



Barnsley Markets

Flood Risk Assessment

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The conclusions reached are those which can reasonably be determined from the sources of information referred to in the report and from our knowledge of current professional practice and standards. Any limitations resulting from the data are identified where possible but both these and our conclusions may require amendment should additional information become available. The report is only intended for use in the stated context and should not be used otherwise.

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Contents

Document Control	i
Contents	iii
1 Executive Summary	1
2 Introduction	3
2.1 Background	3
2.2 Site Location	3
2.3 Data Collection	4
2.4 Proposed Development	4
3 Data	6
3.1 Topographical Survey	6
3.2 Environment Agency	7
3.3 Yorkshire Water	8
3.4 Barnsley Level 1 Strategic Flood Risk Assessment	9
Flood Risk Assessment	10
3.5 Fluvial Flood Risk	10
3.6 Tidal Flood Risk	11
3.7 Overland Flow	11
3.8 Groundwater	13
3.9 Sewer Flooding	13
3.10 Artificial Sources	14
3.11 Climate Change	14
4 Site Drainage	15
4.1 Existing Site Drainage	15
4.2 Proposed New Development Drainage	15
5 Flood Risk Management	19
6 Conclusions	20
Appendix A	21
Appendix B	22
Appendix C	23
Appendix D	24



1 Executive Summary

<p>Existing Site</p>	<p>The site is situated within Barnsley town centre on grid reference 434650mE, 406300mN. The Barnsley to Sheffield railway line bisects the site creating two separate areas, the largest of which lies to the west of the railway and is the proposed site for the new 2.74 ha Barnsley Markets building. The remaining area of the site (0.78 ha) is located to the east of the railway and it is intended that this will be used for surface level parking. Additional areas of existing highway west of the railway line are to be resurfaced.</p> <p>The majority of the western portion of the site is currently occupied by two large concrete buildings associated with the Barnsley Markets and former Council Offices and a masonry clad steel framed building. Paved areas occupy the land surrounding the buildings. The site to the east of the railway line is currently occupied by a disused office block and car park.</p> <p>The proposed development within the western area of the site involves the construction of a new building to house the Barnsley Markets Complex, new retail spaces, a cinema and a multi-storey car park. It is proposed to construct a new surface level car park to the east of the railway line.</p>
<p>Flood Risk Assessment</p>	<p>The Environment Agency (EA) website flood risk zone map shows the site to lie entirely within Flood Risk Zone 1 (low risk – likelihood of flooding less than 0.1% - 1 in 1000 year return period).</p> <p>It is considered that the proposed development is not at significant risk of flooding from sources including rivers and watercourses, overland flow, sewers and groundwater.</p>
<p>Site Drainage</p>	<p>In line with EA requirements the new surface water drainage serving the development will provide a 30% reduction in runoff rates when compared with the existing site arrangements. In order to achieve this surface water flows will be restricted using hydro-brake flow control devices prior to discharging to the public surface water sewer / Sough Dyke.</p> <p>Excess surface water will be stored within below ground tanks and oversized sewers / culverts located within the site. The storage volume provided within the attenuation tanks will be sufficient to accommodate rainfall up to the 1 in 100 year event and including a 20% increase in runoff for climate change.</p> <p>It is not anticipated that the development will result in an overall increase in foul discharge. It is proposed to connect the new foul drainage to the existing public combined sewers in line with current arrangements.</p>



<p>Flood Risk Management</p>	<p>The site lies in flood risk zone 1 and in accordance with PPS25 is considered suitable for the proposed development.</p> <p>In order to protect the lower level of the new building in the event of either Sough Dyke or the public combined sewer surcharging, any new connections should be provided with non-return valves. In addition manholes associated with Sough Dyke and the public combined sewer located on the new service yard access road (which slopes into the basement) should be provided with double sealed covers that can be securely bolted down.</p> <p>Finished floor levels within the proposed new buildings should be set a minimum of 150 mm above surrounding ground levels.</p>
<p>Conclusions</p>	<p>It is concluded that the site is appropriate for the proposed development and a practical means of surface water management for the site can be provided.</p>

2 Introduction

2.1 Background

This Flood Risk Assessment report has been commissioned by The 1249 Regeneration Partnership LLP to support the planning application for the redevelopment of the existing Barnsley indoor market and surrounding area within the town centre of Barnsley. A previous Flood Risk Assessment report for the development of the site was produced by Halloran Payne Associates in April 2007. An Addendum to the Halloran Payne Associates Flood Risk Assessment was produced by Scott Wilson in October 2007 to address issues raised by the EA and to provide an assessment of the hydraulic capacity of Sough Dyke. The FRA Addendum report also considers the likely flow path and extent of flooding in the event of a collapse or partial blockage of the Sough Dyke.

This Flood Risk Assessment report represents an update on the previous reports for the site and includes the latest proposals for development of the site. In addition this report is undertaken in accordance with Planning Policy Statement 25 (March 2010) and the accompanying guidance issued by the Department for Communities and Local Government – Development and Flood Risk: A Practice Guide Companion to PPS25 (December 2009).

2.2 Site Location

The site is situated within the central area of Barnsley town centre on grid reference 434650mE, 406300mN. The area covered by the development of the proposed new Barnsley Markets building and car park is approximately 3.52 ha. Additional areas of existing highway are to be resurfaced. The Barnsley to Sheffield railway line bisects the site creating two separate areas, the largest of which lies to the west of the railway and is the proposed site for the new 2.74 ha Barnsley Markets building. The remaining 0.78ha is located to the east of the railway and it is intended that this will be used for surface level parking. The site areas are shown in figure 2.2 below.

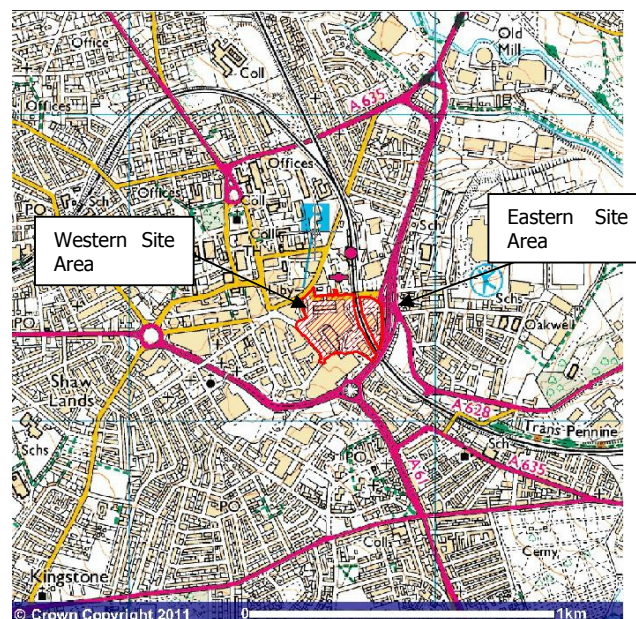


Figure 2.2: Site Location Plan

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The site is located within the urban town centre of Barnsley and is bounded by Kendray Street to the north, Harborough Hill Road to the east, Lambra Road and the Alhambra Shopping Centre to the south and Cheapside and May Day Green to the west.

The majority of the western portion of the site is currently occupied by two large concrete buildings and a masonry clad steel framed building. The northern concrete building contains various retail units at ground floor level and has a six storey office block above. The concrete building in the centre of the site contains the indoor part of the market at ground floor level. An access road and service area are present at a lower level beneath the market. Above the indoor market is a multi-storey car park which is accessed off Kendray Street and Lambra Road via concrete ramp structures. The masonry clad steel framed building is located to the south of the site between Lambra Road and the railway line and is currently vacant.

Paved areas occupy the land surrounding the buildings and include some surface level parking to the south of the market building.

The smaller area of the site to the east of the railway line is currently occupied by a disused office block and car park.

The existing site layout is shown on the topographical survey drawing number 030701-01 included in Appendix A.

2.3 Data Collection

Data sources that have been used for this flood risk assessment are:

- Topographical Survey;
- Environment Agency;
- Yorkshire Water Sewer Records;
- Barnsley Level 1 Strategic Flood Risk Assessment
- Previous Flood Risk Assessment report and Addendum report

2.4 Proposed Development

The development proposals involve the demolition and clearance of the existing buildings within the site.

The proposed development within the western area of the site involves the construction of a new building to house the Barnsley indoor market, new retail spaces, a cinema and a multi-storey car park.

Plans showing the proposed layout of the new building are shown on drawings AL (00) 008 – AL (00) 013 within Appendix B. A brief description of the proposed building is given below.

The new building forms a single structure at the lower ground floor level (interchange level). Part of the new indoor market and four retail units are located within the northern part of the building at the interchange level and are accessed directly off Market Square in the north east of the site. The remaining area of the interchange level is to be used for building services and retail service yard / loading areas and will include vehicular access from Kendray Street to the north and Lambra Road to the south. Further retail space and indoor market stalls are to be provided at the upper ground floor level (Cheapside Level). Two new shopping streets are also to be formed at this level, Midland Street and Market Parade, which provide direct access to the new retail units. Further retail space and a



café are to be provided at first floor level. At second floor level the central area of the building is to be used for a new cinema whilst the first of two floors of car parking is located above the southern and eastern parts of the building. Access to the two storey car park is provided by a spiral ramp off Lambra Road to the south of the site.

The development within the western portion of the site also includes the provision of paved external spaces including Market Square and the resurfacing of Kendray Street, May Day Green and Cheapside.

To the east of the railway line the proposed development involves the construction of a car park at ground level which occupies the entire area of the eastern site.



3 Data

3.1 Topographical Survey

A detailed topographical survey of the site including a survey of below ground services was undertaken during March 2007 by Charter Oaks Ltd. Drawing 030701-01 showing the existing site layout, services and topography is presented within Appendix A.

Within the western part of the site the survey drawing shows the location of the three existing buildings and surrounding paved areas including access roads to the service yard and multi storey car park.

To the centre of the eastern site area is a large building. A number of smaller buildings and containers are located to the south of the main building and two electricity sub-stations are located to the east. Paved areas surround the existing buildings and cover the remaining areas of the site.

The spot levels shown on the topographical survey indicate existing ground levels (in m AOD) within the streets that surround the site. Kendray Street to the north of the site falls in an easterly direction from a high point of approximately 97.5m at the junction of Eldon Street down to a level of approximately 92.1m to the east of the level crossing. Ground levels fall along the western boundary of the site from approximately 98.4m where Cheapside enters the site in the south west to a low point of approximately 95.9m adjacent the western entrance to the Barnsley Market building. Harborough Hill Road to the east of the site is constructed on a fly-over and is at considerably higher level than the site. Lambra Road falls to the south from a ground level of approximately 97.0m adjacent to the site down to approximately 93.0m where it passes beneath Harborough Hill Road.

The Ordnance Survey 1:50,000 scale map of the area indicates that ground levels within the surrounding area generally fall in an easterly direction towards the River Dearne approximately 1km away.

3.2 Environment Agency

The Environment Agency’s website flood risk map was consulted and the site is shown to lie entirely within flood risk zone 1 (low risk – likelihood of flooding less than 0.1% - 1 in 1000 year return period).

The EA website flood risk map is shown in Figure 3.2 below.

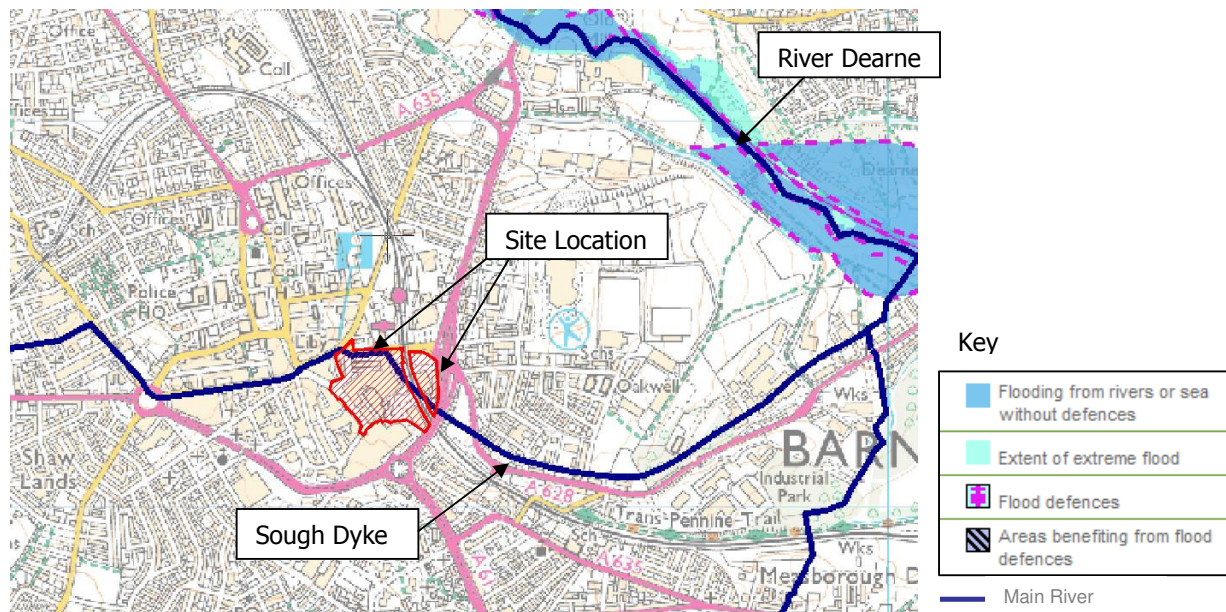


Figure 3.2: Environment Agency website flood risk map

The EA flood risk map indicates that the nearest area of higher flood risk is located approximately 0.8km to the north east and is associated with flooding from the River Dearne.

WYG and Barnsley Metropolitan Borough Council (Wayne Atkins) met with Lesley Slaney and Gary Cliff of the Environment Agency on the 18th February 2011. The latest scheme proposals were discussed and in particular issues relating to the diversion of the Sough Dyke culvert (main watercourse), the requirements for attenuation of runoff from the new impermeable surfaces and the scope of this flood risk assessment.

Sough Dyke is classified as 'Main River' and as such any work within 8m including foundations surfacing and diversion works will require a Flood Defence Consent.

The Environment Agency advised that a 30% reduction in surface water discharge rate from the site would be sought. The provision of storm water attenuation storage will therefore be required as part of the drainage design and this is considered further in section 5.2 of this report.



3.3 Yorkshire Water

Yorkshire Water (YW) sewer record plans have been received and are included within Appendix C. The record plans show two combined public sewer networks within the site vicinity.

The combined sewer network to the north serves a catchment area covering the town centre to the north of the site and May Day Green to the west. Public combined sewers from Eldon Street and May Day Green converge within Kendray Street. A 600mm diameter public combined sewer flows in an easterly direction along Kendray Street then turns south east and increases to a 750mm diameter sewer immediately after the junction with Midland Street. The existing public combined sewer lies within the footprint of the proposed new Barnsley Markets building at two locations and will require diversion. A short length (approximately 82m) of the existing 750mm combined sewer between Kendray Street and the railway and a further length (approximately 112m) of 600mm sewer within May Day Green will require diversion. Consultations are ongoing with YW regarding the diversions but general provisions and arrangement for the diversions have been agreed.

The southern public combined sewer network within the site is shown to drain the northern and western parts of the town centre, and flows into the site via two sewers that combine within a single 1360mm diameter brick sewer in Cheapside. The brick sewer flows in a south easterly direction along Cheapside receiving connections from the west. The combined sewer then passes beneath the Alhambra Shopping centre and flows to the south east along Lambra Road. A short section of this sewer adjacent Lambra Road lies within the proposed building footprint. The current proposal is to seek approval from YW for a build over agreement for the short section of the affected sewer; this has been agreed in principle.

The principal surface water feature in the area is Sough Dyke which is designated by the EA as a main river. YW record plans show the approximate location and alignment of the Sough Dyke (indicated as a continuous blue line on the plan). Sough Dyke is a culverted watercourse that flows in an easterly direction along Kendray Street then turns to the south east and passes underneath the railway line approximately 100m south of the level crossing. The records indicate that the size of the Sough Dyke culvert changes from 1800mm diameter flowing beneath Kendray Street reducing to 1650mm diameter between Kendray Street and the railway and then increasing in size to 2500mm as it passes beneath the railway line. A 1200mm public surface water sewer conveying flows from the south is shown to connect into the Sough Dyke near to the junction of Kendray Street and May Day Green.

Diversion of both the 1200mm surface water sewer within May Day Green (approximately 90m) and the Sough Dyke between Kendray Street and the railway crossing (approximately 117m) will be required in order to facilitate the construction of the proposed new building. Consultations with YW and the EA respectively regarding these proposed diversions are ongoing. A Flood Defence Consent will be required for the diversion of Sough Dyke.

Both the 750mm public combined sewer and the Sough Dyke culvert cross the area of the site to the east of the railway line, however the proposed use of this land as surface level parking will not require any diversion work.



3.4 Barnsley Level 1 Strategic Flood Risk Assessment

The Barnsley Level 1 Strategic Flood Risk Assessment (SFRA), undertaken by JBA Consulting dated September 2010 has been reviewed. Flood risk plans from the Barnsley Level 1 SFRA, for the site areas are included in Appendix D. Map D – 1 indicates the extent of fluvial flooding as a consequence of a 1 in 100year (1% probability) flood event i.e. equivalent to the extent of flood zone 3 on the EA flood risk plan. Map E – 1 indicates the extent of fluvial flooding anticipated during a 1 in 1000year (0.1% probability) flood event i.e. equivalent to the extent of flood zone 2 on the EA flood risk plan. The colour coding on the plans provides an indication of the predicted depth of flooding at a given location. The extent of flooding shown on these plans appears to be less severe than that shown on the EA plan. A further map included within the Barnsley SFRA (map H) shows the extent of flooding when a 20% increase in flood volumes is added to simulate the affects of climate change. All of these plans indicate that the site lies within flood risk zone 1 and that the nearest area of higher flood risk is located approximately 0.5 km away to the north east adjacent the River Dearne.

Map C included within the SFRA provides an indication of the locations where pluvial (over land) flows are likely to occur and the estimated depth of any pooling that might result. The analysis is based on a 1 in 100 year (1% probability) storm and assumes that existing sewers have capacity limited to the 10% (1 in 10 year) storm event.

Whilst Map C provides a good initial overview of the areas likely to be prone to pluvial flooding, the flood zones are only considered to be indicative since the actual sewer capacities were not modelled. Map C indicates a band of pluvial flooding across the western site area running between the two existing concrete buildings and then crossing the railway line into the eastern site area. The deepest predicted flood depth exceeds 2m within the eastern portion of the site.

3.5 Previous FRA and Scott Wilson Hydraulic Modelling

A previous Flood Risk Assessment report for the development of the site was produced by Halloran Payne Associates (HPA) in April 2007. The HPA report had been commissioned in support the planning application for a previous development proposal within the site, which is understood to have been more extensive than the current proposals. The report concluded that the site was at low risk of flooding, however as a result of the surrounding topography SUDS should be incorporated within the site drainage design to ensure that existing developments adjacent and at lower levels do not suffer flooding.

An Addendum to the Halloran Payne Associates Flood Risk Assessment was produced by Scott Wilson in October 2007 to address issues raised by the EA and to provide an assessment of the hydraulic capacity of Sough Dyke. The FRA Addendum report also considers the likely flow path and extent of flooding in the event of a collapse or partial blockage of the Sough Dyke. The hydraulic modelling and report undertaken by Scott Wilson concluded that the Sough Dyke diversion proposed by HPA would not have an adverse effect on the hydraulic performance of the watercourse. The report states that a significant partial blockage or total collapse of Sough Dyke where it passes the site is highly unlikely. Flood flow routes identified within the report suggest that the majority of flood flows generated in the event of a blockage or collapse of Sough Dyke would flow to a low area within the site to the east of the railway line. The flood flow route identified follows Kendray Street to the east, over the level crossing before turning into the eastern site area. The route assumes that measures will be taken to prevent flooding from manhole access points on the line of the culvert located within the lower area of the new building.



4 Flood Risk Assessment

4.1 Fluvial Flood Risk

Both the Environment Agency's website flood risk map and the flood risk map that accompanies the Barnsley Level 1 SFRA indicate that the site lies within Flood Risk Zone 1.

Whilst Sough Dyke is designated as a Main River, the length of the watercourse through the urban centre of Barnsley to the River Dearne flows in a culvert.

The length of Sough Dyke from Kendray Street to a point approximately 380m downstream of the site was modelled by Scott Wilson as part of their Barnsley Markets FRA Addendum – Sough Dyke Culvert report (October 2007). The Scott Wilson hydraulic model was constructed using the WinDes Microdrainage software and uses rainfall data derived from the ReFH method. Results for the 1 in 150 year critical duration storm are provided within Appendix A of the Scott Wilson report and indicate that the stretch of Sough Dyke within the site vicinity has sufficient hydraulic capacity to discharge the flows from the design storm.

According to an inspection report on the Sough Dyke culvert carried out by JBA Consulting dated February 2006 (Tranche A Critical Ordinary Watercourse Hydraulic Assessment – Priority 4 (Culverted Watercourses) the diameter of Sough Dyke reduces downstream of the site to 600mm in diameter. The downstream stretch of Sough Dyke is therefore considered to be at higher risk of flooding. The flow constriction in the downstream watercourse is however unlikely to increase the risk of flooding within the site since ground levels downstream of the site are significantly lower than those within the site (the cover level at the downstream end of the Scott Wilson model is 79.4m AOD). Localised flooding in the vicinity of the constriction is therefore considered more likely.

The results of the Scott Wilson hydraulic modelling appear to be verified by the known history of flooding along the Sough Dyke. Whilst there is no record of flooding from the watercourse within the immediate site vicinity, a flooding incident approximately 400m downstream of the site is identified within the JBA Consulting report. The incident occurred during the summer of 1997 when high water levels within the River Dearne caused Sough Dyke to surcharge; it is reported that the resulting pressure "blew off nearly 50m of the culvert crown near the football ground".

Although it is considered that under normal conditions the Sough Dyke does not pose a significant risk to the site, there remains a residual risk of flooding from the dyke in the event of blockage or collapse. The effects to the site from such flooding events were also considered as part of the Scott Wilson report. Partial and full blockages of the dyke at three separate locations were simulated for the 1 in 1, 1 in 30 and 1 in 100 year flood events. The location and volume of flooding that resulted in each of the hypothetical scenarios is tabulated within the report. The largest overall volume of flooding shown is generated by the 1 in 100 year storm event and occurs as a result of a total blockage of the culvert within the manhole immediately upstream of where the culvert passes beneath the railway. Whilst this is considered highly unlikely the total predicted volume of flooding for this event is given as 28,865m³.

The Scott Wilson report states that it is very unlikely that a full blockage or culvert collapse would occur at the very beginning of the storm event. It is far more likely that a blockage or collapse would occur at the peak of the storm and therefore result in a significantly lower volume of flooding. Furthermore the condition survey of the culvert, undertaken by JBA Consulting in May 2005, found that "overall, the culvert is serviceable and in reasonably good condition".



Notwithstanding this, relatively large volumes of overland flooding would be generated as a consequence of Sough Dyke collapsing or becoming blocked. It is therefore necessary to ensure that sufficient mitigation measures are in place to ensure that any flood water generated can be routed to such places where it can be safely managed. Overland flood routing is considered further within section 4.3 of this report.

4.2 Tidal Flood Risk

The site is remote from the coast and at levels in excess of 90m AOD; and as such is not therefore considered to be at risk of tidal flooding.

4.3 Overland Flow

Map C-1 that accompanies the Barnsley Level 1 SFRA indicates that the site lies within an area that is vulnerable to surface water flooding. A review of ground levels within the site and surrounding area indicates that there are two low points within the site where pluvial flows from the surrounding area could potentially collect. The locations of the low points are adjacent the existing entrance to the markets off May Day Green and within the centre of the eastern site area. These two locations approximately match the areas of vulnerability shown on Map C-1.

Much of the town centre to the west of the site contains a high percentage of impermeable surfaces and falls toward the site. Any overland surface water runoff from the area to the west of the site, not intercepted by existing drainage systems, is therefore likely to enter Cheapside via New Street or Queen Street. In addition overland flows from the north could enter the site at the junction of Kendray site with Eldon Street. Surface water entering Cheapside will currently flow into May Day Green and congregate at the low point of approximately 95.9m A.O.D. adjacent the existing entrance to the markets. Although there is no historic record of the existing drainage system being exceeded or becoming blocked, in the event of this occurring overland flows could potentially pool to a depth of approximately 1.1m (approximately 97.0m A.O.D.) before an alternative flow path becomes available either down Kendray Street or through the open market. Flooding of this extent would be sufficient to cause flooding to shops within May Day Green and Cheapside.

The second low point exists within the site to the east of the railway line, where pooling of surface water would potentially be contained by the retaining wall of Harborough Hill Road and the embankments and retaining walls of the railway line.

The indicative depth of flooding provided on Map C-1 is considered to be a very worst case assessment, since it is based on the conservative assumption that existing drainage networks would only have sufficient capacity to deal with a 1 in 10 year storm event. It is likely that the more recently constructed drains within the vicinity will have greater capacity than this (at least up to 1 in 30 year design storms in accordance with Sewers for Adoption). Furthermore a recent hydraulic modelling study of Sough Dyke (the principal watercourse in the area which flows in a culvert beneath the site) has established that the local stretch of this culverted watercourse has sufficient capacity to discharge flows from a 1 in 150 year storm event. There is no record of surface water flooding within the site areas indicated on Map C-1 or at any other locations within the site.

The recorded history of flooding in the Barnsley area (documented within the previous reports) suggests that the most notable record of flooding locally occurred as a result of prolonged and widespread rainfall during the summer of 1997. The rainstorm resulted in the flooding of an area near to the football ground due to structural failure of the Sough Dyke downstream of the site.



Jason Kilner of the Barnsley Markets has confirmed that in his experience, going back over a period of 24 years, the existing markets building and the streets immediately adjacent the site have never flooded.

The existing risk to the site from overland flooding is therefore considered to be low.

The design of the proposed new market and retail building includes features which will mitigate the risk from surface water flooding. Finished floor levels within the retail units along Cheapside and May Day Green are to be set at 97.0m AOD. This is higher than the finished floor levels of existing stores in this area which vary between 96.4 and 96.7m AOD. The new drainage system serving Cheapside and May Day Green includes the provision of below ground surface water storage and should have a higher capacity to remove standing water from the ground surface.

Overland Flows due to Sough Dyke Blockage or Collapse

There is a residual risk of surface water flooding in the event of a severe blockage or collapse of Sough Dyke. Whilst this scenario is considered relatively unlikely it could potentially lead to large volumes of water flowing overland from one or more manhole upstream of the blockage. Details of the predicted flood volumes and rates are provided within the Scott Wilson report.

As part of the development, Sough Dyke is to be diverted subject to an EA flood defence consent. The re-aligned culvert would have six manhole access points within the site as shown on drawing A66979-1316 (Appendix B). Three of the manholes are located within Kendray Street, two are located on the access ramp leading down to the service yard and the remaining manhole is located within the proposed car park to the east of the railway.

Flooding from either of the manholes located within the service yard access ramp would result in the inundation of the interchange level beneath the new Markets building. In order to ensure that potential flooding is routed to a more suitable location it is proposed that the manholes located on the access ramp be fitted with heavy duty double sealed covers bolted down into the frames. The frames will also need to be securely anchored into the manhole construction. Furthermore any new sewer connections from the new building into Sough Dyke should be protected by means of a suitable non-return flow mechanism. If these flood prevention measures are in place, flows from Sough Dyke would surcharge the culvert and surface at either the manhole within the car park to the east of the railway line or one of the manholes within Kendray Street (depending on the location of the obstruction).

Existing site levels (taken from the topographical survey) indicate a flood route down Kendray Street to the level crossing. Some flood water may enter the railway at this point but it is likely that the majority will continue over the level crossing and into the area of the site to the east of the railway. The predicted flood route is shown on drawing A066979-1316 within Appendix B. Some flooding of the car park would potentially occur and water levels could rise to approximately 90.7m before entering the railway land and flowing away to the south. The lowest proposed level within the car park is 90.15m AOD which suggests a maximum flood depth of approximately 0.55m.

The design of finished levels within Kendray Street will need to be considered carefully to ensure that flows are channelled along Kendray Street and away from entrances to the lower level of the new building. The design of the new markets includes two areas where external ground levels fall towards the building; the area of Market Square which falls toward the entrance of the Indoor Market, and the top of the service yard access ramp. Drawing A066979-1316 indicates suggested levels such that flows would be directed away from these entrances.



In the unlikely event that overland flows enter the interchange (basement) level of the building any resulting flooding would be occur within the service yard where finished floor levels are lower and not the public area of the building. The service yard is to be provided with drains.

Whilst there is a residual risk to the site from overland flows, it is considered that these risks can be suitably mitigated as part of the detailed design. The risk of flooding to the site from overland flows is not therefore considered significant.

4.4 Groundwater

The site does not lie within an area defined within the Barnsley Level 1 SFRA as being at risk of groundwater flooding. There is no known history of groundwater flooding at the Barnsley Markets site including the existing basement area. The lower level / basement of the proposed markets building is to be constructed at a similar level to that of the existing building.

The site is not considered to be at risk of groundwater flooding.

4.5 Sewer Flooding

As outlined in section 3.3 the Yorkshire Water sewer record plans, see Appendix C, indicate a number of public sewers within the proximity of the site boundaries. Flooding from sewers can occur as a result of sewer blockages, or collapses, or as a result of the sewers not having sufficient capacity to convey high flows, particularly during severe rainfall events.

Some of the public surface water and combined sewers within the site vicinity are of relatively large diameter and could therefore potentially give rise to significant levels of flooding in the event of failure. These sewers are, however, owned and maintained by YW and a collapse is not therefore considered likely. In the unlikely event of a sewer blockage it is anticipated that YW would attend the site as a matter of urgency and take appropriate actions to reduce the risk to public health and property.

The volume and rate of flooding from public sewers would be considerably lower than could potentially be generated by a collapse or blockage of the Sough Dyke. Overland flows from surcharging sewers are described in section 3.7 above.

It is intended that some lengths of the existing public sewers will be diverted outside the footprint of the proposed new Barnsley Markets building (see drawing A066979-1310 in Appendix B for details). The new sections of sewer will be designed in accordance with Sewers for Adoption 6th Edition and should remain in good structural condition for many years.

The diversion of the existing combined sewer to the east of the new proposed building includes the construction of a new manhole on the service yard access ramp. It is suggested that protection measures be undertaken at this manhole to prevent flooding of the service yard. Protection measures could include the provision of a sealed and bolted manhole cover and non return valves on any new connections from the proposed building.

The risk of the site flooding from overloaded, blocked or collapsed sewers is considered low.



4.6 Artificial Sources

There are no artificial sources of flooding within the immediate vicinity of the site.

4.7 Climate Change

In accordance with PPS25, the effects of future climate change have been considered. The effects of climate change are likely to increase flood risk but as the site is considered to be at relatively low risk at present and since the proposed development is for a less vulnerable use the residual risk after taking into account climate change will remain acceptable.

The site drainage will be designed taking climate change into account thereby minimising the risk both to the site and the wider catchment. Additional storage will be provided within the new drainage system to allow for the anticipated increase in rainfall intensities over the life of the development due to climate change. A design life of 50 years is deemed appropriate for the new Barnsley Markets building, and in accordance with PPS25 table B.2 an increase in rainfall intensities (and therefore storage provision) of 20% is applicable.



5 Site Drainage

5.1 Existing Site Drainage

The topographical survey of the site (see Appendix A) includes some details of the existing surface water and foul drains that serve the buildings and paved areas currently on the Barnsley Markets site.

The topographical survey plan indicates that there are a number of surface water connections from the existing Barnsley Markets building into the public surface water sewer in Cheapside. Several foul connections from the western elevation of the office block are also shown and it is assumed that these connect to the public combined sewers in May Day Green. A network of private surface water and foul drains serving the office block and car park to the east of the railway line are shown on the topographical survey plan. The direction of flow in the private foul drains suggests a connection into the 750mm public combined sewer within the site although the point of connection is not identified. The private surface water sewers in the eastern site area also flow toward the south, and could potentially connect to either the Sough Dyke or the public combined sewer within the site, but again the connection detail is not included on the topographical survey drawing.

A recent CCTV drainage survey was undertaken by Environmental Drainage Solutions during March 2011 in order to establish details of the existing drainage arrangements within the basement of the Barnsley Markets (not shown on the topographical survey drawing). The approximate location and depth of the drains covered by the CCTV survey are shown on drawing EDS/EAC/3903/01 in Appendix A.

The drawing produced following the recent CCTV drainage investigation shows how the remaining areas of the markets and office block buildings drain to the basement level. Surface water drains combine within the basement and discharge to Sough Dyke immediately upstream of the railway crossing. Foul drains from the existing building above combine in a similar manner and discharge to the existing combined sewer upstream of the railway crossing. The drawing also shows the location of foul and surface water drains which connect the existing masonry clad steel framed building in the south of the site to the public sewerage network.

5.2 Proposed New Development Drainage

Diversion of existing sewers / Watercourse

As discussed in section 3.3 of this report it will be necessary to undertake the diversion of existing public sewers and a part of the Sough Dyke prior to the construction of the new Barnsley Markets building. The scope of this work includes the diversion of public surface water and combined sewers within May Day Green and the diversion of a public combined sewer and section of Sough Dyke located between Kendray Street and the Railway line. In addition a build over agreement will be required for a short section of the existing 1200mm diameter public combined sewer adjacent Lambra Road where the proposed building footprint encroaches over the sewer.

Meetings have been held with both YW and the EA to discuss the sewer and watercourse diversions. The diversion works have been agreed in principal (subject to detailed design approval) and it is intended that the sewer diversions will be carried out under a section 185 agreement with YW whilst the diversion of Sough Dyke will require



a Flood Defence Consent from the EA. An overview of the proposed diversion works is shown on drawing A066979-1310 included within Appendix B.

Proposed Surface Water Drainage

WYG Engineering attended a meeting with Lesley Slaney and Gary Cliff of the Environment Agency (EA) on the 18th February 2011 to discuss the redevelopment of the Barnsley Markets and surrounding area. It was established at the meeting that the EA would seek a reduction in run-off from the site of 30% as part of the development. As the proposals do not include a reduction in the impermeable area of the site, it will be necessary to place a restriction on the rate of discharge from the site and provide suitable surface water storage on site to store the excess surface water.

In order to establish a limit for the future site discharge, it is necessary to establish the existing site runoff situation. The existing areas of the site which lie within the footprint of the proposed Barnsley Markets building and car park are covered by roofs, paved areas, and roof level parking. As a result the existing site is considered 100% impermeable.

Existing runoff rates have been calculated using the rational method and rainfall data for the site location derived from the Flood Estimation Handbook. The 60 minute, 1 in 100 year design storm has been used to establish runoff rates for the existing site. For the 1 in 100year, 60 minute design storm the runoff from the land within the footprint of the proposed building and car park was found to be 408 l/s.

Table 4.2 below shows the FEH design rainfall data for the site location and the 1 in 100 year return period used in the calculations.

Storm Duration (hrs)	0.5	1	2	4	6	10	24
FEH Design Rainfall (mm)	34.8	41.7	49.9	59.8	66.4	75.8	98.4

Table 4.2 FEH design rainfall

Applying a 30% reduction to the existing rate of runoff gives a limit on the rate of runoff from the new building and car park of 285.6 l/s (408 x 0.7). As such attenuation storage within the site drainage system will be required.

Due to the town centre location and the limited available space within the site it is proposed that the surface water storage is provided in the form of below ground tanks and oversized pipes / culvert sections. The proposed drainage strategy is shown on drawing A066979-1317 within Appendix B.

Under the proposed drainage strategy the site is broken down into four separate catchment areas each with a connection to either public surface water sewers or the Sough Dyke. The catchment areas are as follows.

- The runoff from part of the new building roof adjacent Cheapside (where no basement level is proposed) will discharge to the diverted section of the public surface water sewer in May Day Green. Discharge to the public sewer is to be controlled by means of a hydro-brake flow control and excess surface water will be stored within a length of box culvert located within an area of the existing buildings basement that is to be in-filled as part of the development.



- The majority of the runoff from the new building roof area will collect beneath the lower area of the building. A network of oversized sewers / culvert sections will convey flows to a new connection on the Sough Dyke immediately upstream of where the watercourse crosses the railway. A hydro-brake flow control will be located immediately upstream of the connection to limit the offsite discharge and utilise the storage available within the culvert sections.
- Surface water runoff from the new car park access ramp to the south of the site is also currently shown to discharge at Sough Dyke immediately upstream of the railway. Runoff from the ramp and surrounding area is controlled via a hydro-brake and stored in a tank beneath the new spiral ramp. Information from the recent CCTV survey suggests that there may be an alternative connection available for this area utilising the surface water sewer within Lambra Road.
- The proposed car park to the east of the railway is to discharge to a new manhole constructed on Sough Dyke. Again flows will be controlled via a hydro-brake and stored within a below ground attenuation tank.

The table below summarises the proposed strategy for the attenuation and storage of surface water runoff from the developed site.

	Restricted discharge (l/s)	Storm water storage (m ³) For up to 1 in 100 yr + CC (20%) storm event
Roof areas adjacent Cheapside & May Day Green (approx 0.65ha)	52.7	177
New building roof areas (approx 1.89ha)	153.2	513
Lambra Road car park access ramp (approx 0.2ha)	16.2	54
Proposed car park east of railway (approx 0.78ha)	63.2	212

In line with the recommendations set out in PPS25 it will be necessary to provide additional storage to allow for the anticipated increase in rainfall intensities over the life of the development due to climate change. In this instance a design life of 50 years is deemed appropriate, and in accordance with PPS25 table B.2 an increase in rainfall intensities of 20% has been applied in the calculation of storage shown in the table above.



Proposed Foul Drainage

It is proposed that the foul drainage from the new market area, retail units, café and cinema will collect at high level (soffit level) within the service yard area of the building. A new network of below ground foul drains, laid under the lower area of the new market and service yard, will collect the drainage from above together with floor gulleys, toilets, wash basins, etc at the lower level. A single connection is proposed to facilitate the discharge of foul flows from the new building to the public combined sewer to the east immediately upstream of the railway line. The proposed below ground foul drainage is shown on drawing A066979-1317 within Appendix B.

The developed site will generally be used in a similar way to the existing site with the majority of the developed floor space being used for the markets and retail use. The proposals for the site will see the removal of office accommodation and the provision of a new cinema and an increase in retail space. It is not anticipated, however, that the proposed development will result in an overall increase in foul discharge.

It is proposed that the new foul drainage connection will be made under Section 106 of the Water Industry Act 1991.

Phased construction

It is proposed that the demolition of existing structures and the construction of the new buildings will be undertaken in two phases to minimise disruption to the markets and enable its continued use. The proposed phasing of the works is shown on drawings AL (98) 001, AL (98) 002, AL (98) 101 and AL (98) 102 within Appendix B.

The new indoor markets within the northern area of the site will be the first part of the new building to be constructed allowing the market to continue trading in the existing building to the south. Once construction of the new markets building is complete, demolition of the existing market building and multi-storey car park can be undertaken. As a result it is necessary for the drainage provided to serve the phase one building to operate independently of the phase 2 area and discharge separately to the wider drainage network. As a result the phase 2 area can subsequently be constructed and will not affect the phase 1 drainage.

In order to achieve this criterion it is proposed that the foul and surface water drainage for the new markets building constructed in phase 1 is connected to manholes F8 and S4 respectively as part of the phase one scheme (see drawing A066979-1317 for details). Temporary connections from these manholes will be made to existing manholes EDS11 and EDS12 (see drawing EDS/EAC/3903/01 for details). The section of box culvert tank sewer beneath the meat and fish market, has approximately sufficient capacity to provide a 30% reduction in runoff from the phase one roof area. This temporary arrangement would not include spare capacity as an allowance for increased flows due to climate change. This is not however considered necessary since this is a short term measure.

On completion of the phase one and two work the drainage will be connected as shown on drawing A066979-1317. Storage provision will include spare capacity to allow for an increase in rainfall intensities of 20% over the design life of the new building.



6 Flood Risk Management

PPS25 recommends that a risk-based approach and sequential test are used in order to determine whether a site is suitable for a particular development. The assessment of risk and sequential test are considered as follows:

The proposed development site is shown to be located within Flood Zone 1, therefore, in accordance with PPS25, the site is considered suitable for the proposed development.

The proposed development of the site will not result in an increase in impermeable area. Furthermore in line with the EA's requirements; surface water runoff from the developed site is to be 30% lower than from the existing site arrangements. The proposed development will therefore result in a reduced discharge of surface water.

In order to achieve a 30% reduction in off site runoff the rate of surface water flows will be restricted using hydro-brake flow controls prior to discharging to public surface water sewers and Sough Dyke. Excess surface water will be stored within below ground tanks and oversized sewers / culverts located within the site. Storage volume provided within the attenuation tanks, outlined in the previous section, will be sufficient to accommodate rainfall up to the 1 in 100 year event and including a 20% increase in runoff for climate change.

In order to protect the lower level of the new building in the event of either Sough Dyke or the public combined sewer flooding, any new connections should be provided with non-return valves. In addition manholes on the line of Sough Dyke and the public combined sewer that will be located on the new service yard access road should be provided with double sealed covers that can be securely bolted down to prevent surcharging and flooding at these locations.

Finished floor levels within the proposed new buildings should be set a minimum of 150 mm above surrounding ground levels in accordance with the Building Regulations so the future risk of flooding from surface water run-off or overland flow will be minimal. External paved areas should be designed to fall away from the new building and in particular to channel flows away from entrances into the building.



7 Conclusions

This Flood Risk Assessment has been undertaken to support the planning application for the redevelopment of the existing Barnsley Indoor Market and surrounding area.

The site is shown on the EA flood risk map of the area to be located in flood risk zone 1. It is therefore concluded that the site is at low risk of fluvial flooding and in accordance with the requirements of the sequential test in PPS25: Development and Flood Risk, the site is suitable for the proposed development. Furthermore it is considered that the proposed development is not at significant risk of flooding from other sources including overland flow, sewers and groundwater.

In accordance with the recommendations in PPS25, the design of the new development will adopt measures to reduce the surface water discharge through the use of sustainable drainage techniques. Surface water runoff from impermeable areas of the site will be discharged to public surface water sewers and the Sough Dyke at attenuated rates (30% lower than current site discharge rates). Attenuation storage below ground will be provided to prevent flooding of vulnerable areas within the site and of land adjacent to the site.

As part of the new development it will be necessary to divert Sough Dyke beyond the proposed new building footprint. A Flood Defence Consent application will be undertaken with the EA to facilitate this.

This report concludes the site is at low risk of flooding and will not increase flood risk elsewhere in the catchment. Furthermore it is concluded that there is a practical means of foul and surface water management for the site.



Appendix A

Charter Oaks Ltd – Topographical Survey Drawing 030701-01

Environmental Drainage Solutions - CCTV Inspection Drawing EDS/EAC/3903/01



Appendix B

AL (00) 008 – General Arrangement (Plan), Interchange Level

AL (00) 009 – General Arrangement (Plan), Cheapside Level

AL (00) 010 – General Arrangement (Plan), Upper Level

AL (00) 011 – General Arrangement (Plan), Leisure Level

AL (00) 013 – General Arrangement (Plan), Roof Level

A066979-1310 – Existing Public Drainage and Proposed Diversions

A066979-1316 – Indicative Levels and Flood Routes

A066979-1317 – Flood Risk Assessment – Indicative Drainage Layout Plan

AL (98) 002_AC Ph 1 CL Demolition & Phasing

AL (98) 101_AC Ph 1 IL Construction & Phasing

AL (98) 102_AC Ph 1 CL Construction & Phasing

AL (98) 001_AC Ph 1 IL Demolition & Phasing



Appendix C

Yorkshire Water Sewer Record Plans



Appendix D

Barnsley SFRA Map C-1 – Pluvial Flooding Caused by 100 Year Rainstorm

Barnsley SFRA Map D-1 – Extent of 1% Fluvial Flooding

Barnsley SFRA Map E-1 – Extent of 0.1% Fluvial Flooding

Barnsley SFRA Map H-1 – Extent of 1% Fluvial Flooding Including 20% allowance for Climate Change