Thomas Consulting

T17379
FLOOD RISK ASSESSMENT

FOR
CLITHEROE ROAD
BARROW LANCASHIRE

OFFICES AT SHREWSBURY, CHORLEY, LANCASTER & WORKINGTON

CONTENTS

1. INTRODUCTION

1.1 Project Scope

1.1.1 Thomas Consulting Ltd has been commissioned to carry out a Flood Risk Assessment for a proposed residential development off Clitheroe Road, Barrow, Lancashire.

1.1.2 It is understood that this Flood Risk Assessment will be submitted to the Planning Authority and Environment Agency (Agency, hereafter) as part of a planning application. Specifically, this assessment intends to:

a) Carry out an assessment of the practical use of sustainable drainage (SUDS) measures using the relevant soil maps, software and other literature;

b) Determine the existing surface water drainage regime across the site using appropriate methods;

c) Develop a post-development management plan/drainage strategy for surface water across the site, which considers the use of SUDS and alternative methods of surface water disposal;

d) Make an assessment of the flood risk to the site during return period events up to the climate change enhanced 1 in 100 year storm event and recommend mitigation measures accordingly;

e) Carry out an appraisal of flood risk from any other sources such as groundwater as required by NPPF;

f) Report findings and recommendations.

1.1.3 This assessment is carried out in accordance with the requirements of the National Planning Policy Framework (NPPF) and associated Technical Guidance, both dated March 2012. Other documents which have been consulted include:

- DEFRA/EA document entitled *Framework and guidance for assessing and managing flood risk for new development Phase 2 (FD2320/TR2)*, 2005;
- Woods-Ballard., et al. 2007. *The SUDS Manual, Report C697*. London: CIRIA.
- DEFRA/Jacobs 2006. *Groundwater flooding records collation, monitoring and risk assessment (ref HA5)*.

2. DATA COLLECTION

2.1 To assist with this report, the data collected included:

- Ordnance Survey 1:10,000 street view map obtained via Promap (Thomas Consulting Ltd OS licence number 100020411).
- British Geological Survey, *Groundwater Flooding Susceptibility Map* obtained via Promap.
- British Geological Survey, *Online Geology of Britain Viewer*.
- 1:250,000 *Soil Map of Midland and Western England* (Sheet 3) published by Cranfield University and Soil Survey of England and Wales 1983.
- 1:625,000 *Hydrogeological Map of England and Wales*, published in 1977 by the Institute of Geological Sciences (now the British Geological Survey).
- Flood Risk Assessment and Drainage Strategy for part of the site carried out by Thomas Consulting dated July 2014 (ref: P5021/3).
- Topographical survey carried out by Chris Partington Land Surveyors (Drawing Number 250714JC-01).

2.2 All third party data used in this study has been checked and verified prior to use in accordance with Thomas Consulting Ltd Quality Assurance procedures.

3. SITE CHARACTERISTICS

3.1 Existing Site Characteristics and Location

3.1.1 The site is located off Clitheroe Road, Barrow, Lancashire. The approximate Ordnance Survey (OS) grid reference for the site is 373599 437757 and the location of the site is shown on Figure 1.

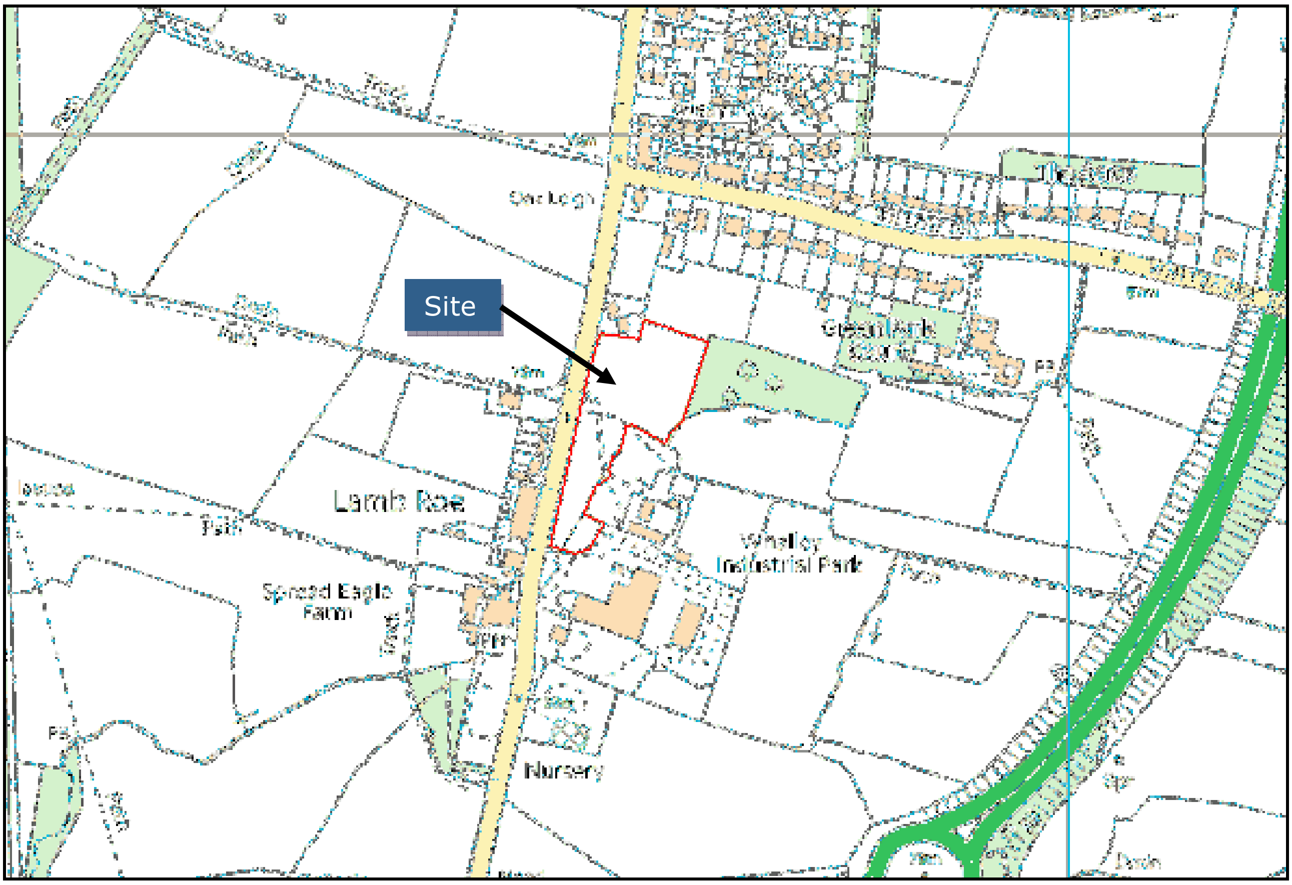

Figure 1: Site location plan (Source: Ordnance Survey, 2014)

3.1.2 The site is irregular in shape and covers a total area of approximately 1.24 ha and is split between Phase 1 0.45 ha and Phase 2 0.79 ha. The site currently comprises open fields located immediately to the east of Clitheroe Road which runs in a north to south direction between the villages of Barrow and Whalley.

3.1.3 The western frontage of the site is bounded by Clitheroe Road from which access onto the site is achieved. The eastern frontage of the site is bounded by farmland, woodland and Whalley Industrial Park. The north frontage of the site is also bounded by farmland and in part residential dwellings. The southern frontage of the site is bounded by Whalley Industrial Park. An access track which serves the site from Clitheroe Road bisects the site and continues towards other areas of Whalley Industrial Park. A watercourse flows in a south westerly direction adjacent to the eastern frontage of the site and through a part of the site to the south.

3.1.4 A topographical survey has been carried out by Chris Partington Land Surveyors and can be seen on Drawing Number 250714JC-01. By consulting the topographical survey it can be seen that ground levels across the site fall in a south westerly direction from 75.62m AOD to 69.81m AOD at an approximate gradient of 1:40.

3.2 Site Proposals

3.2.1 It is the Client's intention to develop the site with 16 residential dwellings (9 on the north site and 7 on the southern approved site) together with gardens, driveways, garages, open space and access roads. The existing access track which bisects the site will be widened in order to continue to serve the development from Clitheroe Road but does not serve the northern plot a new private drive access is proposed directly off Clitheroe Road. Proposed dwellings adjacent to Clitheroe Road will each be accessed directly from Clitheroe Road.

4. BASELINE INFORMATION

4.1 Environment Agency Flood Zone Map

4.1.1 The Environment Agency Flood Map (Figure 2) shows that the site is located within the NPPF Flood Zone 1, 'Low Probability' which comprises land as having less than a 1 in 1000 year annual probability of fluvial or tidal flooding (i.e. an event more severe than the extreme 1 in 1000 year event). NPPF states that all uses of land are appropriate in this zone.

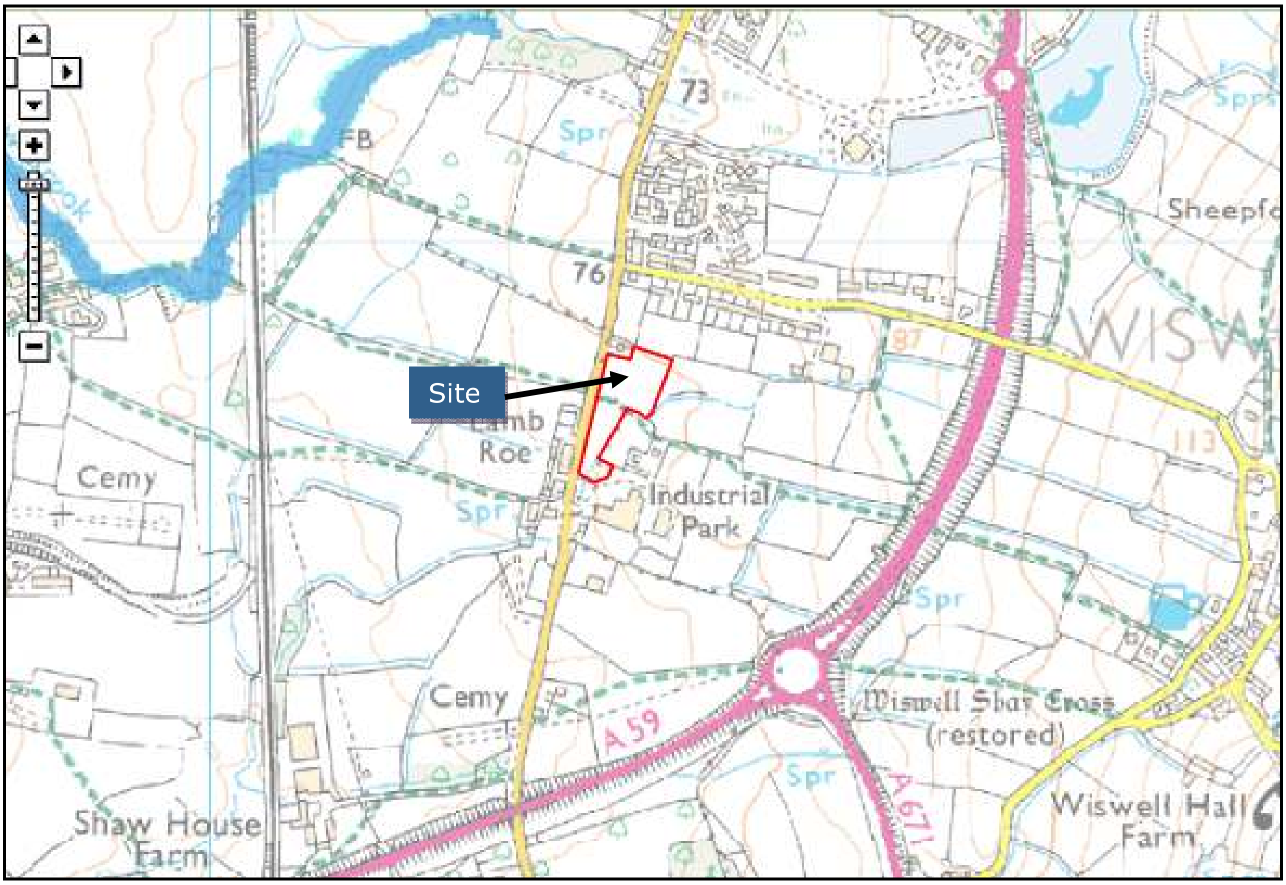

Figure 2: Environment Agency Flood Map (Source: Environment Agency, 2014)

4.2 Catchment Characteristics

4.2.1 The FEH CD-ROM Version 3 (Figure 3) shows the location of the site within the catchment. Catchment descriptors for extracted from the FEH CD-ROM Version 3 (Figure 4) indicate that the area receives a standard average annual rainfall (SAAR) of 1122mm. The attenuating influence of small ponds and lakes on flows is not significant and results in a FARL value of 1. The catchment has a steep gradient (DPSBAR = 42m/km) and is of high elevation (ALTBAR = 80).

4.2.2 It can be seen on Figure 3 that the watercourse which runs adjacent to the eastern frontage of the site and partially through the southern part of the site is not shown on the FEH CD-ROM as the watercourse at this location has an upstream catchment area less than 0.5 sq km.

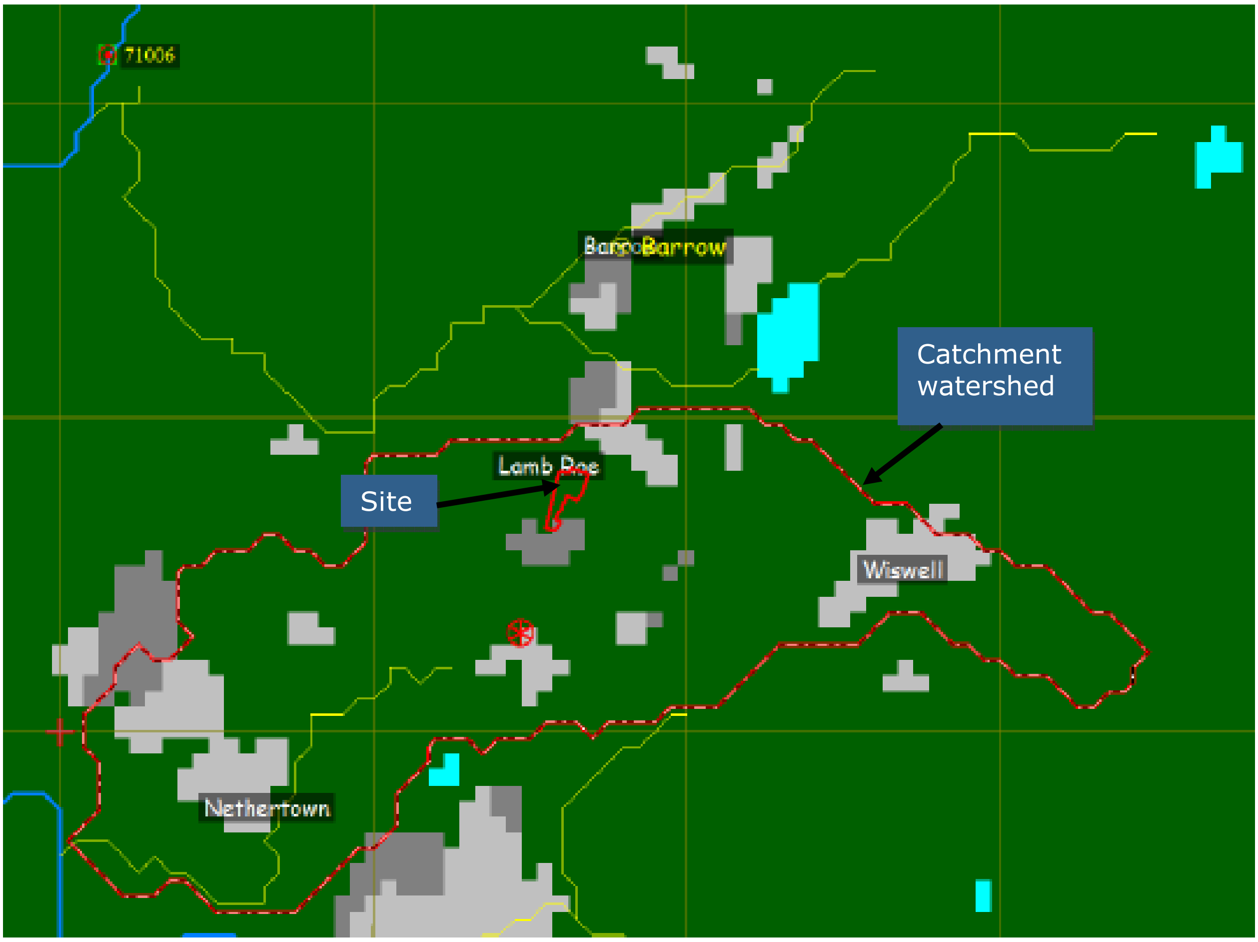

Figure 3: Location of site in relation to catchment watershed (Source: FEH CD-ROM Version 3)

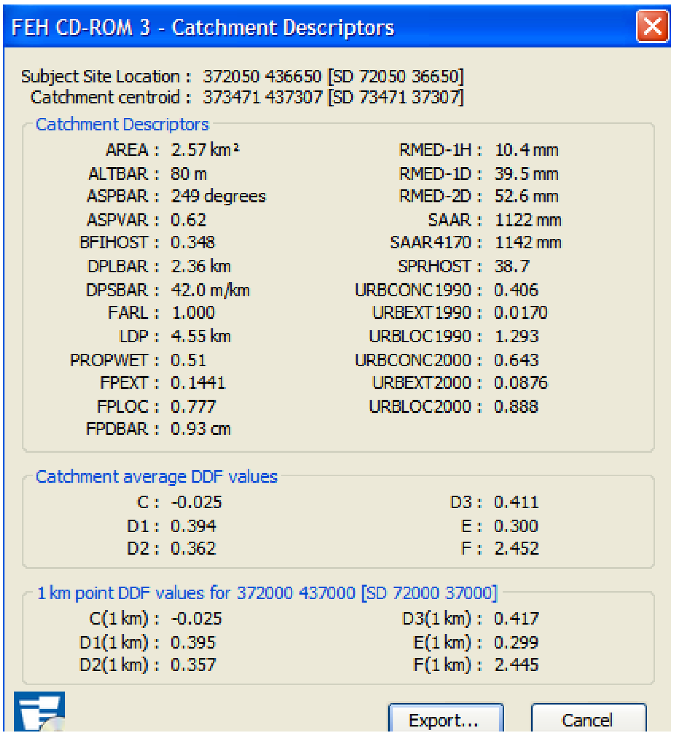

Figure 4: Catchment descriptors (Source: FEH CD-ROM Version 3)

4.3 Fluvial Flood Risk

4.3.1 The previous flood risk assessment, carried out by Thomas Consulting in July 2014 (ref: P5021/3) for the area of the site to the south of the existing access track, investigated the flood risk from the watercourse in more detail.

4.3.2 The flood risk assessment (excerpts in Appendix A) identified that the watercourse flows through twin 0.4m diameter culverts beneath the access track and that during the climate change 1 in 100 year event the watercourse and culverts have sufficient capacity to convey the catchment flows without presenting a flood risk to the site.

5. OTHER SOURCES OF FLOODING

5.1 Groundwater Flooding

5.1.1 In order to assess the potential for groundwater flooding during higher return period rainfall events, the Jacobs/DEFRA report entitled *Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study*, published in May 2004, was consulted, together with the guidance offered within the document entitled *Groundwater flooding records collation, monitoring and risk assessment (ref HA5)*, commissioned by DEFRA and carried out by Jacobs in 2006.

5.1.2 According to Cobby et al (2009), groundwater flooding can be defined as flooding caused by the emergence of water originating from subsurface permeable strata. The greatest risks of groundwater flooding are considered to be from either:

- a rise of groundwater in unconfined permeable strata, such as Chalk, after prolonged periods of extreme rainfall;
- a rise of groundwater in unconsolidated, permeable superficial deposits, which are in hydraulic continuity with local river water levels and where the hydraulic gradient of the water table is low.

5.1.3 As described above, it is widely accepted that groundwater flooding generally occurs from both permeable strata (e.g. Chalk) and superficial deposits (e.g. sands and gravels). In particular, unconfined water-bearing deposits (i.e. those with permeable soils above them) are susceptible to a rise in groundwater during prolonged, extreme rainfall and during periods of high recharge throughout autumn and winter. Antecedent conditions, such as, above average groundwater levels prior to the rainfall event, are also a contributing factor to a variation in the water table.

5.1.4 Permeable superficial deposits can also hold quantities of groundwater, although these tend to be insignificant compared to the stored quantities within consolidated aquifers. Unconsolidated deposits such as sand and gravels are sufficiently permeable to store water; however such deposits which yield a low quantity of water are commonly termed a non-aquifer.

5.1.5 Deposits comprising a mixture of permeable and impermeable soils can lead to a presence of perched water. Perched water tables are located above less permeable deposits such as clay and are located within water-bearing soils such as sand and gravel. If perched water is unconfined then the potential for recharge and groundwater flooding can be high. If the perched water is confined by less permeable clay deposits, then the clay deposits will have a buffering effect on percolating surface water and thus the recharge potential and rise in the water table is low.

Soil and Geology at the Site

5.1.6 It can be seen from the various soil and hydrogeological data, listed in Section 2, that the soil types across the site comprise clayey Till deposits overlying Limestone.

5.1.7 Table 6 and equation 12 of the ADAS document entitled *Pipe Size Design for Field Drainage*, 1980, indicates that the soils have a low Winter Rain Acceptance Potential (WRAP) and high Winter Runoff Potential.

Groundwater Flooding Potential at the Site

5.1.8 There have been no recorded groundwater flood events across the area between 2000 and 2003, as indicated by the Jacobs study. The BGS *Groundwater Flooding Susceptibility Map* (Figure 5) indicates that there is "Potential for Groundwater Flooding of Property Situated Below Ground Level" across most of the site, however, part of the eastern frontage of the site is shown to have "Potential for Groundwater Flooding to Occur at Surface".

5.1.9 The Ribble Valley Borough Council Strategic Flood Risk Assessment (SFRA, hereafter) carried out in 2010, suggests that there is no indication that groundwater flooding forms a significant risk within the borough.

5.1.10 It is unlikely that during periods of prolonged or heavy rainfall the water table will have the capacity to rise and breach the ground surface, particularly as the soils across the site generally have an overall low permeability which will reduce the recharge potential of the water table below the site. It is considered that the evidence suggests an overall low risk of groundwater flooding to the site.

Figure 5: BGS Groundwater Flooding Susceptibility (Source: Promap, 2014)

5.2 Surface Water Flooding and Sewer Flooding

5.2.1 Surface water and sewer flooding across urban areas is often a result of high intensity storm events which exceed the capacity of the sewer thus causing it to surcharge and flood. Poorly maintained sewer networks and blockages can also exacerbate the potential for sewer flooding. Surface water flooding can also occur as a result of overland flow across poorly drained rural areas.

5.2.2 The Agency's Surface Water Flooding Map (Figure 6) indicates that there is generally a very low surface water flooding risk across the site. However, Figure 6 shows that a high area of surface water flood risk follows the watercourse at this location. This is expected considering the watercourse forms a low point in the catchment for overland flows to congregate and therefore does not reflect a surface water flood risk across the site.

5.2.3 Figure 6 also shows that the site is located sufficiently higher and outside of the parts of Clitheroe Road shown to be at risk to the south of the site.

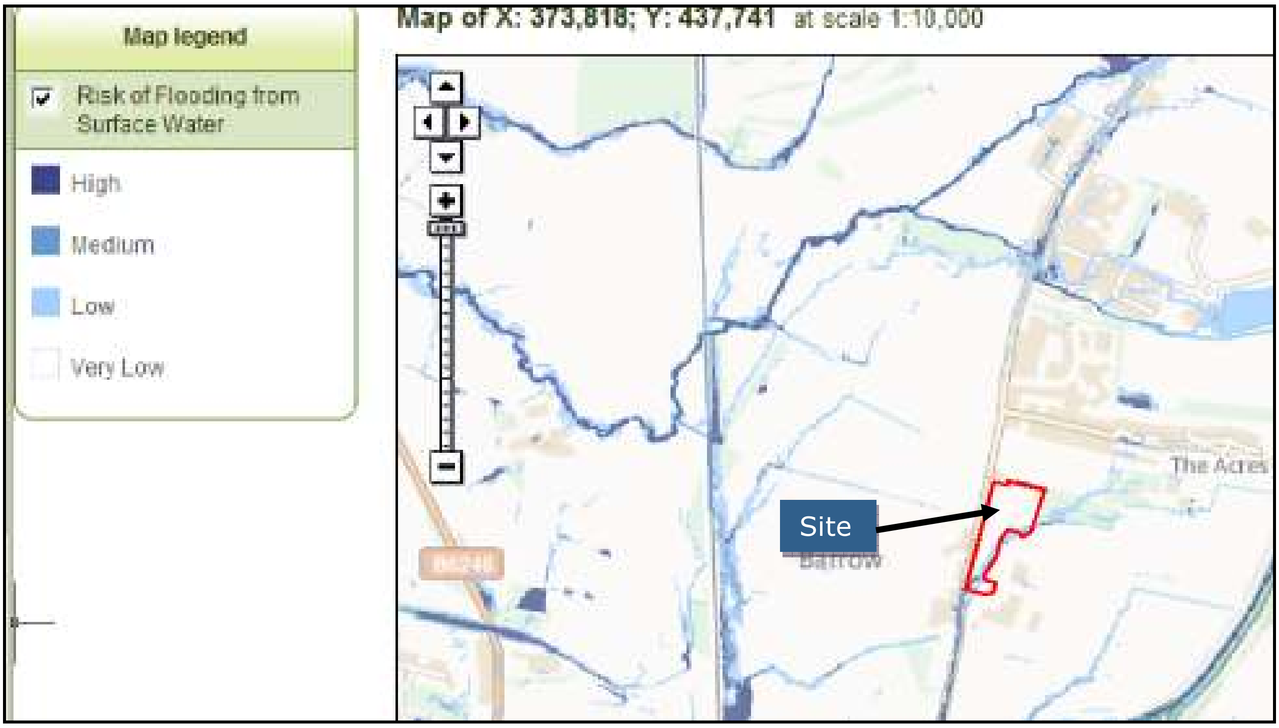

Figure 6: Surface Water Flooding Map (Source: Environment Agency, 2014)

5.3 Reservoirs, Canals And Other Artificial Sources

5.3.1 The failure of man-made infrastructure such as flood defences and other structures can result in unexpected flooding. Flooding from artificial sources such as reservoirs, canals and lakes can also occur suddenly and without warning, leading to high depths and velocities of flood water which pose a safety risk to people and property.

5.3.2 The Environment Agency's "Risk of flooding from reservoirs" map suggests that the site is not at risk from such features.

6. SURFACE WATER DRAINAGE AND SUDS

6.1 Introduction

6.1.1 Planning policy recommends the maximum practical use of Sustainable Drainage Systems (SUDS) within proposals for new sites. There is a requirement that sustainable drainage systems (SUDS) be installed where appropriate, in order to limit the amount of surface water runoff entering drainage systems and to return surface water into the ground to follow its natural drainage path.

6.1.2 The National Planning Policy Framework (NPPF) and the Agency require that the effects of climate change to be considered in any assessment of flood risk for developments. When considering the impacts of climate change on rainfall intensity, NPPF advises that when designing surface water drainage systems for developments, an allowance of 30% for climate change should be included and when designing surface water drainage systems.

6.2 Existing Surface Water Drainage

6.2.1 It has been determined that surface water runoff from the existing site occurs mainly in a south westerly direction. A proportion of the surface water landing across the site will be infiltrating into the soils of the site and this proportion is denoted by an SPRHOST catchment descriptor value of 38.7 as shown on Figure 4 (i.e. 38.7% of the surface water landing on the site typically runs off leaving 61.3% to infiltrate).

6.2.2 In order to quantify the existing runoff rate from the site, the methodology outlined within the Institute of Hydrology Report Number 124 (IoH 124) entitled *Flood Estimation for Small Catchments*, has been adopted. This document together with the guidance stipulated in the *Interim Code of Practice for Sustainable Drainage Systems*, compiled by the National SUDS Working Group in July 2004, suggests that an estimation of peak runoff rates from areas below 50 ha, and up to 200 ha, can be derived from the calculated mean annual flood flow, QBAR.

6.2.3 The ICPSUDS function within the Microdrainage software Version 2014.1.1 can be used which implements IoH 124 method with a pro-rata below 50 ha. The SAAR value of 1122mm has been determined from the catchment descriptors taken from the FEH CD-ROM Version 3. The soil value has been determined using the information from the Winter Rain Acceptance Potential (WRAP) map within the Flood Studies Report, 1975, together with Table 6 and equation 12 of the ADAS document entitled Pipe Size Design for Field Drainage, 1980. The resultant soil value of 0.40 was also checked for consistency with the digital geographical data within the Microdrainage software. The results can be seen on Figure 7.

Evans Rivers & Costal Limited		Page 1
101 Knowsley Road Norwich NR3 4PT	Existing runoff	Micro Drainage
Date 09/10/2014 14:30 File	Designed by Rupert Evans Checked by	
Micro Drainage	Source Control 2014.1.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.400
Area (ha)	1.240	Urban	0.000
SAAR (mm)	1122	Region Number	Region 10

Results	**l/s**
QBAR Rural	7.3
QBAR Urban	7.3
Q2 years	6.8
Q1 year	6.4
Q30 years	12.4
Q100 years	15.2

Figure 7: Greenfield runoff rates for the existing site (Source: Microdrainage Version 2014.1.1)

6.3 Soil Types and SUDS Suitability

6.3.1 By consulting the information outlined in Section 5.1 the soils at the site comprise clayey Till deposits overlying Limestone.

6.3.2 The soil types and infiltration rates across the site are not considered sufficient for the practical use of infiltration devices such as soakaways or pervious surfaces. BRE Digest 365 requires that the time taken for infiltration devices to empty to 50% should be greater than 24 hours. This requirement is unlikely to be achieved.

6.3.3 Pervious surfaces could be used to cleanse and store surface water from proposed (private) hardstanding areas such as driveways. Surface water from building roofs could then be drained onto, or into, these surfaces directly. This approach is described further in CIRIA 582 entitled *Source control using constructed pervious surfaces.*

6.3.4 The access roads across the site would be constructed using conventional building materials and the on-site pipe system would be located beneath these surfaces. The surface water from the access road and pervious surfaces could be directed via the on-site pipe system and be stored within below ground oversized pipes or attenuation tanks prior to discharge into the watercourse at Greenfield rates.

6.3.5 The Environment Agency's website indicates that the site is not located within a Source Protection Zone associated with a groundwater abstraction point. Nevertheless, it is imperative that the pollution risk from any surface water soaking into the ground from hardstanding areas (which can carry pollutants such as oils and soap suds etc), is mitigated to prevent soil and water contamination.

6.4 Pervious Surfaces

6.4.1 The proposed hardstanding areas comprising driveways and any other private hardstanding areas could be constructed using pervious surfaces such as permeable block paving or similar which will be used for attenuation rather than infiltration. Surface water from the proposed building roofs could then be drained onto, or into, these surfaces directly. This approach is described further in CIRIA 582 entitled *Source control using constructed pervious surfaces.*

6.4.2 Pervious surfaces act as an effective way to store surface water and have also been shown to act as a filter and retainer for pollutants, in particular oil. This has been investigated and documented within the Quarterly Journal of Engineering Geology and Hydrogeology, Volume 37, November 2004, in which this approach can also be implemented when considering the protection of groundwater. CIRIA have reported that approximately 70-90 percent of hydrocarbons can be removed by this technique.

6.4.3 The Interpave document entitled *Understanding permeable paving: Guidance for designers, planners and local authorities* dated 2010, suggests that permeable paving can permit a flow rate of up to 4000mm/hr. The system shown on Figure 8 allows for the complete capture of water using an impermeable, flexible membrane placed on top of the subgrade level and up the sides of the permeable sub-base.

6.4.4 The maximum gradient of the pavement should not be greater than 1 in 20 unless check dams or terracing is incorporated. A hydraulically bound coarse aggregate base will be required to withstand heavy vehicles. Figure 9 shows the typical dimensions of the permeable paving for this load category.

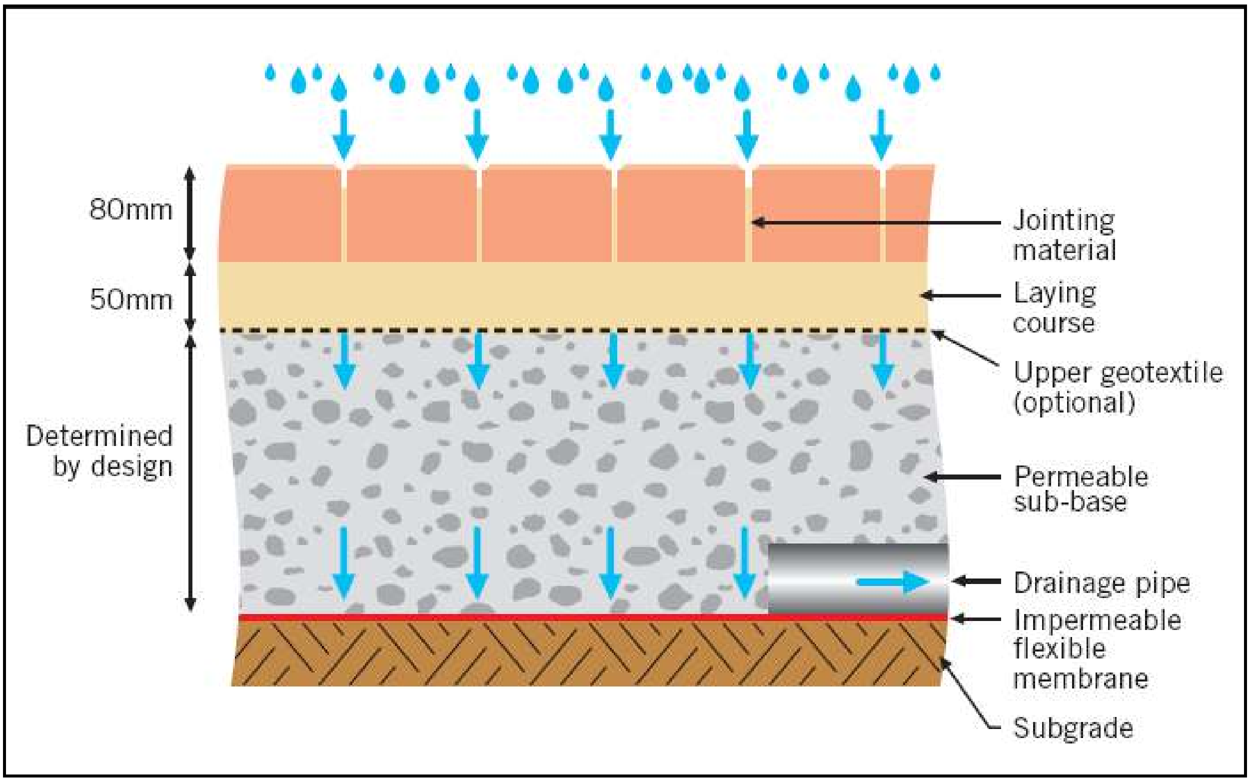

Figure 8: Section through a permeable surface (Source: Interpave *Permeable pavements – guide to the design construction and maintenance of concrete block permeable pavements* dated 2010)

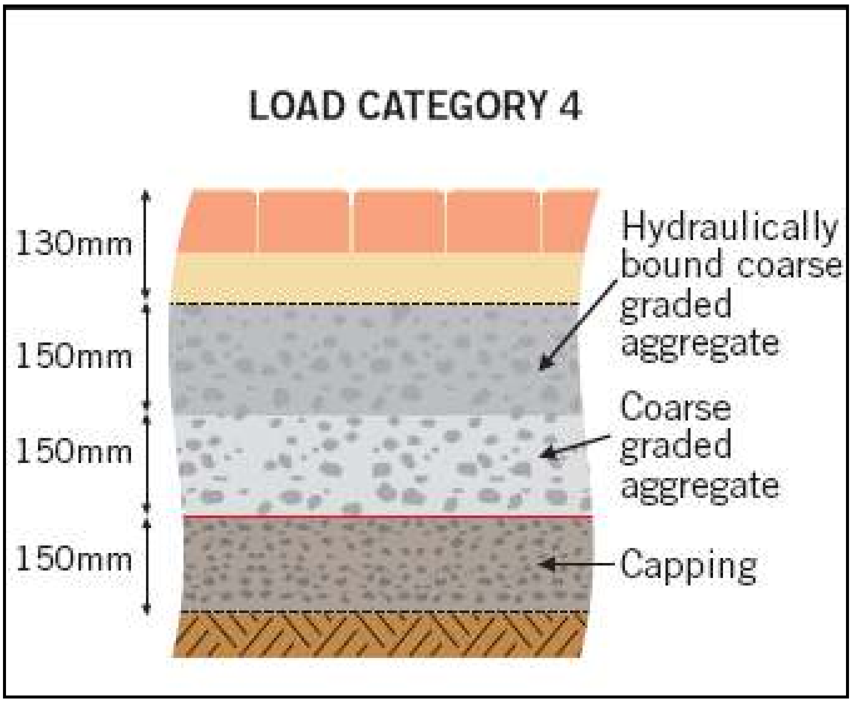

Figure 9: Section through a permeable surface for expected load category (Source: Interpave *Permeable pavements – guide to the design construction and maintenance of concrete block permeable pavements* dated 2010)

6.4.5 The system will be utilising full attenuation and therefore surface water will be temporarily stored within the permeable surface and a 100mm diameter outflow pipe will discharge surface water into the main surface water sewers beneath the proposed access roads.

6.4.6 To provide an example of the performance of the pervious surface, using the design criteria outlined within CIRIA 697 *The SUDS Manual* and CIRIA 582 *Source control using pervious surfaces*, a proposed driveway (i.e. 107 sq m) has been modelled as a pervious surface within the Microdrainage – *Source Control* function, and the dwelling/garage roof area (which will drain onto or into this surface) also entered into the software (i.e. 133 sq m for northern plot 1).

6.4.7 In accordance with section 12.3.1 of CIRIA 697, a safety factor of 10 has been applied to the membrane percolation in the software to represent the gradual silting up effects of the concrete block paving joints over its design life. The model was run to consider the extreme 1 in 100 year plus 30% climate change rainfall event and the DDF rainfall characteristics from the FEH CD-ROM Version 3 have also been entered into the software.

6.4.8 The results can be seen in Appendix B. The software has calculated the worst storm event to be the 15 minute winter storm and all of the surface water has been accommodated by the pervious surface during the extreme event and when considering silting up effects of the system.

6.5 Attenuation

6.5.1 By consulting the proposed site layout and topographical survey, it is recommended that surface water from all hardstanding areas of the site (including the access roads, roofs and driveways) would enter the pipe network located beneath the access roads and drain in a southerly direction towards underground oversized pipes/attenuation tanks located within the vicinity of the watercourse and across the southern parts of the site.

6.5.2 The SUDS measures and calculations outlined in this FRA consider the possibility of exceedence as outlined in CIRIA 635. CIRIA C635 entitled *Designing for exceedance in urban drainage – good practice,* suggests that the extreme event is the rainfall event which results in exceedance flow. Although the guidance does not specify a return period event, the extreme event is usually considered as the climate change 1 in 100 year storm event as most drainage systems are not designed or sized for this return period.

6.5.3 It is widely accepted that for a range of annual flow rate probabilities, up to and including the 1 in 100 year event, the developed rate of runoff from a site should be no greater than the existing rate of runoff for the same event. In order to prevent an increase in flow rate within the watercourse, it is proposed that the discharge from the attenuation feature will be limited to the Greenfield equivalent.

6.5.4 By consulting the proposed layout, the total contributing hardstanding area has been calculated to be 0.4612 ha. The equivalent Greenfield runoff rate has been calculated using the same methodology outlined in Section 6.2 and the results are shown on Figure 10.

Evans Rivers & Costal Limited		Page 1
101 Knowsley Road Norwich NR3 4PT	Post-development greenfield equivalent	
Date 09/10/2014 15:23 File pervious.srcx	Designed by Rupert Evans Checked by	
Micro Drainage	Source Control 2014.1.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	SAAR (mm)	1122	Urban	0.000
Area (ha)	0.461	Soil	0.400	Region Number	Region 10

Results	**l/s**
QBAR Rural	2.7
QBAR Urban	2.7
Q2 years	2.5
Q1 year	2.4
Q30 years	4.6
Q100 years	5.7

Figure 10: Greenfield runoff rates for the hardstanding area of the proposed site (Source: Microdrainage Version 2014.1.1)

6.5.5 CIRIA 697 and the *Interim Code of Practice for Sustainable Drainage Systems* suggest that it is important to match runoff volumes as well as runoff rates from a development with its Greenfield equivalent. Without employing a wide range of infiltration systems, there will be an increased runoff volume from the site which could increase the volume of floodwater within a receiving watercourse. Therefore, as recommended by Box 3.1 of CIRIA 697 and page 49 of the *Interim Code of Practice for Sustainable Drainage Systems*, it is preferable to limit the discharge from the attenuation feature during all return period events up to the 1 in 100 year event to the QBAR value or 2 l/s/ha, whichever is the greater.

6.5.6 By reviewing the Greenfield runoff results for the proposed site as shown on Figure 10, the corresponding Greenfield runoff rate for QBAR is 2.7 l/s. However, it may be difficult to attenuate to such a low discharge rate of 2.7 l/s as the DEFRA/EA technical document entitled *Preliminary rainfall runoff management for developments*, Revision E, dated 2013 states that generally a minimum of 5 l/s from a vortex flow control (e.g. hydrobrake) is a satisfactory compromise between attenuating to a low flow rate while keeping the risk of blockage to an acceptable level. The minimum size of orifice for controlling flow from an attenuation device should normally be 150mm as this also reduces sedimentation.

6.5.7 In order to quantify the approximate volume of surface water needed to be stored within an attenuation feature up to the climate change enhanced 1 in 100 year storm event, the *Source Control – Quick Storage Estimate* function within the Microdrainage software, Version 2014.1.1, has been used together with the DDF rainfall characteristics from the FEH CD-ROM Version 3. The results can be seen on Figure 11.

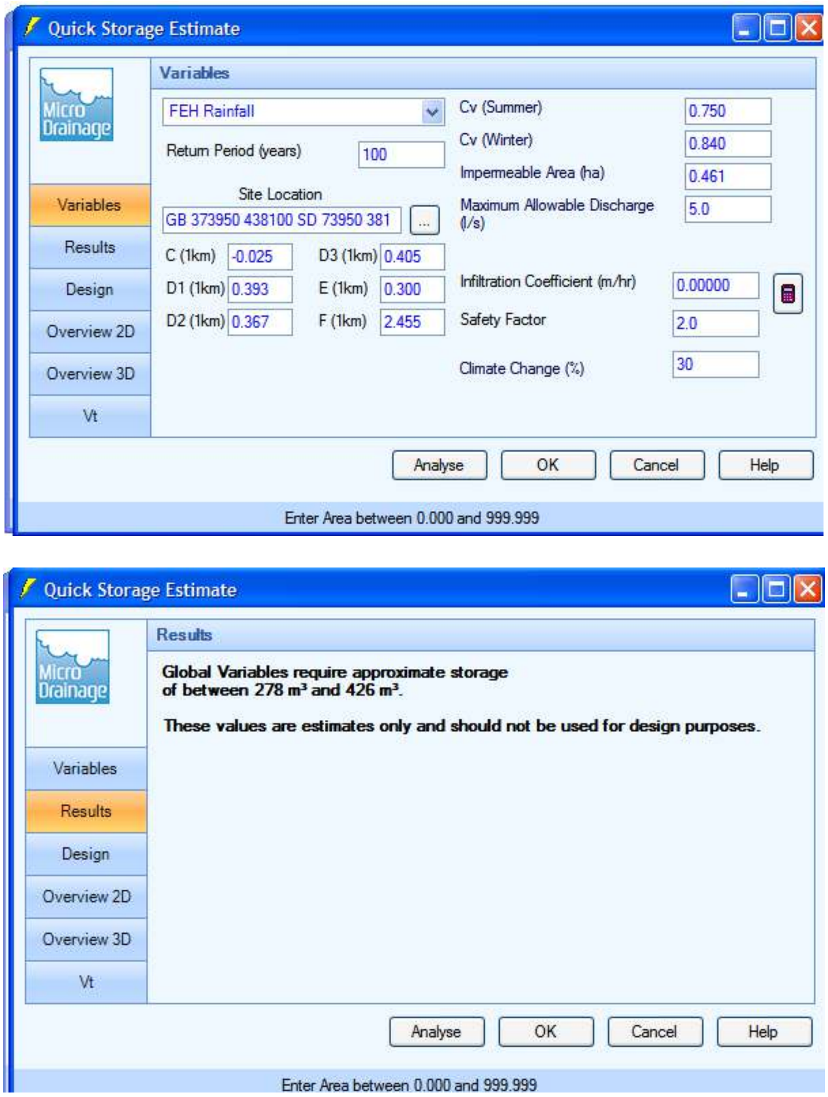

Figure 11: Storage volume during 100 year plus climate change event

6.5.8 It is considered that flood routing can be investigated further at the detailed design stage and that the above measures provide sufficient reassurance that there is scope when designing for exceedence at this site. This element could be conditioned as part of any planning approval.

6.6 Pollution Prevention

6.6.1 Permeable paving will sufficiently cleanse surface water from driveways and car parking areas. Roof water draining to the permeable paving is also considered to be of a suitable quality and will not be required to be subjected to additional pollution prevention measures.

6.6.2 Surface water entering the attenuation device from the access road area will need to undergo pre-treatment in order to suitably clean the surface water which could contain heavy metals and other pollutants from the road surface. A catchpit could be provided before the attenuation device in order to allow the settlement of suspended solids and other pollutants. Figure 12 shows a standard detail of a catchpit which could be used at the site.

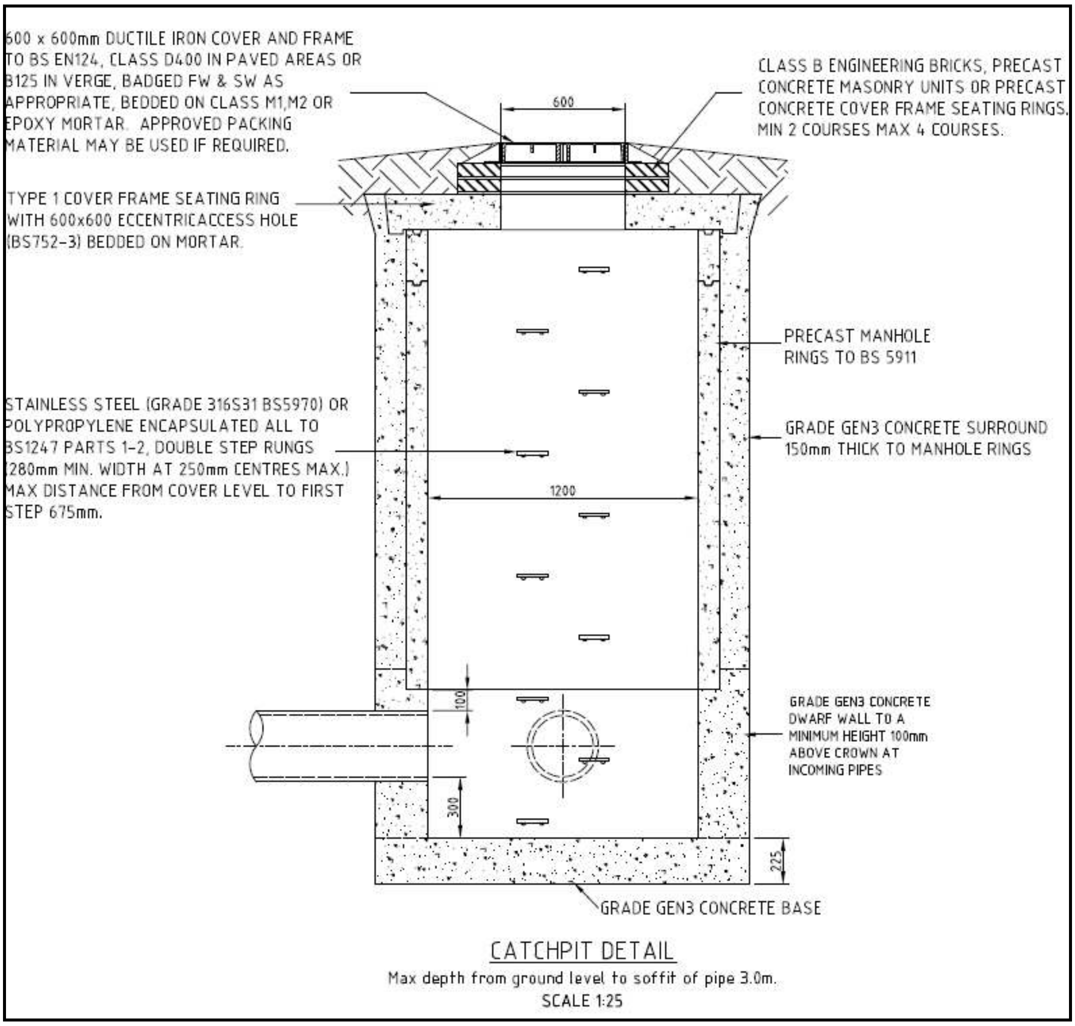

Figure 12: Catchpit Detail

6.7 Adoption

6.7.1 CIRIA 687 entitled *Planning for SUDS – Making it Happen*, published in 2010, states that the Flood and Water Management Act 2010 aims to encourage Local Authorities to be responsible for the approval and eventual adoption of SUDS. Therefore, the attenuation device could be adopted by the Local Authority as part of the Community Infrastructure Levy (Planning Act 2008).

6.7.2 Furthermore, the on-site pipe system could be adopted by United Utilities as most of the surface water entering the pipe system will be from a domestic source, and it may therefore be preferable that any attenuation features are offered to the sewerage undertaker. The permeable paving will be privately adopted and maintained.

7. CONCLUSIONS

- A review of the relevant guidance documents and various types of data collected at the site has enabled a full assessment of the flood risks to be quantified.
- The site is located within the Flood Zone 1 therefore all uses of land are appropriate in this zone.
- This assessment has investigated the possibility of groundwater flooding and flooding from other sources at the site. It is considered that there will be low risk of groundwater flooding across the site and low risk of flooding from other sources.
- An assessment of the practical use of sustainable drainage techniques has been carried out. As soil types will not support the effective use of infiltration devices, it is proposed that surface water is attenuated through the use of permeable paving and oversized pipes/attenuation tank prior to discharge into the watercourse.

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APPENDIX A – EXCERPTS FROM FLOOD RISK ASSESSMENT REF: P5021/3

4.8. Catchment study.

Existing Greenfield flow rates for the open watercourse can be estimated for a range of likely return periods using IH 124[9]

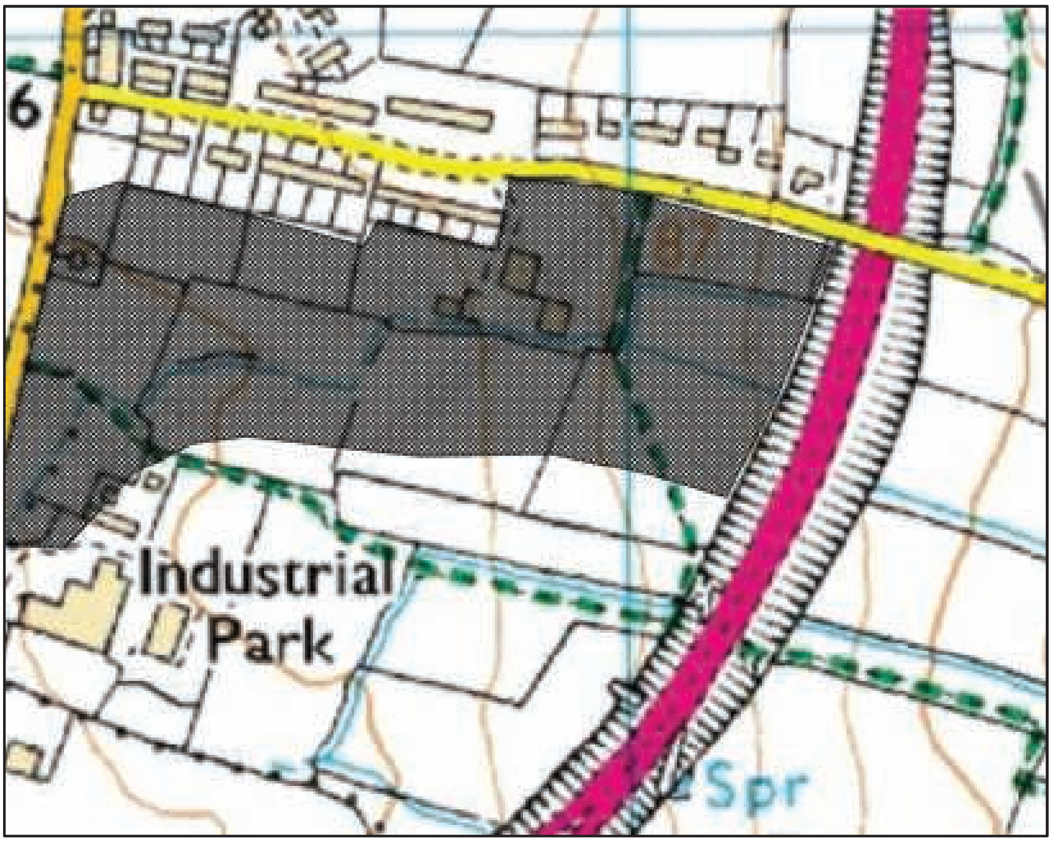


Figure 9 Estimated Catchment Area

The total catchment area for the watercourse is estimated to be 97,850Sq.m (9.8Ha)

Greenfield runoff rates are detailed overleaf.

The maximum runoff rate (1 in 100 years) is estimated to be 174.7L/Sec. (0.17Cumecs).

On the basis of an open channel width as detailed on the site topographical survey (0.6m x 1.0m) this flow rate would not be considered to present any unacceptable flood risk issues.

It is noted that the watercourse is currently crossed by the existing access track to the adjacent farm buildings. The topographical survey identifies the crossing to comprise of twin 400mm diameter pipes.

The estimated capacity of each pipe (unsurcharged) is 237L/Sec. providing a total capacity of 474L/Sec. This is considered adequate for the current watercourse flows.

Where the open watercourse exits the site, it is presumed that this enters into a culvert. The dimensions of the culvert should be investigated to ensure that there is sufficient capacity to cater for the above flow rates.

[9] Flood Estimation for Small Catchments – Institute of hydrology 1994.

HR Wallingford
Working with water

Greenfield runoff estimation for sites

Site name:	Clitheroe Road
Site location:	Barrow

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site coordinates

Latitude:	53.83559° N
Longitude:	2.402° W
Reference:	gcw6326zj36g / 9.8
Date:	29 May 2014

Site characteristics

Total site area	9.8	ha
Significant public open space	0	ha
Area positively drained	9.8	ha

Methodology

Greenfield runoff method	IH124

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	4
HOST class	N/A
SPR	0.47

Hydrological characteristics

	Default	Edited	
SAAR	1143	1143	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.3	0.3	
FEH/FSR conversion factor	0.86	0.86	
Hydrological region	10	10	
Growth curve factor: 1 year	0.87	0.87	
Growth curve factor: 10 year	1.38	1.38	
Growth curve factor: 30 year	1.7	1.7	
Growth curve factor: 100 year	2.08	2.08	

Greenfield runoff rates

	Default	Edited	
Qbar	83.97	83.97	l/s
1 in 1 year	73.05	73.05	l/s
1 in 30 years	142.75	142.75	l/s
1 in 100 years	174.66	174.66	l/s

Please note that a minimum flow of 5 l/s applies to any site

Figure 10 Catchment flow rate analysis - HR Wallingford.

4.9. Climate Change.

Typical projected increases in peak storm intensity and peak river flows likely as a result of climate change are detailed below[10]:

Parameter	1990 To 2025	2025 To 2055	2055 To 2085	2085 To 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Figure 11 Typical Climate Change Scenarios – based upon Table 5 (TGNPPF)

The site is not currently identified as being at risk of flooding. Climate change is unlikely to increase the risk of flooding from any of the above sources in this particular instance.

The capacity of any culvert leaving the site should however be checked to ensure that climate change effects (20% increase in flows) will not represent an increased flood risk.

In respect of the existing twin pipes on site, climate change would not represent an increased flood risk.

In accordance with current best practice, an appropriate allowance for climate change effects should be made within the site surface water drainage designs.

5.0 Flood Risk from the Site.

The proposed development of the site will result in an increase in impermeable area and a subsequent increase in peak surface water runoff rates and volume from the site.

As a result of the current development proposals, surface water flood risk would increase without recourse to some form of effective mitigation.

The hierarchy of preferred drainage options specified within the SUDS manual[11] and Part H of the Building Regulations recommends that surface water runoff from sites should be disposed of to the following in order of preference:-

a) An adequate soakaway or other infiltration system
b) A watercourse
c) A sewer.

An examination of the available BGS data would indicate that the site is unlikely to prove suitable for the installation of infiltration type drainage solutions.

It is therefore likely that surface water flows from site will be directed to the existing open watercourse on site.

[10] Table 5 – Technical Guidance to the National Planning Policy Framework
[11] CIRIA C697 – The SUDS Manual

APPENDIX B – PERVIOUS SURFACES

	Pervious surfaces	
Date 09/10/2014 15:48 File pervious.srcx	Designed by Rupert Evans Checked by	
Micro Drainage	Source Control 2014.1.1	

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

Half Drain Time : 5 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	0.231	0.231	0.0	8.9	8.9	3.2	O K
30 min Summer	0.217	0.217	0.0	8.5	8.5	2.8	O K
60 min Summer	0.183	0.183	0.0	7.6	7.6	2.0	O K
120 min Summer	0.145	0.145	0.0	6.0	6.0	1.3	O K
180 min Summer	0.127	0.127	0.0	4.9	4.9	1.0	O K
240 min Summer	0.116	0.116	0.0	4.2	4.2	0.8	O K
360 min Summer	0.106	0.106	0.0	3.2	3.2	0.7	O K
480 min Summer	0.093	0.093	0.0	2.5	2.5	0.5	O K
600 min Summer	0.079	0.079	0.0	2.2	2.2	0.4	O K
720 min Summer	0.071	0.071	0.0	1.9	1.9	0.3	O K
960 min Summer	0.060	0.060	0.0	1.6	1.6	0.2	O K
1440 min Summer	0.050	0.050	0.0	1.2	1.2	0.2	O K
2160 min Summer	0.044	0.044	0.0	0.9	0.9	0.1	O K
2880 min Summer	0.039	0.039	0.0	0.7	0.7	0.1	O K
4320 min Summer	0.033	0.033	0.0	0.5	0.5	0.1	O K
5760 min Summer	0.030	0.030	0.0	0.4	0.4	0.1	O K
7200 min Summer	0.028	0.028	0.0	0.4	0.4	0.0	O K
8640 min Summer	0.026	0.026	0.0	0.3	0.3	0.0	O K
10080 min Summer	0.024	0.024	0.0	0.3	0.3	0.0	O K
15 min Winter	0.242	0.242	0.0	9.2	9.2	3.5	O K
30 min Winter	0.217	0.217	0.0	8.5	8.5	2.8	O K
60 min Winter	0.169	0.169	0.0	7.2	7.2	1.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	163.746	0.0	6.9	12
30 min Summer	99.272	0.0	8.4	20
60 min Summer	60.184	0.0	10.3	36
120 min Summer	36.487	0.0	12.6	64
180 min Summer	27.227	0.0	14.2	94
240 min Summer	22.120	0.0	15.4	124
360 min Summer	16.506	0.0	17.3	184
480 min Summer	13.411	0.0	18.7	248
600 min Summer	11.415	0.0	19.9	306
720 min Summer	10.007	0.0	21.0	368
960 min Summer	8.070	0.0	22.5	478
1440 min Summer	5.959	0.0	24.9	714
2160 min Summer	4.400	0.0	27.6	1100
2880 min Summer	3.548	0.0	29.6	1460
4320 min Summer	2.660	0.0	33.1	2188
5760 min Summer	2.169	0.0	35.8	2848
7200 min Summer	1.851	0.0	38.0	3552
8640 min Summer	1.626	0.0	39.9	4368
10080 min Summer	1.458	0.0	41.5	4984
15 min Winter	163.746	0.0	7.7	13
30 min Winter	99.272	0.0	9.5	21
60 min Winter	60.184	0.0	11.6	36

	Pervious surfaces
Date 09/10/2014 15:48 File pervious.srcx	Designed by Rupert Evans Checked by
Micro Drainage	Source Control 2014.1.1

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

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
120 min Winter	0.128	0.128	0.0	5.0	5.0	1.0	O K
180 min Winter	0.112	0.112	0.0	3.8	3.8	0.8	O K
240 min Winter	0.105	0.105	0.0	3.1	3.1	0.7	O K
360 min Winter	0.084	0.084	0.0	2.3	2.3	0.4	O K
480 min Winter	0.070	0.070	0.0	1.9	1.9	0.3	O K
600 min Winter	0.060	0.060	0.0	1.6	1.6	0.2	O K
720 min Winter	0.055	0.055	0.0	1.4	1.4	0.2	O K
960 min Winter	0.050	0.050	0.0	1.2	1.2	0.1	O K
1440 min Winter	0.043	0.043	0.0	0.9	0.9	0.1	O K
2160 min Winter	0.036	0.036	0.0	0.6	0.6	0.1	O K
2880 min Winter	0.033	0.033	0.0	0.5	0.5	0.1	O K
4320 min Winter	0.028	0.028	0.0	0.4	0.4	0.0	O K
5760 min Winter	0.025	0.025	0.0	0.3	0.3	0.0	O K
7200 min Winter	0.023	0.023	0.0	0.3	0.3	0.0	O K
8640 min Winter	0.022	0.022	0.0	0.2	0.2	0.0	O K
10080 min Winter	0.021	0.021	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	36.487	0.0	14.2	66
180 min Winter	27.227	0.0	15.9	94
240 min Winter	22.120	0.0	17.3	122
360 min Winter	16.506	0.0	19.4	186
480 min Winter	13.411	0.0	21.0	244
600 min Winter	11.415	0.0	22.4	306
720 min Winter	10.007	0.0	23.6	360
960 min Winter	8.070	0.0	25.3	490
1440 min Winter	5.959	0.0	28.0	726
2160 min Winter	4.400	0.0	31.0	1096
2880 min Winter	3.548	0.0	33.2	1432
4320 min Winter	2.660	0.0	37.2	2204
5760 min Winter	2.169	0.0	40.3	2856
7200 min Winter	1.851	0.0	42.8	3552
8640 min Winter	1.626	0.0	44.9	4328
10080 min Winter	1.458	0.0	46.8	4976

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	GB 373950 438100 SD 73950 38100
C (1km)	-0.025
D1 (1km)	0.393
D2 (1km)	0.367
D3 (1km)	0.405
E (1km)	0.300
F (1km)	2.455
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.024

Time From:	(mins) To:	Area (ha)
0	4	0.024

Model Details

Storage is Online Cover Level (m) 0.580

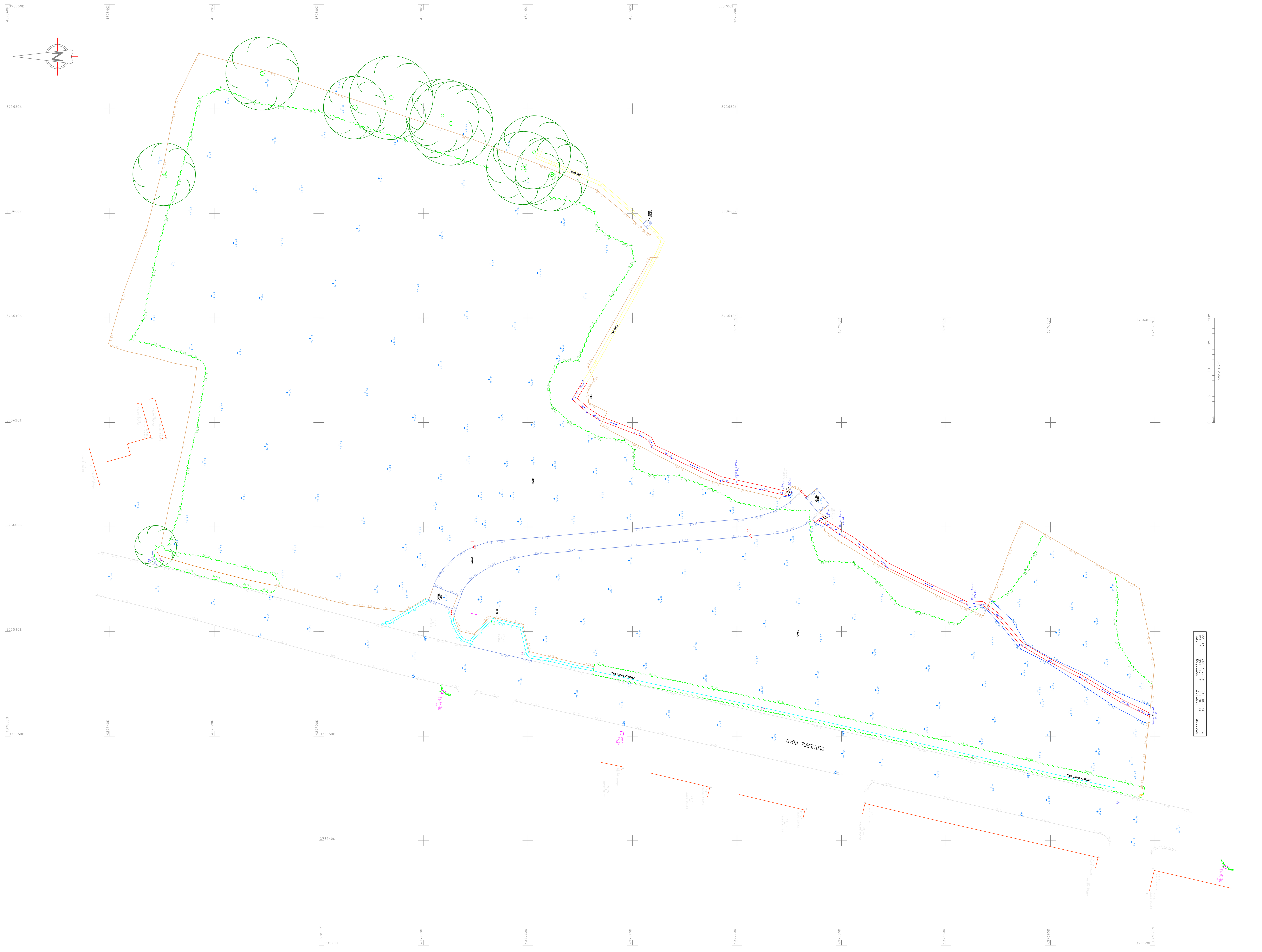
Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	400	Length (m)	10.0
Max Percolation (l/s)	11.1	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	0.000	Cap Volume Depth (m)	0.000

Pipe Outflow Control

Diameter (m)	0.100	Roughness k (mm)	0.600	Upstream Invert Level (m)	0.000
Slope (1:X)	100.0	Entry Loss Coefficient	0.500		
Length (m)	1.000	Coefficient of Contraction	0.600		

DRAWINGS



Abbreviations/Symbols (Measured Building Surveys):

C:	Window Cill Height
H:	Window Head Height
BH:	Beam Height
DH:	Door Height
COL:	Column
SVP:	Soil Vent Pipe
FL:	Floor Level
TH:	Threshold Level
(2.50)	Floor to Ceiling Height
	Vaulted Ceiling

Line types

- Hedge Lines
- Drainage Runs
- Overhead Electricity Cables
- Overhead Telephone Cables

Symbols

- Tree/Bush
- Glass House
- Control Station
- Osbm
- Borehole
- Trial Hole

Abbreviations (Topographic Survey):

AH:	Arch Height
AV:	Air Valve
BB:	Belisha Beacon
BOX:	Electricity Box, Cables Box, Etc.
BOL:	Bollard
BT/IC:	British Telecom Inspection Chamber
BS:	Bus Stop
BS/LP:	Bus Stop / Lamp Post
CATV:	CATV Inspection Chamber
CCTV:	Closed Circuit Television
CL:	Cellar Light
C.PIT:	Catch Pit
ER:	Earth Rod
EC:	Electricity Inspection Chamber
EP:	Electricity Pole
FH:	Fire Hydrant
FP:	Flag Pole
GV:	Gas Valve
G:	Gully
IC:	Inspection Chamber
KO:	Kerb Outlet
LP:	Lamp Post
LB:	Letter Box
LC:	Lighting Column
MKR:	Marker
MH:	Manhole
MP:	Mooring Point
MS:	Mile Stone
NYNEX:	Nynex Inspection Chamber
O/H:	Over Hang
P:	Post
PO/IC:	Post Office Inspection Chamber
R/S:	Road Sign
RE:	Rodding Eye
RTW:	Retaining Wall
S/P:	Sign Post
SNP:	Street Name Plate
ST:	Stop Tap
SV:	Stop Valve
TCB:	Telephone Call Box
TH:	Threshold Level
TL:	Traffic Light
TP:	Telegraph Pole
TROUGH:	Trough
WO:	Water Outlet
WM:	Water Meter

Fence Descriptions:

B/W:	Barbed Wire
C/B:	Close Boarded
C/BARRIER:	Crash Barrier
C/L:	Chain Link
C/P:	Chestnut Paling
C/I:	Corrugated Iron
I/R:	Iron Railing
MISC:	Miscellaneous
P/R:	Post & Rail
P/W:	Post & Wire
P/C:	Post & Chain
S/PAL:	Steel Palisade
W/M:	Wire Mesh

Survey Notes:

Coordinates and Levels related to Ordnance Survey Datum - GPS OSGB36

Revision	Date	Description

Chris Partington Land Surveyors

56b Carrington Lane
Sale
Cheshire
M33 5NR
t: 0161 976 1194
www.cpls.co.uk e:survey@cpls.co.uk

Client

PWL Architects Ltd

Project

Clitheroe Road, Barrow
Site Survey

Scale 1:250	Surveyed By J C	Date July 2014
Drawing No.	Checked By CPLS	Date July 2014
250714JC-01	Drawn By J C	Date July 2014


N
CLITHEROE ROAD
existing lamp post
existing established plating to boundary to be retained where possible
0.9m stone wall to site frontage
2.1m stone wall to parking courtyard
2.4 x 60m visibility splay
new site entrance
5m wide road with 2m footway / service strip
refer to specialist details for landscaping proposals
new footpath to site frontage constructed to adoptable standards
existing low level stone wall
2.1m stone wall to rear garden
1800mm high close boarded timber fence between plots.
lawned private garden
defined right of way
existing watercourse
turning area
house type A
house type B
house type C
house type D
garage
bins
1
2
3
4
5
6
7
8
9
Materials:
block paving parking areas
tarmac to adopted highway standards
lawned private garden
paving flags
0
4m
8m
12m
16m
Project
Proposed Development at Clitheroe Road, Barrow - Phase 2
Title
Proposed Site Layout
PWL
ARCHITECTS
The Studio 29 Bent Lane Leyland Preston PR25 4HP
Tel 01772 467404 E Mail info@pwlarchitects.com
Scale
1:200@A1
Date
April 2016
Drawn
PL
Drwg No
1152-PL-03


N
Project
Proposed Development at
Clitheroe Road, Barrow
Title
Proposed Site Layout
PWL
ARCHITECTS
The Studio 29 Bent Lane Leyland Preston PR25 4HP
Tel 01772 467404 E Mail info@pwlarchitects.com
Scale
1:200@A1
Date
April 2014
Drawn
PL
Drwg No
1149-PL-03E
Rev A: Position of plots 1+2 adjusted, garage for plots 8+9 moved, house types for plots 10+11 changed and plots 12+13 removed 16-6-14
Rev B: Double garage added to plot 11 17-6-14
Rev C: Scheme reduced to 7 houses and red edge boundary adjusted 18-7-14
Rev D: Red edge boundary adjusted 22-7-14
Rev E: Chimney stacks added 4-9-14
Materials:
block paving parking areas
tarmac to adopted highway standards
lawned private garden
paving flags
existing site entrance retained
existing low level stone wall
2.4 x 60m visibility splay
existing cattle grid removed
form new opening in existing low level stone wall for pedestrian access
actual walked right of way
existing footpath sign post
existing stile
defined right of way
existing lamp post
refer to specialist details for landscaping proposals
existing road widened
windows to side elevation
house type A
bins
2.1m stone wall to rear garden
1
new footpath to site frontage constructed to adoptable standards
garage type A
house type C
2.4 x 2.4m pedestrian visibility splay to be provided at each vehicular access and maintained thereafter
turning area
existing watercourse
2
0.9m stone wall to site frontage
existing lamp post to be relocated to allow for new footpath
garage type B
house type B
3
lawned private garden
CLITHEROE ROAD
house type C
bins
4
garage type B
garage type B
bins
house type D
5
new footpath to site frontage constructed to adoptable standards
2.4 x 2.4m pedestrian visibility splay to be provided at each vehicular access and maintained thereafter
garage type A
bins
existing lamp post to be relocated to allow for new footpath
house type B
6
refer to specialist details for landscaping proposals
garden timber bridge
lawned private garden
0.9m stone wall to site frontage
house type B
bins
garden timber bridge
garage type A
7
existing watercourse to be realigned
existing lamp post
Clitheroe Road, Barrow
0 4m 8m 12m 16m