



**FLOOD RISK ASSESSMENT  
BAKERS QUAY, GLOUCESTER  
FOR  
ROKEBY MERCHANT (GLOUCESTER) LTD**

**RDL00415/FR1V1.2**



## REPORT DETAILS

Reference	Report Type	Author / Approved	Issue Date
RDL00415FR1	Flood Risk Assessment	TSL/AMP	7/8/2015

## REVISIONS

Revision	Details of Revision	Initials	Date
V1.0	Planning Issue	TSL	7/8/2015
V1.1	Regulatory comments incorporated. Proposed alteration to scheme following fire in Provender Mill incorporated.	TSL	12/01/2015
V1.2	Regulatory comments incorporated.	DA	02/02/16

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## **1.0 INTRODUCTION**

### **1.1 Terms of Reference**

- 1.1.1 This Flood Risk Assessment (FRA) has been prepared to reflect the requirements of the National Planning Policy Framework 2012, National Planning Policy Technical Guidance document dated.
- 1.1.2 The report relates to the planned redevelopment/change of use of the building/site.
- 1.1.3 The report is based on the following information:
- (i) OS Explorer Series Mapping
  - (iii) Environment Agency mapping and consultation
  - (iv) Severn Trent Water mapping and consultation
  - (v) Site visit undertaken by Jackson Purdue Lever
  - (vi) Gloucester City Council level SFRA 1
  - (vii) Outline FRA for wider Bakers Quay Development
- 1.1.4 This study relies on statistical assessments and therefore positive conclusions with respect to flooding should not be interpreted as a guarantee against flooding of the study site.
- 1.1.5 This report has been updated following significant damage to the Provender Mill by fire. The proposals reflect the scheme delivered by the original application reference 15/01144/FUL and the subsequent amendments reflecting alternative proposals for the Provender Mill.

## 2.0 DETAILS OF SITE

### 2.1 Site Location

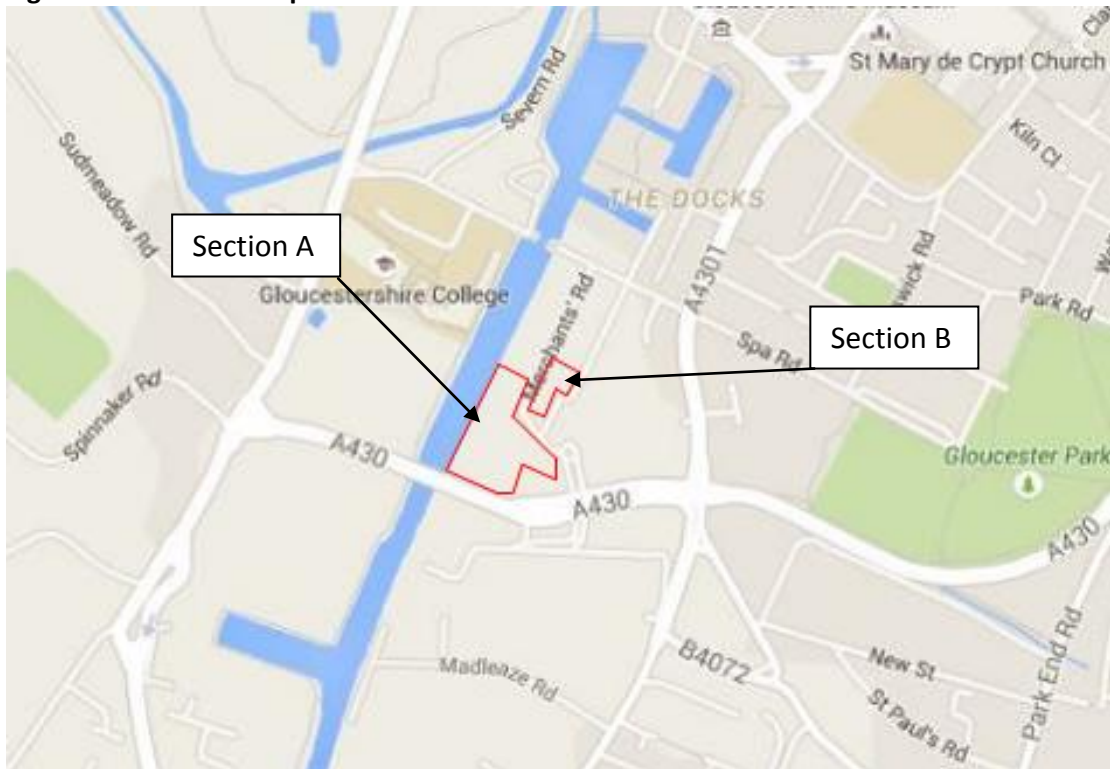
2.1.1 The proposed development is located on a site to the South West of central Gloucester known as Bakers Quay which is to the South of the main basin of Gloucester Dock.

A location plan is provided under **Figure 1**.

**Table 1 – Site Summary**

Project Name	Bakers Quay
Address	Bakers Quay, Gloucester
OS NGR	E: 382581.78 N: 217850.11
Site Area	1.62 ha (Site A 1.34ha) (Site B 0.28ha)
Development Type	Mixed Commercial/Residential Development
Local Planning Authority	Gloucester City Council

**Figure 1 – Site location plan**



## Existing Site Description

- 2.1.2 The site is bound to the west by the Gloucester and Sharpness canal and to the east by the Gloucester Quays outlet centre. The A430 (St Ann Way) runs to the south of the site and to the north lies the recently regenerated area of the Gloucester Quays.

The site consists of two parcels of land which are separated by Bakers St and Merchants Rd. The site is accessed via St Ann Way which is part of the inner city ring road.

As shown in fig 2 below the site has been partly cleared however four grade II listed buildings remain which are the Provender Mill ( and associated engine house), a Transit Shed, Downing's Malthouse and the Malthouse Extension. Also on the site in the north west portion are a series of cottages, a concrete silo and the remains of the kiln of another Malthouse which historically sat in the location of the concrete silo.

However, since the original application the Provender Mill has suffered extensive fire damage and has been partially demolished.

The site is relatively level with existing levels ranging between 10.9AOD and 12.5 AOD

**Figure 2 – Aerial Photos**

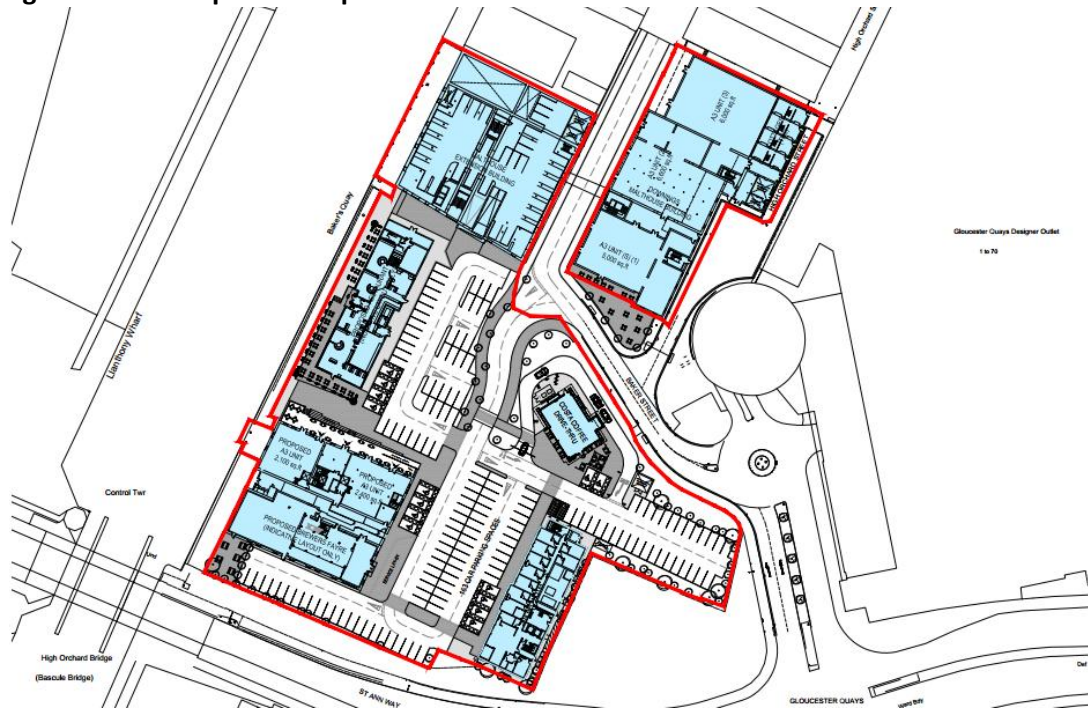


## 2.2 Development Proposals

2.2.1 The original development proposals comprised, a mixed development including residential accommodation, a hotel and leisure facilities. A development layout is presented in a figure 3 below.

Whilst the proposed uses remain unchanged amended proposals reflect amended have been submitted for the Provender Mill following extensive fire damage.

**Figure 3 – Development Proposals**

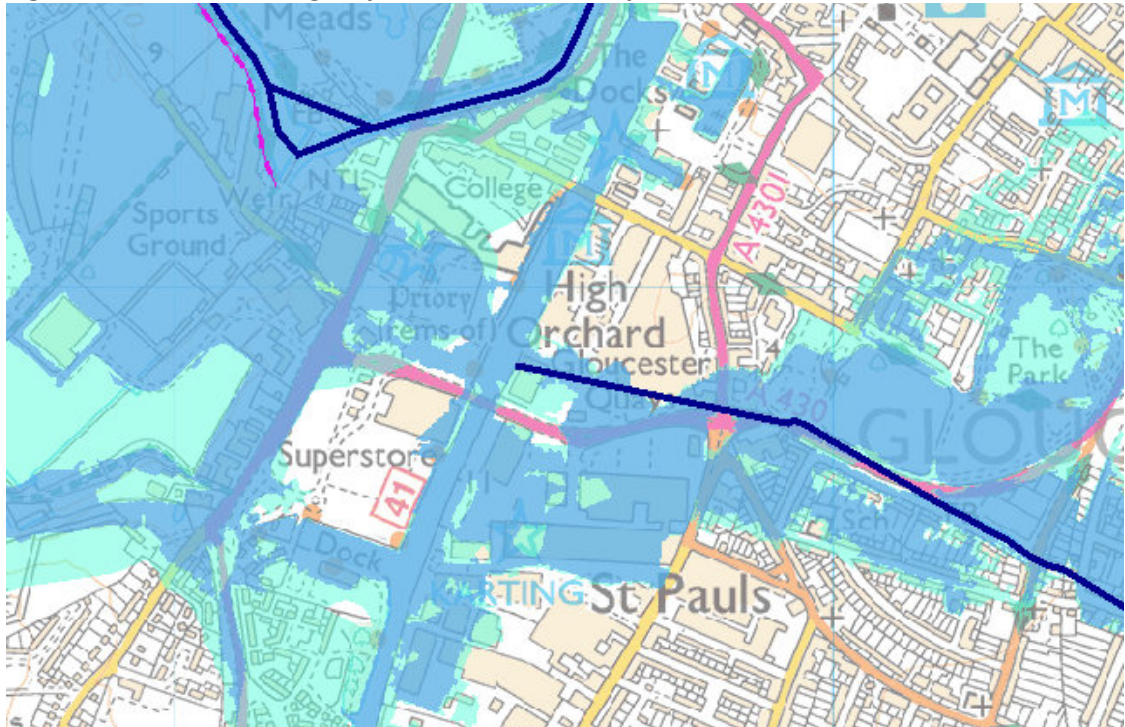


### 3.0 INITIAL ASSESSMENT

#### 3.1 Flood Zone Classification and Historical Flooding

Figure 4 below shows the indicative floodplain map as presented on the Environment Agency Website. The site is shown to lie substantially within Zones 2 & 3 (inside of the 1 in 1000 year and 1 in 100 year flood plains respectively).

**Figure 4 - Environment Agency Indicative Flood Map**





### 3.2 Possible Flood Mechanisms

Set out below are the potential sources of flood risk to the site. The significance of these sources is investigated further in section 4.0 of this report where applicable.

**Table 2 – Possible Flood Mechanisms**

Flood Source	Presence	Description
Flooding from Rivers (Fluvial)	✓	The development is situated approximately 300m from the River Severn (Eastern Branch) and the culverted Sud Brook bisects the site
Flooding from the Sea (Tidal)	✓	The River Severn in close proximity to the site is subject to tidal influences.
Flooding from Groundwater	X	No evidence of ground water flooding was identified in the preparation of this report.
Flooding from Sewers	X	A small diameter combined sewer runs in a southerly direction along Merchant Street between the two parts of the site.  Reference should also be made to the Fluvial flooding section due to the presence of the Sud Brook Culvert beneath the site.
Overland flow originating off site	✓	The site is relatively flat and the surrounding levels do not rise significantly reducing the risk of overland flows. However, consideration should be given to the Sud Brook as any out of bank flows could be manifested as overland flows.
Development Drainage	✓	The site is currently predominantly hard paved, however reconfiguration of the drainage could give rise to increased flood risk on and off site so consideration is warranted.
Reservoirs canals and other artificial sources	✓	The site is in close proximity to the Gloucester and Sharpness Canal and close to the flood plain associated with a breach of the Saintbridge Balancing Pond.

The primary source of flood risk is considered to be from fluvial sources.

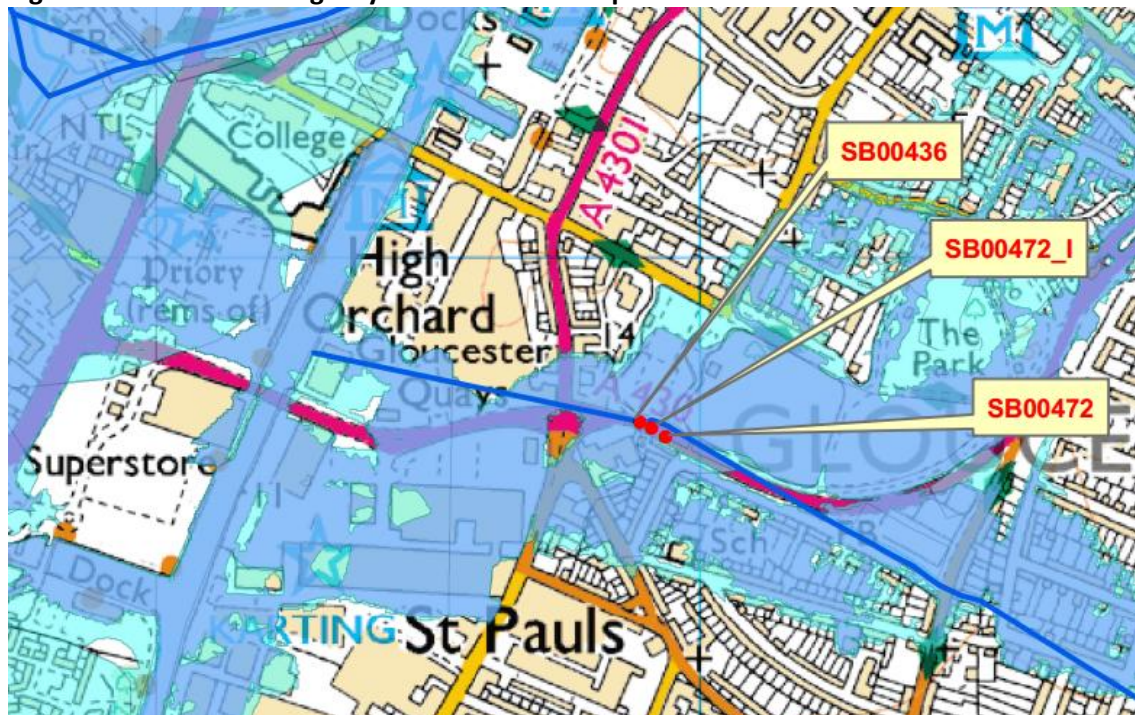
## 4.0 FLOOD RISK ASSESMENT

### 4.1 Flooding from Rivers (Fluvial)

The Environment Agency's Indicative Floodplain Maps show the development area is located substantially within the **Flood Zones 2 and 3** which are defined as being land at a low and medium probability of flooding (inside of the 1 in 1000 year and 1 in 100 year floodplains respectively)

Detailed mapping obtained from the EA confirm the sites setting predominantly within Zones 2 & 3 see. Figure 5 below.

**Figure 5 - Environment Agency Detailed Flood Map**



#### **Hydrology**

The culverted Sud Brook bisects the site flowing in a westerly direction before discharging into the Gloucester and Sharpness Canal, located immediately to the west of the site.

The River Severn (East Channel) is located approximately 300 m to the north-west of the site.

#### **Historic Flooding**

The Gloucester City Council (GCC) Level 1 SFRA and historic EA flood mapping have been reviewed to identify if the site or surrounding area has been subject to historic flooding. Tile E1 of the GCC SFRA and Environment Agency records show that there are no records of flooding at the site from these sources. Refer to figures 6 &7 overleaf.

Figure 6 - Environment Agency Historic Flood Map

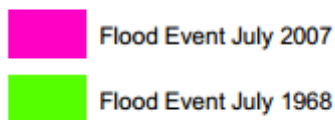
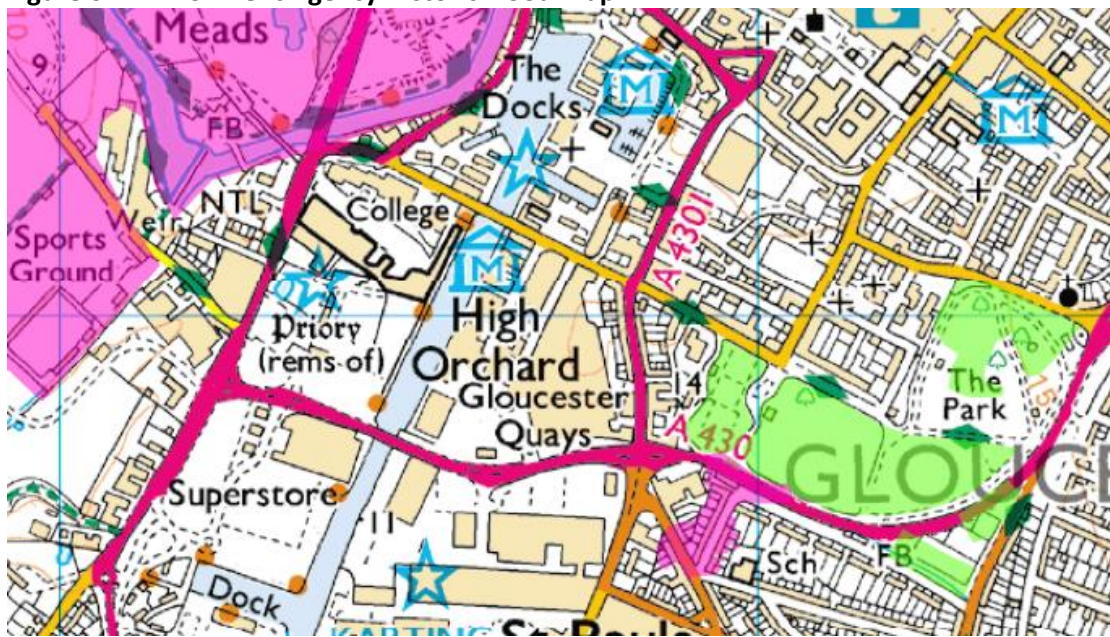
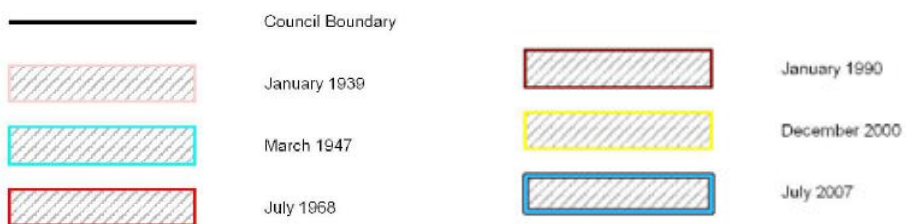
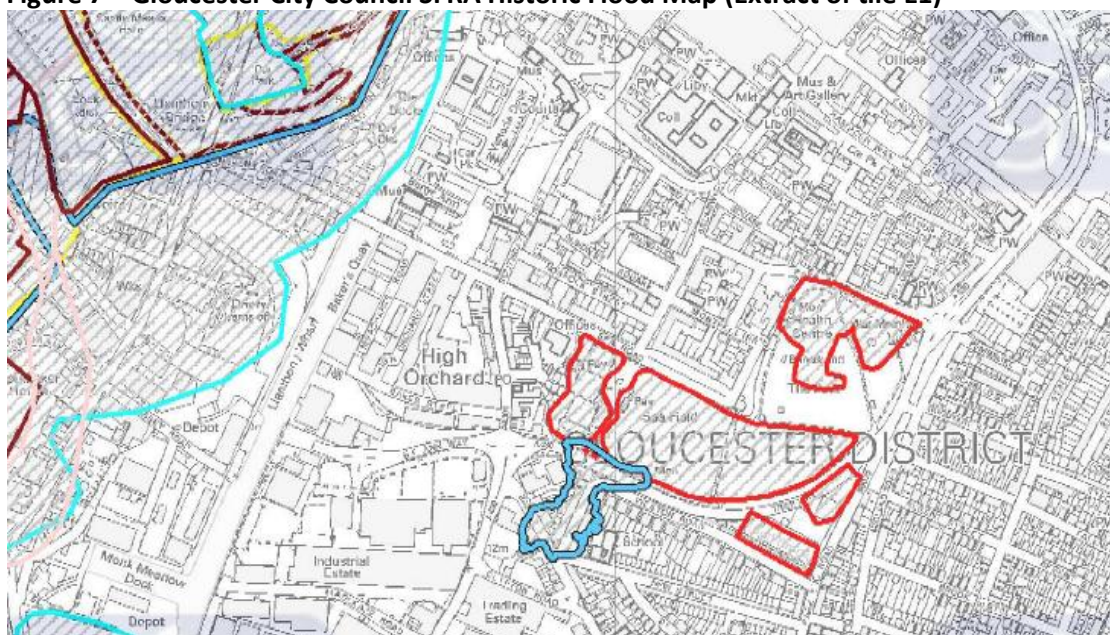


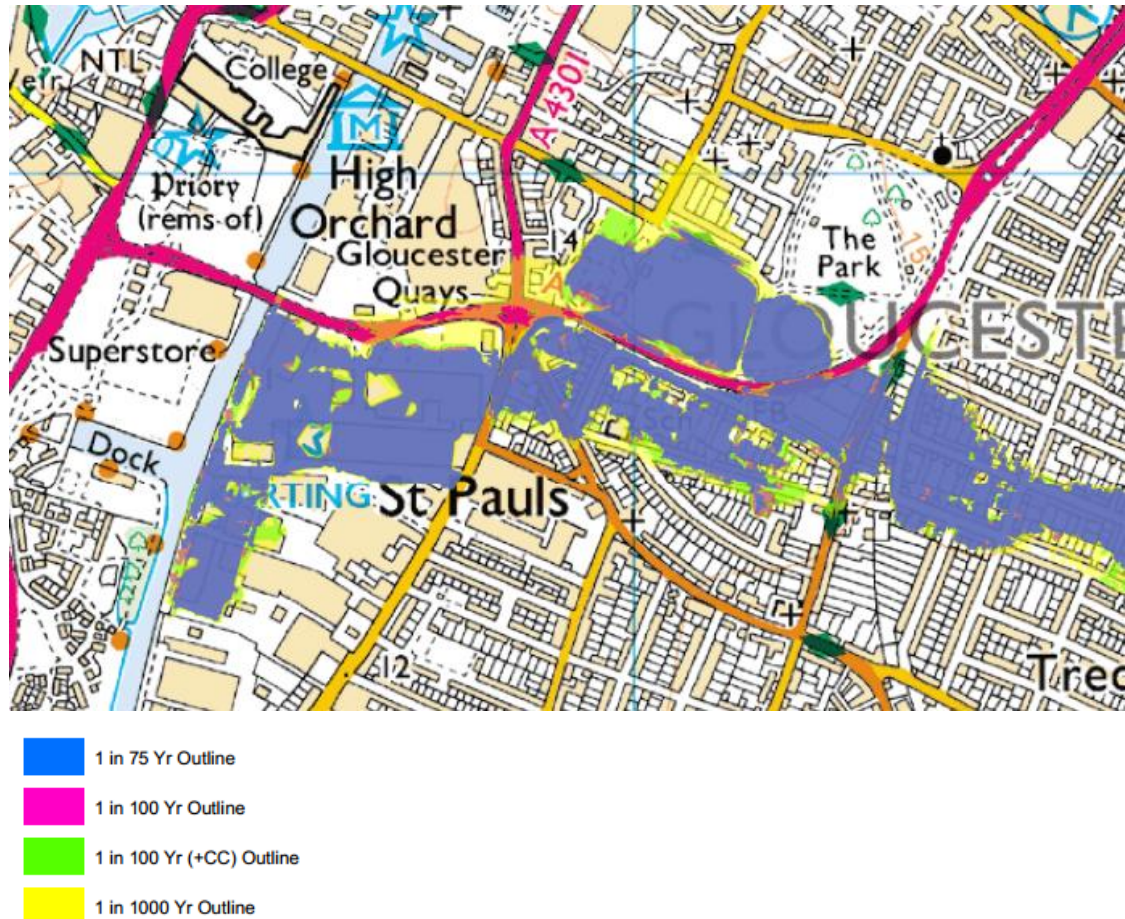
Figure 7 – Gloucester City Council SFRA Historic Flood Map (Extract of tile E1)



## Sud Brook

The mapped extents of flood modelling for the Sud brook have been obtained from the Environment Agency. Whilst the Sud brook is culverted through the site, the modelled flood plain attributable to the Sud brook can be seen to extend to the south of the site rather than impact the site directly. Reference should be made to figure 8 below.

**Figure 8 – Environment Agency Sud Brook Flood Map (Extract of tile E1)**



## Flood Levels

In the preparation of this FRA, data contained in the Outline FRA for the wider Gloucester Quays development has been utilised. The FRA for the wider development adopted a combined 100 year fluvial and tidal flood level of 11.18AOD. This figure was derived from an ISIS model study undertaken by Babbie, Brown and Root in 2002. This flood level is understood to reflect anticipated levels at a node coincident with the Gloucester Docks gauging station (located approximately 650 m to the north of the site).

Whilst it is understood that the Babbie, Brown and Root model was accepted to be robust due to the consideration of combined fluvial and tidal events, 600mm freeboard above the 11.18AOD level has been adopted on previous phases of wider Bakers Quay development. Existing site levels on the proposed development vary from 10.9 to 12.5 although are generally above the flood level of 11.18.

The site is occupied by a number of existing buildings which are listed and are required to be retained as a part of the development. Existing floor levels for ground floor and basements are shown in table 3 below.

It will be necessary to set the finished floor level to all new build extents at a minimum level of 11.78AOD to reflect the appropriate flood level and the adopted freeboard.

Where existing listed buildings are to be reused and floor levels do not meet the minimum level and adopted freeboard, sensitive end uses should be steered away from the lower levels and appropriate flood resilience measures should be considered.

**Table 3 – Comparison of floor level to minimum floor level**

	BUILDING	BASEMENT LEVEL	GROUND FLOOR LEVEL
R e d s h a d i n g d e	MALTHOUSE EXTENSION	11.25	13.80
	PROVINDER MILL (ALTERNATIVE SCHEME FOLLOWING FIRE DAMAGE)		12.00 (min 11.78)
	ENGINE HOUSE		12.66
	DOWNINGS MALTHOUSE	11.46	13.83
	COTTAGES		14.90
	HOTEL		12.20 (Min 11.78)
	RESTAURANT		12.00 (Min 11.78)
	COSTA		12.50 (Min 11.78)

notes existing floor level is below the minimum floor level (including freeboard) and careful consideration of end use and flood resilience measures need to be given.

#### **4.2 Flooding from the Sea (Tidal)**

Whilst the River Severn is subject to tidal influence, the flood modelling which forms the basis of the fluvial assessment does consider combined tidal and fluvial influence.

#### **4.3 Flooding from Groundwater**

No evidence that the site may be vulnerable to flooding from groundwater has been identified in the preparation of this report.

#### **4.4 Flooding from Sewers**

Sewer records have been obtained from Severn Trent Water (STW) and are included in Appendix B. A small diameter combined sewer is shown within Merchant Street between the two parts of the development flowing in a southerly direction.

A SW sewer runs to the north along Merchant Street which is not shown on the STW records.

The culverted Sud Brook bisects the site flowing in a westerly direction before discharging into the Gloucester and Sharpness Canal, located immediately to the west of the site. Reference should be made to section 4.1 of this report for consideration of the Sud Brook.

#### **4.5 Overland flow**

The site is relatively flat and the surrounding levels do not rise steeply from the site reducing the potential for overland flows originating offsite. To achieve the minimum floor levels defined to provide an adequate level of protection from fluvial flooding, it will be necessary to generally fall levels away from the new buildings naturally routing and overland flows away from buildings. The external levels over the Sud Brook are also to remain low protecting an overland surface water route to the Canal from the site.

#### **4.6 Development Drainage**

##### **4.6.1 Existing Drainage Survey**

The site is currently almost exclusively hard paved and could be considered to be 100% impermeable. Detailed drainage surveys have been undertaken with some elements of CCTV ongoing. A catchment plan indicating the routing of surface water drainage is presented in appendix C.

The main body of the site (section A) was ultimately found to drain to the Gloucester and Sharpness canal albeit some elements are routed via the final length of the culverted Sud brook as it crosses the site before discharging into the Canal.

The section of the site on the opposite side of Merchant Street to the main body (section B) comprises the Downing's Malthouse and the cottages. These elements are understood to drain into the sewers in Merchant St and surrounding road network.

##### **4.6.2 Proposed Storm water Discharge**

The National Planning Policy Framework Technical Guidance seeks to promote the use of Sustainable Urban Drainage Systems (SUDS) for new developments to limit both peak discharges and the volumes of surface water leaving sites.

CIRIA C697, the SUDS Manual defines a hierarchy of SUDS methods with Prevention identified as most preferable followed by Source Control, Site Control and ultimately regional control.

Whilst where possible SUDS systems should be incorporated to improve water quality and control water at source, due to the underlying geology preventing effective infiltration drainage it will be necessary to provide surface water attenuation to deal with exceedance

events. From discussions with the regulator through the application period it is proposed to incorporate filter trenches within the drainage system and to provide petrol interceptors to hard standing as methods of improving water quality.

The site is occupied by existing mill buildings that are to be retained and have historic drainage connections to the surrounding drainage network. Due to the proximity of the mills to the existing roads (particularly the Downing's Malthouse) it is not considered practical to incorporate the Mill building drainage into any new drainage network.

With respect to new build elements and external works, it is considered appropriate to provide 40% betterment to existing flows in accordance with GCC local requirements and include appropriate attenuation to prevent flooding in a 1 in 100 year + 30% event.

In line with the above anticipated attenuation volumes are shown below.

**Table 4 – Indicative attenuation volumes**

Section of the site	Existing impermeable area	Existing Flow	Betterment	Proposed impermeable area	Allowable discharge	Indicative Attenuation Volume
Section A (existing Mill buildings)	3677m <sup>2</sup>	Existing drainage to mill buildings to be retained and repaired as necessary				
Section A (new external works and new build)	9785m <sup>2</sup>	136l/s	40%	8900 m <sup>2</sup>	82l/s	137-271m <sup>3</sup>
Section B (existing Mill buildings)	1017m <sup>2</sup>	Existing drainage to mill buildings to be retained and repaired as necessary				
Section B (new build)	457m <sup>2</sup>	6l/s	40%	457m <sup>2</sup>	4l/s	7-14m <sup>3</sup>
Section B (new build)	614m <sup>2</sup> (SEMI PERMEABLE)	Flow restricted to 5l/s/Ha		614m <sup>2</sup>	0.3l/s	31-44m <sup>3</sup>

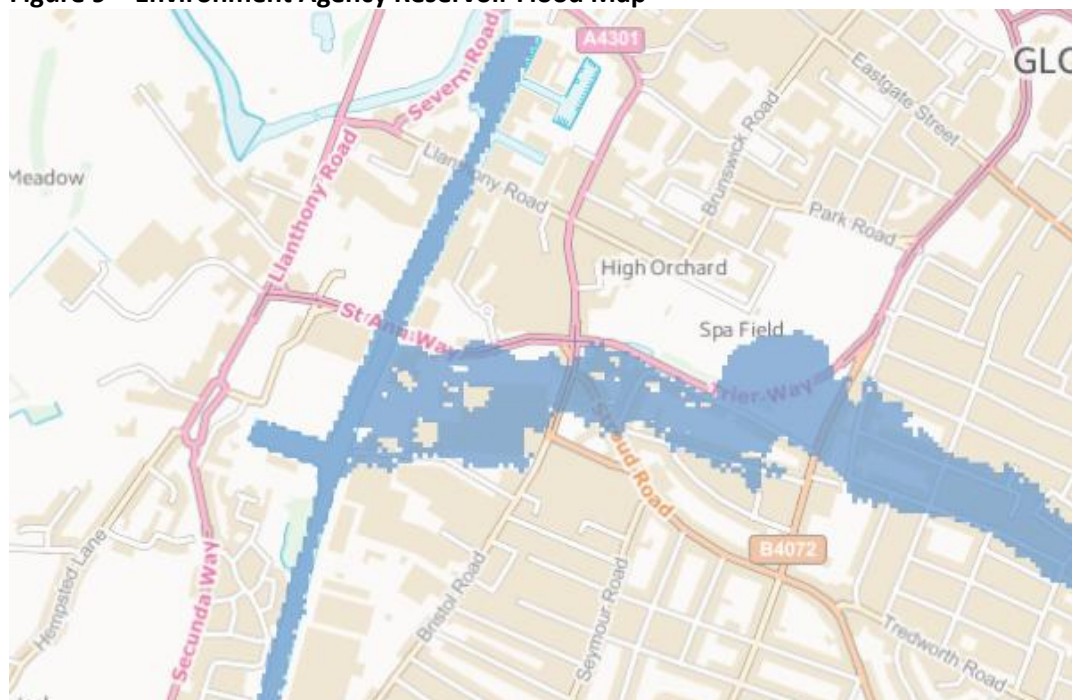
Microdrainge Quick Storage estimates are presented in Appendix D

#### 4.7 Flooding from Reservoirs, Canals and Other Artificial Sources

The site is situated immediately adjacent to Gloucester and Sharpness canal. The canal is not considered to be a significant contributor to flood risk in isolation, however reference should be made to section 4.1 with respect to fluvial flooding and the necessary mitigation measures.

The site is shown to be in close proximity to an area potentially at risk of flooding following a breach event at the Saintbridge Balancing Ponds 1 and 2 situated approximately 2.6km to the east of the site.

**Figure 9 – Environment Agency Reservoir Flood Map**



Reservoir structures are regulated by the reservoir act 1975 which places stringent obligations on the operators to ensure the structures are maintained adequately to prevent failure.

Given the extent of potential impact to the site and the likelihood of failure the Saintbridge balancing ponds are not considered to pose a significant risk to the proposed development.



## 5.0 SEQUENTIAL TEST AND EXCEPTION TEST

- 5.1 The development proposals comprise a mixed use development including residential, hotel and leisure end uses. These uses are classified in the Technical guidance accompanying the National Planning Policy Framework as a more vulnerable and less vulnerable respectively.
- 5.2 As discussed in section 4.1 the site is classified as being situated in flood zones 2&3 as defined in the National Planning Policy Framework Technical Guidance.
- 5.3 With respect to the new build elements, the more vulnerable hotel end use has been located on the part of the site classified as within zone 2 with the less vulnerable leisure end uses within zone 3. With reference to the requirements of the National Planning Policy Framework Technical Guidance summarised in tables NPPF2 and NPPF3 overleaf, the new build end uses could be considered acceptable development on their respective parts of the site. On the basis that the site has an existing outline approval for similar uses, the new build elements are likely to be considered sequentially preferable following a stage 1 assessment in line with EA guidance “Demonstrating the flood risk Sequential Test for Planning Applications”.
- 5.4 With respect to the refurbishment or reconstruction of the listed buildings, residential end use is proposed. With reference to the requirements of the National Planning Policy Framework Technical Guidance summarised in tables NPPF2 and NPPF3 overleaf, Residential end use would be considered acceptable development within Zone 2 however the Provender Mill is within zone 2 and consequently an exception test must be applied. The national planning policy framework requires the following to be satisfied for an exception test to be passed.
- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
  - A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted.

In this instance the site contains a series of historic buildings that are listed indicating that their preservation and the redevelopment of this area has a wider social and economic benefit. It is therefore considered likely that redevelopment would be supported through the first requirement of an exception test, however further discussion with the planning authority is likely to be required during the application period to agree and formalise this position with respect to an exception test. Whilst the more vulnerable hotel new build is located in zone 2 this element is considered key to the economic viability of the scheme and

therefore would also likely be considered within the exception test applied to the residential elements within the listed buildings.

This report endeavours to address the second requirement directly by demonstrating that the development will be safe following the implementation of the recommended mitigating measures.

**Table NPPF2: Flood Risk Vulnerability Classification – Residential (Zone 3)**

Essential Infrastructure	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
Highly Vulnerable	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
More Vulnerable	<ul style="list-style-type: none"> <li>Hospitals.</li> <li>Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.</li> <li>Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.</li> <li>Non–residential uses for health services, nurseries and educational establishments.</li> <li>Landfill and sites used for waste management facilities for hazardous waste.<sup>20</sup></li> <li>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</li> </ul>
Less Vulnerable	<ul style="list-style-type: none"> <li>Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in ‘more vulnerable’; and assembly and leisure.</li> <li>Land and buildings used for agriculture and forestry.</li> <li>Waste treatment (except landfill and hazardous waste facilities).</li> <li>Minerals working and processing (except for sand and gravel working).</li> <li>Water treatment plants.</li> <li>Sewage treatment plants (if adequate pollution control measures are in place).</li> </ul>
Water-compatible Development	<ul style="list-style-type: none"> <li>Flood control infrastructure.</li> <li>Water transmission infrastructure and pumping stations.</li> <li>Sewage transmission infrastructure and pumping stations.</li> <li>Sand and gravel workings.</li> <li>Docks, marinas and wharves.</li> <li>Navigation facilities.</li> <li>MOD defence installations.</li> <li>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</li> <li>Water-based recreation (excluding sleeping accommodation).</li> <li>Lifeguard and coastguard stations.</li> <li>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</li> <li>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, <b>subject to a specific warning and evacuation plan.</b></li> </ul>

**Table NPPF3: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (See Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b ‘Functional Floodplain’	Exception Test required	✓	x	x	x

**Table NPPF2: Flood Risk Vulnerability Classification – Residential (Zone 2)**

Essential Infrastructure	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
Highly Vulnerable	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
More Vulnerable	<ul style="list-style-type: none"> <li>Hospitals.</li> <li>Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.</li> <li>Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.</li> <li>Non-residential uses for health services, nurseries and educational establishments.</li> <li>Landfill and sites used for waste management facilities for hazardous waste.20</li> <li>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</li> </ul>
Less Vulnerable	<ul style="list-style-type: none"> <li>Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in ‘more vulnerable’; and assembly and leisure.</li> <li>Land and buildings used for agriculture and forestry.</li> <li>Waste treatment (except landfill and hazardous waste facilities).</li> <li>Minerals working and processing (except for sand and gravel working).</li> <li>Water treatment plants.</li> <li>Sewage treatment plants (if adequate pollution control measures are in place).</li> </ul>
Water-compatible Development	<ul style="list-style-type: none"> <li>Flood control infrastructure.</li> <li>Water transmission infrastructure and pumping stations.</li> <li>Sewage transmission infrastructure and pumping stations.</li> <li>Sand and gravel workings.</li> <li>Docks, marinas and wharves.</li> <li>Navigation facilities.</li> <li>MOD defence installations.</li> <li>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</li> <li>Water-based recreation (excluding sleeping accommodation).</li> <li>Lifeguard and coastguard stations.</li> <li>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</li> <li>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, <b>subject to a specific warning and evacuation plan.</b></li> </ul>

**Table NPPF3: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (See Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b ‘Functional Floodplain’	Exception Test required	✓	x	x	x

**Table NPPF2: Flood Risk Vulnerability Classification –Hotel (Zone 2)**

Essential Infrastructure	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
Highly Vulnerable	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
More Vulnerable	<ul style="list-style-type: none"> <li>Hospitals.</li> <li>Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.</li> <li>Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.</li> <li>Non-residential uses for health services, nurseries and educational establishments.</li> <li>Landfill and sites used for waste management facilities for hazardous waste.<sup>20</sup></li> <li>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</li> </ul>
Less Vulnerable	<ul style="list-style-type: none"> <li>Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions not included in ‘more vulnerable’; and assembly and leisure.</li> <li>Land and buildings used for agriculture and forestry.</li> <li>Waste treatment (except landfill and hazardous waste facilities).</li> <li>Minerals working and processing (except for sand and gravel working).</li> <li>Water treatment plants.</li> <li>Sewage treatment plants (if adequate pollution control measures are in place).</li> </ul>
Water-compatible Development	<ul style="list-style-type: none"> <li>Flood control infrastructure.</li> <li>Water transmission infrastructure and pumping stations.</li> <li>Sewage transmission infrastructure and pumping stations.</li> <li>Sand and gravel workings.</li> <li>Docks, marinas and wharves.</li> <li>Navigation facilities.</li> <li>MOD defence installations.</li> <li>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</li> <li>Water-based recreation (excluding sleeping accommodation).</li> <li>Lifeguard and coastguard stations.</li> <li>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</li> <li>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, <b>subject to a specific warning and evacuation plan.</b></li> </ul>

**Table NPPF3: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (See Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b ‘Functional Floodplain’	Exception Test required	✓	x	x	x

**Table NPPF2: Flood Risk Vulnerability Classification – Leisure (Zone 3)**

Essential Infrastructure	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
Highly Vulnerable	<ul style="list-style-type: none"> <li>Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.</li> </ul>
More Vulnerable	<ul style="list-style-type: none"> <li>Hospitals.</li> <li>Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels.</li> <li>Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.</li> <li>Non–residential uses for health services, nurseries and educational establishments.</li> <li>Landfill and sites used for waste management facilities for hazardous waste.<sup>20</sup></li> <li>Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.</li> </ul>
Less Vulnerable	<ul style="list-style-type: none"> <li>Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in ‘more vulnerable’; and assembly and leisure.</li> <li>Land and buildings used for agriculture and forestry.</li> <li>Waste treatment (except landfill and hazardous waste facilities).</li> <li>Minerals working and processing (except for sand and gravel working).</li> <li>Water treatment plants.</li> <li>Sewage treatment plants (if adequate pollution control measures are in place).</li> </ul>
Water-compatible Development	<ul style="list-style-type: none"> <li>Flood control infrastructure.</li> <li>Water transmission infrastructure and pumping stations.</li> <li>Sewage transmission infrastructure and pumping stations.</li> <li>Sand and gravel workings.</li> <li>Docks, marinas and wharves.</li> <li>Navigation facilities.</li> <li>MOD defence installations.</li> <li>Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.</li> <li>Water-based recreation (excluding sleeping accommodation).</li> <li>Lifeguard and coastguard stations.</li> <li>Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.</li> <li>Essential ancillary sleeping or residential accommodation for staff required by uses in this category, <b>subject to a specific warning and evacuation plan.</b></li> </ul>

**Table NPPF3: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (See Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b ‘Functional Floodplain’	Exception Test required	✓	x	x	x

## 6.0 SUMMARY OF FLOOD MITIGATION MEASURES

6.1 The proposed development is situated predominantly in zone 2 and 3 based on the EA detailed flood map and is therefore at a medium to high risk of flooding. However it should be noted that assessment of the individual sources including historical flood map and the latest flood models indicate that flooding is unlikely to impact the site.

6.2 The development comprises a mixed end use including leisure, residential and a hotel. The leisure element of the development would be considered sequentially preferable when assessed in line with the requirements of the NPPF. The residential accommodation is situated within existing listed buildings. Whilst the placement of residential accommodation within flood zone 3 demands the application of an exception test, it is considered likely that the development would be viewed as meeting the criteria of an exception test. The wider social and economic benefit associated with the renovation and the listed buildings and the demonstration of safe operation and no increased flood risk set out in this report are considered key to this assessment. The hotel accommodation is positioned essentially within flood zone 2 resulting in it being sequentially preferable although the hotel is key to the economic viability of the scheme and therefore would also likely be considered favourably within the exception test applied for the residential elements.

6.3 The flood risk demonstrates that the risk of flooding on and off site will not be increased and the proposed development will be able to operate safely with respect to flooding for its intended life providing the following mitigation measures are incorporated.

- Finished floor level for all new build elements are to be set at a minimum FFL of 11.78AOD.
- Finished floor level for all more vulnerable end uses are to be limited to levels within the existing building with a floor level of 11.78AOD or above. Practically this needs to exclude access cores, stores and service facilities ancillary to the end use.
- Existing basement areas to the Downing's Malthouse and Malthouse Extension are all below the minimum floor level of 11.78 to differing degrees. Whilst the threshold levels offer some protection detailing of the external works to reduce routes for flood water into the basement, the careful consideration of any proposed end uses and provision of flood resilient detailing within the refurbishment are all considered appropriate to minimise impact.
- External levels are to be designed to fall away from the buildings and a surface water overland flow route to the canal is to be maintained along the route of the Sud Brook.
- Whilst surface water discharge from the existing mill buildings is to make use of the existing drainage connections where possible. Surface water discharge from external works and new buildings is to be restricted to 82l/s for site A and 9l/s for site B based on existing flows after application of 40% betterment. Surface water storage is to be provided to prevent flooding in a 1 in 100 year + 30% event.
- The drainage connections from the existing Mills are to be inspected and repaired as necessary.
- The existing Sud Brook culvert is to be inspected prior to the construction works and protected for the duration of the works. Any defects that could give rise to blockage of the culvert are to be remediated.

## **Appendix A**



# Detailed FRA Map centred on Gloucester - created 3 September 2014 [W5858]

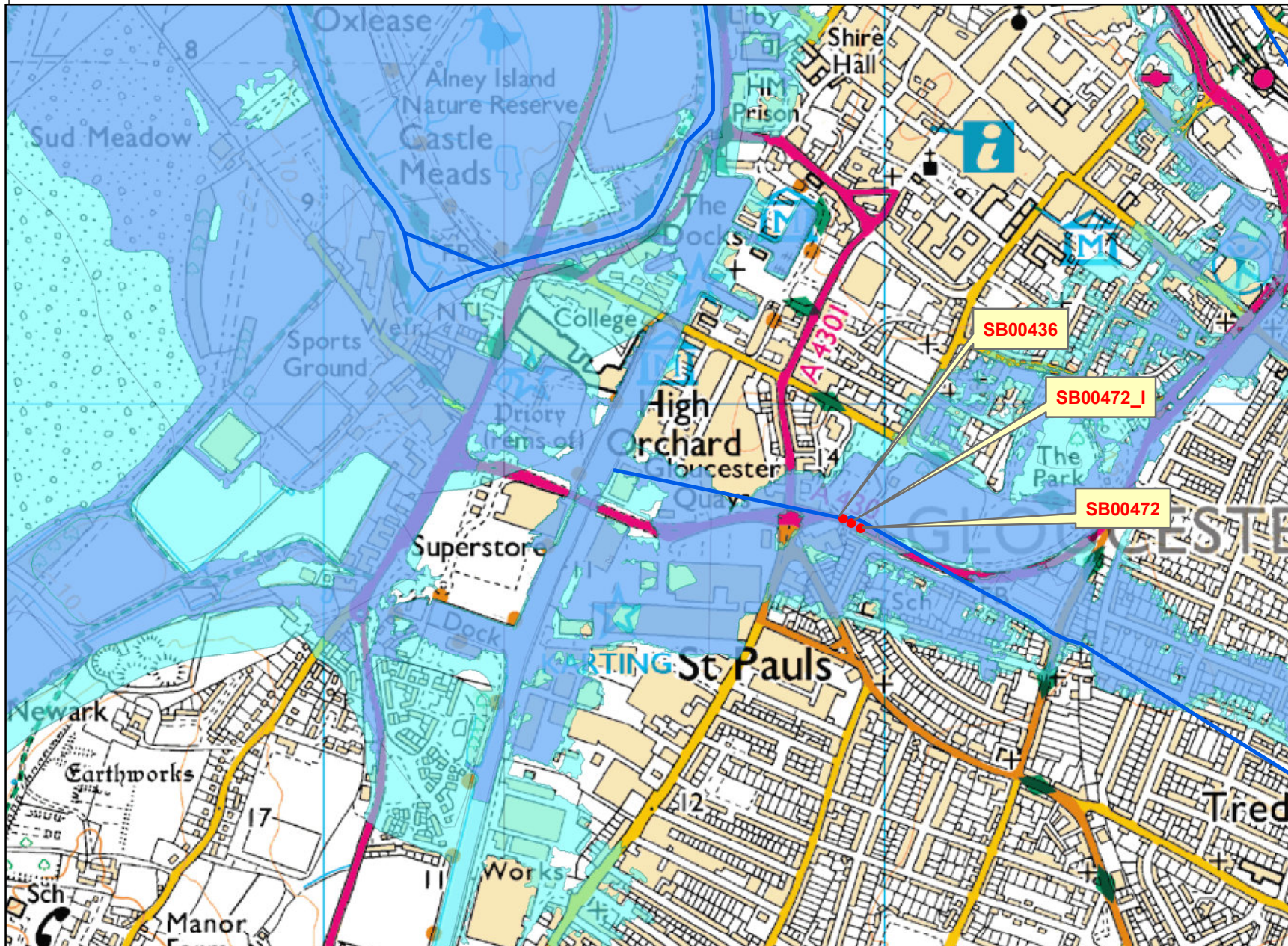


1: 10,000



## Legend

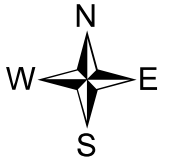
- Node Point Ref
- main rivers
- Flood Zone 3 (1% 1 in 100 Yr)
- Flood Zone 2 (0.1% 1 in 1000 Yr)



# Historical Flood Event Map centred on Gloucester - created 3 September 2014 [W5858]

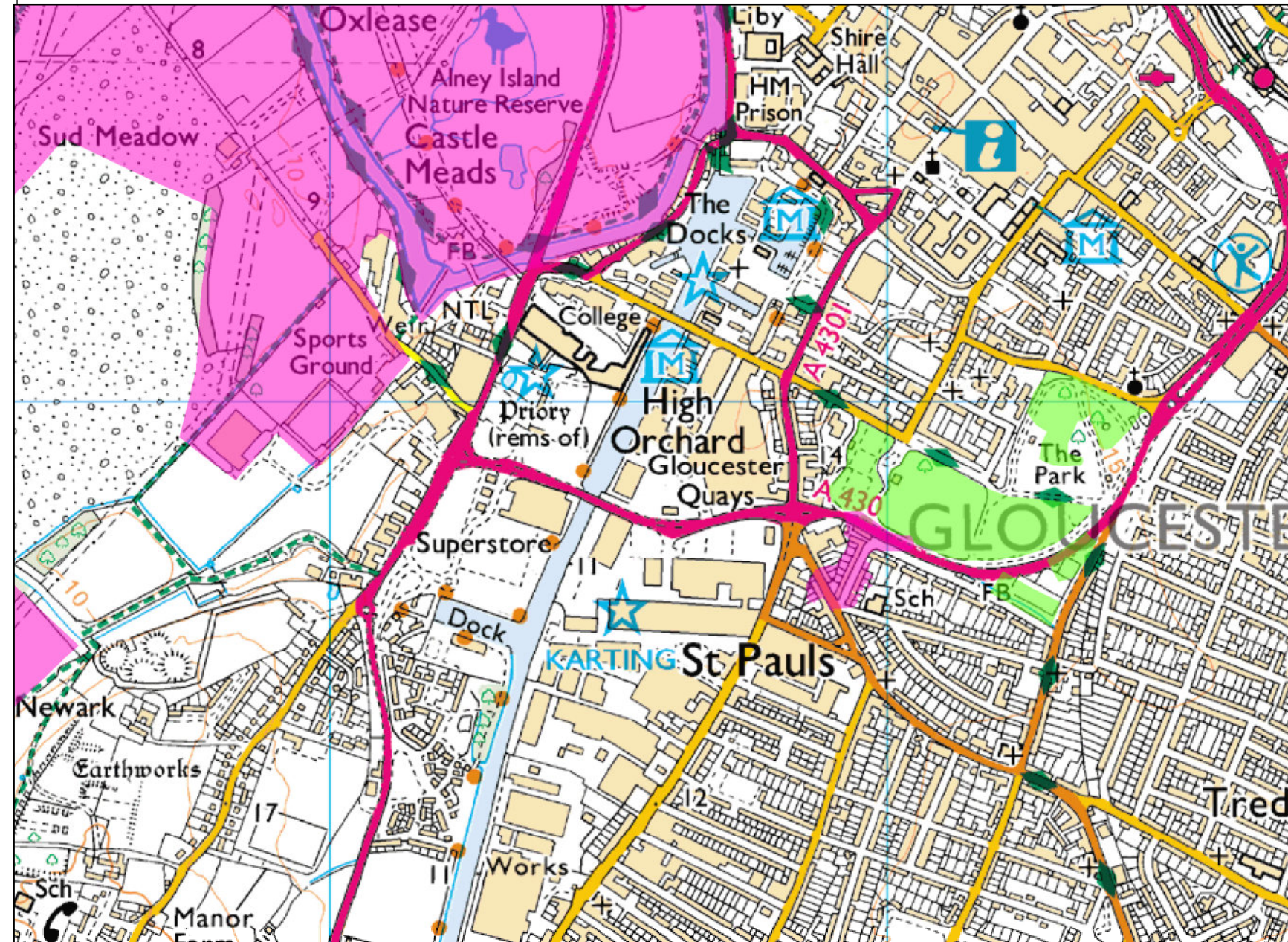


1: 10,000



## Legend

- Flood Event July 2007
- Flood Event July 1968



# Modelled Extent Outline Map centred on Gloucester - created 3 September 2014 [W5858]



1: 10,000



## Legend

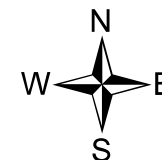
- 1 in 75 Yr Outline
- 1 in 100 Yr Outline
- 1 in 100 Yr (+CC) Outline
- 1 in 1000 Yr Outline



# Modelled Extent Outline Map centred on Gloucester - created 3 September 2014 [W5858]

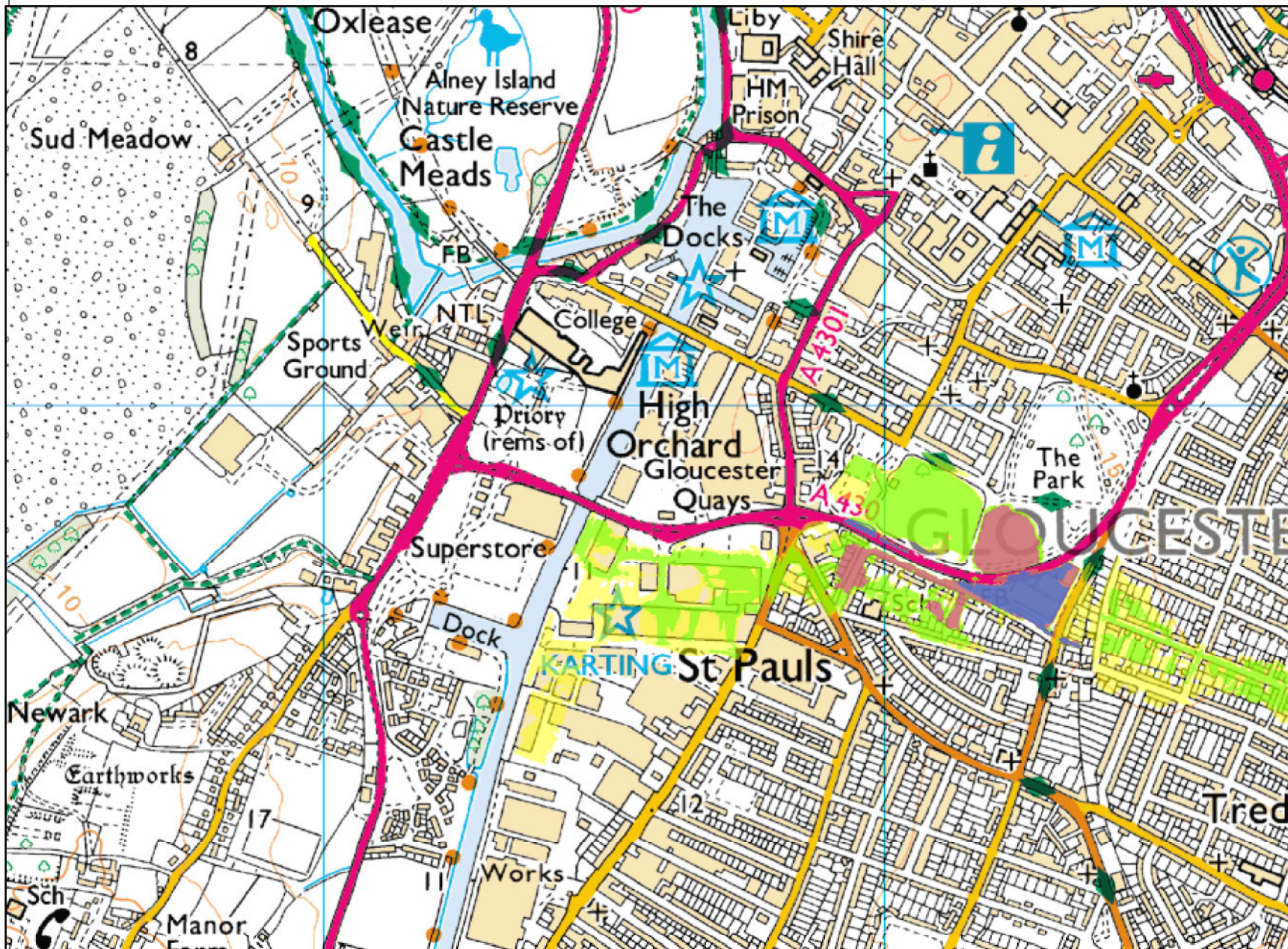


1: 10,000



## Legend

- 1 in 5 Yr Outline
- 1 in 10 Yr Outline
- 1 in 20 Yr Outline
- 1 in 50 Yr Outline



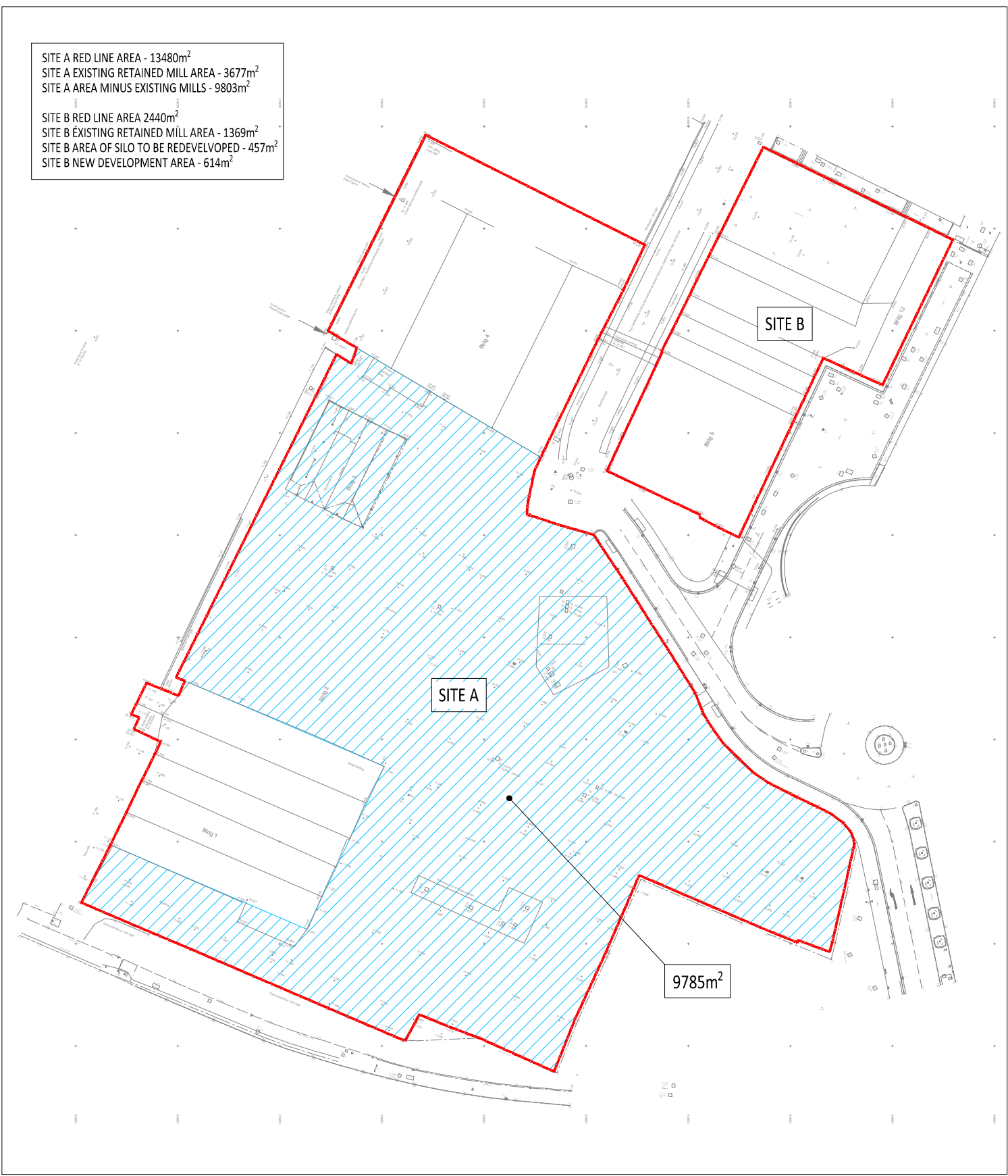
## **Appendix B**



## Appendix C

SITE A RED LINE AREA - 13480m<sup>2</sup>  
 SITE A EXISTING RETAINED MILL AREA - 3677m<sup>2</sup>  
 SITE A AREA MINUS EXISTING MILLS - 9803m<sup>2</sup>  
  
 SITE B RED LINE AREA 2440m<sup>2</sup>  
 SITE B EXISTING RETAINED MILL AREA - 1369m<sup>2</sup>  
 SITE B AREA OF SILO TO BE REDEVELOPED - 457m<sup>2</sup>  
 SITE B NEW DEVELOPMENT AREA - 614m<sup>2</sup>

1. DO NOT SCALE THIS DRAWING. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND EXISTING CONDITIONS ON SITE PRIOR TO COMMENCING THE WORKS.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.



Project Title <b>BAKERS QUAY, GLOUCESTER</b>		Drawing Title <b>EXISTING &amp; PROPOSED CATCHMENT PLAN</b>		Rev	Date	Revision description	Drawn	Auth'd
Client <b>Rokeby Developments</b>		Date AUG 2015	Drawn AB	P2	13.01.16	UPDATED TO REFLECT GCC COMMENTS	AB	SL
Scale 1:500 @A1		Authorised SL	Status <b>INFORMATION</b>	P1	13.08.15	ISSUED FOR INFORMATION	AB	SL
Job No RDL00415	Drawing No SK402	Revision P2						



## Appendix D

Site A Quick storage estimate

O/A site A area minus existing mill footprints = 9785m<sup>2</sup>

Allowable discharge = 9785 x 50 / 3600 = 136 l/s

40% betterment = 136 x 0.6 = 82 l/s

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

Map

M5-60 (mm) 18.000

Ratio R 0.350

Cv (Summer) 0.750

Cv (Winter) 0.840

Impemeable Area (ha) 0.890

Maximum Allowable Discharge (l/s) 82.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 30

Analyse OK Cancel Help

Select required Rainfall Model from the list

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 137 m<sup>3</sup> and 271 m<sup>3</sup>.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Select required Rainfall Model from the list

Site B Quick storage estimate for new build portion 40% Betterment

Site B area = 457 m<sup>2</sup>

Allowable discharge =  $457 \times 50 / 3600 = 6.3$  l/s

40% betterment =  $6.3 \times 0.6 = 3.8$  l/s

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 7.3 m<sup>3</sup> and 14 m<sup>3</sup>.

These values are estimates only and should not be used for design purposes.

Variables

Results

Design

Overview 2D

Overview 3D

Vt

Analyse OK Cancel Help

Select required Rainfall Model from the list

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

Map

M5-60 (mm) 18.000

Ratio R 0.350

Cv (Summer) 0.750

Cv (Winter) 0.840

Impemeable Area (ha) 0.046

Maximum Allowable Discharge (l/s) 4.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 2.0

Climate Change (%) 30

Analyse OK Cancel Help

Select required Rainfall Model from the list

Site B Quick storage estimate for new build portion

Site B area = 614 m<sup>2</sup>

Assume 5l/s based on minimum practical flow control as semi permeable

The screenshot shows the 'Quick Storage Estimate' dialog box with the 'Variables' tab selected. The 'Micro Drainage' logo is in the top left. A vertical sidebar on the left contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area is titled 'Variables' and contains the following settings:

FSR Rainfall	Cv (Summer)	0.750
Return Period (years)	Cv (Winter)	0.840
100	Impermeable Area (ha)	0.061
Region	Maximum Allowable Discharge (l/s)	0.3
England and Wales	Infiltration Coefficient (m/hr)	0.00000
Map	Safety Factor	2.0
M5-60 (mm)	Climate Change (%)	20
18.000		
Ratio R		
0.350		

Buttons at the bottom: Analyse, OK, Cancel, Help.

The screenshot shows the 'Quick Storage Estimate' dialog box with the 'Results' tab selected. The 'Micro Drainage' logo is in the top left. A vertical sidebar on the left contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area is titled 'Results' and contains the following text:

**Global Variables require approximate storage of between 31 m<sup>3</sup> and 44 m<sup>3</sup>.**

**These values are estimates only and should not be used for design purposes.**

Buttons at the bottom: Analyse, OK, Cancel, Help.

Enter Maximum Allowable Discharge between 0.0 and 999999.0

## **Appendix E**

