Ladybarn Lane, Withington, Manchester, M14 6RQ

NPPF: Flood Risk Assessment

For Dan Sudbury

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www.krsenvironmental.com

CONTACT DETAILS

Registered Office:
KRS Environmental Ltd
3 Princes Square
Princes Street
Montgomery
Powys
SY15 6PZ

Tel: 01686 668957
Mob: 07857 264 376

Office also at:
KRS Environmental Ltd
The Media Centre
7 Northumberland Street
Huddersfield
West Yorkshire
HD1 1RL

Tel: 01484 437420
Mob: 07857 264 376

Email: keelan@krsenvironmental.com
Web: www.krsenvironmental.com
LinkedIn: uk.linkedin.com/in/keelanserjeant/

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Prepared by	Emma Serjeant LL.B, MSc
Reviewed by	Keelan Serjeant BSc (Hons), MSc, MCIWEM
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EXECUTIVE SUMMARY

The proposed development would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this Flood Risk Assessment (FRA), including adoption of a SuDS Strategy, are implemented: flood risk from all sources would be minimised; the consequences of flooding would be acceptable; and the development would be in accordance with the requirements of the National Planning Policy Framework (NPPF).

The proposed development should not be precluded on the grounds of flood risk.

1.0 INTRODUCTION

1.1 Background

This Flood Risk Assessment (FRA) has been prepared by KRS Environmental Limited at the request of Dan Sudbury to support a planning application at Ladybarn Lane, Withington, Manchester, M14 6RQ. This FRA includes an assessment of the existing and proposed surface water drainage of the site.

This FRA has been carried out in accordance with guidance contained in the National Planning Policy Framework (NPPF)[1] and associated Planning Practice Guidance[2]. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

It is recognised that developments which are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.

1.2 National Planning Policy Framework (NPPF)

One of the key aims of the NPPF is to ensure that flood risk is taken into account at all stages of the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk.

It advises that where new development is exceptionally necessary in areas of higher risk, this should be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall. A risk-based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FRA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all sources;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- if necessary, provide the evidence to the Local Planning Authority (LPA) that the Sequential Test can be applied; and
- whether the development will be safe and pass part c) of the Exception Test if this is appropriate.

1.3 Report Structure

This FRA has the following report structure:

- Section 2 describes the location area and the existing and proposed development;

[1] Ministry of Housing, Communities and Local Government (2021) National Planning Policy Framework.
[2] Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.

- Section 3 outlines the flood risk to the existing and proposed development;
- Section 4 details the proposed surface water drainage for the site and assesses the potential impacts of the proposed development on surface water drainage;
- Section 5 outlines the mitigation measures used to reduce the overall level of flood risk;
- Section 6 details the sequential and exception tests; and
- Section 7 presents a summary and conclusions.

2.0 LOCATION & DEVELOPMENT DESCRIPTION

2.1 Site Location

The site is located at Ladybarn Lane, Withington, Manchester, M14 6RQ (see Figure 1). The National Grid Reference of the site is 385900, 393253. The total site area proposed for redevelopment covers an area of approximately 0.1179 hectares (ha) and is accessed via Ladybarn Lane.

Figure 1 - Site Location

2.2 Existing Development

The site is the Brewers Arms Public House which included an extensive car parking area, as such, the site is considered to be impermeable (see Appendix 1).

2.3 Proposed Development

It is understood that the application is for 3 houses (see Appendix 1). Further details with regard to the proposed development can be found in the accompanying information submitted with the planning application.

2.4 Ground Levels

Existing ground levels within the boundary of the site vary from 38.25 metres Above Ordnance Datum (mAOD) at the south east corner of the site, up to 38.85mAOD located at the north west corner of the site.

2.5 Catchment Hydrology / Drainage

The Cringle Black Brook is located approximately 180m to the north of the site. There are no other watercourses located on, or within the vicinity of the site. At its nearest to the site, the Cringle Black Brook is an open channel. The Cringle Black Brook enters a large culvert in line with the site with flood walls located directly upstream for a short distance.

There was previously a formalised drainage system, such as, roof gutter and down pipes to the former building which conveyed flows below ground to the United Utilities combined public sewers (see Figure 2).

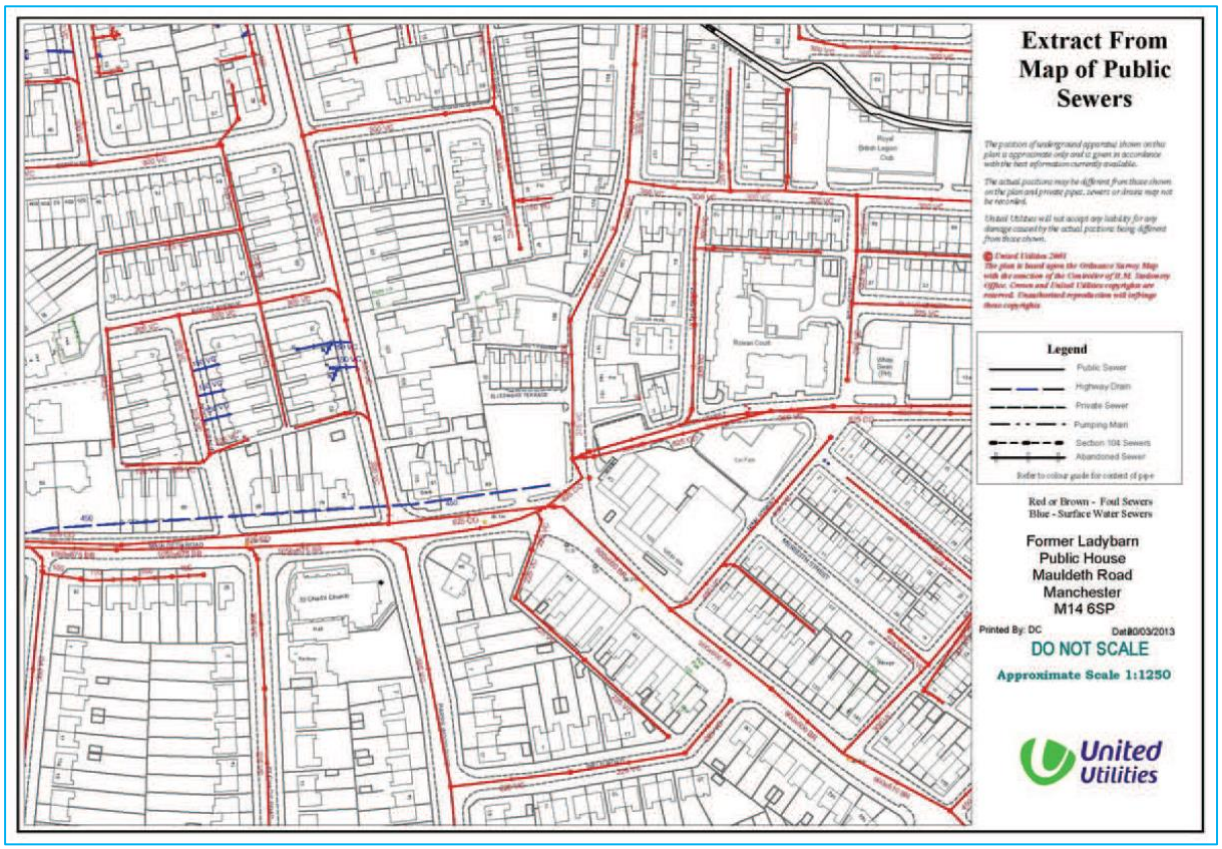

Figure 2 - Public Sewers

2.6 Ground Conditions

It is anticipated that the site is underlain by Made Ground. The British Geological Survey (BGS) Map[3] indicates that no superficial deposits underlying the site consist of Till, Devensian – diamicton. The bedrock deposits underlying the site consist of the Chester Formation – sandstone. Information from the National Soil Resource Institute[4] details the site area as being situated on slowly permeable seasonally wet acid loamy and clayey soils.

[3] https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.26065533.1914503988.1633088921-557297800.1574946602
[4] https://www.landis.org.uk/soilscapes/

3.0 FLOOD RISK

3.1 Sources of Flooding

All sources of flooding have been considered, these are; fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure failure.

3.2 Environment Agency

Information regarding the current flood risk at the application site and local flood defences has been obtained from the Environment Agency (see Appendix 2).

3.3 Historic Flooding

The Environment Agency historic flood map and the Manchester City Council Strategic Flood Risk Assessment (SFRA) show that the site has not historically flooded. There are no other records of anecdotal information of flooding at the site. The British Hydrological Society "Chronology of British Hydrological Event[5]" has no information on flooding within the vicinity of the site.

3.4 Existing and Planned Flood Defence Measures

There are existing flood defences which protect and reduce the flood risk posed to the site and provide a Standard of Protection (SoP) of 1 in 100 years. Further property level protection measures will be used to protect the site from flooding these are discussed in Section 5.0.

3.5 Environment Agency Flood Zones

A review of the Environment Agency's Flood Zones indicates that the site is located within Flood Zones 2 and 3 and therefore has a 'medium to high probability' of flooding as shown in Figure 3. Flood Zone 2 has between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year and Flood Zone 3 has a 1 in 100 or greater annual probability of river flooding (>1%) in any year. The site is located on the edge of Flood Zones 2 and 3.

The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur <u>without the presence of flood defences</u>, because these can be breached, overtopped and may not be in existence for the lifetime of the development. They show the worst-case scenario. The flood outline shown on Figure 3 would only occur if the flood defences were to be overtopped/breached.

The Environment Agency Flood Zones and acceptable development types are explained in Table 1. Table 1 shows that some development types are generally acceptable in Flood Zones 2 and 3.

[5] http://www.dundee.ac.uk/geography/cbhe/

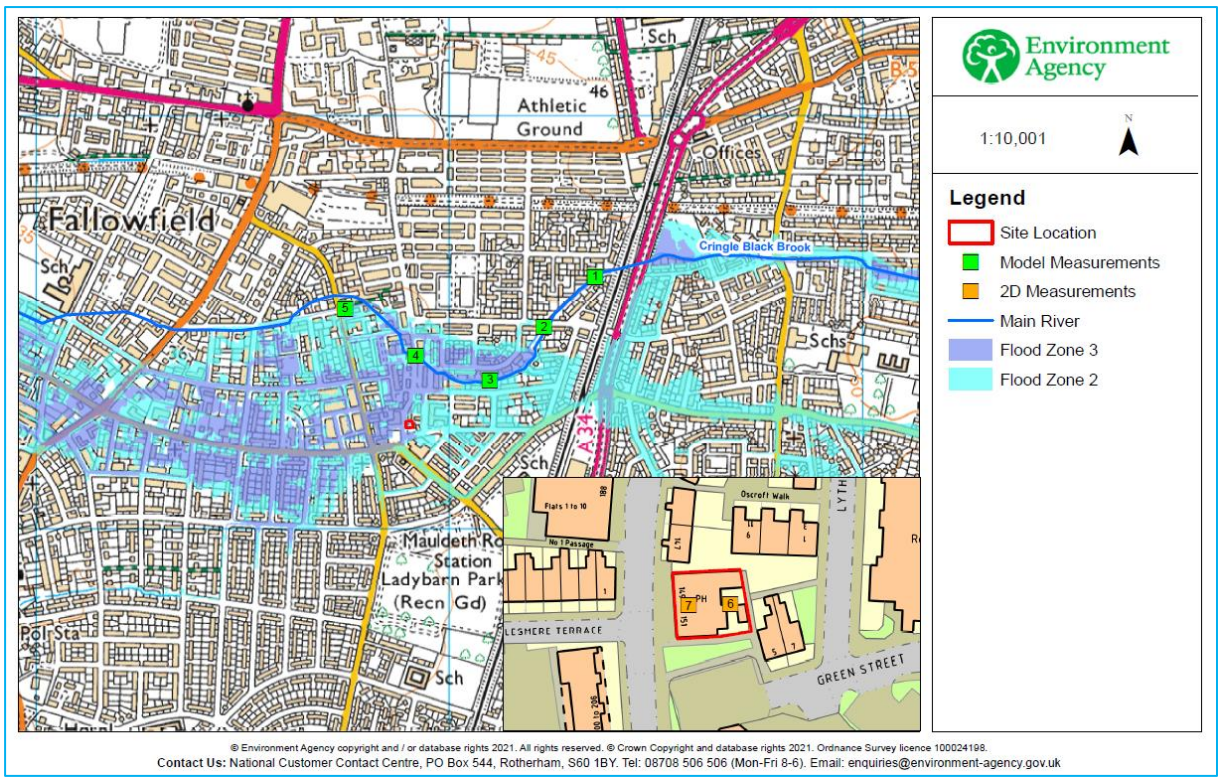

Figure 3 - Environment Agency Flood Zones

Table 1 - Environment Agency Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable

3.6 Flood Vulnerability

In the Planning Practice Guidance, appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in the Planning Practice Guidance to the NPPF, the proposed use for residential uses is classified as 'more vulnerable'. Table 2 of this report and the Planning Practice Guidance to the NPPF state that 'more vulnerable' uses are appropriate within Flood Zone 3.

Table 2 - Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	×	Exception test required	✓
Zone 3b 'Functional Floodplain'	Exception test required	✓	×	×	×

Key: *✓: Development is appropriate, ×: Development should not be permitted.*

3.7 Climate Change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the Flood risk assessments: climate change allowances guidance[6].

Table 3 shows the peak river flow allowances by river basin district. The flood risk assessments: climate change allowances guidance recommends that for 'more vulnerable' uses in Flood Zone 3 that the central allowances are used. Environment Agency recommendations are that the lifetime for residential development is 100 years, and for other development it is considered to be 60 years. Therefore, the design flood event for the site is the 1 in 100 year (+41%) event.

Table 3 - Peak River Flow Allowances by River Basin District (use 1961 to 1990 baseline)

River Basin District	Allowance Category	2020s	2050s	2080s
Upper Mersey Management Catchment	Upper	+27%	+51%	+85%
	Higher	+17%	+31%	+53%
	Central	+13%	+22%	+41%

3.8 Fluvial (river) Flooding

Actual Risk

The principal flood risk to the site is from fluvial flooding from Cringle Black Brook. Table 4 shows the Environment Agency defended modelled water levels for the site.

[6] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances

Flood defence measures provide protection against fluvial flooding and reduce the flood risk to the site directly from the Cringle Black Brook. The actual risk of fluvial flooding at the site is much reduced (compared to the Environment Agency Flood Zones) by the presence of the flood defences. These flood defences provide a SoP of 1 in 100 years therefore, the site will not be inundated with floodwater for all events up to and including the defended 1 in 100 year event. The site will be flood free during the 1 in 100 year event and the actual flood risk posed to the site is less than the 1 in 100 year event.

Water levels have been modelled at 38.85mAOD and 38.86mAOD during the defended 1 in 100 year (+35%) and defended 1 in 100 year (+70%) events, respectively. The site minimum ground level is 38.25mAOD therefore, the site may be inundated with floodwater to a maximum depth of 0.60m during the defended 1 in 100 year (+35%) event and to a maximum depth of 0.61m during the defended 1 in 100 year (+70%) event.

The design flood event for the site is the defended 1 in 100 year (+41%) event which will have water level of 38.85mAOD. Therefore, the site may be inundated with floodwater to a maximum depth of 0.60m during the defended 1 in 100 year (+41%) event (i.e. the design flood event). Water levels have been modelled at 38.93mAOD during the defended 1 in 1000 year event, therefore, the site may be inundated with floodwater to a maximum depth of 0.68m.

Table 4 - Environment Agency Defended Modelled Water Levels (mAOD)

Map Ref	Easting	Northing	Return Period (years)			
			100 (+35%)	100 (+70%)	1000	1000 (+30%)
6	385909	393253	N/A	N/A	38.93	38.98
7	385899	393253	38.85	38.86	38.93	38.97

Residual Risk

Considerable investment has been made in the provision of the flood defences to protect the site from fluvial flooding. However, the flood defences can only protect up to a point, they may malfunction, can be breached and have a finite structure life. Therefore, there is a residual risk of fluvial flooding. The condition of the defences is mainly fair therefore; it is unlikely that a breach in the flood defences would occur.

If the flood defences were not there, the area would be flooded. However, an area of land may benefit from the presence of flood defences even if the flood defences are overtopped, the presence of the flood defences means that the floodwater does not extend as far as it would if the flood defences were not there. The residual risk of flooding caused by overtopping of the defences during a fluvial flood event will be reduced compared to the extent of flooding shown in the Environment Agency Flood Zones.

Table 5 shows the Environment Agency undefended modelled water levels for the site. Water levels have been modelled at 38.85mAOD during the undefended 1 in 100 year event, the site minimum ground level is 38.25mAOD therefore, the site may be inundated with floodwater to a maximum depth of 0.60m.

Water levels have been modelled at 38.88mAOD during the undefended 1 in 100 year (+35%) event, therefore, the site may be inundated with floodwater to a maximum depth of 0.63m. The design flood event for the site is the undefended 1 in 100 year (+41%) event which will have water level of 38.89mAOD. Therefore, the site may be inundated with floodwater to a maximum depth of 0.64m during the undefended 1 in 100 year (+41%) event (i.e. the design flood event).

Water levels have been modelled at 38.96mAOD during the undefended 1 in 1000 year event, therefore, the site may be inundated with floodwater to a maximum depth of 0.71m.

Table 5 - Environment Agency Undefended Modelled Water Levels (mAOD)

Map Ref	Easting	Northing	Return Period (years)							
			75	100	100 (+30%)	100 (+35%)	100 (+70%)	200	1000	1000 (+30%)
6	385909	393253	N/A	N/A	N/A	N/A	38.91	N/A	38.96	39.01
7	385899	393253	38.86	38.85	38.88	38.88	38.91	38.86	38.96	39.00

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low actual and residual flood risk to the site. The risk of flooding from fluvial flooding is considered to be of **medium significance**. The fluvial flood risk will be mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 5.0).

3.9 Tidal (coastal) Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be **not significant**.

3.10 Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded.

Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers). No below surface infrastructure and buildings are located or are proposed for the site. The risk of flooding from groundwater flooding is considered to be **not significant**.

3.11 Surface Water (pluvial) Flooding

The site is not situated near to large areas of poor permeability or areas with the geology and/or topography which may result in surface water flooding. The site surroundings are relatively flat and there are no large catchments that would tend to generate surface water runoff towards the site. Surface water flow flooding tends to occur sporadically in both location and time such surface water flows would tend to be confined to the streets around the development.

The Environment Agency Surface Water flood map shows that the site has a very low to low risk of surface water flooding with a chance of flooding of less than 1 in 1000 (0.1%) to 1 in 100 (1%) years (see Figure 4). Therefore, the risk of flooding from surface water flooding is considered to be of **low significance**. The risk from this source will be further mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 5.0).

Figure 4 - Environment Agency Surface Water Flood Risk Map

3.12 Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

It is understood that there are existing sewers located within the vicinity of the site and these will inevitably have a limited capacity so in extreme conditions there would be surcharges, which may in turn cause flooding. Flood flows could also be generated by burst water mains, but these would tend to be of a restricted and much lower volume than weather generated events and so can be discounted for the purposes of this assessment.

Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 20 years. The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less. Therefore, the risk of flooding from sewer flooding is considered to be **not significant**.

3.13 Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, reservoirs, water channels and artificial drainage systems that could be considered a flood risk to the site. Figure 5 shows that the site is not at risk of flooding from reservoir failure. The risk of flooding from artifical drainage systems/infrastructure failure is considered to be **not significant.**

Figure 5 - Environment Agency Reservoir Flood Risk Map

3.14 Summary of Site-Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 6.

The site is unlikely to flood except in extreme conditions. The principal flood risk to the site is from fluvial flooding from the Cringle Black Brook. The site is located within Flood Zone 3 and therefore has a 'high probability' of flooding, with a 1 in 100 or greater annual probability of river flooding (>1%) in any year. The site is located on the edge of Flood Zones 2 and 3.

Actual Risk

However, the site is protected against flooding by existing flood defence measures with an SoP of 1 in 100 years. The site will be flood free during the defended 1 in 100 year event and the actual flood risk posed to the site is less than the 1 in 100 year event.

The site may be inundated with floodwater to a maximum depth of 0.60m during the defended 1 in 100 year (+41%) event (i.e. the design flood event) and to a maximum depth of 0.68m during the defended 1 in 1000 year event.

Residual Risk

During the undefended 1 in 100 year (+35%) event, therefore, the site may be inundated with floodwater to a maximum depth of 0.63m and to a maximum depth of 0.64m during the undefended 1 in 100 year (+41%) event (i.e. the design flood event). During the undefended 1 in 1000 year event, therefore, the site may be inundated with floodwater to a maximum depth of 0.71m.

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low actual and residual flood risk to the site. The risk of flooding from fluvial flooding is considered to be of **medium significance.** A secondary flooding source has been identified which may pose a **low significant** risk to the site. This is:

- Surface Water Flooding

The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site. The flood risk will be mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 5.0).

The proposed use for residential uses is classified as 'more vulnerable', 'more vulnerable' uses are appropriate within Flood Zones 2 and 3.

Table 6 - Risk Posed by Flooding Sources

Sources of Flooding	Potential Flood Risk	Potential Source	Probability/Significance
Fluvial Flooding	Yes	Cringle Black Brook	Medium
Tidal Flooding	No	None Reported	None
Groundwater Flooding	No	None Reported	None
Surface Water Flooding	Yes	Poor Permeability	Low
Sewer Flooding	No	None Reported	None
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	None Reported	None

4.0 SURFACE WATER DRAINAGE

4.1 Surface Water Management Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A SuDS Strategy for the proposed development has been prepared to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the site can be determined and reviewed against existing arrangements.

The requirement for managing surface water runoff from developments depends on the predeveloped nature of a site. The surface water drainage arrangements for any development location should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the development unless specific offsite arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance as well as the Defra non-statutory technical standards for SuDS.

4.2 Climate Change

Projections of future climate change in the UK indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRAs. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF[7].

The recommended national precautionary sensitivity range for peak rainfall intensity are summarised in Table 7.

Table 7 - Peak Rainfall Intensity Allowance in Small and Urban Catchment (use 1961 to 1990 baseline)

Parameter	2010 to 2039	2040 to 2059	2060 to 2120
Upper end	+10%	+20%	+40%
Central	+5%	+10%	+20%

[7] Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.

4.3 Surface Water Runoff Rates

An estimation of surface water runoff is required to permit effective surface water management and prevent any increase in flood risk to off-site receptors. In accordance with The SuDS Manual, the greenfield runoff rate from the site has been calculated using the IoH124 method. Table 8 shows the IoH 124 method greenfield runoff rates for the proposed impermeable area of 0.095 hectares (ha) (see Appendix 3). QBAR has been calculated to be 0.20 litres/second (l/s). The method used for calculating the runoff complies with the NPPF, as well as the Defra non-statutory technical standards for SuDS.

Table 8 - IoH124 method Greenfield Runoff Rates

Rainfall Event	Runoff Rate (l/s)
1	0.20
QBAR (rural)	0.20
30	0.40
100	0.40

4.4 Opportunities for Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirements of the Building Regulations; a hierarchy that is also promoted within the NPPF. Rainwater shall discharge to one of the following, listed in order of priority:

- an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- a watercourse; or where that is not reasonably practicable,
- a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water.

4.5 Soakaway / Infiltration System

An overview of the general ground conditions may be used to gauge if there is potential for their application. Due to the site ground conditions i.e. Made Ground, it is unlikely that infiltration devices will be suitable for the discharge of surface water. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations. Such work is beyond the scope of this FRA but may be required to inform the detailed drainage strategy for the site.

4.6 Watercourse

Should infiltration be found to be unsuitable, the next option is discharge to a watercourse. There are no watercourses, on or, within the vicinity of the site. No formal drainage features are identified within the existing site boundary or within the vicinity of the site. Consequently, it would not be possible to discharge surface water runoff from the site into a watercourse.

4.7 Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public combined sewer would be possible, on Ladybarn Lane. Surface water discharge to the public sewers would be restricted and attenuated on site before discharge to the public sewers. The surface water runoff will be restricted to 5.00l/s for all events up to and including the 1 in 100 year (+40%) event.

4.8 SuDS and Water Quality

A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution, and this is particularly true for surface water courses. This can be effectively managed by an appropriate "train" or sequence of SuDS components that are connected in series. The frequent and short duration rainfall events or the initial phase of longer duration events are those that are mostly loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10mm of rainfall (first flush) should be adequately treated with SuDS that are most effective in removing these potential contaminants (infiltration to the ground, filtration through a parking area sub-base, detention and sedimentation through storage in ponds and swales).

Proposed SuDS must account for a sufficient number of treatment stages to protect the receiving waterbody. The minimum number of treatment stages will depend on the sensitivity of the receiving groundwater body and the potential hazard associated with the proposed development.

Current guidance promotes sustainable water management through the use of SuDS. SuDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SuDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

A hierarchy of techniques is identified[8]:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).

3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).

4. **Regional Control** – management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

It is generally accepted that the implementation of SUDS as opposed to conventional drainage systems, provides several benefits by:

[8] CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity.

The application of the SuDS Manual requires that the runoff from sites is not only restricted to meet the Greenfield runoff characteristics but also that SuDS systems are utilised to improve the quality of the runoff prior to outfall from the site. The various options for the site are considered in outlined in Table 9. The SuDS Manual and Environment Agency guidance applies a sustainability hierarchy to the various types of SuDS systems, this is summarised in Table 10.

Table 9 - SuDS Techniques

SuDS Technique	Comments	Suitability for Development
Green / Living Roofs / Living Wall	Can be used on low rise buildings to provide retention, attenuation and treatment of rainwater, and promotes evaporation and local biodiversity.	Not a practical option for the proposed development. A green/living roof/living wall would not provide all of the attenuation storage requirements alone.
Basins / Ponds	Provides storage of runoff and flow attenuation. Vegetated surfaces can be used to support the prevention of runoff from the site for small rainfall events (interception) and improve water quality associated with the removal of sediment and buoyant materials.	Not the required area available, especially given the side slopes need to be 1 in 4 max. Without the space the volume attenuated would be very small to be virtually insignificant.
Filter Strips / Swales	Good removal of urban pollutants, reduces runoff rates and volumes.	Not the required area available, especially given the side slopes need to be 1 in 4 max. Without the space the volume attenuated would be very small to be virtually insignificant.
Infiltration Devices (e.g. soakaways)	Reduces total runoff volume from the development.	Not suitable due to the ground conditions.

Permeable Surfaces and Filter Drains	Permeable surfaces together with their associated substructures are an efficient means of intercepting runoff, reducing the volume and frequency of runoff and providing a treatment medium.	Can be used as a conveyance feature and to provide water quality benefits on the site but not as a primary means of infiltration.
Tanked Systems	Ideal for sites with insufficient space for basins etc., provide a volume of below ground storage with a high void ratio.	Potential to be installed under the site.
Water Butts / Rainwater Harvesting	Can provide non-potable water for re-use on site.	Will not provide the required attenuation storage requirements b due to the low demand of the site, may be used to provide betterment
Bioretention Areas / Tree Pits	Can be used to provide small scale infiltration/evaporation of water as well as water quality, amenity and biodiversity benefits.	Can be used as a conveyance features and to provide water quality benefits on the site but not as a primary means of infiltration.
Flow Reduction	Manages and reduces the flood risk to the local surface water sewers and watercourses	A hydrobrake can be installed downstream of attenuation tanks and control flows to the natural Greenfield runoff rates.

Table 10 - Sustainability Hierarchy

Most Sustainable	SuDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife	Proposed for Use on the Site
	Rainwater Harvesting	✓	✓	✓	
	Green / Living Roofs	✓	✓	✓	
	Basins and Ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓	
	Filter Strips and Swales	✓	✓	✓	
	Infiltration Devices - Soakaways	✓	✓	✓	
	Permeable Surfaces and Filter Drains - Gravelled areas - Solid paving blocks - Permeable paving	✓	✓		✓
Least Sustainable	**Tanked Systems** - Over-sized pipes / tanks - Cellular storage	✓			✓

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

The usual approach is to consider the 'SuDS train' where each of the above options are considered in turn until a suitable solution is found. Thus, source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds.

According to the Defra Draft National Standards (see Table 11), the proposed development is a combination of low (roof water) to medium hazard (runoff from car parking and road).

Table 11 - Level of Hazard

Hazard	Source of Hazard
Low	Roof drainage
Medium	Residential, amenity, commercial, industrial uses including car parking spaces and roads
High	Areas used for handling and storage or chemicals and fuels, handling of storage and waste (incl. scrap-yards).

Table 12 has been extrapolated from the Defra Draft National Standards and indicates in green the stages of treatment suggested for the different runoff waters identified for the proposed development. It is noted that if the site is on clay and does not discharge to the aquifer then less treatment is required.

Table 12 - Minimum Number of Treatment Stages for Groundwater

Sensitivity of the groundwater below the site	Hazard		
	Low	Medium	High
SPZ 1; within 50 m of an existing well, a spring or a borehole that supplies potable water	1	3	Consult with the Environment Agency
Discharge into or immediately adjacent to a sensitive receptor that could be influenced by infiltrated water. Includes designated nature conservation, heritage and landscape sites – including Biodiversity Action Plan (BAP) habitats and Protected Species	1	3	
SPZ 2 or SPZ 3 or Principal Aquifer	1	3	
Secondary Aquifer	1	2	

1.1 Site Storage Volumes

The provision of suitable storage on site to mitigate the flood risk resulting from the development of the site will be a key factor in the evolution of the site development layout. The provision of large volumes of attenuation, as is likely in this case, can be achieved by a number of methods; however, not all systems can be assessed in direct comparison.

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SuDS and it is the requirement of NPPF that these are

considered as the primary means of collection, control and disposal for storm water as close to source as possible.

The principle applied in the design of storage is to limit the discharge rate of surface water runoff from the developed site for events of similar frequency of occurrence to the same peak rate of runoff as that which takes place from a greenfield site prior to development.

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable, SuDS methods that are designed not to infiltrate can be considered (e.g. underground storage tanks, oversized drainage networks, cellular storage). QBAR (rural) has been calculated to be 0.20l/s. Using a control device and practical minimum pipe sizes it is not practical to control the discharge rate to below 5.00l/s. Therefore, a value of 5.00l/s has been used as the limiting discharge rate before discharge to the public sewers

Table 13 shows the volume of storage required for the proposed development estimated within the MicroDrainage Software for the 1 in 100 year event, with a 40% allowance for climate change (increase in peak rainfall) assuming the proposed 0.095ha of impermeable area with 5.00l/s used as the limiting discharge rate before discharge off-site (see Appendix 4).

At this stage, it is proposed that cellular storage will be used to provide the require attenuation storage volume of 37m^3. Additional storage would be provided within the permeable paving, bioretention areas, manholes, pipes and drainage gullies which will provide betterment over and above the 1 in 100 year (+40%) event. A conservative estimate of 100% runoff from impermeable areas has been used within the calculations.

Table 13 - Attenuation Storage Volumes

Return Period (years)	Limiting Discharge Rate (l/s)	Volume	
		Total (m^3)	Pro-rata (m^3/m^2)
100 +40%	5.00	37	0.04

4.9 Proposed SuDS Strategy

The objective of this SuDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The SuDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that the site provides its own attenuation. This will be in the form of:

- Water butts for each house.
- Any areas of hardstanding areas (car parks, driveways etc.) within the development shall be constructed of a permeable surface including:

  - Using gravel or a mainly green, vegetated area.
  - Paths around the buildings drain to grassed lawns.
  - Directing water from an impermeable surface to a border rain garden or connected to the drainage network.
  - Using permeable block paving, porous asphalt/concrete connected to the drainage network.
- Bioretention areas/tree pits.
- Underground cellular/tank/oversize pipe storage with an outfall to the public sewers restricted to 5.00 litres/second.
- For larger events in other areas such landscaped areas, provided that it will not cause damage or prevent access.

For all development, both the Building Regulations and NPPF promote a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy. Discharge of surface water will be to the public sewers at a restricted runoff rate of 5.00 litres/second.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, permeable paving and underground attenuation storage will be required before discharge to the public sewers. The size of the attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate the 1 in 100 year (+40% climate change) storm event.

Permeable paving, the bioretention areas and tree pits will provide storage for the first 5mm (interception storage) as a minimum. It should be noted that any permeable paving system to be installed by a developer must have an infiltration rate of at least 30mm/hr (0.03m/hr) to avoid ponding on the surface before it reaches the natural soil (permeable paving systems generally would have an infiltration rate in excess of 30mm/hr).

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the runoff. Treatment processes that occur within the surface structure and the geotextile layers include:

- Filtration
- Absorption
- Biodegradation
- Sedimentation

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable or contaminated, SuDS methods that are designed not to infiltrate can be considered. Passive treatment systems can include a pond, wetland, tank or a basin on the lower parts of a site. These

will reduce peak flows, but not the volume of runoff, and slow down flows before disposal to a surface water drainage system.

The paths around the buildings will be designed to drain to the grassed lawns. The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

All areas drained to the permeable paving and underground attenuation storage have been designed to accommodate the 1 in 100 year (+40%) event no flooding will occur within any part of the site during the 1 in 100 year (+40%) event.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the LPA, the LLFA, United Utilities and the Environment Agency.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The adoption of a SuDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

4.10 Designing for Local Drainage System Failure/Design Exceedance

The exceedance flow routes are shown in Figure 9. When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SuDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the SuDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground[9].

The SuDS Strategy has been designed to accommodate the 1 in 100 year storm event plus climate change (+40%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers and lateral drains connecting the properties to the infiltration devices. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings. Exceedance flows would be contained within the highways and would

[9] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

flow to the lower ground levels where the public open space is located. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+40%) event, there is safety, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this (i.e. within the attenuation storage, the manholes, pipework etc.). If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure.

The ground levels will slightly slope away from the buildings which will result in exceedance flows away from the buildings into the drainage network and if required the landscaped areas on the boundary of the site. Furthermore, the finished floor levels of the buildings will be raised above the external ground levels. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

5.0 RISK MANAGEMENT

5.1 Introduction

The flood risk at this location is considered suitable for 'more vulnerable' developments within the NPPF. In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development and the use of flood mitigation measures.

A number of techniques and mitigation strategies to manage and reduce the overall flood risk in the area will be used. This will ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and;
- Minimal disruption to natural heritage.

The flood risk at the site will be reduced by property level protection measures; these are discussed in more detail below.

5.2 Finished Floor Levels

The finished floor levels of the buildings will be located at 38.90mAOD therefore, the buildings will be flood free during the 1 in 100 year (+41%) event (i.e. the design event).

It is recognised however that owing to limited headroom constraints, massing, planning policy and Building Regulations it is considered impractical to raise the finished floor levels further than those discussed above. Therefore, in order to mitigate against this, it is recommended that the occupants of the buildings sign up to receive flood warnings from the Environment Agency and implement a Flood Plan to a safe area away from the buildings during times of flood. A combination of resistance (proofing) and resilience measures will be included to provide further protection. This is discussed below.

5.3 First Floor Accommodation

Accommodation will be located on the first floor and above as well as the ground floor of the buildings. This will allow occupants to retreat to higher floor levels if needed. The levels of the first floor are located approximately 2.50m above the ground floor finished floor level at 41.60mAOD well above any floodwater levels.

This provides a 'safe haven' above any floodwater levels. This will enable rapid escape should flooding occur which is unlikely. The upper floors are accessed via internal stairs and are sufficient in size to safely house all occupants of the buildings. The 'safe haven' will only be required in very extreme events or if a flood warning has not been received.

5.4 Sleeping Accommodation

All the sleeping accommodation will be located on the first and second floors. The levels of the first floor are located approximately 2.50m above the ground floor finished floor level at 41.60mAOD well above any floodwater levels. No sleeping accommodation will be located on the ground floors.

5.5 Flood Resistance

Flood risk can be mitigated through the design of the buildings. Flood resistance measures are measures that help resist floodwaters entering a property (airbrick covers are an example of a flood resistance measure). Flood resistant measures will be used, including:

- Flood doors/barriers will be employed on external doors.
- All window will be a minimum of 1m above the ground level at 39.73mAOD.
- The walls of the buildings will be thick.
- Sealant will be used around external doors and windows.
- All external doors and windows will be constructed from hard wearing materials.
- Non-return valves/anti flow valves will be fitted at the last point of inspection chamber before connection to the existing drains.
- There will be no air bricks.

The flood resistance measures will minimise the impact of flooding on the buildings. They are entirely suitable for the buildings and it is not being suggested that the building will be flood-proof only more resistant to floodwater during a flood. By employing these methods the hydrostatic loading on the buildings structure will not be impacted. This would, if required, delay water entering the buildings long enough to enable evacuation or removal of content. This is confirmed as being acceptable in the BSI Standard Publication BS 85500:2015.

5.6 Flood Resilience

Flood resilience measures are designed in such a way as to reduce the cost and time required to reinstate the property should it be flooded (tiled floors are an example of a flood resilience measure). The building will be constructed in such a way that although floodwater may enter the building, elements that are damaged by flood water can be easily repaired or replaced. This is a form of flood resilience. They are suitable as no other measure is practicable.

Robust materials and finishes will be used, up to a level of 39.49mAOD which provides a freeboard of 600mm above the design flood level, including:

- laying 1 or 2 layers of plasterboards horizontally at base of internal studwork construction to ground floors (to act as sacrificial layer in the event of flooding);
- fixings to be galvanised/stainless steel or copper - no mild steel to be used - cause rust/staining or walls;
- low permeability paints to be used rather than emulsion - allows walls to dry out quickly;
- cavities insulated with Polyisocyanurate (PIR) closed cell type insulation (e.g. celotex); and
- all electrical wiring, switches, sockets, socket outlets, electrical, and gas meters etc. will be located at a minimum of 39.49mAOD.

5.7 Food Warning and Evacuation

The site is located in a flood risk area therefore; the site will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0345 988 1188) in order to receive Flood Warnings/Alerts.

The Environment Agency operate a free flood warning service providing alerts by phone, text or email when flooding is anticipated providing an opportunity for owners to take necessary precautions, giving enough time for the building to be safely evacuated and mitigation measures to be put in place.

All occupants of the site will be made aware of the Environment Agency Floodline telephone number (Call Floodline on 0345 988 1188 to get more information) and the Flood Warning Codes and their meaning. The owner of the property will carry out the role of Flood Warden for the site and ensure they have an understanding of the flood mechanisms of the site and will ensure that the safety of the occupants and visitors will not be compromised.

The Environment Agency uses Flood Warnings Codes. They can be issued in any order, usually ending with an 'all clear'. They are issued by the Environment Agency through their website and Floodline Warning Service. The flood warning will be passed onto the visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

5.8 Flood Plan

A Flood Plan outlining the precautions and actions you should take when a flood event is anticipated to help reduce the impact and damage flooding may cause will be developed. Sensible precautions would include raising electrical items, irreplaceable items and sentimental items off the ground or where possible moving them to a higher floor, rolling up carpets and rugs and turning off utilities. In addition, consider what actions you would take should the property need to be evacuated including access and egress routes and preparing a flood kit in advance containing warm clothing, medication, a torch, food and wellingtons.

The Flood Plan is a ‘living’ document and therefore should be periodically reviewed and updated to provide advice and guidance to occupants in the event of an extreme flood. The Flood Plan will therefore reduce the vulnerability of the occupants to flooding and makes them aware of the mechanisms of flooding at the site.

Residual Risk

If flooding starts to affect the site without any pre-warning i.e. in real time (e.g. through a failure of the flood warning delivery) the following actions will be taken:

- Occupants and visitors should consider evacuating the site.
- If flood levels continue to rise, occupants and visitors are advised to evacuate before safe access is lost. Occupants and visitors should monitor the flood progression and evacuate.

The Flood Warden will monitor flood levels and keep occupants and visitors informed and will decide whether to initiate the Flood Plan. If required a ‘safe haven’ can also be maintained and may be required in very extreme events if a flood warning has not been received.

5.9 Safe Access and Egress Route

The NPPF requires that, where required, safe access and escape is available to/from new developments in flood risk areas. Access routes should be such that occupants can safely access and exit their dwellings in design flood conditions. These routes must also provide the emergency services with access to the development during a flood event and enable flood defence authorities to carry out any necessary duties during the period of flood.

The Planning Practice Guidance to the NPPF confirms that *‘Access and egress must be designed to be functional for changing circumstances over the lifetime of the development. Specifically:*

- *Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. Vehicular access to allow the emergency services to safely reach the development during design flood conditions will also normally be required.*

- *Wherever possible, safe access routes should be provided that are located above design flood levels and avoiding flow paths. Where this is not possible, limited depths of flooding may be acceptable, provided that the proposed access is designed with appropriate signage etc to make it safe. The acceptable flood depth for safe access will vary depending on flood velocities and the risk of debris within the flood water. Even low levels of flooding can pose a risk to people in situ (because of, for example, the presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention)'.*

A safe access and egress route, including emergency access can be maintained for vehicles and/or by foot. The site is at such a ground level that it would only flood in the most extreme flood event. Likewise, the access and egress route will remain dry in all but these most extreme scenarios. A safe access and egress route with minimum water depths would be possible for many hours if not days. This would provide more than an adequate amount of time for the site to be evacuated, if required.

The Safe Access and Egress Route shown in Figure 6 indicates the exit route that all people (i.e. occupants and visitors) on site should follow once a flood warning has been received. People should make their way to areas outside of the flood zone via the site access and then via Ladybarn Lane to the south and then via Mauldeth Road to the south east. Therefore, safe access and egress can be maintained for all events up to and including the 1 in 100 year (+41%) event in accordance with the NPPF and Environment Agency guidance.

Facilities such as community centres, shops etc. are located to the north of the site which may be used in the event of a flood event. There may also be large areas than those shown in Figure 2 that are flood free located nearer and within the vicinity of the site. In the event of a Flood Warning, vital belongings, including waterproof clothing, necessary medication and essentials for infants and children will be collected. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site using the route shown in Figure 6.

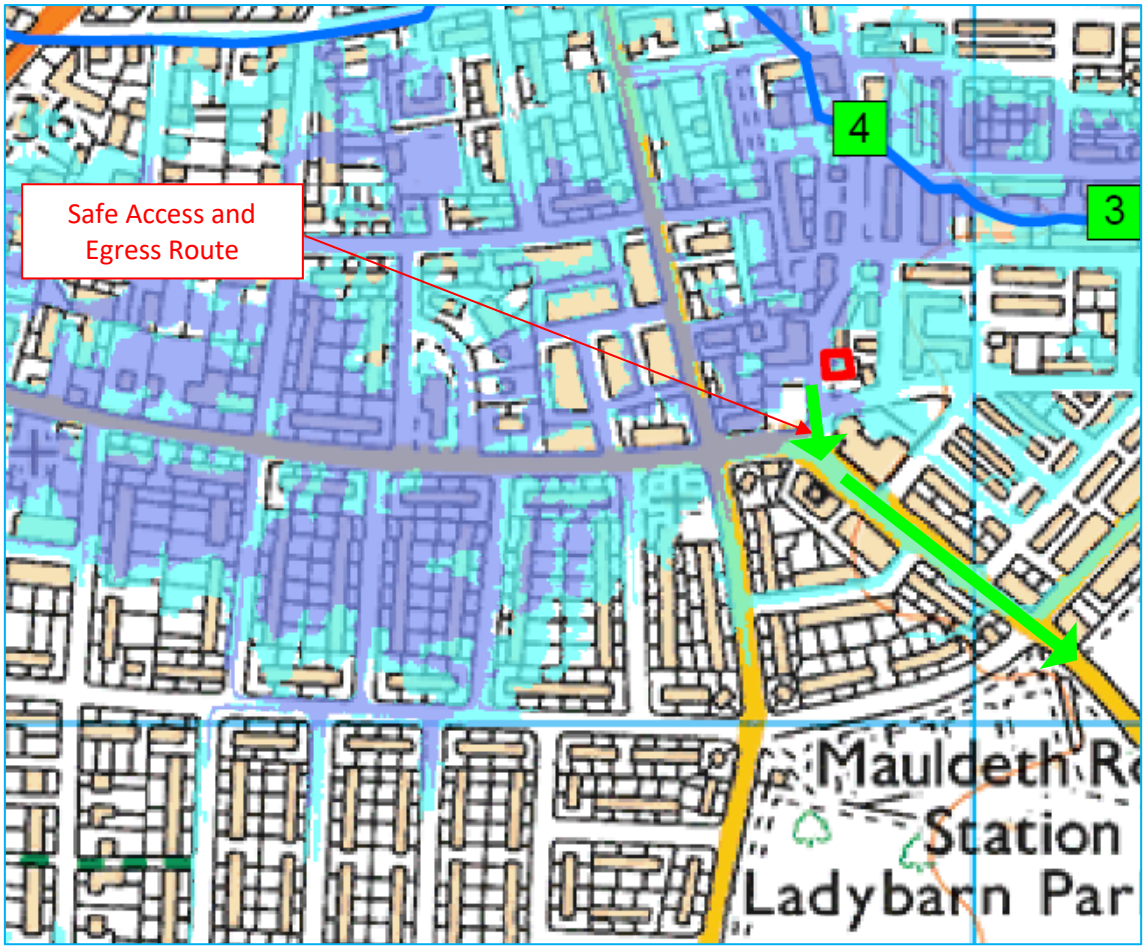

Figure 6 - Safe Access and Egress Route

5.10 Flood Warning Codes / Flood Evacuation Procedures

In order for the following evacuation procedures to be effective:

- The site will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0345 988 1188) in order to receive Flood Warnings/Alerts.
- The flood warning will be passed onto the visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

Flood Alert

'*Flooding of low-lying land and roads is expected. Be aware, be prepared, watch out!*'.

The Environment Agency will issue a Flood Alert status when flooding is possible, based upon weather and river/sea conditions. Be prepared to act on your flood plan. At this stage occupants and visitors

should make themselves aware of the Flood Plan and evacuation routes. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast.

Flood Warning

'Flooding of homes and businesses is expected. Act now!'.

The Flood Warning alert will be issued when water levels are rising, and further rain is expected. The site will be evacuated. Move family, pets and valuables to a safe place. Safe access and egress, including emergency access can be maintained for vehicles and/or by foot. Water, electricity and gas supplies should be located and switched off before evacuating. The Environment Agency Floodline on 0345 988 1188 to get more information should be contacted to get more information, periodically and listen to and watch for weather and flood warnings on local radio and television stations.

Severe Flood Warning

'Severe Flooding is expected. There is extreme danger life and property. Act now!'.

If the site has not already been evacuated, it will be evacuated immediately. Co-operate with the emergency services and call 999 if immediately in danger. Safe access and egress, including emergency access can be maintained for vehicles and/or by foot.

Warning No Longer in Force

'Flood Watches or Flood Warnings are no longer in force for this area'.

Occupants and visitors should contact Manchester City Council to check that it is safe to return to the site. Please be careful water may be around for several days. If there is any doubt that appliances may be water damaged, they must be checked before switching the power or gas back on. Contact your insurance company as soon as possible to get their approval before arranging any clean-up or repairs.

5.11 Residual Risk

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable. The site is unlikely to flood except in extreme conditions. This takes into account the property level protection measures.

6.0 SEQUENTIAL APPROACH

6.1 Sequential Test

The risk-based Sequential Test in accordance with the NPPF aims to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1). However, where an individual proposes to develop a site in an existing flood risk area the consideration of alternative sites is not likely to be a realistic option. The planning applicant should state why there is no alternative available to them to develop.

It is impractical to suggest that there are more suitable locations for this development elsewhere. This is the only site in the ownership of the client and therefore the only site available to them to develop. The cost of buying a similar site and the cost to construct a similar development would make it uneconomical. This is the only site in the ownership of the client and therefore the only site available to them to develop. The site proposals cannot be located in another site elsewhere. There are no alternative sites available to develop with a comparable size for residential uses within this area.

No 'reasonably available' alternative sites have been identified within the sites identified for residential uses within this area. The sites are already developed and are not available to construct the site proposals.

The Council's objectives are to sustain and enhance the vitality and viability of the region, and to ensure a wide range of businesses to which people have easy access by a range of transport therefore, improving the overall quality of life. This is underpinned by the quality of the physical environment, social well-being and economic and environmental improvements. The Council seeks to grant permission for developments that add to the vitality and viability of the region.

This site will help to regenerate the region and will help to deliver these objectives. This site will help encourage economic impetus that will in turn help deliver a stronger service function and mix of housing uses.

The site proposals remain consistent with the relevant planning policies and are not at odds with the current use of the site and can only enhance and preserve the residential base which currently exists. The wider area surrounding the proposed development site is affected by a very similar, and in many cases, higher risk of flooding. The application is for a new, suitable flood-resilient design. The exposure of people and property will be minimised.

Flood risk at the site will be further mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site. The proposed development will improve the sites resilience, resistance to flooding and by using property level protection measures to protect the site from flooding the vulnerability of the site will be improved (see Section 5.0).

Incidentally, the level of identified need for houses means that it is not a simple case of development on this site or on an alternative site. The Council continues to assess potential sites, in addition to this site. Whilst flood risk is a significant material planning consideration and the LPA will continue to seek to minimise flood risk and identify development sites at the lowest risk of flooding - suitable, available and viable sites for housing is scarce. Those sites that meet the criteria, subject to gaining planning permission, need to be brought forward to help meet the identified need.

It can be seen that in the short term at least it will be difficult to achieve housing targets due to market conditions such that developers are unwilling to develop sites where the rate of house sales remain

at relatively low levels. Additionally, in the present housing climate there is an increased risk of delays to building completions.

Historically, a significant proportion of housing development across the district has come forward on 'windfall' sites comprising small infill sites, changes of use and conversions. Given the compelling evidence of historic completion rates and expected future trends of housing delivery sites suitable for 'windfall' sites, it is clear therefore that 'windfall' site such as this site will remain an important element of the provision of the required new houses. It is therefore clear that the subject site and many other 'windfall' sites will be required if the Council is to have any chance of meeting its 5 year land supply of housing.

Similar developments on any site outside a Flood Zone will not offer any advantage vis-a-vis flooding. Consequently, application of the Sequential Test demonstrates that there is no measurable advantage to constructing the proposed housing elsewhere.

Application of the Sequential Test requires that there are other suitable sites available that offer less risk in terms of flooding. Development of this site with the floor levels proposed provides greater safety for the occupants than a similar site immediately adjacent to the flood risk area with levels marginally above the design flood risk level.

Hence this proposal provides greater protection to occupants than might be afforded by another notional site. Consequently, the Sequential Test would suggest that this site is one to which development should be moved, rather than one from which it should directed. Indeed, using a pragmatic approach it is doubtful that the Sequential Test should be applied at all.

From the above it is shown that there are overriding sustainability reasons for the development to be granted planning permission. The development proposals should therefore be considered by the LPA to satisfy the Sequential Test as set out in the NPPF.

6.2 Exception Test

For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA.

The key emphasis of the NPPF is to achieve sustainable development. The NPPF provides the following aims under the umbrella of sustainable development.

1. Building a strong, competitive economy
2. Ensuring the vitality of town centres
3. Supporting a prosperous rural economy
4. Promoting sustainable transport
5. Supporting high quality communications infrastructure
6. Delivering a wide choice of high quality homes
7. Requiring good design
8. Promoting healthy communities
9. Protecting Green Belt land
10. Meeting the challenge of climate change, flooding and coastal change
11. Conserving and enhancing the natural environment
12. Conserving and enhancing the historic environment
13. Facilitating the sustainable use of mineral

The site is sustainable and within walking distance of the local community and services. The development of the site will improve the appearance of the site and make a positive contribution to as well as providing much a needed home in a highly sustainable location well-served by public transport and close to local facilities including schools.

The Councils' policies make clear for the need to focus on new development in locations which are accessible and sustainable, making use of existing infrastructure and community facilities and services. There is an important need within this area for affordable housing, which is suitable for a wide variety of people.

The added material benefit is the contribution that this site will make to the Councils' housing supply position in full compliance with the emerging strategic housing policy. There is an identified need for residential uses to meet future housing needs and accordingly there is a sound and strong planning reason for bringing the site forward.

These outcomes will provide wider sustainability benefits to the community that outweigh flood risk and will deliver considerably wider sustainability benefits than could conceivably only be achieved through use of the site for residential purposes. The development proposals should therefore be considered by the Council to satisfy the first condition of the Exceptions Test as set out in the NPPF.

b) A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

This FRA has demonstrated that the development will be safe, without increasing flood risk elsewhere.

The development proposals should therefore be considered by the LPA to satisfy the Exception Test as set out in the NPPF.

7.0 SUMMARY AND CONCLUSIONS

7.1 Introduction

This report presents a FRA in accordance with the NPPF for the proposed development at Ladybarn Lane, Withington, Manchester, M14 6RQ.

This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

7.2 Flood Risk

The site is unlikely to flood except in extreme conditions. The principal flood risk to the site is from fluvial flooding from the Cringle Black Brook. The site is located within Flood Zone 3 and therefore has a 'high probability' of flooding, with a 1 in 100 or greater annual probability of river flooding (>1%) in any year. The site is located on the edge of Flood Zones 2 and 3.

Actual Risk

However, the site is protected against flooding by existing flood defence measures with an SoP of 1 in 100 years. The site will be flood free during the defended 1 in 100 year event and the actual flood risk posed to the site is less than the 1 in 100 year event.

The site may be inundated with floodwater to a maximum depth of 0.60m during the defended 1 in 100 year (+41%) event (i.e. the design flood event) and to a maximum depth of 0.68m during the defended 1 in 1000 year event.

Residual Risk

During the undefended 1 in 100 year (+35%) event, therefore, the site may be inundated with floodwater to a maximum depth of 0.63m and to a maximum depth of 0.64m during the undefended 1 in 100 year (+41%) event (i.e. the design flood event). During the undefended 1 in 1000 year event, therefore, the site may be inundated with floodwater to a maximum depth of 0.71m.

Given the scale and nature of the proposed development and the size and location of the fluvial flooding sources it has been concluded that fluvial flooding poses a low actual and residual flood risk to the site. The risk of flooding from fluvial flooding is considered to be of **medium significance.** A secondary flooding source has been identified which may pose a **low significant** risk to the site. This is:

- Surface Water Flooding

The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site. The flood risk will be mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site.

The proposed use for residential uses is classified as 'more vulnerable', 'more vulnerable' uses are appropriate within Flood Zones 2 and 3.

7.3 SuDS Strategy

The SuDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The SuDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that the site provides its own attenuation. This will be in the form of:

- Water butts for each house.
- Any areas of hardstanding areas (car parks, driveways etc.) within the development shall be constructed of a permeable surface including:
    - Using gravel or a mainly green, vegetated area.
    - Paths around the buildings drain to grassed lawns.
    - Directing water from an impermeable surface to a border rain garden or connected to the drainage network.
    - Using permeable block paving, porous asphalt/concrete connected to the drainage network.
- Bioretention areas/tree pits.
- Underground cellular/tank/oversize pipe storage with an outfall to the public sewers restricted to 5.00 litres/second.
- For larger events in other areas such landscaped areas, provided that it will not cause damage or prevent access.

For all development, both the Building Regulations and NPPF promote a hierarchical approach to surface water management. This approach has been adopted within this SuDS Strategy. Discharge of surface water will be to the public sewers at a restricted runoff rate of 5.00 litres/second.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, permeable paving and underground attenuation storage will be required before discharge to the public sewers. The size of the attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 40% increase in rainfall intensity that is predicted to occur as a result

of climate change. Consequently, all areas drained have been designed to accommodate the 1 in 100 year (+40% climate change) storm event.

Permeable paving, the bioretention areas and tree pits will provide storage for the first 5mm (interception storage) as a minimum. It should be noted that any permeable paving system to be installed by a developer must have an infiltration rate of at least 30mm/hr (0.03m/hr) to avoid ponding on the surface before it reaches the natural soil (permeable paving systems generally would have an infiltration rate in excess of 30mm/hr).

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the runoff. Treatment processes that occur within the surface structure and the geotextile layers include:

- Filtration
- Absorption
- Biodegradation
- Sedimentation

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable or contaminated, SuDS methods that are designed not to infiltrate can be considered. Passive treatment systems can include a pond, wetland, tank or a basin on the lower parts of a site. These will reduce peak flows, but not the volume of runoff, and slow down flows before disposal to a surface water drainage system.

The paths around the buildings will be designed to drain to the grassed lawns. The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

All areas drained to the permeable paving and underground attenuation storage have been designed to accommodate the 1 in 100 year (+40%) event no flooding will occur within any part of the site during the 1 in 100 year (+40%) event.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the LPA, the LLFA, United Utilities and the Environment Agency.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. The adoption of a SuDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

7.4 Risk Management

The flood risk at the site will be reduced by property level protection measures. Measures used:

Finished Floor Levels: The finished floor levels of the buildings will be located at 38.90mAOD therefore, the buildings will be flood free during the 1 in 100 year (+41%) event (i.e. the design event).

It is recognised however that owing to limited headroom constraints, massing, planning policy and Building Regulations it is considered impractical to raise the finished floor levels further than those discussed above. Therefore, in order to mitigate against this, it is recommended that the occupants of the buildings sign up to receive flood warnings from the Environment Agency and implement a Flood Plan to a safe area away from the buildings during times of flood. A combination of resistance (proofing) and resilience measures will be included to provide further protection. This is discussed below.

First Floor Accommodation: Accommodation will be located on the first floor and above as well as the ground floor of the buildings. This will allow occupants to retreat to higher floor levels if needed. The levels of the first floor are located approximately 2.50m above the ground floor finished floor level at 41.60mAOD well above any floodwater levels.

This provides a 'safe haven' above any floodwater levels. This will enable rapid escape should flooding occur which is unlikely. The upper floors are accessed via internal stairs and are sufficient in size to safely house all occupants of the buildings. The 'safe haven' will only be required in very extreme events or if a flood warning has not been received.

Sleeping Accommodation: All the sleeping accommodation will be located on the first and second floors. The levels of the first floor are located approximately 2.50m above the ground floor finished floor level at 41.60mAOD well above any floodwater levels. No sleeping accommodation will be located on the ground floors.

Flood Resistance: Flood resistant measures will be used, including:

- Flood doors/barriers will be employed on external doors.
- All window will be a minimum of 1m above the ground level at 39.73mAOD.
- The walls of the buildings will be thick.
- Sealant will be used around external doors and windows.
- All external doors and windows will be constructed from hard wearing materials.
- Non-return valves/anti flow valves will be fitted at the last point of inspection chamber before connection to the existing drains.
- There will be no air bricks.

The flood resistance measures will minimise the impact of flooding on the buildings. They are entirely suitable for the buildings and it is not being suggested that the building will be flood-proof only more resistant to floodwater during a flood. By employing these methods the hydrostatic loading on the buildings structure will not be impacted. This would, if required, delay water entering the buildings long enough to enable evacuation or removal of content. This is confirmed as being acceptable in the BSI Standard Publication BS 85500:2015.

Flood Resilience: Robust materials and finishes will be used, up to a level of 39.49mAOD which provides a freeboard of 600mm above the design flood level, including:

- laying 1 or 2 layers of plasterboards horizontally at base of internal studwork construction to ground floors (to act as sacrificial layer in the event of flooding);

- fixings to be galvanised/stainless steel or copper - no mild steel to be used - cause rust/staining or walls;
- low permeability paints to be used rather than emulsion - allows walls to dry out quickly;
- cavities insulated with Polyisocyanurate (PIR) closed cell type insulation (e.g. celotex); and
- all electrical wiring, switches, sockets, socket outlets, electrical, and gas meters etc. will be located at a minimum of 39.49mAOD.

Flood Warning and Evacuation: The site is located in a flood risk area therefore; the site will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0345 988 1188) in order to receive Flood Warnings/Alerts.

Flood Plan: A Flood Plan outlining the precautions and actions you should take when a flood event is anticipated to help reduce the impact and damage flooding may cause will be developed.

Safe Access and Egress Route: A safe access and egress route, including emergency access can be maintained for vehicles and/or by foot. The site is at such a ground level that it would only flood in the most extreme flood event. Likewise, the access and egress route will remain dry in all but these most extreme scenarios. A safe access and egress route with minimum water depths would be possible for many hours if not days. This would provide more than an adequate amount of time for the site to be evacuated, if required.

The Safe Access and Egress Route indicates the exit route that all people (i.e. occupants and visitors) on site should follow once a flood warning has been received. People should make their way to areas outside of the flood zone via the site access and then via Ladybarn Lane to the south and then via Mauldeth Road to the south east. Therefore, safe access and egress can be maintained for all events up to and including the 1 in 100 year (+41%) event in accordance with the NPPF and Environment Agency guidance.

Flood Warning Codes / Flood Evacuation Procedures: The flood evacuation procedures have been developed so that the site can be safely evacuated. The property will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0345 988 1188) in order to receive Flood Warnings. Flood warning will be passed onto the visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

7.5 Sequential Approach

The development proposals should be considered by the LPA to satisfy the Sequential and Exception Tests as set out in the NPPF.

7.6 Conclusion

In conclusion, the proposed development would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are implemented, flood risk from all sources would be minimised, the consequences of flooding would be acceptable, and the Proposed Development would be in accordance with the requirements of the NPPF.

The adoption of a SuDS Strategy for the site will reduce the risk of flooding to the site and off-site locations. This FRA demonstrates that the Proposed Development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The proposed development should not therefore be precluded on the grounds of flood risk.

APPENDIX 1 – Existing and Proposed Site Layout

A1

EXISTING SITE PLAN

Scale: 1 : 200

North

Graphical Scale 1:200

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Revision		Date	Drawn	Checked
A	FIRST ISSUE	21.08.13	AA	JH

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T: 0114 279 6003 E: information@codastudios.co.uk

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AA	JH	08/17/21	1 : 200

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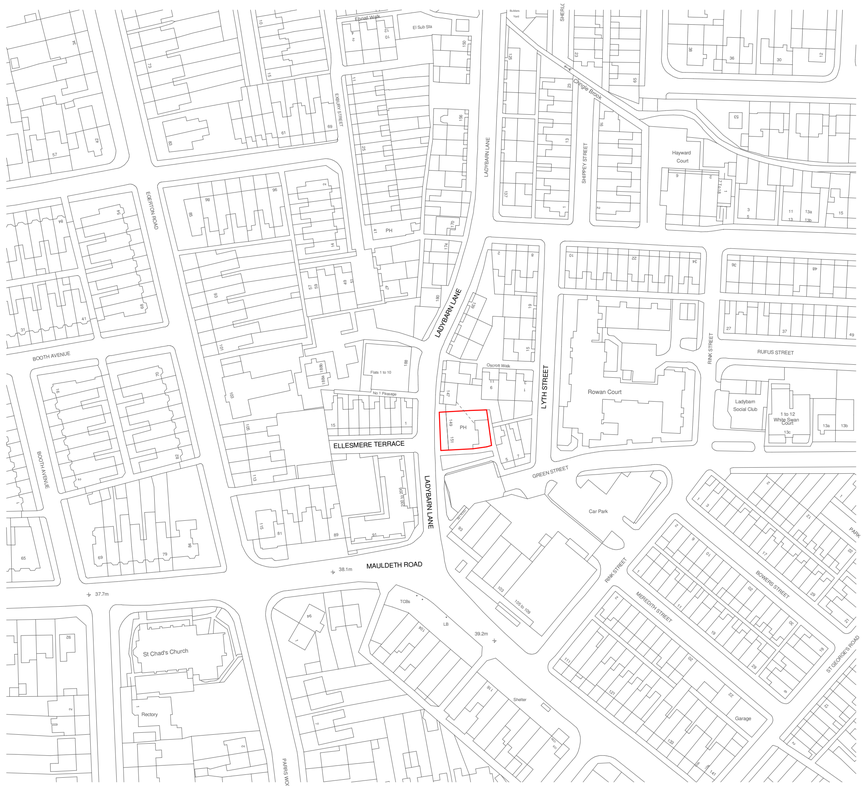
PROJECT
LADYBARN

Title
EXISTING SITE PLAN

Drawing No
3006 - **PL** - **0100** - **A**
Project Role: Number: Revision:

Purpose for issue

M.03



North

Graphical Scale 1:1250

0 5 10 15 20 30 40 50 60 70 80 90 100 110 120 130 140 150m

EXISTING SITE LOCATION PLAN

Scale: 1 : 1250

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PROJECT
LADYBARN

Title
EXISTING SITE LOCATION PLAN

Drawing No
3006 - **PL** - **0101** - **A**
Project Stage Number Revision

Purpose for issue

M.03

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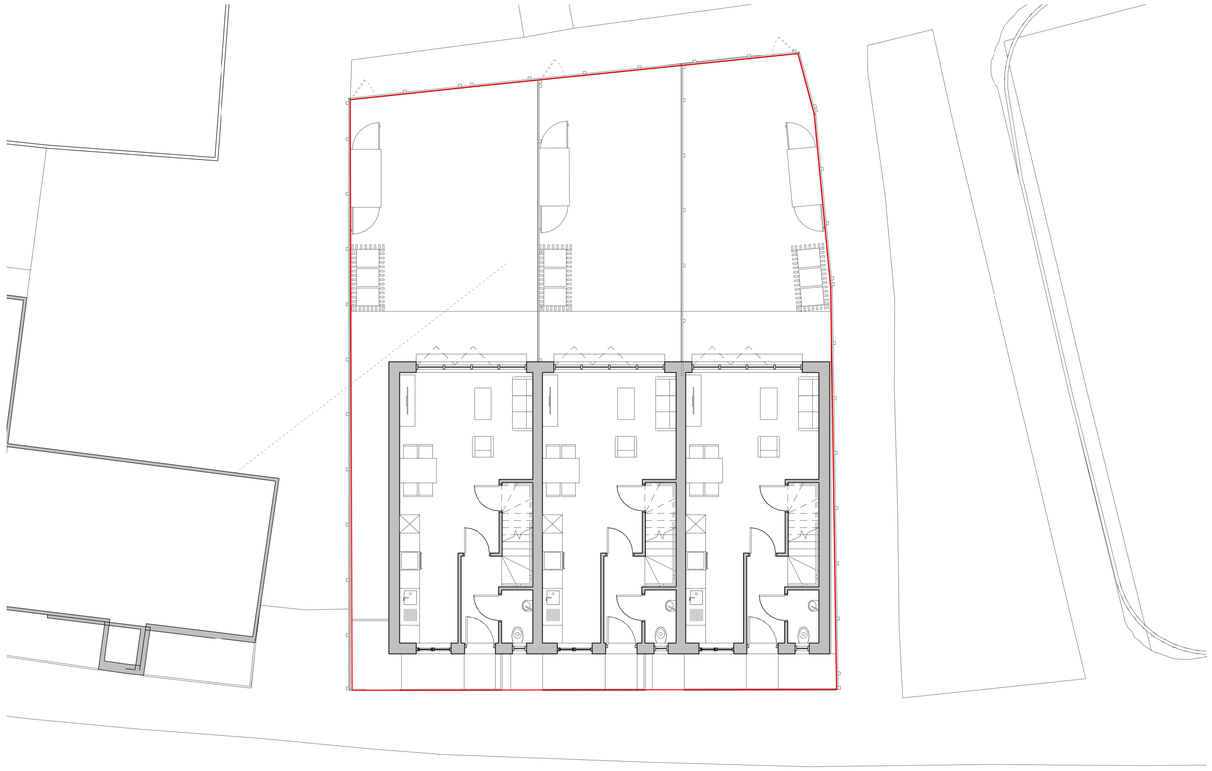
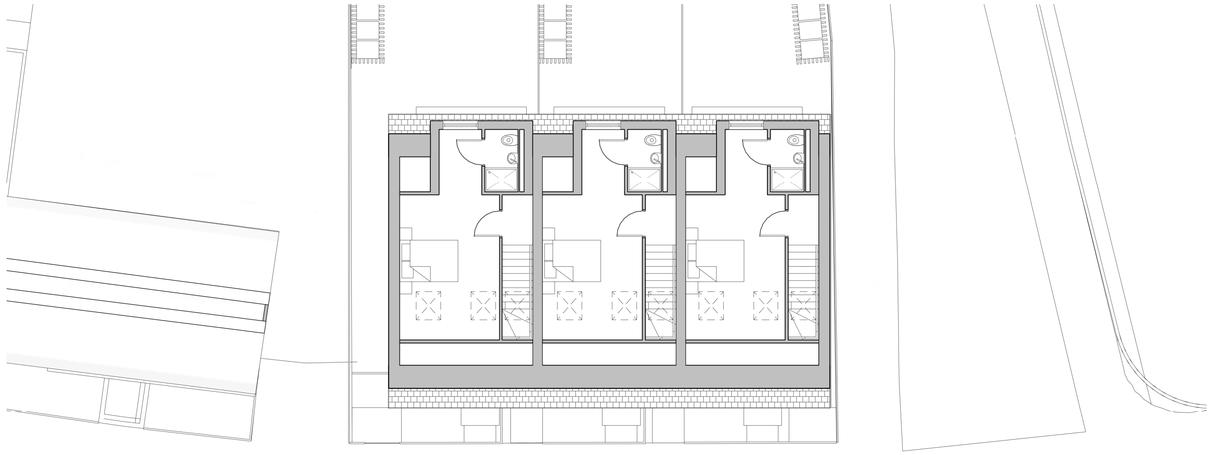


00 - PROPOSED GROUND FLOOR

Scale: 1 : 100

01 - PROPOSED FIRST FLOOR

Scale: 1 : 100



02 - PROPOSED SECOND FLOOR

Scale: 1 : 100

Graphical Scale 1:100

0 1 2 3 4 5 10m

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B	REVISED PLANS	21.11.08	AA	JH
C	REVISED SCHEME	22.08.22	VK	JH

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CODA Studios Ltd. 18 Lloyd Street, Manchester, M5 2WA
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PROJECT
LADYBARN

Title
PROPOSED PLANS

Drawing No
3051 - **PL** - **0600** - **C**
Project Note: Number: Revision:

Purpose for issue

M.03

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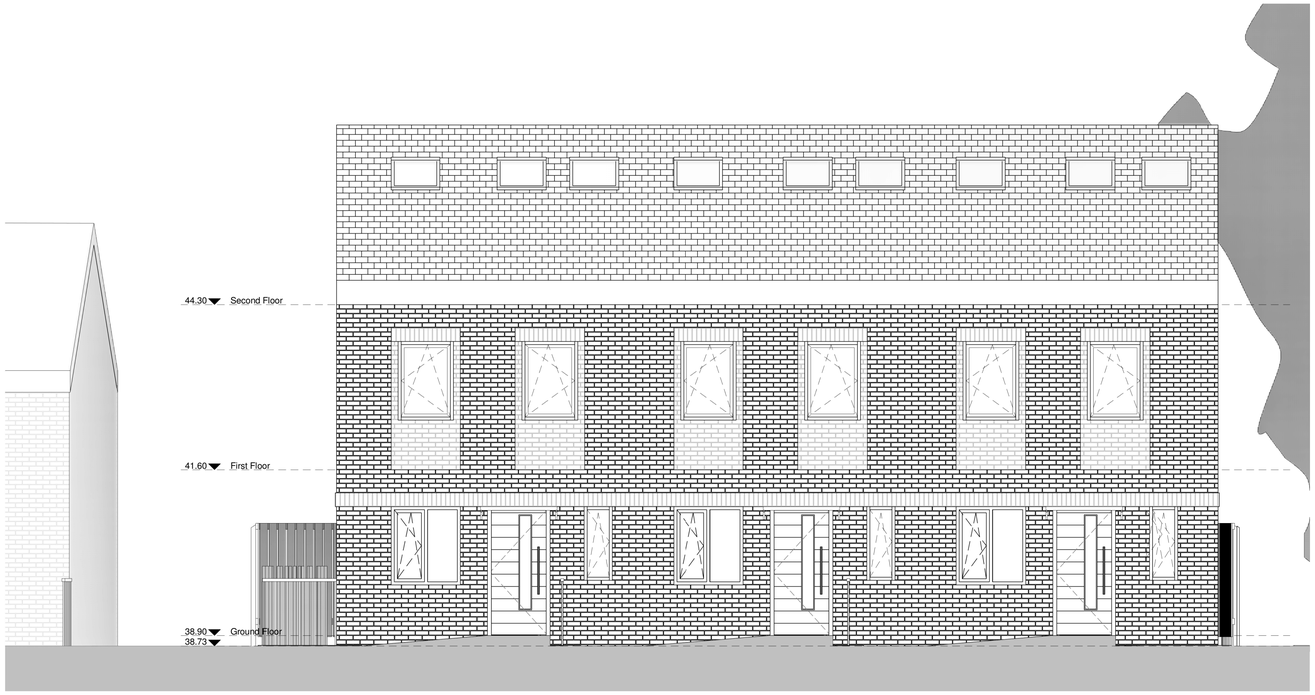

PROPOSED FRONT ELEVATION

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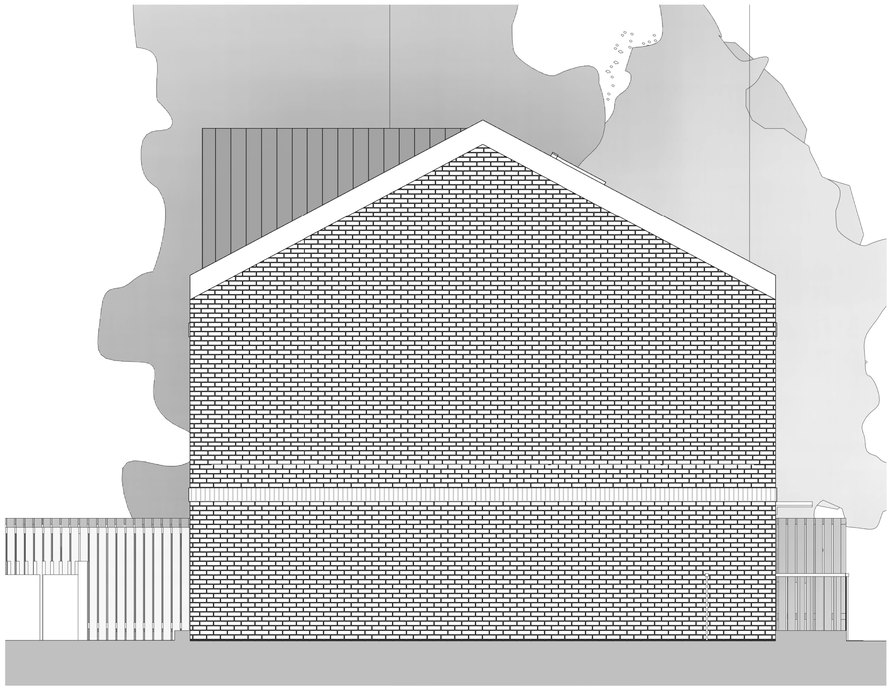

PROPOSED NORTH ELEVATION

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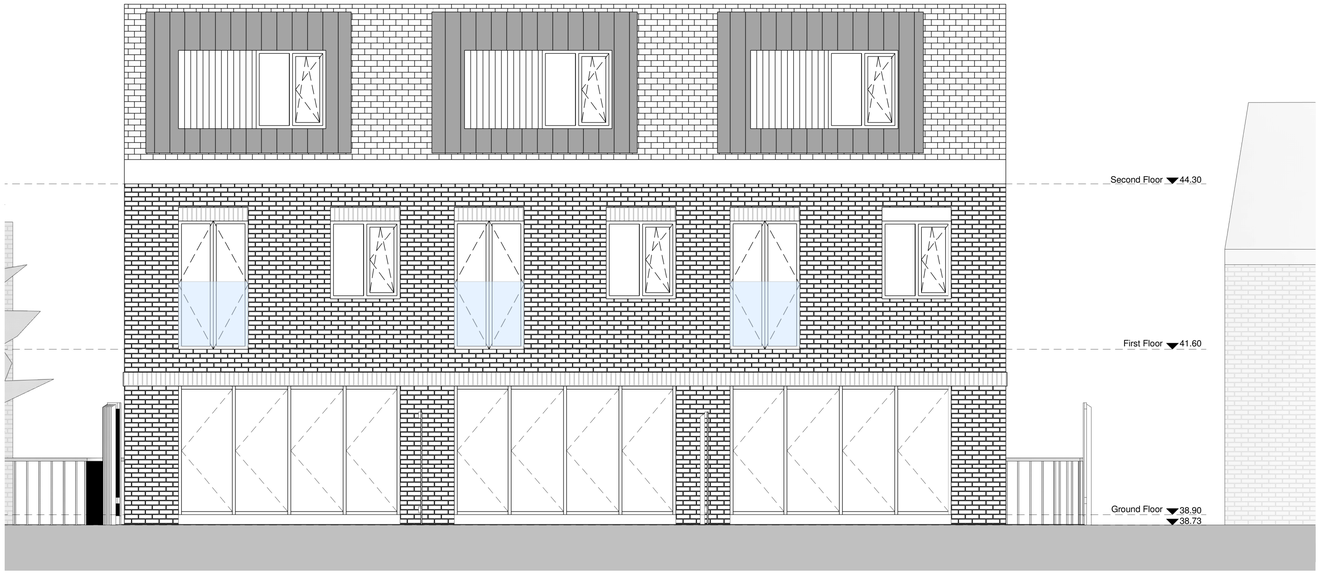

PROPOSED REAR ELEVATION

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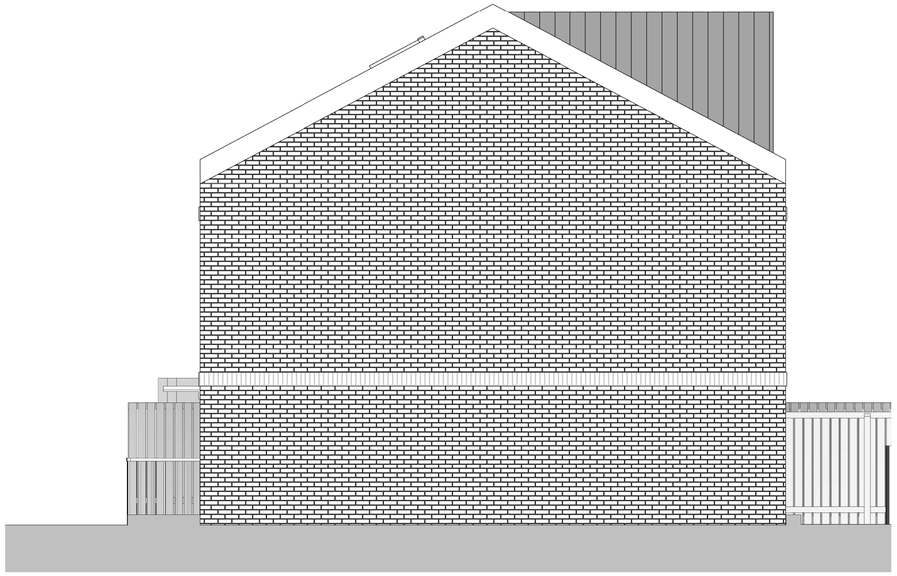

PROPOSED SOUTH ELEVATION

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AREA MEASUREMENT
The areas are approximate and can only be verified by a detailed dimensional survey of the completed building. Any decisions to be made on the basis of these predictions, whether as to project viability, pre-letting, lease agreements or otherwise, should include due allowance for the increases and decreases inherent in the design development and building processes. Existing buildings may present anomalies in relation to surveyed/drawn plans that may also effect the stated areas. All areas are subject to Town Planning and Conservation Area Consent and detailed Rights to Light analysis. Figures relate to the likely areas of the building at the current stage of the design and are calculated using one of the following (as stated in the accompanying areas schedule) IPM S1, IPM S2, IPM S3, Gross External Area (GEA), Gross Internal Area (GIA) or Nett Internal Area (NIA) methods of measurement from the RICS Property Measurement 1st edition.

23/08/2022 11:18:36

Revision		Date	Drawn	Checked
A	FIRST ISSUE	21.08.13	AA	JH
B	REVISED PLANS	21.11.08	AA	JH
C	AMENDEMENTS MADE FROM PLANNING APPLICATION COMMENTS	21.12.03	AA	JH
D	ROOF MASSING LOWERED	21.12.09	AA	JH
E	REVISED SCHEME	22.08.22	VK	JH

CODA Bespoke

CODA Studios Ltd. 18 Lloyd Street, Manchester, M5 2WA
T: 0114 279 6003 E: information@codastudios.co.uk

Drawn	Checked	Date	Scale @A1
AA	JH	11/04/20	1 : 50

CLIENT
DS

PROJECT
LADYBARN

Title
PROPOSED ELEVATIONS

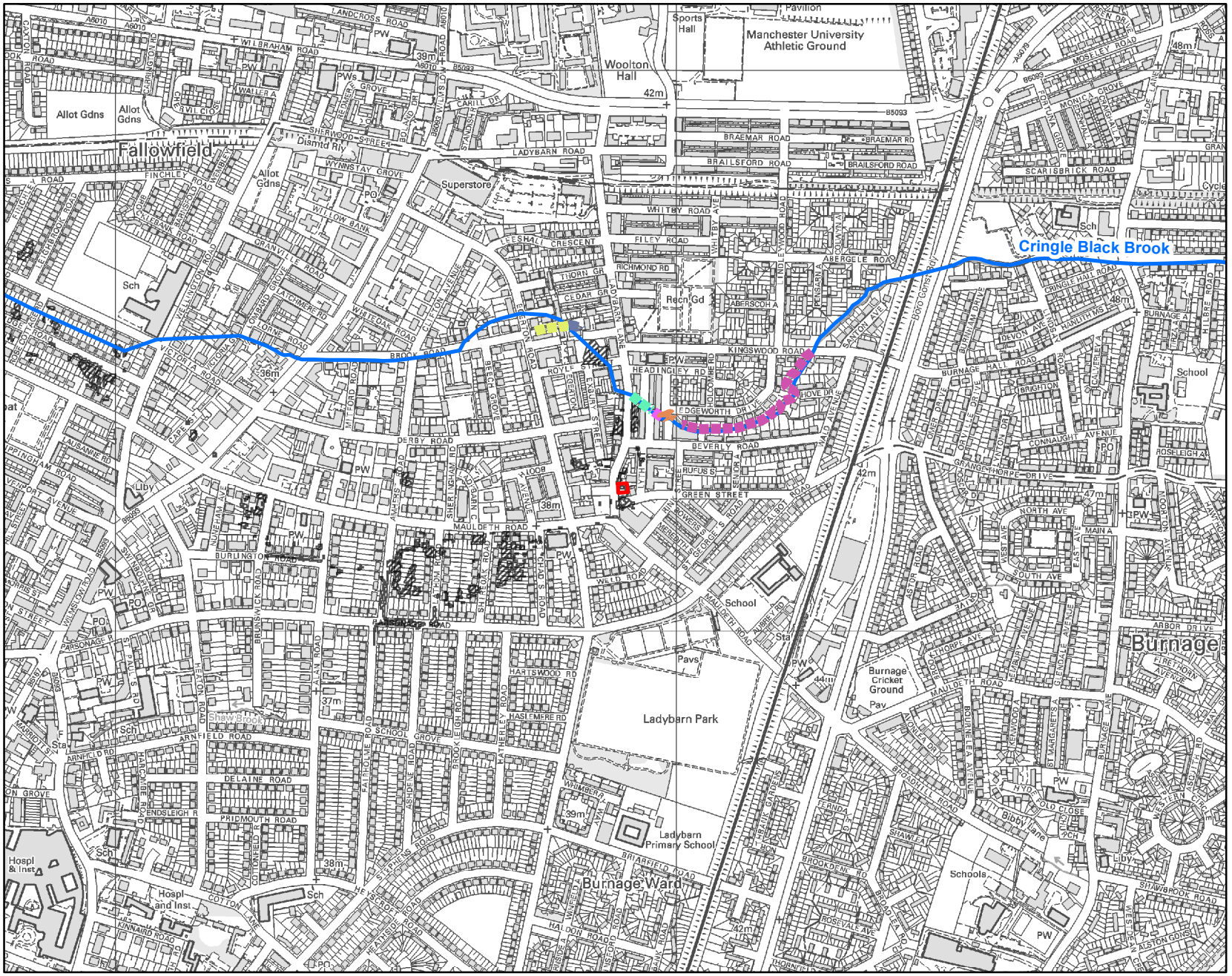
Drawing No
3051 - **PL** - **0700** - **E**
Project Note Number Revision

Purpose for issue

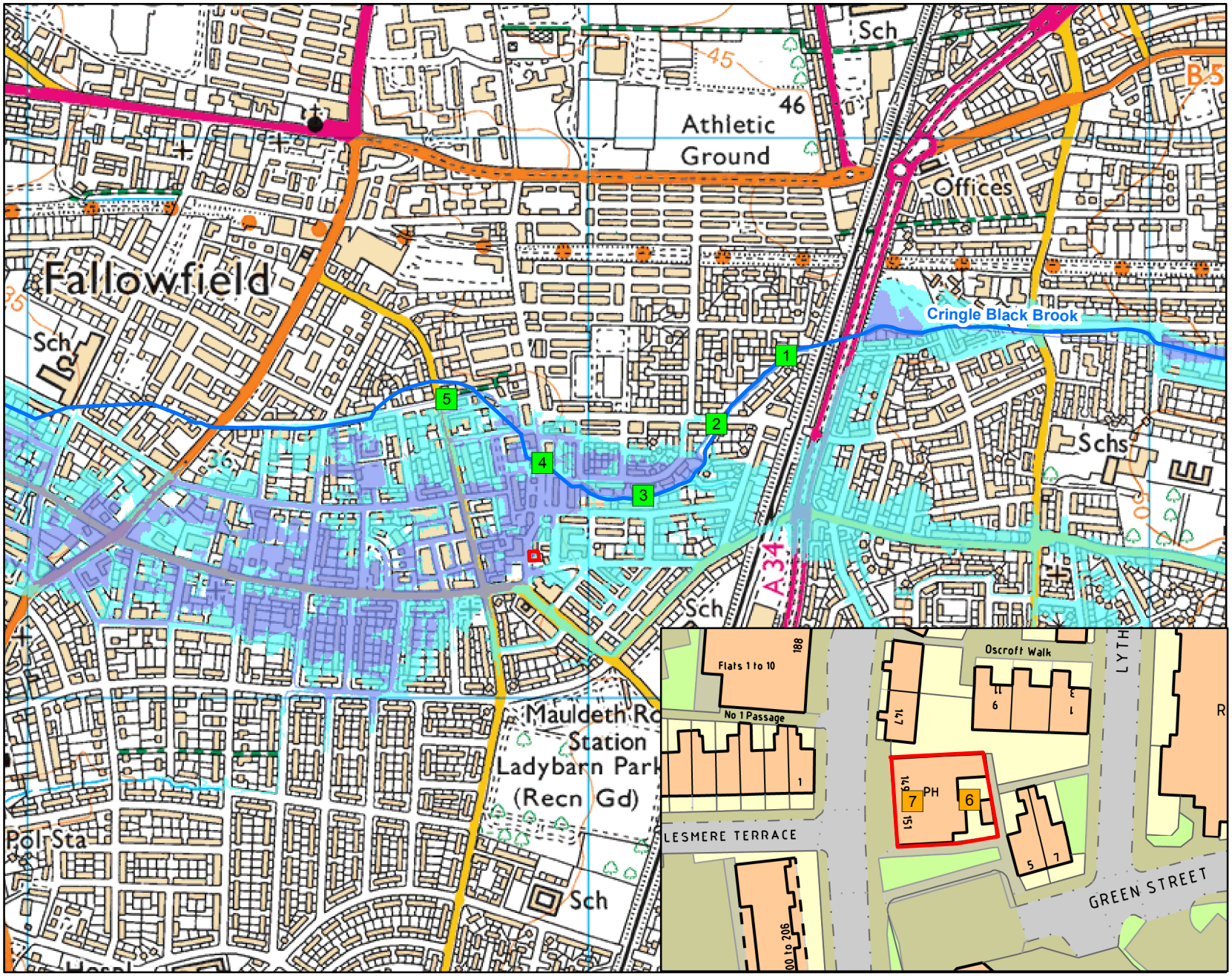
M.03

APPENDIX 2 – Environment Agency Correspondence

Flood Defence Map centred on Ladybarn Lane, Withington, Manchester, M14 6RQ.
Created on 10/09/2021 [GMMC232842CC]


Cringle Black Brook
Manchester University Athletic Ground
Woolton Hall
Fallowfield
Superstore
Ladybarn Park
Ladybarn Primary School
Burnage Ward
Burnage
Burnage Cricket Ground
Schools
School
Hospl & Inst
Hospl and Inst
Allot Gdns
Recn Gd
Sch
Pavs
Pav
Sta
Liby
LADYBARN ROAD
BRAEMAR ROAD
BRAILSFORD ROAD
WHITBY ROAD
FILEY ROAD
KINGSWOOD ROAD
HEADINGLEY RD
EDGEWORTH DRIVE
BEVERLY ROAD
GREEN STREET
MAULDETH ROAD
DERBY ROAD
BURLINGTON ROAD
ARNFIELD ROAD
DELAINE ROAD
PRIDMOUTH ROAD
HARTSWOOD RD
HASLEMERE RD
BRIARFIELD ROAD
SCARISBRICK ROAD
MOSELEY ROAD
BURNAGE LANE
BURNAGE HALL ROAD
CONNAUGHT AVENUE
GRANGE THORPE DRIVE
NORTH AVE
SOUTH AVE
ARBOR DRIVE
FIRE HORN AVENUE
Bibby Lane
SHAWBROOK ROAD
WESTERN CRESCENT
ASTON GDNS
ROSEVALE AVE
HALDON ROAD
BROOKDENE RD
TERNDA
SHAWLEAF
NYDALE CLOSE
ST MARGARETS
KENWOOD A
BURNAGE AVENUE
BORDERVILLE AVENUE
BRIGHTON
CALVERLEY A
ROSELEIGH A
DEVON AVE
CRINGLE HALL ROAD
HANLITH MS
BURNAGE A
ABERGELE ROAD
ABERSCOH A
DENSARN A
COLWYN A
SANTON AVE
HOVE DR
ALDA AVENUE
BURNAGE LANE
BURNAGE A
MAIN A
EAST AVE
WEST AVE
ASTOR ROAD
BURNSIDE DR
ELTHORPE AVE
ELTHORPE DRIVE
GRANGE THORPE DRIVE
CLIFTON AVENUE
WELLINGTON ROAD
VICTORIA ROAD
CARLTON ROAD
WHITEOAK ROAD
CEDAR GR
THORN GR
LEESHALL CRESCENT
WILLOW BANK
GRANVILLE ROAD
WYNNSTAY GROVE
SHERWOOD STREET
FINCHLEY ROAD
WILBRAHAM ROAD
LANDCROSS ROAD
CARILL DR
STANDISH ST
BOLAND DR
WALLER A
ROYLE ST
ROYLE GR
ENGLAND STREET
BEECH GROVE
MIFFORD ROAD
CARR HILL
LAUSANNE RD
VENTNOR AVENUE
SHERINGHAM RD
ALBERT ROAD
ALAN ROAD
BRUNSWICK ROAD
HEATON ROAD
PARSONAGE R
WILMSLOW ROAD
WEST DR
ARDEN ROAD
ASHFORD ROAD
BROOKLEIGH ROAD
SCHOOL GROVE
FAIRHOLME ROAD
ASHCROFT ROAD
WHIMBREL A
WINDELLA A
HEATHFIELD ROAD
COTTONFIELD R
COTTON AVE
KINNAIRD ROAD
HENDSLEIGH R
MARCHBEE ROAD
HARCOMBE ROAD
WEST DR
WEST GR
WEST ROAD
WEST GR
WEST ROAD
WEST GR
WEST ROAD

Detailed Flood Map centred on Ladybarn Lane, Withington, Manchester, M14 6RQ.
Created on 10/09/2021 [GMMC232842CC]



Environment Agency

1:10,001

N

Legend

- Site Location
- Model Measurements
- 2D Measurements
- Main River
- Flood Zone 3
- Flood Zone 2

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Map Reference	Model Node Reference	Easting	Northing	Data	Undefended													Defended														
					50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	5 % AEP (1 in 20 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow	50 % AEP (1 in 2 year)	20 % AEP (1 in 5 year)	10 % AEP (1 in 10 year)	5 % AEP (1 in 20 year)	4 % AEP (1 in 25 year)	2 % AEP (1 in 50 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow
1	ea013_0230_CRN01_2387	380355	393611	Modelled Water Level (m ausNd)	41.47	41.57	41.68	41.73	41.74	41.79	41.81	41.82	41.87	41.87	41.90	41.93	41.92	41.47	41.57	41.68	41.73	41.74	41.79	41.81	41.82	41.87	41.87	41.90	41.85	41.91	41.92	41.92
				Modelled Flow (cumecs)	2.01	2.36	3.23	3.54	3.62	3.91	4.07	4.18	4.53	4.58	4.77	4.87	4.97	2.01	2.56	3.23	3.54	3.62	3.91	4.07	4.18	4.53	4.58	4.77	4.27	4.87	4.96
2	ea013_0230_CRN01_2210d	380230	393489	Modelled Water Level (m ausNd)	40.27	40.40	40.58	40.63	40.64	40.68	40.70	40.71	40.75	40.76	40.79	40.74	40.84	40.88	40.27	40.40	40.56	40.63	40.64	40.68	40.70	40.71	40.75	40.76	40.79	40.74	40.84	40.88
				Modelled Flow (cumecs)	2.15	2.72	3.47	3.80	3.86	4.11	4.29	4.37	4.73	4.79	5.05	4.97	5.54	5.78	2.15	2.72	3.47	3.80	3.86	4.11	4.29	4.37	4.73	4.79	5.06	4.97	5.54	5.78
3	ea013_0230_CRN01_1991	380099	393361	Modelled Water Level (m ausNd)	39.77	39.87	39.99	40.04	40.05	40.09	40.11	40.12	40.17	40.18	40.23	40.16	40.29	40.31	39.77	39.87	39.99	40.04	40.05	40.08	40.11	40.12	40.17	40.18	40.23	40.16	40.29	40.31
				Modelled Flow (cumecs)	3.03	3.70	4.57	5.07	5.17	5.54	5.71	5.81	6.37	6.45	7.27	6.16	9.19	10.54	3.03	3.70	4.57	5.07	5.17	5.54	5.71	5.81	6.37	6.45	7.27	6.16	9.19	10.54
4	ea013_0230_CRN01_1701u	380502	393420	Modelled Water Level (m ausNd)	38.46	38.77	39.21	39.33	39.34	39.35	39.36	39.36	39.37	39.38	39.39	39.27	39.43	39.46	38.46	38.77	39.21	39.33	39.34	39.35	39.36	39.36	39.37	39.38	39.39	39.27	39.43	39.46
				Modelled Flow (cumecs)	3.03	3.69	4.28	4.39	4.38	4.40	4.41	4.42	4.44	4.44	4.49	4.44	4.48	4.51	3.03	3.69	4.28	4.39	4.38	4.40	4.41	4.42	4.44	4.44	4.49	4.44	4.48	4.51
5	ea013_0230_CRN01_1551u	380748	393534	Modelled Water Level (m ausNd)	37.83	38.02	38.43	38.45	38.45	38.47	38.47	38.47	38.49	38.50	38.53	38.48	38.56	38.61	37.83	38.02	38.43	38.45	38.45	38.47	38.47	38.47	38.49	38.50	38.53	38.48	38.56	38.61
				Modelled Flow (cumecs)	3.03	3.69	4.27	4.37	4.38	4.40	4.41	4.42	4.44	4.44	4.44	4.43	4.47	4.49	3.03	3.69	4.27	4.37	4.38	4.40	4.41	4.42	4.44	4.44	4.44	4.43	4.47	4.49

Map Reference	Model Node Reference	Easting	Northing	Data	Undefended								Defended			
					1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.1 % AEP (1 in 1000 year)	0.1 % AEP (1 in 1000 year) + 30% increase in flow
6	ZO Measurement	380409	393253	Modelled Water Level (m ausNd)	38.91	38.95	38.99	39.00	38.91	38.96	38.96	39.00	38.95	38.96	38.93	38.97
7		380399	393253	Modelled Water Level (m ausNd)	38.91	38.95	38.99	39.00	38.91	38.96	38.96	39.00	38.95	38.96	38.93	38.97

Model data taken from Cringle Brook 2017 Study

AEP - Annual Exceedence Probability

m ausNd - metres above ordnance datum New lyn

cumecs - cubic metres per second

Notes: *Climate Change Scenario - 30%, 35% and 70% increases in flow calculated for the 2080's (2070 - 2115). Please see https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.*

Flood Defences

Start Date	Asset Type	Asset ID	Standard of Protection	Upstream Actual Crest Level (m ausN)	Downstream Actual Crest Level (m ausN)
01/01/2004	Wall	32270	100	39.29	39.21
01/01/2004	Wall	32271	100	39.73	39.4
01/01/2004	Wall	32357	100	40.97	40.67
01/01/2004	Wall	32358	100	46.71	46.72
01/01/2004	Wall	8870	100	39.83	39.84
01/01/2004	High Ground	8871	100	41.17	39.56

APPENDIX 3 – IoH 124 Method Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	0.095	Urban	0.000
SAAR (mm)	828	Region Number	Region 10

Results	**l/s**
QBAR Rural	0.2
QBAR Urban	0.2
Q100 years	0.4
Q1 year	0.2
Q30 years	0.4
Q100 years	0.4

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APPENDIX 4 – Attenuation Storage Calculations

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	37.442	0.342	5.0	25.3	O K
30 min Summer	37.531	0.431	5.0	31.9	O K
60 min Summer	37.583	0.483	5.0	35.7	O K
120 min Summer	37.595	0.495	5.0	36.6	O K
180 min Summer	37.578	0.478	5.0	35.4	O K
240 min Summer	37.553	0.453	5.0	33.5	O K
360 min Summer	37.494	0.394	5.0	29.2	O K
480 min Summer	37.430	0.330	5.0	24.4	O K
600 min Summer	37.375	0.275	5.0	20.3	O K
720 min Summer	37.329	0.229	5.0	17.0	O K
960 min Summer	37.264	0.164	5.0	12.2	O K
1440 min Summer	37.213	0.113	4.5	8.4	O K
2160 min Summer	37.190	0.090	3.4	6.6	O K
2880 min Summer	37.177	0.077	2.7	5.7	O K
4320 min Summer	37.164	0.064	2.0	4.7	O K
5760 min Summer	37.156	0.056	1.6	4.1	O K
7200 min Summer	37.150	0.050	1.3	3.7	O K
8640 min Summer	37.147	0.047	1.2	3.4	O K
10080 min Summer	37.143	0.043	1.0	3.2	O K
15 min Winter	37.442	0.342	5.0	25.3	O K
30 min Winter	37.530	0.430	5.0	31.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	120.209	0.0	28.4	17
30 min Summer	79.963	0.0	37.9	31
60 min Summer	50.812	0.0	48.2	56
120 min Summer	31.262	0.0	59.3	88
180 min Summer	23.234	0.0	66.2	124
240 min Summer	18.716	0.0	71.1	158
360 min Summer	13.678	0.0	77.9	226
480 min Summer	10.951	0.0	83.2	290
600 min Summer	9.211	0.0	87.4	350
720 min Summer	7.992	0.0	91.0	406
960 min Summer	6.384	0.0	97.0	518
1440 min Summer	4.644	0.0	105.8	738
2160 min Summer	3.372	0.0	115.3	1100
2880 min Summer	2.683	0.0	122.3	1468
4320 min Summer	1.942	0.0	132.7	2200
5760 min Summer	1.542	0.0	140.6	2896
7200 min Summer	1.289	0.0	146.9	3672
8640 min Summer	1.113	0.0	152.2	4368
10080 min Summer	0.982	0.0	156.7	5136
15 min Winter	120.209	0.0	28.4	17
30 min Winter	79.963	0.0	37.9	31

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	37.584	0.484	5.0	35.8	O K
120 min Winter	37.586	0.486	5.0	36.0	O K
180 min Winter	37.558	0.458	5.0	33.9	O K
240 min Winter	37.517	0.417	5.0	30.9	O K
360 min Winter	37.416	0.316	5.0	23.4	O K
480 min Winter	37.330	0.230	5.0	17.0	O K
600 min Winter	37.268	0.168	5.0	12.4	O K
720 min Winter	37.230	0.130	4.9	9.6	O K
960 min Winter	37.205	0.105	4.1	7.8	O K
1440 min Winter	37.183	0.083	3.1	6.2	O K
2160 min Winter	37.168	0.068	2.3	5.0	O K
2880 min Winter	37.160	0.060	1.8	4.4	O K
4320 min Winter	37.150	0.050	1.3	3.7	O K
5760 min Winter	37.144	0.044	1.0	3.2	O K
7200 min Winter	37.140	0.040	0.9	2.9	O K
8640 min Winter	37.137	0.037	0.7	2.7	O K
10080 min Winter	37.134	0.034	0.7	2.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	50.812	0.0	48.2	58
120 min Winter	31.262	0.0	59.3	92
180 min Winter	23.234	0.0	66.2	132
240 min Winter	18.716	0.0	71.1	170
360 min Winter	13.678	0.0	77.9	236
480 min Winter	10.951	0.0	83.2	296
600 min Winter	9.211	0.0	87.4	348
720 min Winter	7.992	0.0	91.0	392
960 min Winter	6.384	0.0	97.0	502
1440 min Winter	4.644	0.0	105.8	738
2160 min Winter	3.372	0.0	115.3	1096
2880 min Winter	2.683	0.0	122.3	1464
4320 min Winter	1.942	0.0	132.7	2180
5760 min Winter	1.542	0.0	140.6	2872
7200 min Winter	1.289	0.0	146.9	3728
8640 min Winter	1.113	0.0	152.2	4360
10080 min Winter	0.982	0.0	156.7	5040

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	1.000
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.374	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.095

Time (mins) From:	To:	Area (ha)
0	4	0.095

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Model Details

Storage is Online Cover Level (m) 38.300

Tank or Pond Structure

Invert Level (m) 37.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	74.0	0.500	74.0	0.501	0.0	1.200	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0113-5000-0500-5000
Design Head (m)	0.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	113
Invert Level (m)	37.100
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	5.0
Flush-Flo™	0.179	5.0
Kick-Flo®	0.372	4.4
Mean Flow over Head Range	-	4.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	7.5	3.000	11.6	7.000	17.4
0.200	5.0	1.400	8.1	3.500	12.5	7.500	18.1
0.300	4.8	1.600	8.6	4.000	13.3	8.000	18.7
0.400	4.5	1.800	9.1	4.500	14.1	8.500	19.2
0.500	5.0	2.000	9.6	5.000	14.8	9.000	19.8
0.600	5.4	2.200	10.0	5.500	15.4	9.500	20.3
0.800	6.2	2.400	10.4	6.000	16.1		
1.000	6.9	2.600	10.8	6.500	16.8		

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KRS Environmental Ltd

Mob: 07857 264 376

Tel: 01686 668957

Tel: 01484 437420

Email: keelan@krsenvironmental.com

Web: www.krsenvironmental.com