning • Environment

LAND AT ALDHAM BRIDGE, WOMBWELL

FLOOD RISK ASSESSMENT

Final Report v1.1

June 2014

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Flood Risk Assessment
Final Report v1.1

Client: Riseholm Investments Ltd

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1 INTRODUCTION

Weetwood Services Ltd ("Weetwood") has been instructed by Riseholm Investments Ltd to undertake a Flood Risk Assessment (FRA) for the proposed redevelopment of a site in Wombwell, Barnsley, in accordance with the requirements of the National Planning Policy Framework (NPPF).

1.1 SITE LOCATION

The site is located at Aldham Bridge, south-east Barnsley at Ordnance Survey (OS) National Grid Reference SE 386 044, as shown in **Figure 1**.

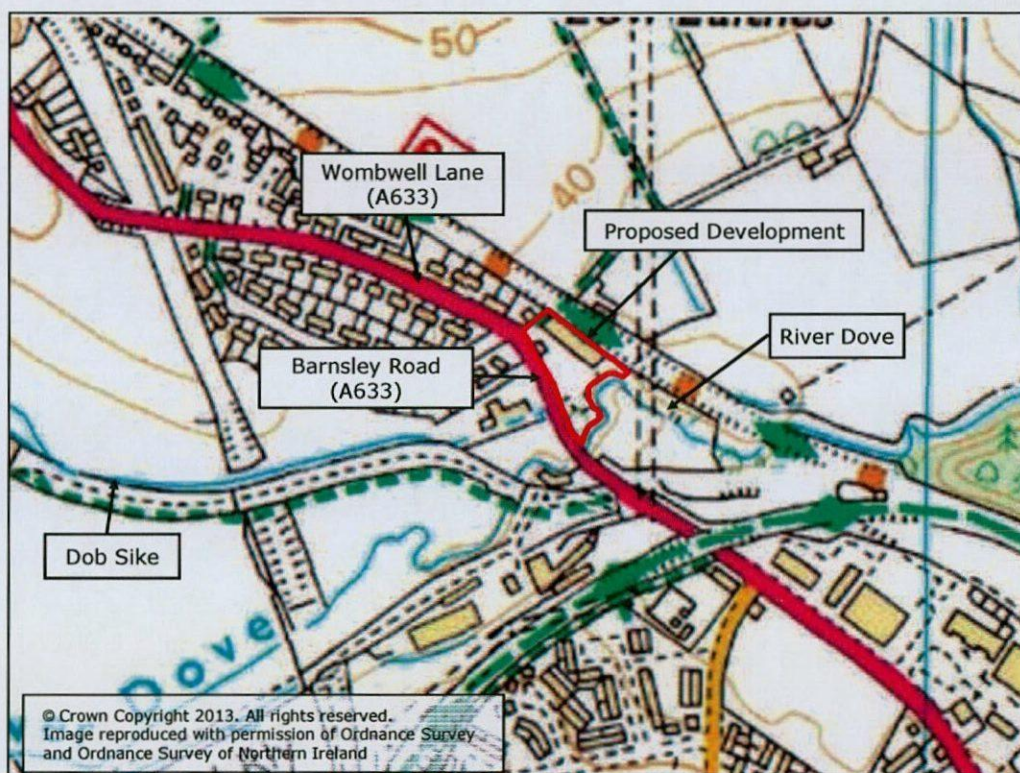


Figure 1: Site location

1.2 EXISTING AND PROPOSED DEVELOPMENT

The application site is approximately 0.52 hectares (ha) in area. The site is partially occupied by retail units, a car wash and areas of hard standing. Part of the remainder of the site was previously occupied by a petrol filling station with associated kiosk, canopy and forecourt.

The development proposals (**Appendix A**) entail the development of a retail unit (gross external area 743 m²) on the south east corner, together with the demolition of the canopy and the refurbishment of the existing buildings to the rear of the site.

The NPPF classifies retail use as 'less vulnerable' land use¹.

1.3 SITE LEVELS

A topographic survey of the site has been undertaken by Site and Survey Services and is provided in **Appendix B**.

The site slopes from south-east to west from 37.34 metres Above Ordnance Datum (m AOD) to 35.83 m AOD as shown in **Figure 2**.

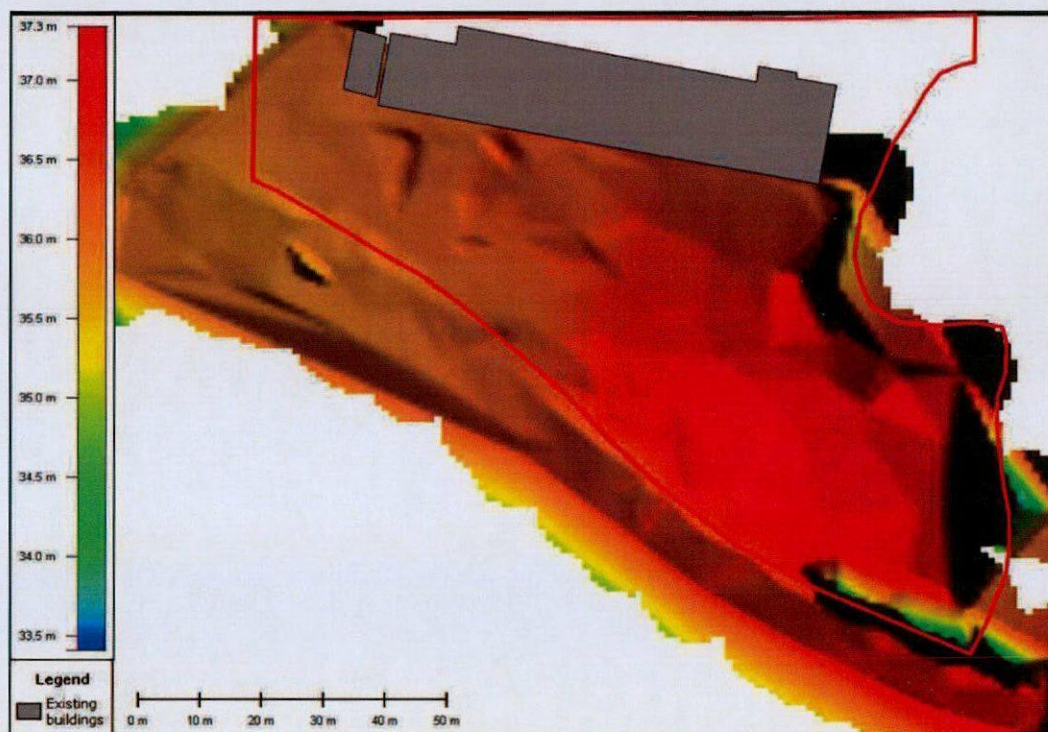


Figure 2: Digital terrain model

1.4 ACCESS AND EGRESS

Access and egress to the site is provided off the A633 Barnsley Road. Barnsley Road slopes from south-east to north-west, with levels ranging between 37.18 m AOD and 35.80 m AOD.

¹ NPPF Technical Guidance, Table 2

2 NATIONAL PLANNING POLICY FRAMEWORK

The aim of the NPPF is to ensure that flood risk is taken into account at all stages in the planning process and is appropriately addressed.

2.1 FLOOD ZONE DESIGNATION

According to the Environment Agency (EA) Flood Map (**Figure 3**) the site is located in Flood Zone 3 (approximately 75%) and Flood Zone 2 (approximately 25%).

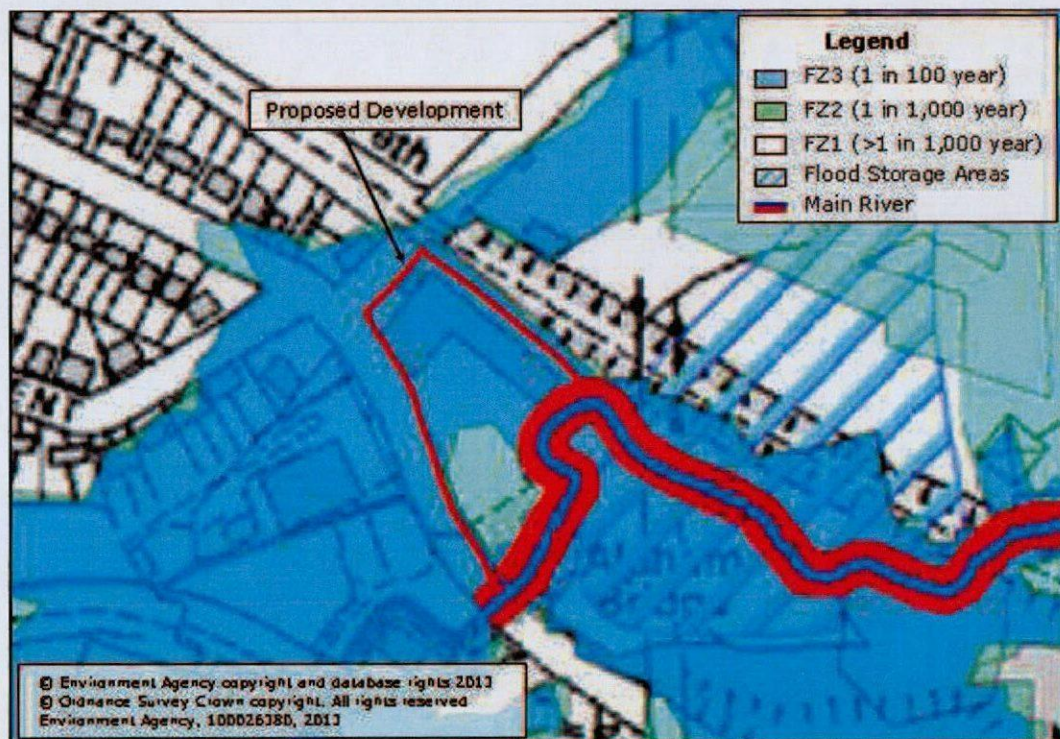


Figure 3: Flood map (Source: EA)

The NPPF defines flood zones as follows²:

- **Flood Zone 1: Low Probability.** Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year.
- **Flood Zone 2: Medium Probability.** Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between a 1 in 200 and 1 in 1000 annual probability of flooding from the sea in any year.
- **Flood Zone 3a: High Probability.** Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

² NPPF Technical Guidance, Table 1

- **Flood Zone 3b: The Functional Floodplain.** Land where water has to flow or be stored in times of flood. The identification of the functional floodplain should take account of local circumstance and not be defined solely on rigid probability parameters. However, land which would flood with an annual probability of 1 in 20 or greater in any year should provide a starting point for consideration and discussion.

The Barnsley Strategic Flood Risk Assessment (SFRA) was published by Barnsley Metropolitan Borough Council (MBC) in 2010. Map 6 of the SFRA³ indicates the site is not located within the functional floodplain. The flood zone categorisation of the site is thus Flood Zone 3a.

2.2 FLOOD RISK SEQUENTIAL TEST

The aim of the flood risk Sequential Test⁴ is to encourage development to be located in areas at the lowest probability of flooding.

The Sequential Test has been addressed by ID Planning Ltd in consultation with Barnsley MBC. The proposed development would provide part replacement and part new retail floorspace in this location. The ID Planning 'Sequential Assessment' highlights that in retail policy terms the application site is out of centre. It is therefore necessary under the NPPF (paragraph 24) to carry out a sequential assessment in the retail policy context which examines whether there are any suitable or available sites within or on the edge of Wombwell District Centre which could accommodate the proposed development. In policy terms other 'out of centre' locations are not sequentially preferable. The findings of ID Planning's assessment are set out in a separate report and demonstrate there are no sequentially preferable sites.

³ Barnsley SFRA General Map Study Area – Map 6 Functional Floodplain (FZ3b)

⁴ As outlined in Chapter 10 of the NPPF and paragraphs 3-5 of the Technical Guidance

3 REVIEW OF FLOOD RISK

3.1 HISTORICAL RECORDS OF FLOODING

The British Hydrological Society (BHS) Chronology⁵ has no records of flooding occurring within the vicinity of the proposed site.

The Barnsley SFRA refers to the extents of four historical flood events (March 1947, January 1982, November 2000 and June 2007) within the Barnsley MBC area. It appears from Map 2 of the SFRA⁶ that the site was not inundated during the June 2007 flood event.

The Barnsley MBC Preliminary Flood Risk Assessment (PFRA) states the Aldham Bridge district was affected by two flooding events on 15th and 25th June 2007; the impact ranged from just a few inches to several feet of water flowing into properties, with many properties affected by contaminated flood waters. According to Appendix 2 Annex 3 of the PFRA the site was not recorded as a flooded property on the 2007 register.

According to the EA Flood History Map (**Figure 4**) the site does not have any records of flooding. However, land to the south-west region of the site including the A633 Barnsley Road was flooded during the 2007 flood event.

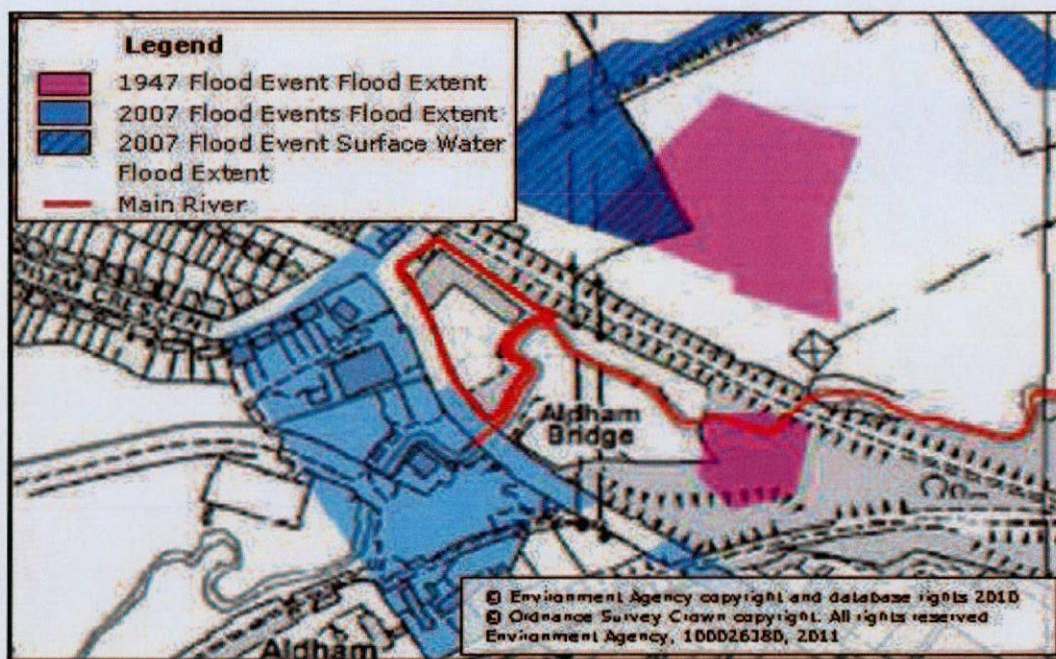


Figure 4: Flood history map (Source: EA)

⁵ British Hydrological Society Chronology www.dundee.ac.uk/geography/cbhe

⁶ Barnsley SFRA General Map Study Area – Map 2 Historical Flood Extents

3.2 FLUVIAL FLOOD RISK

The River Dove flows in a predominantly easterly direction adjacent to the south-east of the site. The river flows beneath Barnsley Road at Aldham Bridge to the south of the site before meandering around the south-east portion of the site (**Figure 1**). The River Dove outfalls to the River Dearne approximately 3.7 km east of the site.

The River Dove is designated a Main River from Barnsley Road. Upstream of the Barnsley Road the river is designated as an Ordinary Watercourse.

According to the EA flood defence database, flood defences along the River Dove within the vicinity of the proposed site are either maintained channels or culverted channels.

Dob Sike is a left bank tributary of the River Dove located to the west of the site (**Figure 1**) and flows in an easterly direction towards a culvert beneath Barnsley Road, approximately 40 m north-west of the River Dove. Dob Sike flows into the River Dove adjacent to the south of the site. The watercourse is approximately 2.2 km in length.

OS mapping indicates the presence of a small drainage ditch to the east of the site; a raised railway line runs between the site and the drain.

To determine potential flood levels on site, modelled flood levels for the River Dove were provided by the EA. Unfortunately, no valid model output is available for the river reach alongside the site. Approximate flood levels have therefore been derived through a comparison between the EA Flood Map and the topographic survey.

Based on this analysis, the peak flood level of the 1 in 100 year event has been estimated to be 37.0 m AOD. This level exceeds ground levels for a large proportion of the site and flooding of the site would be expected to occur during this design event.

The flood risk to the site will be mitigated through the implementation of the measures proposed in **Section 4** of this report.

3.3 FLOOD RISK FROM RESERVOIRS AND CANALS

Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

There are no canals within the vicinity of the proposed site. As such, the site is not at risk of flooding from this source.

The EA Risk of Flooding from Reservoirs Map (**Figure 5**) indicates the north-west of the site to be at potential risk of flooding from Worsbrough reservoir. However, the likelihood of failure is assessed to be low due to the maintenance regime required under the Reservoirs Act 1975. In addition, the maximum extent of flooding from this source is within the fluvial flood extent of the River Dove.

As such, the measures proposed to mitigate fluvial flood risk from the River Dove (**Section 4**) will also mitigate against this potential source of flooding.

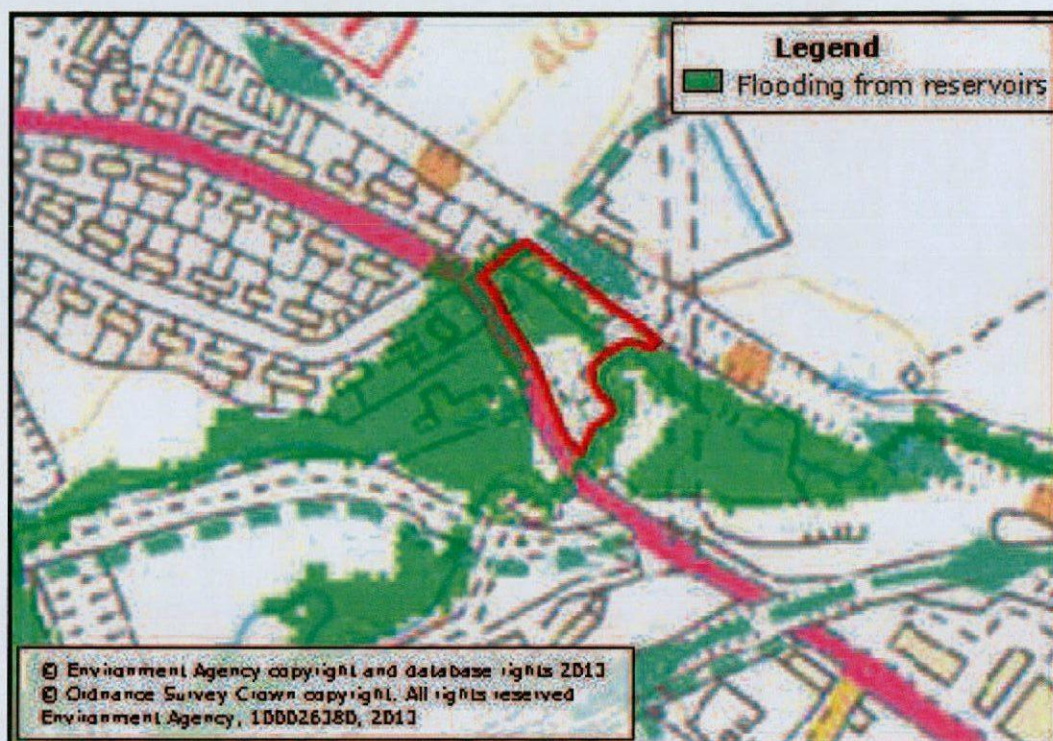


Figure 5: Risk of flooding from reservoirs map (Source: EA)

3.4 GROUNDWATER FLOODING

Groundwater flooding generally occurs during intense, long-duration rainfall events, when infiltration of rainwater into the ground raises the level of the water table until it exceeds ground levels. It is most common in low-lying areas overlain by permeable soils and permeable geology, or in areas with a naturally high water table.

According to the Soilscales maps produced by the National Soils Research Institute⁷ soil conditions at the site and within the surrounding area are described as '*Slowly permeable seasonally wet acid loamy and clayey soils*'.

According to EA groundwater vulnerability mapping (**Figure 6**), the site is underlain by a Secondary A superficial (i.e. permeable unconsolidated deposits) and bedrock (i.e. solid permeable formations) aquifer. Secondary A aquifers are defined as consisting of permeable layers capable of supporting water supplies at a local rather than strategic scale.

⁷ Soilscales www.landis.org.uk/soilscales/

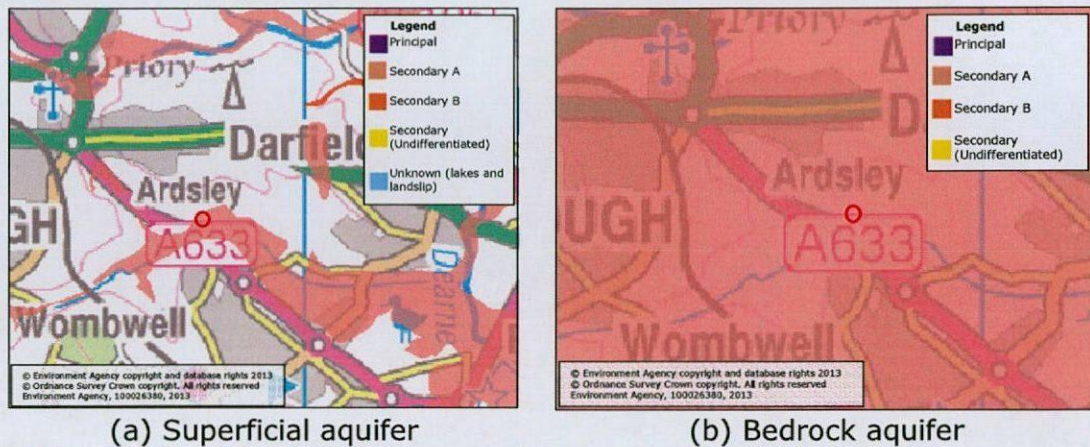


Figure 6: Groundwater vulnerability map (Source: EA)

According to the British Geological Survey (BGS) Groundwater Flooding Hazard Map (**Figure 7**) the site is not susceptible to groundwater flooding.

In addition, the existing site is extensively paved.

The risk of groundwater flooding is considered to be very low. Any risk of flooding from this source will be mitigated through the implementation of the measures proposed in **Section 4** of this report.

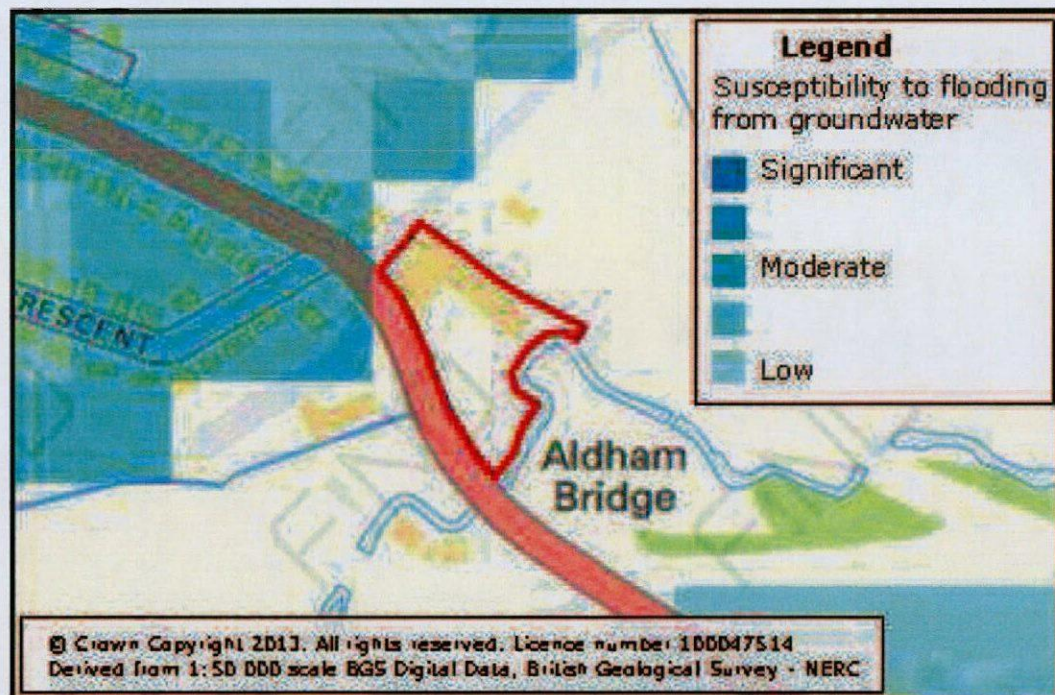


Figure 7: Groundwater flooding hazard map (Source: BGS)

3.5 SURFACE WATER FLOODING

3.5.1 Pluvial Flooding

Pluvial flooding results from rainfall-generated overland flow, before the runoff enters any watercourse or sewer, or where the sewerage/drainage systems and watercourses are overwhelmed and therefore unable to accept surface water.

Pluvial flooding is usually associated with high intensity rainfall events but may also occur with lower intensity rainfall where the ground is saturated, developed or otherwise has low permeability resulting in overland flow and ponding within depressions in the topography.

The EA Surface Water Flooding Map (see **Figure 8**) indicates that a small portion of the site may be at low risk of flooding from surface water.

However, the site is positively drained by a surface water drainage system. This will reduce the likelihood of surface water flooding and the likelihood of significant pluvial flooding at the site is assessed to be low. However, any residual flood risk from this source will be addressed through the mitigation measures as detailed in **Section 4** and the surface water drainage strategy in **Section 5**.



Figure 8: Surface water flood map (Source: EA)

3.5.2 Sewer Flooding

Sewer flooding can occur when the capacity of the sewer system is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity, resulting in flooding of land and/or property. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters.

Yorkshire Water's online incident database⁸ does not list any records of sewer flooding at or within the vicinity of the site.

However, Barnsley MDC hold one record of sewer flooding within the vicinity of the site. The A633 Barnsley Road carriageway lowers beneath the railway bridge (Area A on **Figure 9**). This section of the A633 flooded twice during June 2007 and again in September 2008 and September 2009. Works have since been carried out to remove roots and blockages from the surface water drain between the railway bridge and the River Dove and no issues have been recorded since.

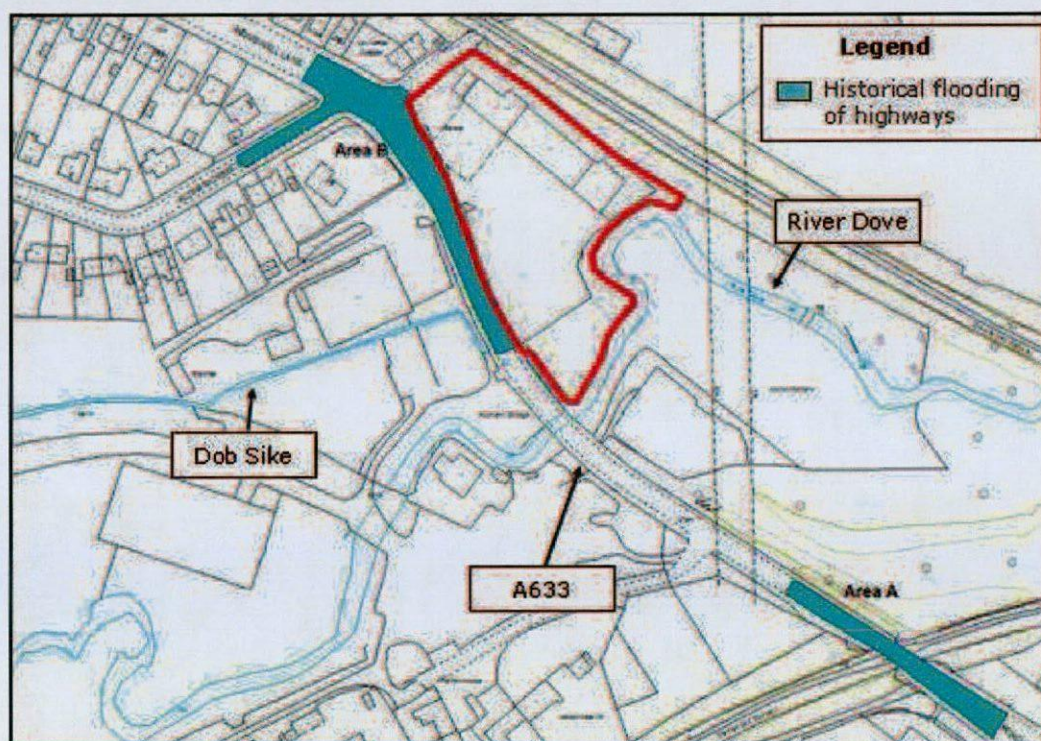


Figure 9: Local flooding map (Source: Barnsley Council)

3.5.3 Other Sources

Barnsley MDC⁹ has confirmed that flooding in Area B of **Figure 9** occurred in 2007 due to the collapse of a bridge adjacent to the former site of Darfield Main Colliery downstream from the site. This caused the River Dove to back up and overflow into Dob Sike.

Subsequently, Dob Sike overtopped causing flooding to the A633 Barnsley Road and properties on Aldham Crescent and Barnsley Road/Wombwell Lane. The flooding also inundated a Yorkshire Water pumping station on Wombwell Lane causing pump failure, thus leading to sewage flooding at this location.

No issues have been recorded since.

⁸ www.yorkshirewater.com/extra-services/in-your-area.aspx

⁹ Email response from Ian Grayson (Barnsley MDC) to Weetwood on 5 November 2013

4 MITIGATION MEASURES

Flood risk to the site will be mitigated through the implementation of the measures proposed within the following section of this report.

4.1 FINISHED FLOOR LEVELS

Finished floor levels (FFL) of new commercial units to be set at a minimum of 37.30 m AOD and not less than 300 mm above adjacent ground level. This would provide a freeboard of 300 mm above the 1 in 100 year flood water level.

This will enable any potential surface water to be conveyed safely across the site without affecting property in accordance with the approach promoted within DEFRA's Making Space for Water.

4.2 FLOOD RESISTANT AND RESILIENT CONSTRUCTION

To provide additional mitigation, flood resilient construction techniques could be incorporated into the design of the buildings, in line with guidance provided in the Communities and Local Government Document, *'Improving the Flood Performance of New Buildings: Flood Resilient Construction'*¹⁰.

These include design features and finish materials to minimise the entry of water and/or reduce the damage in the unlikely event of the development being inundated; including fitting electrical sockets and light fittings a minimum of 600 mm above FFL and locating water vulnerable equipment 300 mm above FFL.

4.3 COMPENSATORY STORAGE

Developers must ensure there will be no loss of flood flow or flood storage capacity for floods up to the severity of the 1% (1 in 100 year) event as a result of their development.

Based on the estimated peak flood level for the 1 in 100 year design event, it has been determined that the proposed development would result in a loss of approximately 5.3 m³ of on-site compensatory flood storage.

On-site flood storage will be required to compensate for this loss and could be accommodated by lowering ground levels within the site.

4.4 FLOOD MANAGEMENT PLAN

According to the EA Flood Warning Map (**Figure 10**), the site is included in the 'River Dove from Aldham Bridge to Low Valley including Wombwell Ings Caravan Site' flood warning area.

¹⁰ Improving the Flood Performance of New Buildings: Flood Resilient Construction. Department for Communities and Local Government. May 2007.

It is recommended that a Flood Management Plan (FMP) is prepared in consultation with Barnsley MDC Emergency Planners prior to occupation of the development detailing the procedures to be implemented in the event that flooding is expected or has occurred.

The requirement to produce a FMP may be conditioned as part of any planning permission granted.

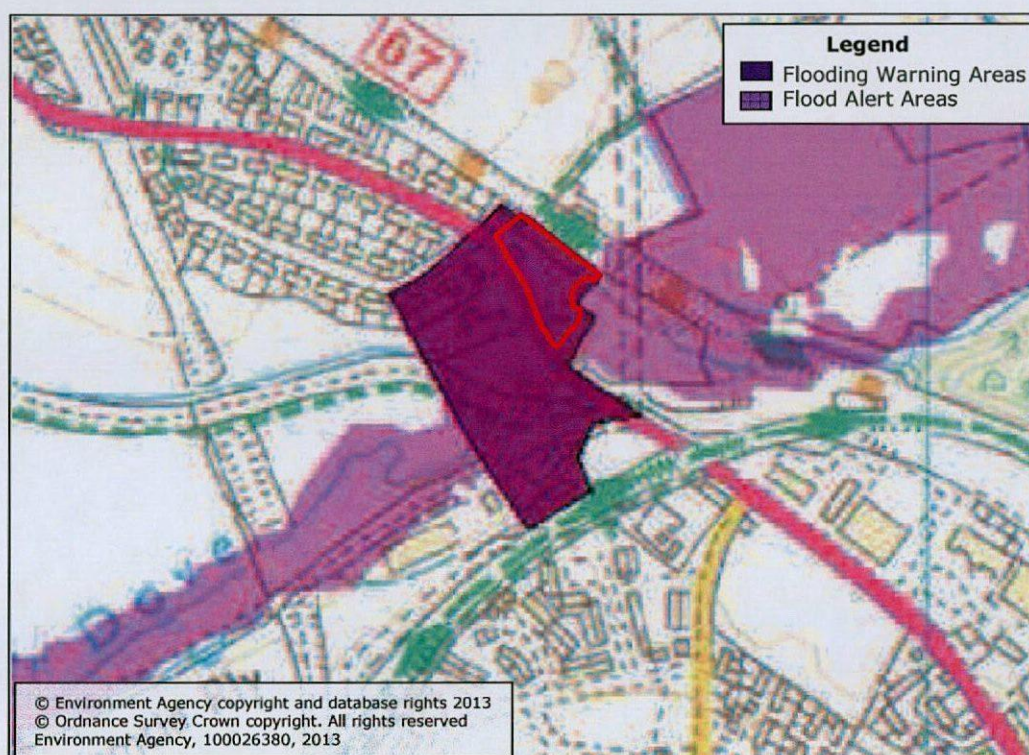


Figure 10: Flood warning map (Source: EA)

4.5 ACCESS AND EGRESS

Access and egress to the site will remain via the A633 Barnsley Road. However, this road would be expected to flood to a maximum depth of approximately 1.17 m at the north end of the site during the 1 in 100 flood event.

It is therefore recommended that if possible the site is evacuated prior to the onset of flooding as set out in the FMP (see **Section 4.4**). If this is not possible, the retail units will provide a safe dry haven (see **Section 4.1**).

4.6 MAIN RIVER

The River Dove is classified as a Main River. The EA has discretionary powers, within the Water Resources Act 1991, to carry out works to the River for which access must be maintained. The Land Drainage Byelaws require the prior written consent of the EA for '*Works Affecting Watercourses*' for any proposed works or structures in, over, under or within a distance of 8 metres from the top of the banks of the River. This shall not be unreasonably withheld.

An undeveloped buffer strip adjacent to the River Dove should be provided for maintenance purposes where possible.

5 SURFACE WATER MANAGEMENT

5.1 PLANNING POLICY AND GUIDANCE

5.1.1 National Policy

Surface water arising from a developed site should, as far as is practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development.

Development of the site should be such that the peak flow rates of surface water leaving the developed site are no greater than the rates prior to development. Opportunities to reduce surface water runoff, and the associated flood risk, should also be identified and climate change taken into consideration.

Recognising the above, and the requirements of the EA¹¹, Building Regulations Approved Document H, and the requirement placed upon local planning authorities within the NPPF and its supporting Technical Guidance to promote the use of Sustainable Drainage Systems (SuDS), surface water runoff from the proposed site should demonstrate:

- No increase in existing flow rates discharged to watercourse/public sewer
- The use of SuDS as the preferred method of dealing with surface water
- How runoff up to the 1 in 100 year event plus an allowance for climate change will be dealt with without increasing flood risk elsewhere

5.1.2 Local Policy and Guidance

CSP 4 Flood Risk¹² states the extent and impact of flooding will be reduced by:

- Requiring all development proposals on Brownfield Sites to reduce surface water run-off by at least 30% and development on Greenfield sites to maintain or reduce existing run-off rates.
- Requiring development proposals to use SuDS in accordance with policy CSP 3 SuDS.
- Using flood resilient design in areas of high flood risk.

CSP 3 SuDS states:

- Only in exceptional circumstances, where it can be demonstrated that all types of SuDS are impractical, will other drainage management systems be permitted.
- Planning applications must include an assessment to show that SuDS will work and be maintained. Measures should be taken to avoid water contamination and safeguard groundwater supply.
- Developers will be required to contribute to the maintenance of SuDS.

¹¹ Preliminary Rainfall Runoff Management for Developments, R&D Technical Report W5-074/A/TR/1 Revision C, 2005

¹² Barnsley MBC Local Development Framework Core Strategy (adopted September 2010)

5.2 SITE BACKGROUND

The existing site is 0.520 ha of which 0.459 ha is impermeable. The impermeable area is expected to decrease to 0.442 ha post redevelopment.

There is a formal system of surface water drainage comprising pipes and channels which discharge into the 225 mm public combined sewer (Yorkshire Water, YW) adjacent to Low Laithes Cottages via an interceptor (**Appendix C**).

The 225 mm sewer discharges into a combined pumping station (PS) a short distance downstream of the site. There is likely to be an overflow at the PS with a spill into the river to accommodate fluctuations in flow rates during rainfall as well as an emergency overflow in case of pump breakdown.

There is also a 525 mm diameter public surface water sewer located in Wombwell Lane adjacent the site which outfalls to the river a short distance downstream. However, there is no existing connection between the site drainage system and this public surface water sewer.

5.3 EXISTING SURFACE WATER RUNOFF

The Modified Rational Method¹³ has been used to calculate existing site runoff rates.

The SUDS Tool website suggests Soil Type 2 but an investigation of Soilscales suggests soils at the site are slowly permeable and naturally wet (as would be expected from a site adjacent to a watercourse). As such, Soil Type 4 has been used in the analysis.

The calculated flow rates from the impermeable surfaces (using a time of entry of 4 minutes and a time of flow of 2 minutes) are as follows:

- 1 year – 63.9 l/s
- 2 year – 82.3 l/s
- 30 year – 152.6 l/s
- 100 year – 193.9 l/s

No levels are provided on the YW sewer records. However, a gradient of 1/31 would be required on the 225 mm public combined sewer to convey a flow of 82.3 l/s.

The 525 mm diameter public surface water sewer located in Wombwell Lane would have a capacity of 430 l/sec based on a pipe gradient of 1/100.

5.4 POST DEVELOPMENT SURFACE WATER MANAGEMENT OPTIONS

5.4.1 Disposal of Surface Water

Building Regulations Approved Document Part H sets out the following hierarchy of preferred methods for the disposal of surface water runoff¹⁴: disposal by infiltration; disposal to a watercourse; and, disposal to a public sewer.

¹³ The Wallingford Procedure, Volume 4, 1981

¹⁴ Building Regulations Approved Document H Section 3 page 45

As stated in **Section 5.3**, the existing surface water drainage system serving the site connects in to a public combined sewer.

To provide a more sustainable approach, we propose the following:

- That the existing connection to the combined sewer is removed
- A new connection to the 525 mm diameter public surface water sewer is made
- The peak runoff rate is reduced by 50% compared to existing (i.e. 41.1 l/s compared to the current 1 in 2 year flow rate of 82.3 l/s)

The drainage system for the proposed site will be designed to manage flows in up to the 1 in 100 year event including an allowance for climate change.

This solution would provide significant environmental benefit, since it would reduce the number of unsatisfactory intermittent discharges to the River Dove from the combined sewer and pumping station overflows, reduce the loading on the receiving wastewater treatment works and reduce the energy consumption associated with pumping and treatment.

5.4.2 Storage Calculations

In order to restrict runoff rates, attenuation storage will be provided.

The surface water storage facilities described have been modelled using the Detailed Design module of MicroDrainage Source Control. The parameters used in the storage calculation along with the MicroDrainage Source Control output results are presented in **Appendix D**.

The required storage volume has been based on a post development impermeable area of 0.442 ha (i.e. a percentage impermeable percentage, PIMP of 85%), sized to store the 1 in 100 year storm event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with the NPPF¹⁵.

The modelling indicates that a storage volume of 106 m³ would be required.

5.4.3 Summary

The purpose of this FRA is to demonstrate that a surface water drainage strategy is feasible for the site given the development proposals and the land available.

The proposals demonstrate that peak runoff rates will be significantly reduced through the use of attenuation storage.

In addition, it is proposed to alter the existing arrangements so that surface water runoff discharges from the site to the public surface water sewer rather than the public combined sewer as is currently the case, thereby providing significant environmental benefits.

¹⁵ NPPF Technical Guidance, Table 5

6 SUMMARY

There are proposals for the redevelopment of a site located at Aldham Bridge, Wombwell. The proposals include the development of a retail unit (gross external area 743 m²) on the south east corner, together with the demolition of the existing canopy and refurbishment of existing buildings to the rear of the site.

According to the EA flood map the proposed development site is located within the 1 in 100 year and 1 in 1000 year flood outlines and is therefore defined as being situated within Flood Zone 3 and Flood Zone 2 under the NPPF.

The retail unit to the south-east of the site has been sequentially located so that it is predominantly located in Flood Zone 2.

The Sequential Test has been carried out by ID Planning Ltd and has identified that there are no sequentially preferable retail sites within or on the edge of Wombwell District Centre which could accommodate the proposed development. The assessment is separately reported.

The principal source of flood risk to the site is from the River Dove and Dob Sike (i.e. fluvial flood risk).

Measures have been proposed to mitigate flood risk in order to ensure the development remains safe throughout its lifetime.

Access and egress to the developed site will be provided via Barnsley Road (A633).

Approximately 5.3 m³ of compensatory flood storage would need to be provided on-site to offset the loss of storage due to the redevelopment of the site.

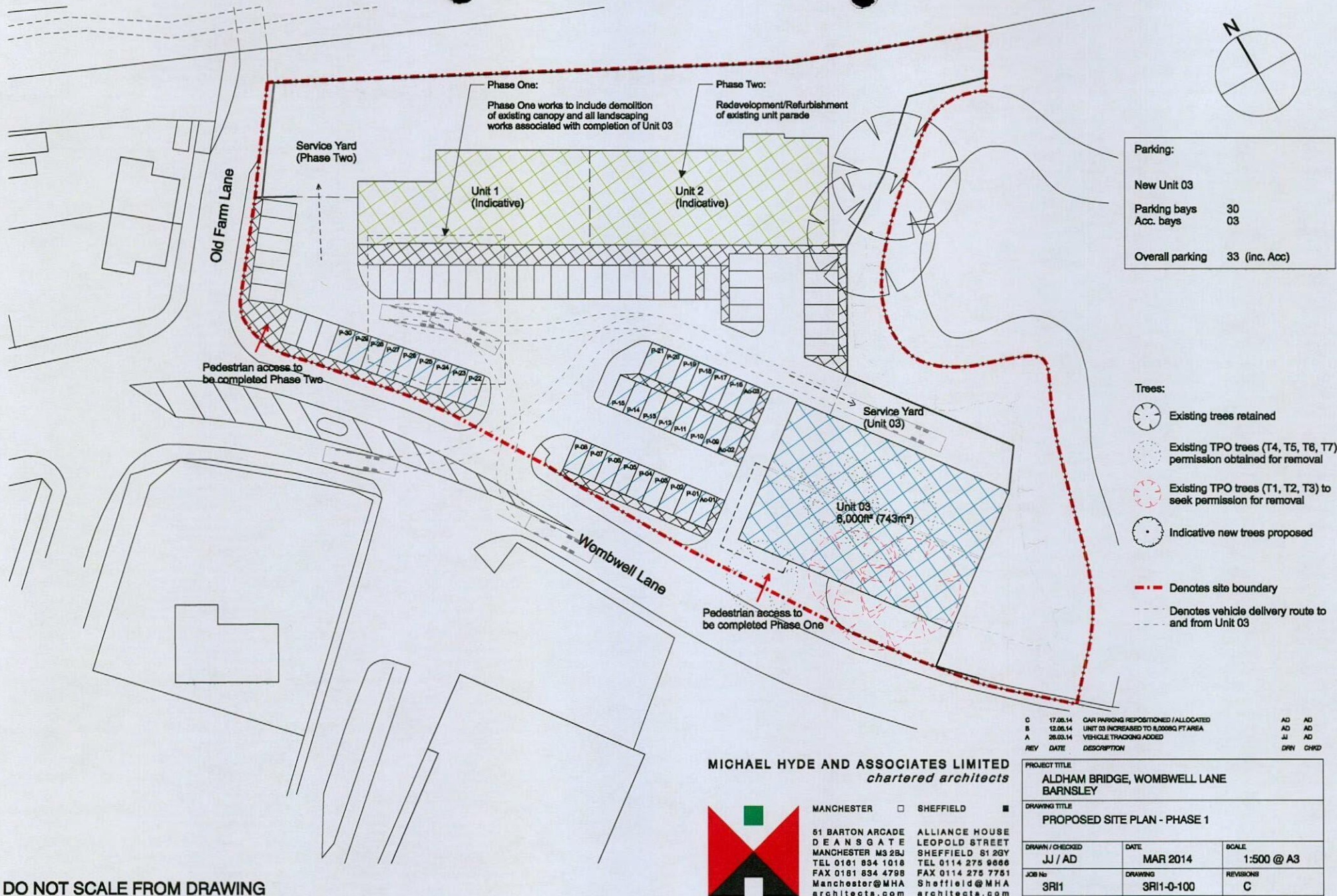
This FRA demonstrates that surface water runoff from the developed site can be sustainably managed in accordance with the NPPF and Technical Guidance, and local policy.

7 RECOMMENDATIONS

This FRA has demonstrated that the proposed development may be completed without conflicting with the requirements of the NPPF and supporting Technical Guidance subject to the following:

- Finished floor levels to be set at a minimum of 37.30 m AOD and not less than 300 mm above adjacent ground level.
- Flood Warning Plan to be developed in consultation with Barnsley MBC.
- Compensatory flood storage to be provided in accordance with the principles set out in this report.
- The detailed drainage design, developed in accordance with the principles set down in this FRA, should be submitted to and approved by the local planning authority prior to the commencement of development

APPENDIX A: Development Proposals



MICHAEL HYDE AND ASSOCIATES LIMITED
chartered architects



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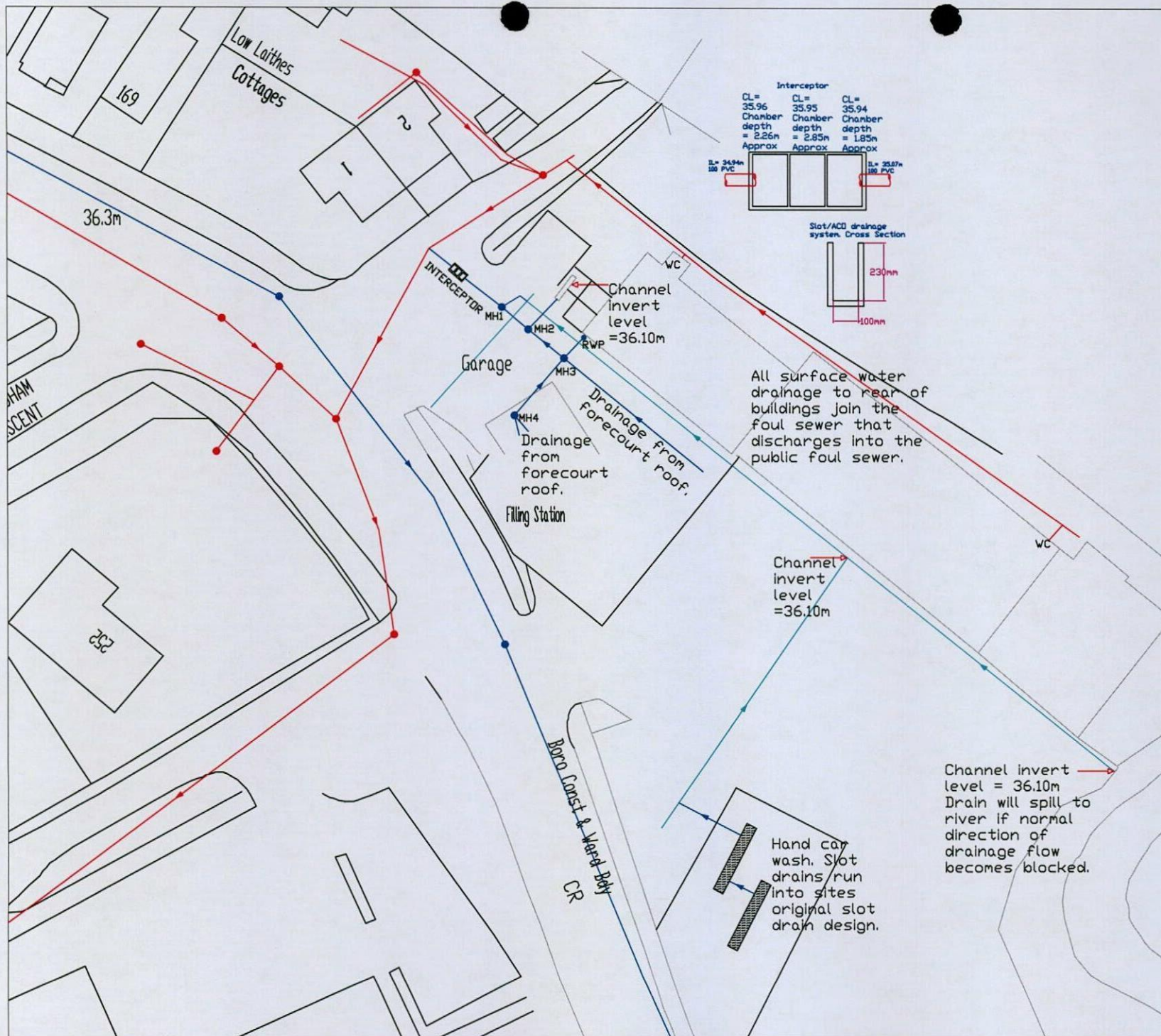
ALLIANCE HOUSE
LEOPOLD STREET
SHEFFIELD S1 2GY
TEL 0114 275 9886
FAX 0114 275 7751
Sheffield@MHA
architects.com

C	17.05.14	CAR PARKING REPOSITIONED / ALLOCATED	AD	AD
B	12.05.14	UNIT 03 INCREASED TO 8,000SQ FT AREA	AD	AD
A	26.03.14	VEHICLE TRACKING ADDED	JJ	AD
REV	DATE	DESCRIPTION	DRAWN	CHECKED

PROJECT TITLE		
ALDHAM BRIDGE, WOMBWELL LANE BARNSELEY		
DRAWING TITLE		
PROPOSED SITE PLAN - PHASE 1		
DRAWN / CHECKED	DATE	SCALE
JJ / AD	MAR 2014	1:500 @ A3
JOB No	DRAWING	REVISIONS
3RI1	3RI1-0-100	C

APPENDIX B: Topographic Survey

APPENDIX C: On Site Drainage Survey



Legend



Warrington Business Park,
Long Lane,
Warrington,
Cheshire
WA2 8TX
Tel: 01925 244376 email: kevin@invek.com
Web Site: www.invek.com

Project - Wombwell

Title - Drainage Survey

Date - 12/12/13

Drawn - P.W.

Scale - N.T.S

Checked - K.N

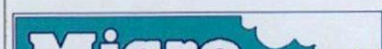
Figure - Layout 01

Approved - K.N

File Ref - J0789/ Wombwell/Report/Layout

APPENDIX D: Storage Volume Calculations

Weetwood			Page 1			
Suite 1 Park House						
Broncoed Bus Park						
Wrexham Rd Mold						
Date 20/01/2014 15:24		Designed by staffguest				
File 2560 Tank 100ycc...		Checked by				
Micro Drainage		Source Control 2013.1.1				
<u>Summary of Results for 100 year Return Period (+30%)</u>						
Storm Event		Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer		0.746	0.746	40.4	78.8	O K
30 min Summer		0.875	0.875	40.4	92.4	O K
60 min Summer		0.894	0.894	40.4	94.4	O K
120 min Summer		0.776	0.776	40.4	81.9	O K
180 min Summer		0.634	0.634	40.4	67.0	O K
240 min Summer		0.515	0.515	40.4	54.4	O K
360 min Summer		0.371	0.371	37.6	39.2	O K
480 min Summer		0.298	0.298	33.6	31.4	O K
600 min Summer		0.255	0.255	29.6	26.9	O K
720 min Summer		0.227	0.227	26.3	23.9	O K
960 min Summer		0.190	0.190	21.5	20.0	O K
1440 min Summer		0.150	0.150	16.0	15.8	O K
2160 min Summer		0.119	0.119	11.6	12.5	O K
2880 min Summer		0.101	0.101	9.3	10.7	O K
4320 min Summer		0.081	0.081	6.7	8.6	O K
5760 min Summer		0.069	0.069	5.3	7.3	O K
7200 min Summer		0.062	0.062	4.4	6.5	O K
8640 min Summer		0.056	0.056	3.8	5.9	O K
10080 min Summer		0.052	0.052	3.4	5.4	O K
15 min Winter		0.851	0.851	40.4	89.8	O K
30 min Winter		1.000	1.000	41.0	105.6	O K
60 min Winter		0.998	0.998	41.0	105.4	O K
120 min Winter		0.802	0.802	40.4	84.7	O K
Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer		128.285	0.0	106.3	17	
30 min Summer		84.226	0.0	139.6	27	
60 min Summer		52.662	0.0	174.5	44	
120 min Summer		31.800	0.0	210.8	78	
180 min Summer		23.353	0.0	232.2	108	
240 min Summer		18.644	0.0	247.2	138	
360 min Summer		13.543	0.0	269.3	196	
480 min Summer		10.792	0.0	286.2	254	
600 min Summer		9.043	0.0	299.7	314	
720 min Summer		7.823	0.0	311.1	372	
960 min Summer		6.219	0.0	329.8	492	
1440 min Summer		4.493	0.0	357.4	736	
2160 min Summer		3.241	0.0	386.7	1100	
2880 min Summer		2.568	0.0	408.6	1468	
4320 min Summer		1.847	0.0	440.9	2184	
5760 min Summer		1.461	0.0	464.8	2936	
7200 min Summer		1.217	0.0	484.1	3648	
8640 min Summer		1.048	0.0	500.2	4400	
10080 min Summer		0.923	0.0	514.1	5120	
15 min Winter		128.285	0.0	119.0	18	
30 min Winter		84.226	0.0	156.3	29	
60 min Winter		52.662	0.0	195.5	48	
120 min Winter		31.800	0.0	236.1	84	
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Weetwood		Page 2
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold		
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Source Control 2013.1.1		

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	0.585	0.585	40.4	61.7	O K
240 min Winter	0.432	0.432	39.5	45.6	O K
360 min Winter	0.291	0.291	33.0	30.8	O K
480 min Winter	0.234	0.234	27.2	24.8	O K
600 min Winter	0.202	0.202	23.1	21.3	O K
720 min Winter	0.179	0.179	20.1	18.9	O K
960 min Winter	0.151	0.151	16.1	15.9	O K
1440 min Winter	0.119	0.119	11.7	12.6	O K
2160 min Winter	0.095	0.095	8.5	10.0	O K
2880 min Winter	0.081	0.081	6.7	8.6	O K
4320 min Winter	0.066	0.066	4.9	6.9	O K
5760 min Winter	0.056	0.056	3.8	5.9	O K
7200 min Winter	0.050	0.050	3.2	5.3	O K
8640 min Winter	0.046	0.046	2.8	4.8	O K
10080 min Winter	0.042	0.042	2.4	4.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	260.1	114
240 min Winter	18.644	0.0	276.9	142
360 min Winter	13.543	0.0	301.7	198
480 min Winter	10.792	0.0	320.5	256
600 min Winter	9.043	0.0	335.7	314
720 min Winter	7.823	0.0	348.5	374
960 min Winter	6.219	0.0	369.4	494
1440 min Winter	4.493	0.0	400.3	736
2160 min Winter	3.241	0.0	433.2	1100
2880 min Winter	2.568	0.0	457.6	1452
4320 min Winter	1.847	0.0	493.8	2196
5760 min Winter	1.461	0.0	520.6	2880
7200 min Winter	1.217	0.0	542.2	3632
8640 min Winter	1.048	0.0	560.2	4288
10080 min Winter	0.923	0.0	575.8	5096

Weetwood		Page 3																																				
Suite 1 Park House Broncoed Bus Park Wrexham Rd Mold																																						
Date 20/01/2014 15:24 File 2560 Tank 100ycc...	Designed by staffguest Checked by																																					
Micro Drainage		Source Control 2013.1.1																																				
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>20.000</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.400</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+30</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.442 <table> <thead> <tr> <th>Time (mins)</th> <th>Area</th> <th>Time (mins)</th> <th>Area</th> </tr> <tr> <th>From:</th> <th>To: (ha)</th> <th>From:</th> <th>To: (ha)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>4 0.295</td> <td>4</td> <td>8 0.147</td> </tr> </tbody> </table>			Rainfall Model	FSR	Winter Storms	Yes	Return Period (years)	100	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	20.000	Shortest Storm (mins)	15	Ratio R	0.400	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+30	Time (mins)	Area	Time (mins)	Area	From:	To: (ha)	From:	To: (ha)	0	4 0.295	4	8 0.147
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Micro Drainage Source Control 2013.1.1		

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m) Area (m²)

0.000 105.6

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md5 SW Only Invert Level (m) 0.000
Design Flow (l/s) 41.2 Diameter (mm) 253

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	9.1	1.200	43.3	3.000	66.7	7.000	101.9
0.200	22.9	1.400	46.1	3.500	72.1	7.500	105.5
0.300	33.7	1.600	48.9	4.000	77.0	8.000	109.0
0.400	38.6	1.800	51.8	4.500	81.7	8.500	112.3
0.500	40.3	2.000	54.5	5.000	86.1	9.000	115.6
0.600	40.3	2.200	57.2	5.500	90.3	9.500	118.7
0.800	39.9	2.400	59.7	6.000	94.4		
1.000	41.0	2.600	62.1	6.500	98.2		