**Consulting Civil, Structural & Geo-Environmental Engineers**

# Flood Risk Assessment

## Site Address:

Nether Mill Farm
Penistone

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## Flood Risk Assessment

Paul Waite Associates have been appointed by Ms Rebecca Scott & Mr Ben Hinchliff to support a planning application for proposed redevelopment of existing farm buildings and land to provide residential development at Nether Mill Farm in Penistone, South Yorkshire.

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## Executive Summary

Paul Waite Associates have been appointed to support a planning application for proposed redevelopment of existing farm buildings and land to provide residential development at Nether Mill Farm in Penistone, South Yorkshire.

The proposed development is intended to be phased over 2No individual areas within the Nether Mill Farm site and covers an area totalling 2.48 Hectares.

For reference purposes the areas of the farm to be redeveloped are labelled A and B; with Area A sub-divided into areas A1; A2; and A3.

Areas A3 & B are shown to be situated predominantly within Flood Zones 2 and 3 of the Environment Agency Flood Map; with Areas A1 and A2 located predominantly within Flood Zone 1.

A small part of Development Area A1, along the border with Barnsley Road, is located within Flood Zone 2.

The primary sources of flood risk to the proposed development are identified to be from the River Don and its tributary Scout Dike.

Following a comprehensive assessment through comparison of modelled flood levels for the River Don against topographical survey information, it is concluded that Development Areas A1 an A2 lie within Flood Zone 1; and therefore have a low risk from fluvial flooding.

In contrast, the assessment confirmed the location of Development Areas A3 and B within Flood Zone 3.

In order to mitigate against flooding within these proposed development areas it is proposed that ground floor levels within new build dwellings are raised to a minimum of 600mm above the 1 in 100 year plus climate change flood level; with flood resistance/resilience measures incorporated to this level within existing building structures to be refurbished, where site constraints prevent ground raising to occur.

This means that finished flood levels within Development Area B are elevated to a level of 194.5mAOD.

Proposals for the existing barn within Development area A3; involve building up of existing door and window openings on the front and gable elevations so that no opening will have a threshold that is lower than 194.0mAOD.

Furthermore the ground floor level of the former tractor shed, also within Development Area A34, will be elevated to a level of 193.80mAOD.

Flood resistance/resilience measures within Development Area A3 should be provided up to a level of 194.457mAOD i.e. 600mm above the 1 in 100 year plus climate change event.

Due to the proximity of the River Don and Scout Dike to these Development Areas, it is highly recommended that residents are advised to sign up to received flood warnings from the Environment Agency's free Flood Warnings Direct Service; and encouraged to develop a personal flood plan in the event that evacuation is advised.

Calculations indicate that in general escape from Development Areas A1 and A along Barnsley Road is low hazard. The hazard rating significantly increases for residents travelling via the site access at Development Area A3. As such an alternative escape route has been evaluated from this area of the site which will allow residents to escape via a low hazard route.

This route should be clearly marked with no obstructions to prevent safe egress from the site if necessary.

The escape route from Development Area B is northwards via Water Hall Lane. At the junction of the site with Water Hall Lane, the depth of flooding presents a hazard to pedestrians. In order to reduce the hazard to acceptable levels, the level of the road may be elevated slightly. It is however noted that raising the level of the access road/Water Hall junction will have a negative impact on the flood storage capacity within the site.

Undertaking an evaluation of pre and post-development flood storage capacity within Development Area B; indicates that due to the careful design of development, which includes conveyance routes through proposed stone boundary walls, there is minimal displacement of stored volumes as a result of the development works.

The impermeable area within the proposed development is generally increased as a result of the proposed works.

Development Areas A1, A2 and A3 are considered brownfield development. Increased surface water runoff from these areas will be restricted to existing rates incorporating a 30% reduction to accommodate climate change over the lifetime of the development. Post-development runoff emanating from these areas in excess of the restricted rates will be attenuated on-site prior to discharge.

Foul and surface water flows from the development areas to the north side of Barnsley Road are believed to currently discharge into the public combined sewer within the highway.

In accordance with the hierarchy set out within Approved Document H of the Building regulations, surface water should be directed to a) infiltration; b) watercourse; c) sewer in order of preference.

Investigations indicate that infiltration methods are unlikely to be feasible at the location of the development; and owing to topography and interception of the route to watercourse by Barnsley Road; discharge to the River Don also appears to be unfeasible.

As such it is recommended that existing outfalls into the public sewer system are re-utilised as part of the drainage strategy for the project.

It is noted however that Yorkshire Water do not have to accept surface water flows from the development; and as such it is recommended that early consultation with Yorkshire Water is sought during the detailed design phase of the project.

Development Area B is also considered to be brownfield development. It is proposed that surface water runoff will be directed via a new outfall to the River Don.

Surface water discharge will be restricted to existing rates, incorporating a betterment (as required) will additional flows attenuated within the development prior to discharge into the receiving watercourse.

In order to prevent backflows during high water levels within the River Don, it is recommended that a flap valve is installed at the proposed outfall structure.

An evaluation of Sustainable Urban Drainage methods indicates that permeable paving; online/offline underground storage; green roof technology; and rainwater harvesting are the most appropriate methods for inclusion within the surface water drainage strategy for the individual development areas at Nether Mill Farm.

It is proposed that foul or wastewater flows will be directed to the public combined sewer system within the vicinity of the development.

Yorkshire Water sewer records indicate that 225mm diameter and 100mm diameter combined public combined sewers traverse Development Area B; and it is noted that any proposed diversion works will need to be approved by Yorkshire Water under a Section 185 Agreement.

Any diverted sewers will require a minimum 3 metre easement either side of the pipe.

Furthermore the Environment Agency will require a minimum 8 metre easement from the river bank; and any works within this area; including installation of a new surface water outfall from Development Area B; will require their formal consent.

Any part of the proposed drainage system within the redevelopment at Nether Mill Farm in Penistone which is not to form part of Section 104 agreement with Yorkshire Water i.e. private drainage system, must be inspected and maintained on a regular basis, to prevent siltation at gullies and flow control chambers; thereby reducing the risk of surface flooding.

It is also noted that the current site owners propose to undertake works within the channel of Scout Dike at Barnsley Road Bridge, to remove excess silt, in order to reduce the risk of fluvial flooding from the watercourse as witnessed during the historical flood event in June 2012.

Any works proposed within the channel at this location must be approved by the Local Lead Flood Authority i.e. Barnsley Council.

## 1.0 Introduction

Paul Waite Associates have been appointed by Ms Rebecca Scott & Mr Ben Hinchliff to support a planning application for proposed redevelopment of existing farm buildings and land to provide residential development at Nether Mill Farm in Penistone, South Yorkshire.

The proposed development is intended to be phased over 3No individual areas within the Nether Mill Farm site and covers an area totalling 2.48 Hectares.

For reference purposes the areas of the farm to be redeveloped are labelled A and B; with Area A sub-divided into areas A1; A2; and A3.

Areas A3 & B are shown to be situated predominantly within Flood Zones 2 and 3 of the Environment Agency Flood Map; with Areas A1 and A2 located predominantly within Flood Zone 1.

A small part of Development Area A1, along the border with Barnsley Road, is located within Flood Zone 2.

Land and property within Flood Zone 1 has a low probability of flooding and is defined as being the zone comprising land as having less than the 1 in 1,000 annual probability of river or tidal/coastal flooding in any year (<0.1%).

Land and property within Flood Zone 2 has a medium probability of flooding is defined as land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Land and property within Flood Zone 3 has a high probability of flooding and is defined as 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.

The primary sources of flood risk to the proposed development areas within the Nether Mill Farm site have been identified as the River Don; and its tributary known as Scout Dike. It is noted however, that other non-fluvial sources of flooding have been considered within this assessment.

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

# 2.0 Approach to the Flood Risk Assessment

## 2.1 Approach

A topographical survey of Nether Mill Farm has been provided by the Client; and it is understood that it has been calibrated to Ordnance Datum. As such, the levels provided by the topographical survey have been utilised within this report.

The requirements for flood risk assessments are generally as set out in the 'Technical Guidance to the National Planning Policy Framework', published in March 2012; and in more detail from the Environment Agency's 'Standing Advice on Flood Risk' available from http://www.environment-agency.gov.uk/reasearch/planning/82584.aspx.

## 2.2 Application of the Sequential and Exceptions Test

The risk based sequential test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding, within Zone 1. The flood zones are the starting point for the sequential approach.

The proposed development areas are shown to be situated within Flood Zones 1, 2 and 3 of the Environment Agency Flood Map, and therefore some areas within the site are likely to be more prone to flooding then other areas.

Proposals for the site incorporate residential development, and as such Table 2 of the Technical Guidance to the National Planning Policy Framework (March 2012) indicates that the development is classified as 'more vulnerable'.

**Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility'**

| **Flood Risk Vulnerability Classification** | | **Essential Infrastructure** | **Water compatible** | **Highly Vulnerable** | **More Vulnerable** | **Less Vulnerable** |
|---|---|---|---|---|---|---|
| **Flood Zone** | **Zone 1** | ✓ | ✓ | ✓ | ✓ | ✓ |
| | **Zone 2** | ✓ | ✓ | Exception Test required | ✓ | ✓ |
| | **Zone 3a** | Exception Test required | ✓ | × | **Exception Test required** | ✓ |
| | **Zone 3b** | Exception Test required | ✓ | × | × | × |

✓ Development is appropriate
× Development should not be permitted

In accordance with the vulnerability table above, residential development within Flood Zone 1 is deemed to be appropriate; whilst similar development within the areas shown to be situated within Flood Zones 2 and 3 will need to pass the Sequential Test and possibly the Exceptions Test before being considered appropriate for the site.

A Sequential/Exceptions Test has been undertaken by Paul Waite Associates to support development at the Nether Mill Farm site and is presented within PWA document reference 12051/I/01.

# 3.0 Site Details

## 3.1 Location

The site is centred on ordnance survey grid reference:

- Area A: SE 244 038
- Area B: SE 246 038

An Ordnance Survey plan of the proposed development is presented below.

**Figure 1: Location Plan – Nether Mill Farm, Penistone**

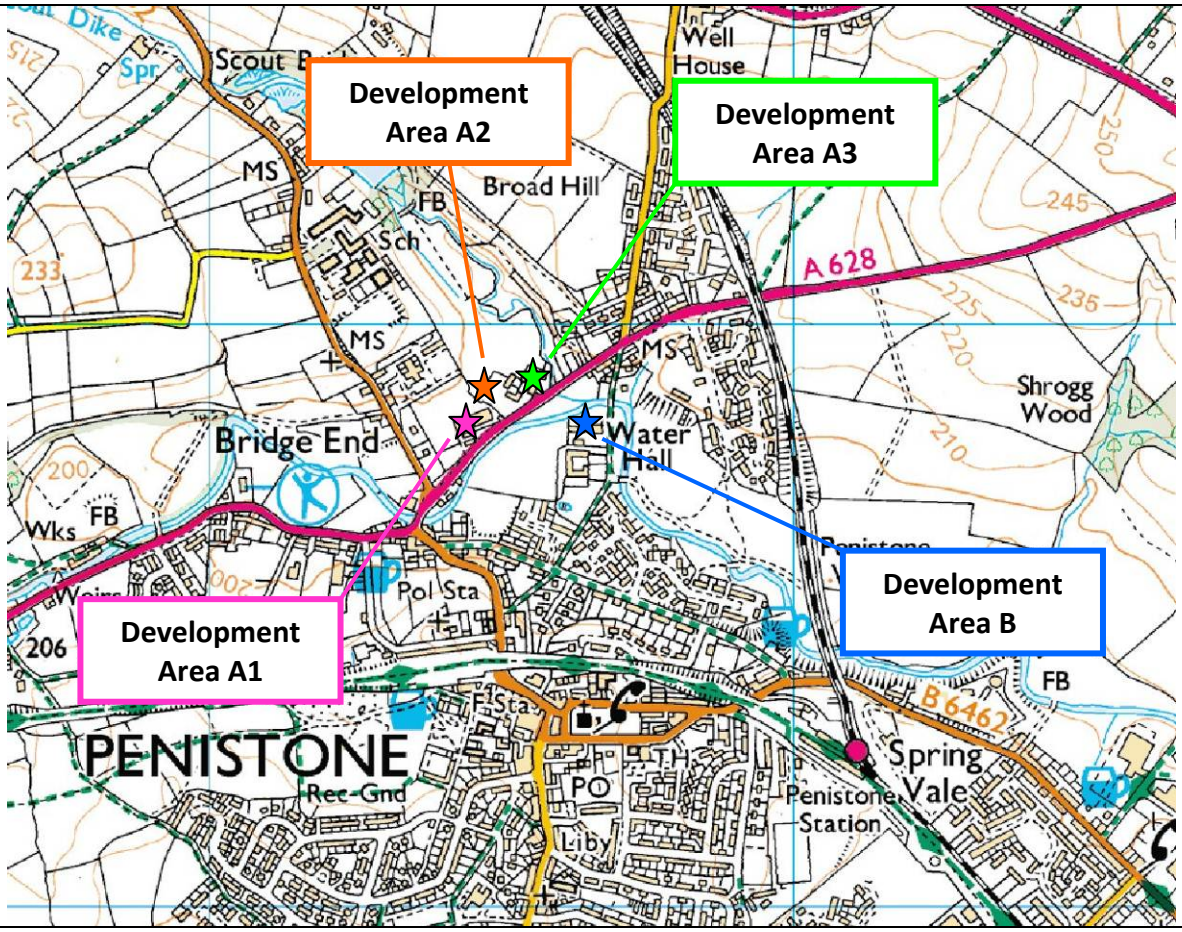



*Image produced from the Ordnance Survey Get-a-map service.*
*Image reproduced with kind permission of Ordnance Survey and Ordnance Survey of Northern Ireland.*

## 3.2 Former/Current Use

Historically the land and buildings have formed part of the farmstead associated with Nether Mill House; which continued as an operational farm until recently.

Figure 2 below illustrates the site layout at the beginning of the 20th Century.

The topographical survey covering Areas A & B is provided for information within Appendix A.

**Figure 2: Historical Map of Nether Mill Farm (Circa 1906)**

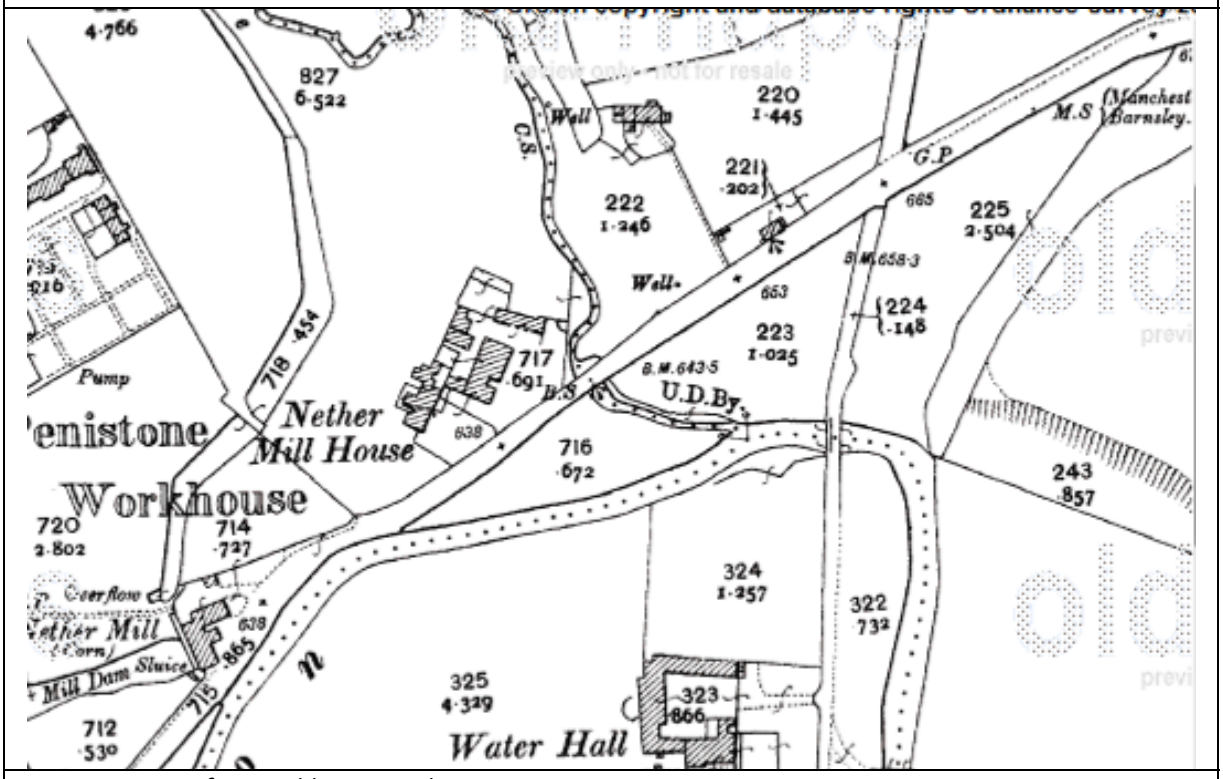



*Image courtesy of www.oldmaps.co.uk*

## 3.3 Proposals

Proposals for redevelopment at the site comprise a phased approach, as follows:

- **Site A:**
  - **A1:** Conversion of existing farm building fronting the highway to provide residential accommodation; with the potential for the addition of a small number of units designed in a sympathetic manner to the existing buildings. Total number of dwellings = 13No (referenced A8 – A20).
  - **A2 & A3:** Retention of existing house and cottage with site A2 making a significant contribution towards the character and setting of site A3. Total number of dwellings = 9No (referenced A1 – A7)
- **Site B:** Small number of residential units. Total number of dwellings = 5No (referenced B1 – B5).

The proposed development layout plans, where available, have been provided within Appendix B of this report.

## 3.4 Boundaries

Nether Mill Farm is situated within the small market town of Penistone in South Yorkshire.

The proposed development is situated approximately 650 metres to the north of central Penistone; and 10.3 kilometres west of Barnsley.

Penistone Grammar School; Scout Dike Reservoir; and large swathes of agricultural land are located to the north side of Nether Mill Farm.

Existing residential development at Wordsworth Court off Water Hall Lane is situated immediately to the south side of proposed Development Area B; with the main body of Penistone town situated beyond.

The A628 Barnsley Road acts to divide the Nether Mill Farm site; with Development Area B to the south and areas A1, A2 and A3 to the north.

Substantial blocks of existing residential development are located of Well House Lane and Wordsworth Road to the East of the development. The land beyond this area on the north eastern fringe of Penistone is predominantly agricultural in nature, spreading eastwards towards Barnsley and interspersed with small villages such as Hoylandswaine and Noblethorpe.

Existing residential development off Huddersfield Road forms the west boundary to the development areas north of Barnsley Road.

An open field is sited beyond the west boundary of the Development Area B to the south side of Barnsley Road.

The River Don is classified as a ‘Main River’; and flows eastwards between Barnsley Road and Development Area B.

Scout Dike is a tributary of the River Don and is classified as ‘Ordinary Watercourse’. The watercourse flows generally in a south easterly direction along the east boundary of Nether Mill Farm, joining with the River Don immediately to the north of Development Area B.

Vehicular access to Development Areas A1, A2, and A3 is available from Barnsley Road; whilst access into Development Area B is from Water Hall Lane.

**Figure 3: Existing Site Access into Development Area A1 from Barnsley Road**




*Image courtesy of Google Maps*

**Figure 4: Existing Site Access into Development Areas A2 & A3 from Barnsley Road**



*Image courtesy of Google Maps*

**Figure 5: Existing Site Access into Development Area B from Water Hall Lane**



*Image courtesy of Google Maps*

## 3.5 Topography

A topographical survey of Nether Mill Farm has been undertaken and highlights the following:

### Area A

The high point within this area is elevated at 197.61mAOD, and situated within the north corner of Development Area A2.

The low point within this area is elevated at 193.10mAOD, and is situated within along the south east boundary of Area A.

Barnsley Road forms the south boundary of Area A and ranges in level from 193.18mAOD and the eastern extremity, rising to 195.70mAOD within the south west part of the site.

The vehicular access into Development Areas A1 and C from Barnsley Road is at a level approximating 194.82mAOD; and 194.54mAOD at the access into Development Areas A2 and A3.

### Area B

The high point within Area B is located along the south boundary of the site, where the ground level is surveyed at 194.36mAOD.

The low point within this development area is found to be 192.37mAOD and it situated along the river bank forming the north boundary of the site.

Access into Development Area B from Water Hall Lane is elevated to 193.42mAOD.

### Proposed Development Levels

Finished ground floor levels for a number of proposed residential units within the site have been provided by the Architect via drawings 11.050.021 Rev A; 11.050.022 Rev A; and 11.050.023 Rev A; and have been tabulated below for reference.

**Table 2: Finished Ground Floor Levels**

| Residential Unit Reference | Ex. GFL (mAOD) | Prop. GFL (mAOD) |
|---|---|---|
| **Development Area A1** | | |
| A14 (Existing Mill) | 194.800 | 194.800 |
| A15 (Existing Mill) | 194.300 | 194.300 |
| **Development Area A2 & A3** | | |
| A1 (Tractor Shed) | 193.200 | 193.800 |
| A2 (Existing Barn) | 193.600 – 194.000 | 193.600 – 194.000 |
| A3 (Existing Barn) | 193.750 – 194.000 | 193.750 – 194.000 |
| A4 (Stable) | 196.530 | 196.530 |
| A5 (Farmhouse) | 194.630 | 194.630 |
| **Area B** | | |
| B1 – B5 | - | 194.500 |

## 3.6 Existing Drainage

It has been observed that the roof area from the existing farm buildings to be converted into residential accommodation i.e. Development Areas A1 and A3 are positively drained via rainwater pipes; and it is believed that surface water runoff from these areas is directed into the public combined sewer within the vicinity of the site.

Development Area A2 is largely undeveloped and as such are not positively drained.

Similarly it is noted that rainwater from the roof areas of the existing farm buildings contained within Development Area B are also not positively drained, with runoff allowed to discharge within the site at ground level.

Information obtained from Yorkshire Water's sewer record plans for the area surrounding Nether Mill Farm, indicates that a 150mm diameter public combined sewer traverses southwards through Development Area A2, and connects with a 150mm diameter public combined sewer which flows eastwards within Barnsley Road.

Furthermore a 225mm diameter public combined sewer is shown to flow west along Barnsley Road.

The sewers connect within the highway at a manhole located immediately to the south of Development Area A3, and change direction to flow south easterly, crossing the River Don, and traversing Development Area B via a 225mm diameter pipe. The public sewer exits the site along the south boundary.

A 300mm diameter public surface water sewer, which is believed to serve residential development off Wentworth Road, flows northwards across the field adjoining Development Area B, enables discharge of surface water runoff directly into the River Don.

A copy of the water supply and sewer record plans supplied by Yorkshire Water are provided for reference within Appendix E of this report.

## 3.7 History of Flooding

### 3.7.1 British Hydrological Society – Hydrological Events

A search on the British Hydrological Society Chronology of British Hydrological Events website (http://www.dundee.ac.uk/geography/cbhe) indicates numerous incidents relating to historic flooding within the River Don Catchment, however there are no records specifically within Penistone or Barnsley areas.

### 3.7.2 Internet Search for Historical Flooding

Following what was reported to be 2 months' worth of rainfall over a 24 hour period in July 2012, an area of Penistone to the south of the development areas at Nether Mill Farm, known as Green Road became flooded.

Penistone Cricket Club located off Sheffield Road to the south east of the proposed development was also reported to have become inundated due overtopping of the natural river bank, along the River Don.

Information obtained from Barnsley Council's website indicates that during this period, Green Road was closed to vehicles and the flood status along part of the A628 in Penistone was upgraded to 'Flood Warning' from 'Flood Alert'.

It is not clear from the reports however which part of the A628 through Penistone that this report refers to.

The Barnsley Chronicle reported the following:

'In Penistone areas such as Green Road and Barnsley Road had water running down the streets, and Hoyle Mill Lane, next to the River Don in Thurlstone, along with Manchester Road at Millhouse Green were also badly affected.'

### 3.7.3 Barnsley Council's Level 1 SFRA (2010)

Table 5.1 within the SFRA document outlines the major historical flood events within the Upper Don Catchment and Dearne Valley. It is noted that all events listed are related to flood events along the River Dearne; with no incidents listed in Penistone or within the immediate vicinity of Nether Mill Farm.

### 3.7.4 Barnsley Council's PFRA (2011)

The Preliminary Flood Risk Assessment document has been prepared to assist Barnsley Council meet their duties to manage local flood risk and deliver the requirements of the Flood Risk Regulations (2009).

Within the new legislative framework Barnsley Council is defined as a Lead Local Flood Authority (LLFA).

A review of the historical flood information provided within Table 4-2 of this report, did not deliver evidence of flooding within the vicinity of the proposed development sites at Nether Mill Farm or indeed the Penistone area.

### 3.7.5 Anecdotal Information

Through liaison with the site owners, it has been established that prior to July 2012, the proposed Development Areas A3 & B have no memorable history of flooding.

During the event of 2012 however it was advised that flooding at the application site occurred, with the following information supplied by the Architect for the project:

'*During the exceptional flooding of last summer Scout Dike backed up as the flow of water down Scout Dike was not able to get into the River Don due in part to the flow in the Don and, according to our clients, the restricted space available within the culvert beneath Barnsley road due to silting of the bed of Scout Dike.*

*Flood water from Scout Dike gained access to the site by flowing through the existing dry stone boundary wall.*

*I am advised that the flooding within Site A covered the area in front of the tractor shed, the interior of the tractor shed and a small part of the front lower internal floor area of the principle stone barn that stands at right angles to the tractor shed*.'

The depth of flooding within the tractor shed is understood to have approximated 0.5 metres.

It was also reported that a small portion of Development Area B was also flooded during the July 2012 incident.

### 3.7.6 Environment Agency Historical Flood Level Data

The Environment Agency has provided details of historic flooding during the autumn 2000 and June 2007 flood events.

The flood level within the River Don adjacent to Development Area B, within the Nether Mill Farm site, during the autumn 2000 event was recorded at 192.87mAOD.

The topographical survey records the south river bank levels at 192.37mAOD to 192.76mAOD within the site; and therefore overtopping is likely to have occurred during this flood event.

However, ground levels moving away from the river bank rise very quickly and the general site area lies at a level above 193.00mAOD. As such the main part of Development Area B is unlikely to have become inundated during this flood event.

Whilst flood levels are not provided for the 2007 flood event within the River Don, the flood outline indicate at all areas within the site remained dry.

# 4.0 Flooding Mechanisms

**Table 3: Sources of Flooding**

| Source/Pathway | Significant? | Comment/Reason |
|---|---|---|
| **Fluvial** | Yes | River Don; Scout Dike |
| **Tidal/Coastal** | No | |
| **Canal** | No | |
| **Pluvial (urban drainage)** | Yes | Surface Water Runoff |
| **Groundwater** | No | |
| **Overland flow** | Yes | Due to topography of the area – there is potential for flooding via this mechanism |
| **Blockage** | Yes | Existing road bridges |
| **Infrastructure failure** | Yes | Existing road bridges; reservoirs |
| **Rainfall Ponding** | Yes | Low points within development areas |

## 4.1 Fluvial: River Don

### 4.1.1 General

The River Don rises in the Pennines and flows for 70 miles generally in an easterly direction, through the Don Valley, via Penistone, Sheffield, Rotherham, Mexborough, Conisbrough, Doncaster and Stainforth.

It originally joined the River Trent, but was re-engineered by Vermuyden in the 1620's, and now joins the River Ouse at Goole in the East Riding of Yorkshire.

The upper reaches of the River Don, and those of several of its tributaries, are defined by dams built to provide a public water supply. The middle section of the river contains many weirs, which were built to supply mills, foundries and cutlers' wheels with water power, while the lower section of the watercourse contains weirs and locks, designed to maintain water levels for navigation.

The River Don's major tributaries are the Loxley, the Rivelin, the Sheaf, the Rother and the Dearne.

The river channel near to the proposed developments at Nether Mill Farm in Penistone is predominantly open channel, with road crossings located at Penistone Bridge, upstream of the site and at Water Hall Bridge, immediately downstream from Development Area B.

Furthermore there are no formal flood defences along the river banks within the immediate vicinity of the proposed development.

As such the impact of flooding caused by overtopping of the natural river banks and through blockage/infrastructure failure at Water Hall bridge needs to be investigated in further detail within this report.

**Figure 6: River Don Viewed Downstream at Water Hall Bridge**



*Image courtesy of JBA Modelling Data*

### 4.1.2 Environment Agency Flood Level Data

The Environment Agency has provided modelled flood levels for a range of probabilities at a number of locations along the River Don.

In order to assess the impact of flooding within the River Don on the development areas within Nether Mill Farm, 3No modelled nodes have been selected due to their proximity in in relation to the site.

**Table 4: Modelled Flood Levels (River Don)**

| Return Period | Water Level Node Ref 27870 (mAOD) | Water Level Node Ref 27718 (mAOD) | Water Level Node Ref 27678 (mAOD) |
|---|---|---|---|
| 1 in 5 years | 193.582 | 193.046 | 192.912 |
| 1 in 10 years | 193.709 | 193.223 | 193.067 |
| 1 in 25 years | 193.856 | 193.440 | 193.292 |
| 1 in 50 years | 193.959 | 193.576 | 193.442 |
| 1 in 75 years | 194.019 | 193.635 | 193.492 |
| 1 in 100 years | 194.054 | 193.666 | 193.511 |
| 1 in 200 years | 194.152 | 193.743 | 193.538 |
| 1 in 1000 years | 194.457 | 194.112 | 193.952 |

### 4.1.3 Overtopping: 1 in 100 year Flood Event

#### Area A

Surveyed ground levels within this development area range from 193.10mAOD to 197.61mAOD.

It is noted that due to the elevation of Barnsley Road, direct inundation within Development Areas A1 and A2 during a 1 in 100 year flood event within the River Don is considered unlikely. As such there is a low probability of flooding within these development areas.

This is also true with regard to Development Area A3. However, a conveyance route beneath Barnsley Road is provided by Scout Dike, and as such it is considered that flood water from the River Don will be able to 'back up' the channel of the tributary, overtopping the river bank upstream of Barnsley Road, causing inundation within this area.

The 1 in 100 year flood level within this part of the site is estimated to be 193.758mAOD; which compares well to the flood level observed within this part of the site during the flood event of July 2012.

The ground floor level of the existing farm buildings likely to be affected i.e. the tractor shed and barn are 193.26mAOD and 193.6 – 194.000mAOD respectively, and as such it is considered that flood water will be able to ingress into the buildings.

#### Area B

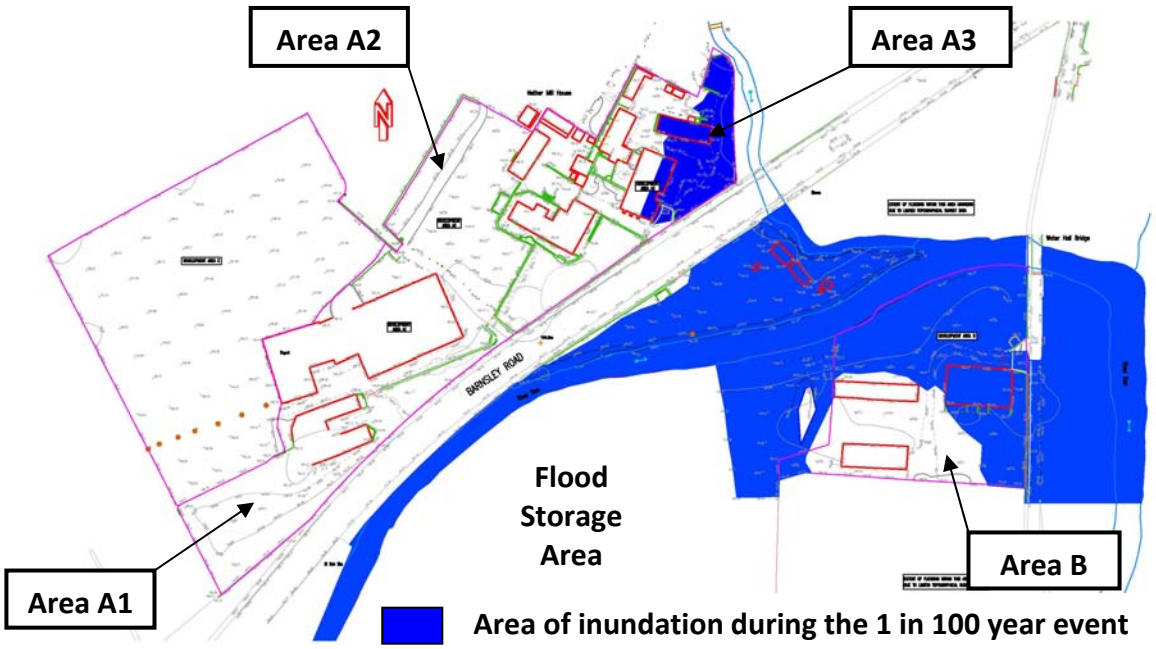
Through interpolation of modelled flood levels between the above nodes the 1 in 100 year flood level at the upstream extent of the site is estimated as 193.807mAOD.

Similarly the 1 in 100 year flood level along the west boundary, within the centre of the site and along the east boundary are estimated to be 193.758mAOD; 193.666mAOD and 193.511mAOD.

Surveyed ground levels along the natural river bank, although limited, indicate that the north boundary of Area B lies at approximately 192.37mAOD to 192.76mAOD.

Consequently, during the 1 in 100 year flood event it is noted that the river bank will become overtopped, and the site is likely to become inundated.

**Figure 7: 1 in 100 year Flood Outline Attributed to the River Don**




### 4.1.4 Overtopping: Climate Change

In accordance with the requirements of the NPPF (2012), the impact of climate change over the lifetime of the development must be evaluated.

Unfortunately the modelled flood levels available for the River Don do not make a provision for climate change.

From Table 5 of the 'Technical Guidance for the NPPF' an increase of 20% to peak river flows is deemed appropriate to assess the impact of climate change.

Therefore through interpolation of modelled flows and flood levels, the estimated flood level within the River Don, during the 1 in 100 year plus 20% climate change for each node has been estimated and is tabulated below.

**Table 5: Estimated 1 in 100 year plus 20% Climate Change Flood Levels (River Don)**

| Return Period | Water Level Node Ref 27870 (mAOD) | Water Level Node Ref 27718 (mAOD) | Water Level Node Ref 27678 (mAOD) |
|---|---|---|---|
| 1 in 100 year + 20% | 194.162 | 193.762 | 193.569 |

### Area A

Surveyed ground levels within this development area range from 193.10mAOD to 197.61mAOD.

It is noted that the application of climate change is unlikely affect Development Areas A1 and A2, which are considered to have a low probability of flooding during the 1 in 100 year plus 20% climate change flood event within the River Don.

At Development Area A3, the flood envelope attributed to the 1 in 100 year flood event within the River Don is marginally expanded with the application of climate change, as illustrated within Figure 8 overleaf. The estimated 1 in 100 year plus climate change flood level within this part of the site is estimated at 193.857mAOD.

### Area B

Through interpolation the 1 in 100 year plus 20% climate change flood level at the upstream extent of the site is estimated as 193.916mAOD.

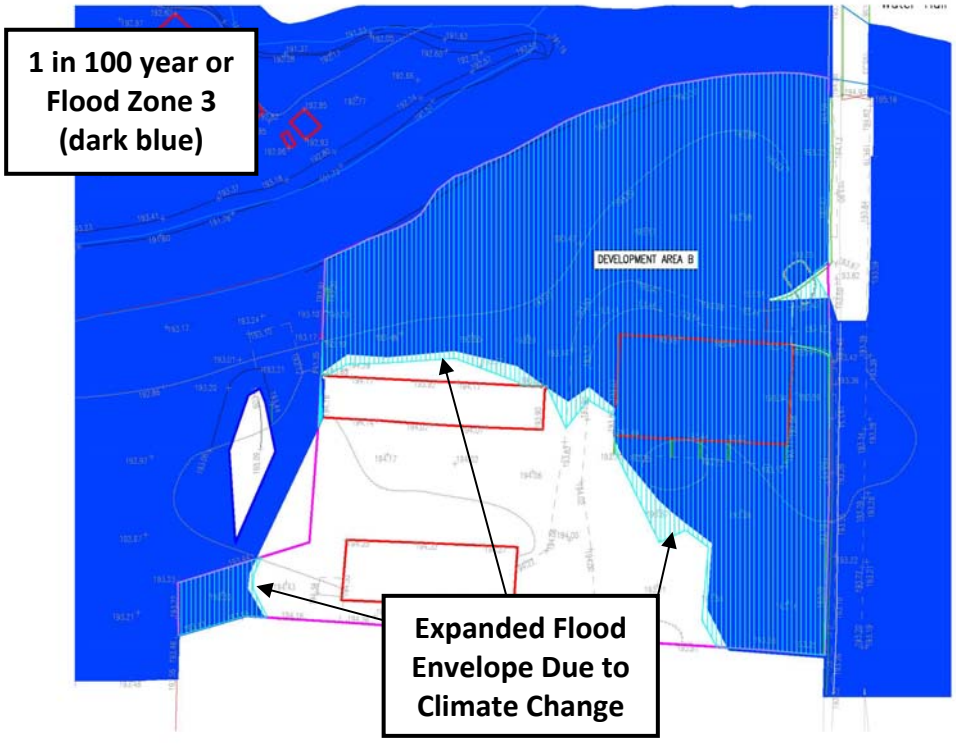
Similarly the 1 in 100 year flood level along the west boundary, within the centre of the site and along the east boundary are estimated to be 193.867mAOD; 193.762mAOD and 193.569mAOD respectively.

The extent of flooding within Development Area B is considered to marginally expand as a result of future climate change, with the predicted outline illustrated within Figure 9.

**Figure 8: 1 in 100 year Plus 20% Climate Change Flood Outline – Area A3**




**Figure 9: 1 in 100 year Plus 20% Climate Change Flood Outline – Area B**



### 4.1.5 Overtopping: Extreme 1 in 1000 year Event

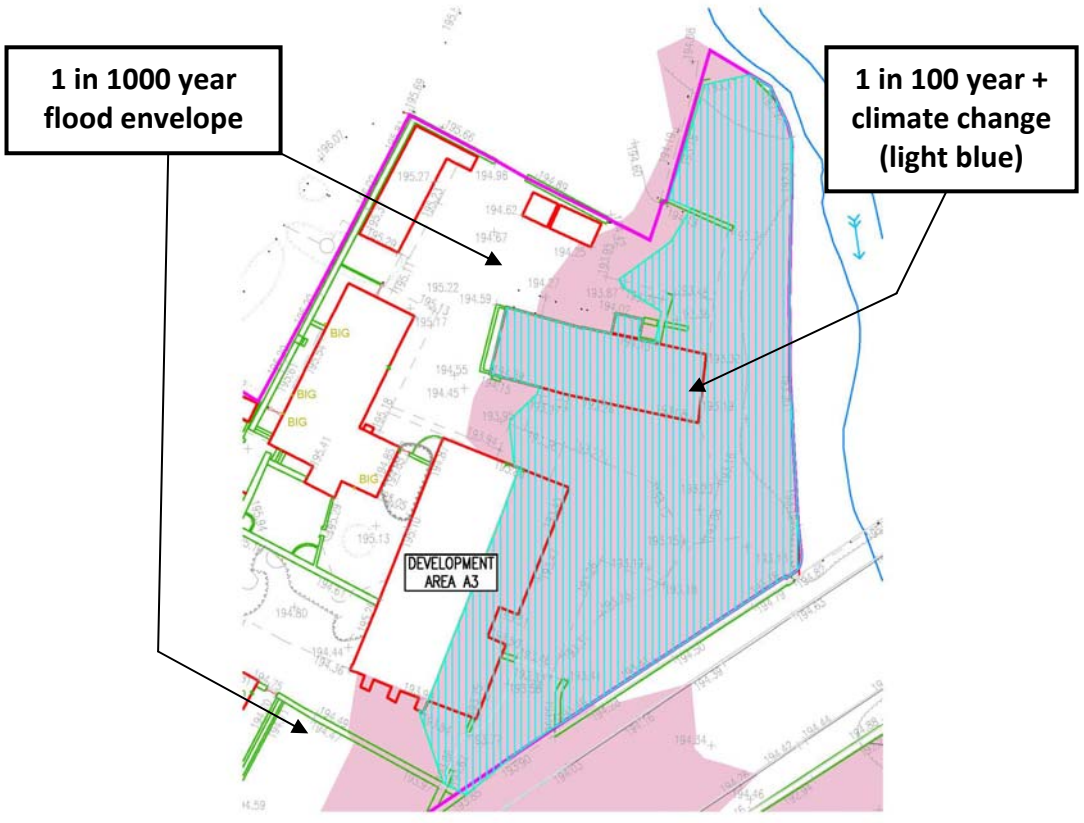
#### Area A

Surveyed ground levels within this development area range from 193.10mAOD to 197.61mAOD.

Superimposing modelled flood levels for the River Don during the extreme event onto the topographical survey indicates that, whilst Barnsley Road will become inundated, Development Areas A1 and A2 retain a low probability of flooding during the 1 in 1000 year event.

At Development Area A3, the flood envelope attributed to the 1 in 100 year flood event within the River Don is further expanded in comparison to the 1 in 100 year plus climate change flood envelope.

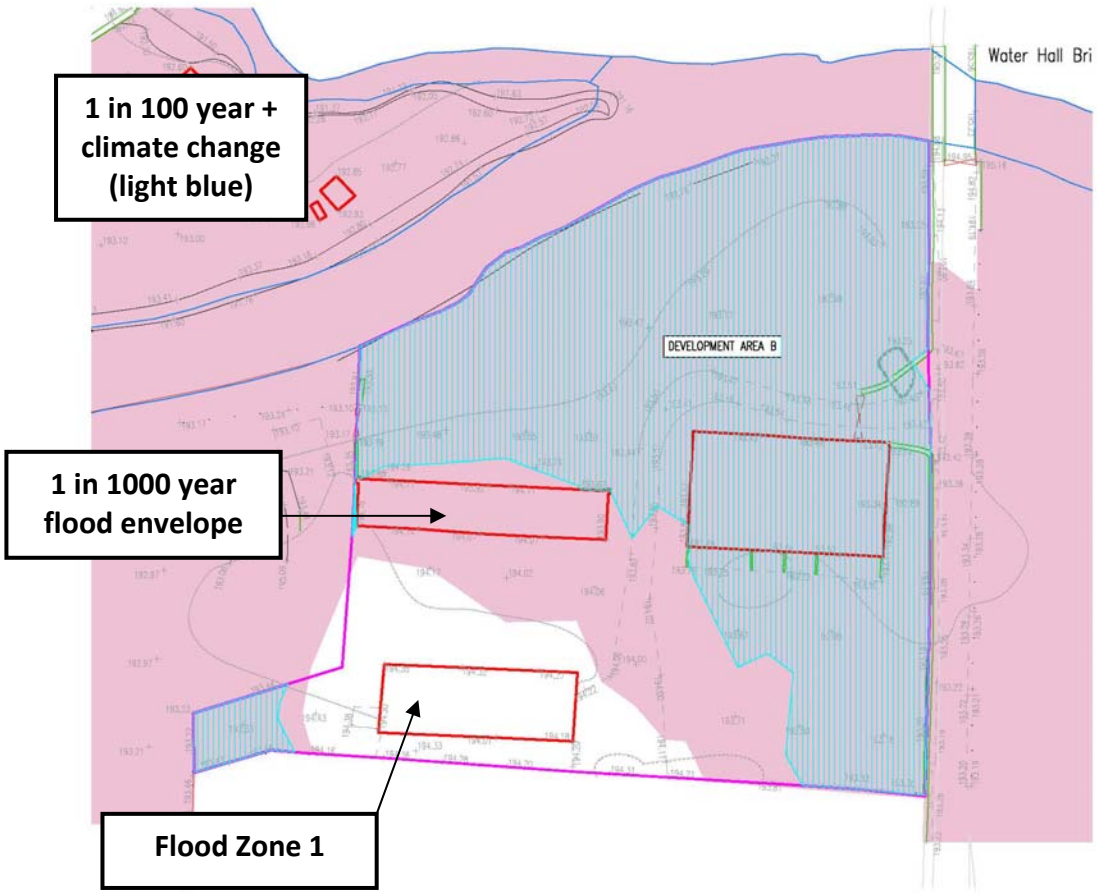
**Figure 10: 1 in 1000 year Flood Outline – Area A3**




#### Area B

Application of the 1 in 1000 year modelled flood levels to surveyed ground levels within Development Area B indicates that a small area along the south boundary of the site is located outside of the River Don's floodplain i.e. within Flood Zone 1.

**Figure 11: 1 in 1000 year Flood Outline – Area B**




### 4.1.6 Infrastructure Failure: Blockage or Collapse at Water Hall Bridge

During flood conditions there is the potential for debris to enter open channel sections of the watercourse, and be washed downstream.

An accumulation of debris such as uprooted vegetation or silt at bridged and/or culverted sections of the watercourse, may lead to blockages within structures located along the channel, causing flood water to backup.

Similarly, should the bridge spanning the River Don at Water Hall Lane fail, the capacity of the culverted section of watercourse is likely to be greatly reduced, which again is likely to cause flood water to backup within the channel upstream from the bridge crossing.

It is considered likely therefore that the extent of flooding will be exacerbated in the event of severe blockage or structural collapse of the nearby bridge structure.

It is noted that the River Don is designated as 'Main River' within the vicinity of Nether Hall farm and therefore the Environment Agency are responsible for managing flood risk along the watercourse.

The Environment Agency undertakes an annual programme of maintenance, which generally includes the following activities:

- Maintaining flood barriers & pumping stations
- Clearing grills and removing obstructions from rivers
- Controlling aquatic weeds within rivers
- Managing grass, trees and bushes on flood embankments
- Inspection and repair of flood defence structures

An extract from the Environment Agency's routine maintenance programme for 2012-13 at Penistone includes the following:

'Weed cut by machine. Weed is removed from the channel where it is required to maintain flows within the channel and reduce flood risk. This is undertaken by the use of large excavators or by specialist boat equipment where necessary.'

As such, blockage or structural collapse at Water Hall Bridge is therefore considered to have a relatively low probability.

### 4.1.7 Conclusion

The resulting flood pattern identified within the Nether Mill Farm site was found to compare well with the extent of flooding depicted by the Environment Agency Flood Map of the area.

Under normal flood conditions it is concluded that the River Don presents a flood risk to Development Areas A3 and B.

Furthermore, the watercourse is considered to present a low flood risk to Development Areas A1 and A2.

## 4.2 Fluvial: Scout Dike

### 4.2.1 General

Scout Dike is a tributary of the River Don. The watercourse begins as a number of small streams on moorland located to the north west of Penistone.

The watercourse serves a number of reservoirs, including Broadstone; Ingbirchworth; Royd Moor and Scout Dike, emerging from this final reservoir as Scout Dike.

The channel flows generally in a southerly direction along the east boundary of Nether Mill Farm, beneath Barnsley Road, joining with the River Don to the north side of Development Area B.

There are no raised flood defences evident along the banks of the watercourse.

The flood mechanisms in respect of the watercourse are similar to those identified for the River Don i.e. overtopping of the river bank, along with blockage and/or infrastructure failure of the existing road bridge.

The watercourse is classified as 'Ordinary Watercourse' and as such the responsibility for managing activity on or alongside the watercourse lies with the Local Lead Flood Authority i.e. Barnsley Council. The responsibility for maintenance of the watercourse however lies with the riparian owner.

Unfortunately the Environment Agency has been unable to provide modelled water levels for Scout Dike.

### 4.2.2 Overtopping

It is considered that flood levels within the lower reaches of the watercourse are dominated by water levels within the River Don.

As such inundation at the Nether Mill Farm site attributed to this mechanism has been investigated previously within Section 4.1 of this report.

The flood envelopes produced by the 1 in 100 year and 1 in 1000 year River Don flood levels was found to compare well with Flood Zones 2 and 3, as illustrated on the Environment Agency's Flood Map for the Penistone area.

This also corresponds to the pattern of flooding witnessed by the Client during the July 2012 flood, where Development Area A3 was subject to inundation via overtopping of the river bank; with seepage of flood water into the site through an existing dry-stone wall.

The estimated depth of flooding at the existing tractor shed within Development Area A3 was given as 500mm. The threshold level of the building is at 193.2mAOD; consequently the historic flood level has been taken as 193.7mAOD for the purposes of this assessment.

It is noted that this historic flood level compares well to the 1 in 100 year River Don Flood level at Development Area A3, estimated using the modelled flood level data supplied by the Environment Agency.

Flow into the upper reaches of the watercourse is largely controlled via Scout Dike reservoir. However historic flood maps provided by the Environment Agency indicate that out of bank flooding occurred immediately upstream of Nether Mill Farm during 2007.

The historic flood outline indicates that the open field bordering Development Areas A2 and A3 was inundated over a large area. Reference is made to the Environment Agency Maps provided within Appendix D of this report.

### 4.2.3 Infrastructure Failure: Blockage or Collapse at Barnsley Road Bridge

The bridge which provides a conveyance route under Barnsley Road is considered to be a highway asset, and therefore from a structural perspective is the responsibility of the Highways and Transportation Department at Barnsley Council.

As such, it is considered that the bridge structure undergoes a regular schedule of inspection, with the Highways Authority undertaking maintenance as required.

It is therefore considered that the road bridge has a low probability of structural failure.

In contrast, due to the semi-wooded nature of the river banks, it is considered possible that during high water levels within Scout Dike, vegetation such as tree branches may become washed into the watercourse; resulting in blockage at the road crossing.

The watercourse is under riparian ownership and therefore the land owner at Nether Mill has responsibility with regard to ensuring that the bridge opening is regularly cleared of debris to minimise large blockages from occurring.

In the event that the bridge opening becomes blocked, water levels upstream of the bridge are likely to become elevated, and overtopping of the river bank, particularly within the lower reaches, just upstream from the bridge are likely to occur.

The resulting impact on the extent of inundation within the Nether Mill Farm site is difficult to ascertain during such an event; however due to its proximity to Scout Dike, it is likely that Development Area A3 will be worst affected.

### 4.2.4 Conclusion

It is concluded that Scout Dike presents a flood risk to proposed Development Area A3.

## 4.3 Pluvial: Surface Water Runoff

### 4.3.1 Barnsley MBC Level 1 SFRA – Surface Water Flooding

In regard to the potential for surface water flooding within the Penistone area, the following details have been extracted from the Level 1 SFRA document.

'*Surface water flooding occurs where high rainfall events exceed the drainage capacity in an area and these events can lead to serious flooding of property and possessions as demonstrated by the summer 2007 floods. In addition, large amounts of surface water runoff can lead to water quality problems and potential health risks to people*.'

**Figure 12: Extract from SFRA Map C - Surface Water Flooding**

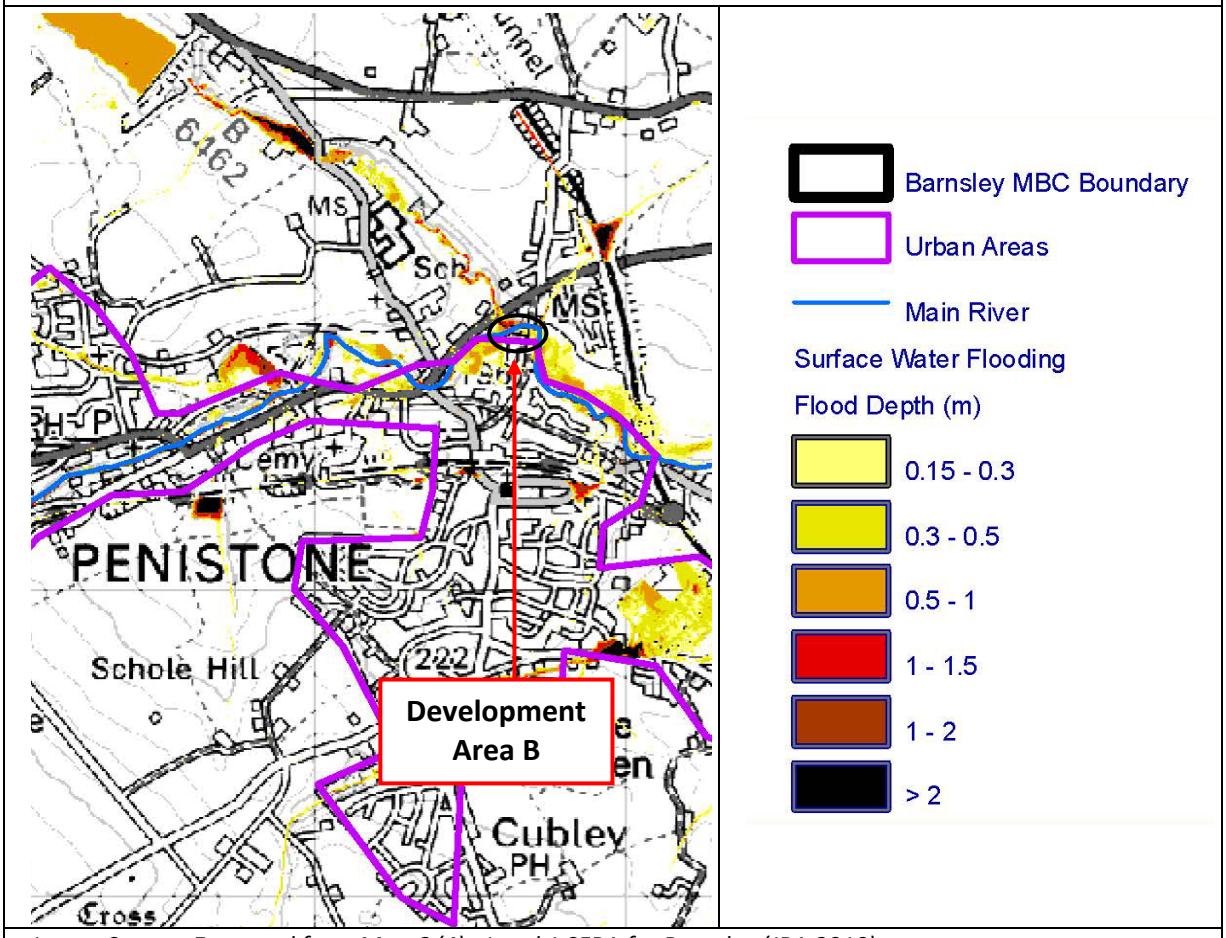



*Image Source: Extracted from Map C (4) - Level 1 SFRA for Barnsley (JBA 2010)*

'*The topography of the Barnsley MBC area, especially in and around a number of the built-up areas makes them potentially prone to flooding caused by direct rainfall due to the amount of impermeable surfaces and the lack of sufficient sewer capacity. Some modelling of the possible surface water flooding within the urban areas as a result of the 100 year rainfall event has been undertaken in order to provide an indication of areas where surface water (derived from rainfall only) will naturally flow towards and possibly pond.*'

*'Areas where surface ponding may generate flood depths in excess of 0.5m (which could also be further exacerbated by flooding from local watercourses), are distributed across the Barnsley MBC urban areas with particular concentrations in:*

- *The railway area just east of Market Hall in Barnsley town centre*
- *South western parts of Thurnscoe*
- *North western parts of Bolton-on-Dearne*
- *Eastern parts of Penistone'*

A review of Map C illustrates that there is no surface water flooding predicted for Development Areas A1; A2; A3; and C. However it is predicted that pluvial flooding caused by the 1 in 100 year rainfall event will result in flooding within Development Area B to depths approximating 0.15m – 0.3m.

### 4.3.2 Increased Runoff Due to Development: General

The total development area within the Nether Mill Farm site approximates 2.48 Hectares and is composed of the following:

- Development Area A (A1; A2; and A3) – 1.18 Hectares
- Development Area B – 0.47 Hectares

Proposals involve provision of residential accommodation via redevelopment of existing farm buildings or new build properties over 3No phases.

Due to the placement of each phase within the overall development, the surface water management issues with regard to each development area have been dealt with within this report on an individual basis.

### 4.3.3 Evaluation of Existing Contributing Areas – A1

Area A comprises the smaller development areas identified as A1; A2; and A3.

The area within the boundary associated with Area A1 is approximately 0.5 Hectares; and is comprised of:

- 2No adjoined stone built dwellings fronting Barnsley Road
  - Building 1 – single storey cottage style dwelling
  - Building 2 – two storey, derelict farmhouse/barn
- A row of open fronted, block built storage sheds to the rear of the existing dwellings. The buildings are single storey and comprise corrugated metal roofing.
- 2No large barns

**Figure 13: Existing Dwellings within Development Area A1**



*Image Source: Google Earth*

Roof water from the existing dwellings and barns are shown to be positively drained via downpipes; however the topographical survey did not highlight any manhole chambers within this area of the site. It is therefore surmised that roof water is allowed to discharge to ground surface level; where it flows overland to Barnsley Road via the site access or via the south west boundary of the development; where it is collected by road gullies; and is ultimately directed into the River Don.

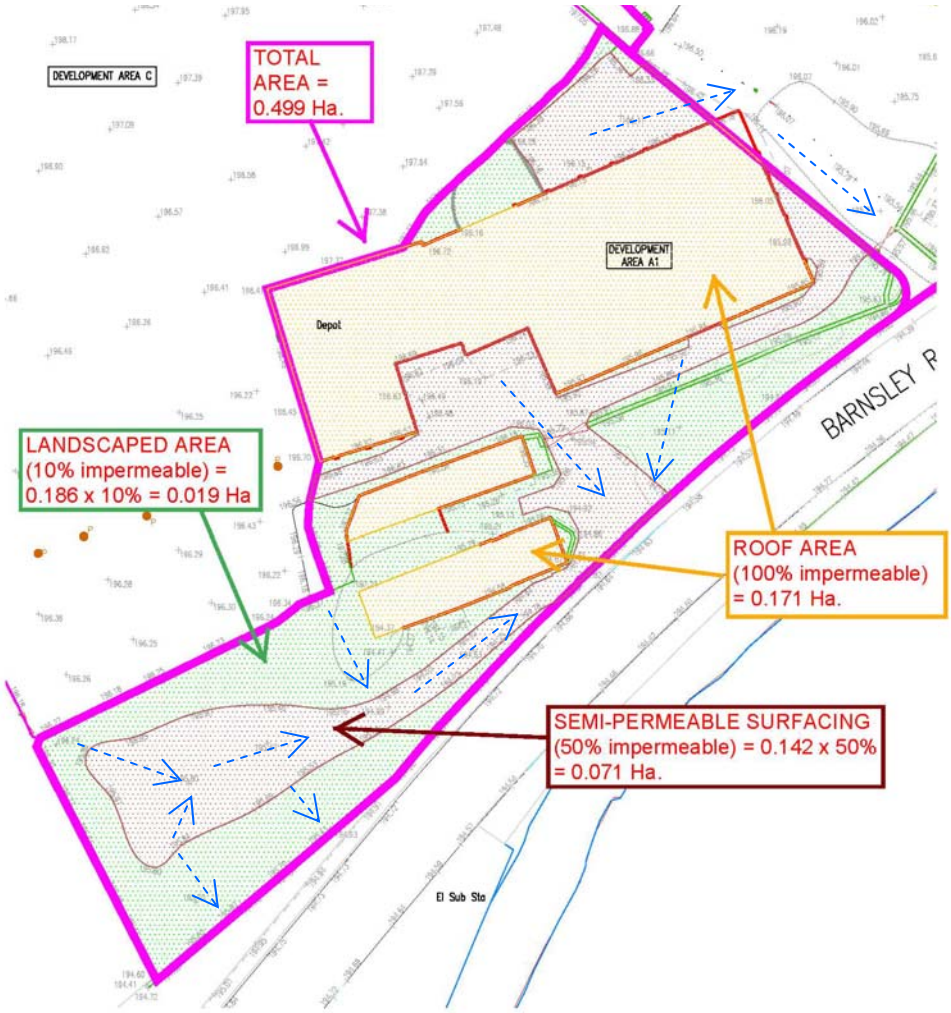
An evaluation of the roof and hardstanding areas within Development Area A1 has been undertaken, and is tabulated below. A sketch illustrating this assessment is provided within Figure 14 overleaf.

**Table 6: Existing Contributing Areas – Development Area A1**

| Surface Type | % Impermeable | Total Area (Ha) | Contributing Area (Ha) |
|---|---|---|---|
| **Roof/Building Footprint** | 100 | 0.171 | 0.171 |
| **Open storage & yard areas (Gravel/Chippings)** | 50 | 0.142 | 0.071 |
| **Concrete/Tarmacadam Hardstanding** | 100 | 0 | 0 |
| **Landscape** | 10 | 0.186 | 0.019 |
| **Total** | | 0.499 | 0.261 |

It is estimated therefore that the site is roof and paved to approximately 52% of the total development area.

**Figure 14: Existing Areas Contributing to SW Runoff (Development Area A1)**




### 4.3.4 Estimation of Existing Peak Surface Water Runoff – A1

Utilising rainfall profiles obtained from the FEH CD-ROM (Version 3.0) and the Modified Rational Method, the peak surface water flows for a range of probabilities have been calculated and tabulated below. The full calculation spreadsheets are provided for reference within Appendix F of this report.

**Table 7: Existing Surface Water Runoff – Development Area A1**

| Return Period | Ex. Peak Runoff Rate (l/s) | 30% Reduction (l/s) |
|---|---|---|
| 1 in 2 year | 20.3 | 14.2 |
| 1 in 30 year | 58.9 | 41.2 |
| 1 in 100 year | 90.5 | 63.4 |

In order to accommodate future climate change and provide a betterment to the existing situation, the Environment Agency; Yorkshire Water and Barnsley Council requires the application of a 30% reduction to existing peak runoff rates generated by the existing development.

Flows in excess of this should be attenuated on-site prior to discharge into the receiving sewer or watercourse.

### 4.3.5 Evaluation of Existing Contributing Areas – A2 & A3

Area A comprises the smaller development areas identified as A1; A2; and A3.

The area within the boundary associated with Areas A2 & A3 is approximately 0.675 Hectares; and is comprised of 11No existing buildings made up of residential and farm outbuildings principally of stone construction.

**Figure 15: Existing Tractor Shed within Development Area A3**



*Image Source: PWA Associates*

Similar to Development Area A1, roof water from some of the existing buildings is shown to be positively drained via downpipes; however it is again believed that roof water is allowed to discharge to ground surface level; where it flows overland to Barnsley Road and is collected by road gullies; and ultimately into the River Don.

An evaluation of the roof and hardstanding areas within Development Areas A2 & A3 has been undertaken, and is tabulated below. A sketch illustrating this assessment is provided within Figure 16 overleaf.

**Table 8: Existing Contributing Areas – Development Areas A2 & A3**

| Surface Type | % Impermeable | Total Area (Ha) | Contributing Area (Ha) |
|---|---|---|---|
| **Roof/Building Footprint** | 100 | 0.116 | 0.116 |
| **Semi-permeable (Gravel/Chippings)** | 50 | 0.040 | 0.020 |
| **Concrete/Tarmacadam Hardstanding** | 100 | 0.157 | 0.157 |
| **Landscape** | 10 | 0.362 | 0.036 |
| **Total** | | 0.675 | 0.329 |

It is estimated therefore that the site is roof and paved to approximately 49% of the total development area.

### 4.3.6 Estimation of Existing Peak Surface Water Runoff – A2 & A3

Utilising rainfall profiles obtained from the FEH CD-ROM (Version 3.0) and the Modified Rational Method, the peak surface water flows for a range of probabilities have been calculated and tabulated below. The full calculation spreadsheets are provided for reference within Appendix F of this report.

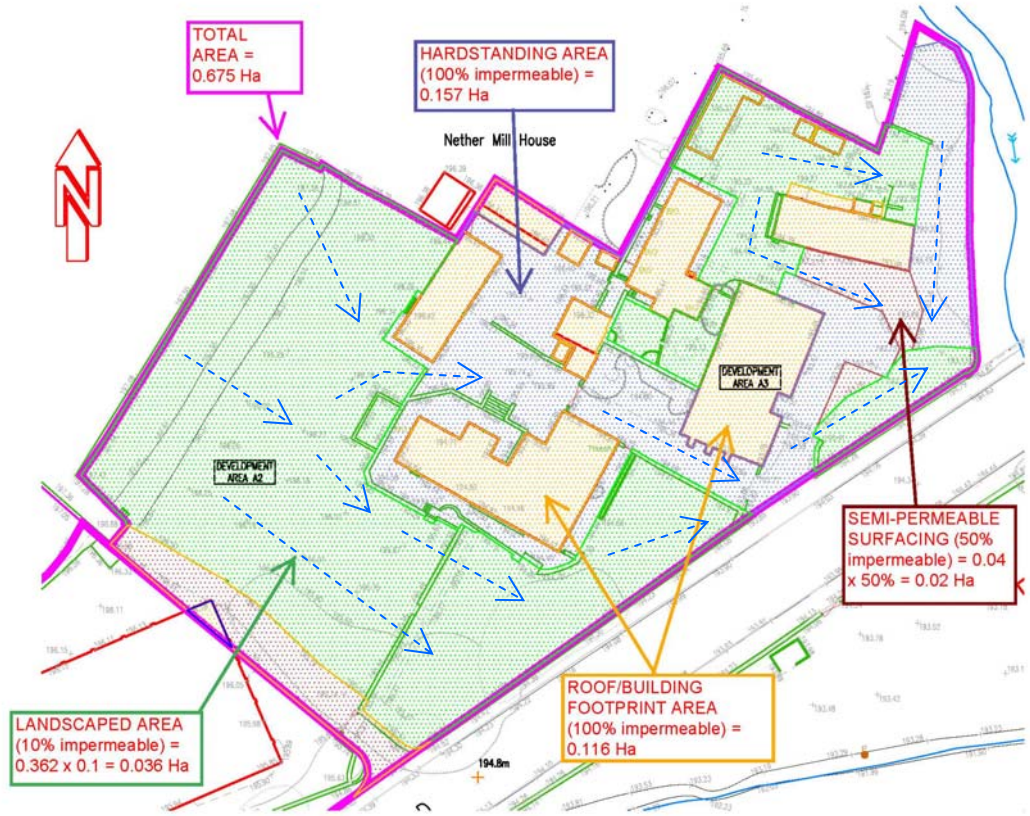
**Table 9: Existing Surface Water Runoff – Development Areas A2 & A3**

| Return Period | Ex. Peak Runoff Rate (l/s) | 30% Reduction (l/s) |
|---|---|---|
| 1 in 2 year | 27.2 | 19.0 |
| 1 in 30 year | 79.5 | 55.7 |
| 1 in 100 year | 122.5 | 85.8 |

In order to accommodate future climate change and provide a betterment to the existing situation, the Environment Agency; Yorkshire Water and Barnsley Council requires the application of a 30% reduction to existing peak runoff rates generated by the existing development.

Flows in excess of this should be attenuated on-site prior to discharge into the receiving sewer or watercourse.

**Figure 16: Existing Areas Contributing to SW Runoff (Development Areas A2 & A3)**




### 4.3.7 Evaluation of Existing Contributing Areas – B

The area within the boundary associated with Development Area B is approximately 0.47 Hectares; and is comprised of 3No barns. One barn, which is located near to the south boundary within the site, is open sided; whilst the other 2No buildings are stone construction.

Surface water runoff from the site is not currently drained via a positive drainage system. Roof water is allowed to discharge to ground surface level; where it flows overland towards the Don.

An evaluation of the roof and hardstanding areas within Development Area B has been undertaken, and is tabulated below. A sketch illustrating this assessment is provided within Figure 18.