



UK Flood Risk
Flood Risk Consultants

Flood Risk Assessment (FRA) & Sustainable Drainage Systems (SuDS)

**Albuhera, Farm Road, Northwood,
Middlesex HA6 2NZ**

Project Ref: QFRA 2805

Version: 1.0

Date: 10/12/2025

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Revision Records

Issued	Report Version	Comments	Issued to
December 2025	1.0	1 st Issue	MASS&MANY LTD

Prepared by	SG	Senior Flood Risk Consultant	10/12/2025
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Issue Date: 10/12/2025

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Executive Summary

The planning proposal is for the erection of a new dwelling following demolition of the existing dwelling at Albuhera, Farm Road, Northwood, Middlesex HA6 2NZ.

The sources of information to undertake this flood risk assessment (FRA) and SuDS are the flood maps and data of the Environment Agency and the previous flood studies undertaken by the Local Authority along with the National Planning Policy Framework (NPPF, February 2025), the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes, and the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

The proposed development, classified as "more vulnerable" under NPPF guidelines, is appropriate for its location within Flood Zone 1, where the probability of flooding is very low and remains so even when future climate change is considered.

There are no major watercourses nearby, and neither the Local Authority's SFRA nor Environment Agency records show any history of flooding at the site.

The risk from rivers, surface water, groundwater, sewers, and reservoirs is all low.

Although infiltration SuDS are unsuitable due to the underlying London Clay, surface runoff will be effectively managed using a SuDS strategy that includes permeable paving and an underground attenuation tank with a 52 m² footprint and 0.40 m depth, controlled by a Hydrobrake. This system limits discharge to the Greenfield runoff rate of 0.90 Litres/sec and provides full storage for the 1 in 100-year event plus 40% climate change, with no predicted flooding or overflow.

The controlled outflow will discharge to the on-site surface water sewer, and permeable paving will further reduce runoff.

The landowner will be responsible for maintaining these systems, and the proposed development will be safe for its lifetime without increasing flood risk elsewhere.

The SuDS system will be maintained by the landowner throughout the lifetime of the proposed development, and the development will not increase flood risk elsewhere.

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1.0 Background

UK Flood Risk has been commissioned to prepare this Flood Risk Assessment (FRA) and Sustainable Drainage Systems (SuDS) Strategy in support of a planning proposal for the erection of a new dwelling following demolition of the existing dwelling at Albuhera, Farm Road, Northwood, Middlesex HA6 2NZ.

This Flood Risk Assessment (FRA) and SuDS Strategy has been prepared in accordance with the requirements of the National Planning Policy Framework (NPPF, February 2025), the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes, and recognised best practices in flood risk management. The assessment also complies with the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015), ensuring that the proposed development incorporates appropriate surface water drainage measures and addresses all relevant flood risk considerations.

2.0 FRA Requirements and Objectives

The key objectives of this Site-Specific Flood Risk Assessment (FRA) are to:

- Identify all potential sources of flooding that may affect the development site, including fluvial (river), surface water, groundwater, sewer, and reservoir flooding.
- Assess the level of flood risk to the proposed development, both in the present day and accounting for the potential impacts of climate change.
- Evaluate the suitability of the proposed development type and its location in relation to the identified flood risk, in accordance with the National Planning Policy Framework (NPPF) and relevant local policy.
- Demonstrate that the development will be safe for its lifetime without increasing flood risk elsewhere, through appropriate mitigation and resilience measures.
- Inform the design of site layout and drainage strategy, ensuring flood risk is managed effectively through sustainable drainage solutions (SuDS) and other appropriate infrastructure.
- Comply with the requirements of the Environment Agency, Lead Local Flood Authority (LLFA), and Local Planning Authority (LPA) for managing flood risk in the planning process.

3.0 General Description of the Site and the Proposals

3.1. Description of the site

The proposed development site is located at Albuhera, Farm Road, Northwood, Middlesex HA6 2NZ, and is approximately centred on the Ordnance Survey Grid Reference TQ 08021 92214 (**Appendix A Figure 1**). The site lies within the administrative boundary of the London Borough of Hillingdon, which acts as the Lead Local Flood Authority (LLFA) for the area and is responsible for the management of flood risk from surface water, groundwater, and ordinary watercourses, in accordance with the Flood and Water Management Act 2010.

The site occupies an area of approximately 0.216ha. Approximately 269m² is occupied by the building footprint and garages, and 195m² is occupied by hardstanding area. Approximately 1695m² is covered by soft landscaping (**Appendix B**).

Access to the site is via Farm Road. The surrounding area is characterized by a mix of forest and residential use (**Appendix A Figure 2**).

The British Geological Survey's geological maps are provided in **Appendix C**. The geological maps show that the bedrock of the site comprises London Clay Formation-Clay. These sedimentary rocks are marine in origin. They are detrital and comprise coarse- to fine-grained slurries of debris from the continental shelf flowing into a deep-sea environment, forming distinctively graded beds.

There are no major watercourses in the vicinity of the site.

The site has a sloped topography, with the general elevations ranging from approximately 95mAOD to 98mAOD as shown in **Appendix D**. Further details regarding the existing site conditions are provided in **Appendix B**.

3.2. Proposed Development

The proposal is for the erection of a new dwelling following demolition of the existing dwelling. The footprint area of the proposed dwelling is approximately 281m². Further details about the proposals have been provided in **Appendix B**.

4.0 Development and Flood Risk Policy

4.1. National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF, February 2025) sets out the government's planning policies for England. The NPPF sets out planning and policies related to development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency's Flood Maps. The aim of the flood risk assessment is to identify which Flood Zones the site is located in and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

4.2. Flood Zones

The Flood Zones refer to the probability of river and sea flooding which ignores the presence of defences. The national flood maps have been developed by the Environment Agency that shows the risk of tidal and/or fluvial flooding across England and Wales for different return period events. The Environment Agency's Flood Maps are the maps which have been developed using broad scale hydraulic modelling. It is therefore important to understand that the flood maps may not be very accurate at a site-specific level which may need further field observation and measurements. The Flood Zones do not take into account of the climate change impacts which must be considered in any flood risk assessment as required by the NPPF.

4.3. Sequential and Exception Tests

As set out in the NPPF, the overall aim of the Sequential Test should be to steer new development to Flood Zone 1 (Low Probability Flooding). Where there are no reasonably available sites in Flood Zone 1, the Local Authority should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. Where there are no reasonably available sites in Flood Zones 1 or 2, the suitability of sites in Flood Zone 3 should be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

As the proposal site is located in Flood zone 1 (i.e. low probability flooding), the Sequential Test will not be required.

The Exception Test, as set out in the NPPF Framework, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites

at lower risk of flooding are not available. There are two requirements to meet for the Exception Tests. The proposed development will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

4.4. Vulnerability of Use and Flood Risk Assessment

The proposed development is categorised as ‘more vulnerable’ (**Table 2**). The site is located in Flood Zone 1 (i.e. low probability flooding). The proposed development is therefore considered appropriate at this location (**Table 3**). As part of the Flood Risk Assessment, all types of flood risk are considered as part of the Flood Risk Assessment: *‘A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall’.*

This FRA aims to demonstrate that the proposal will remain safe for its lifetime and will not increase flood risk elsewhere.

4.5. NPPF Flood Zones

Table 1 below shows the NPPF Flood Zones and the requirements and policy aims in terms of undertaking site-specific flood risk assessment.

Table 1 - NPPF Flood Zones and Requirements (NPPF Technical Guidance)

Zone 1: Low Probability Flood Zone	This is defined as the land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
Appropriate uses	All uses of land are appropriate in this zone.
FRA requirements	For development proposals on sites comprising 1 ha or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA.
Policy aims	Developers and local authorities should seek opportunities to reduce the overall level of flood risk

	through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 2: Medium Probability Flood Zone	This is defined as the land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.
Appropriate uses	The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table 2 are appropriate in this zone. Highly vulnerable uses in Table 2 are only appropriate in this zone if the Exception Test is passed.
FRA requirements	All proposals in this zone should be accompanied by a FRA.
Policy aims	Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 3a: High Probability Flood Zone	This is defined as the land assessed as having a 1 in 100 or greater annual probability of river flooding (<1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Appropriate uses	The water-compatible and less vulnerable uses of land in Table 2 are appropriate in this zone. The highly vulnerable uses (Table 2) should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2 should only be permitted in this zone if the Exception Test is passed.
FRA requirements	All proposals in this zone should be accompanied by a FRA.

Table 2 - Flood Risk Vulnerability Classification (NPPF Technical Guidance)

Essential Infrastructure	Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	<ul style="list-style-type: none"> ❖ Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. ❖ Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. ❖ Installations requiring hazardous substances consent.
More Vulnerable	<ul style="list-style-type: none"> ❖ Hospitals, residential institutions such as residential care homes, children’s homes, ❖ Social services homes, prisons and hostels. ❖ Buildings used for: dwelling houses, student halls of residence, drinking establishments, nightclubs, hotels and sites used for holiday or short-let caravans and camping. ❖ Non–residential uses for health services, nurseries and education. ❖ Landfill and waste management facilities for hazardous waste.
Less Vulnerable	<ul style="list-style-type: none"> ❖ Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, and assembly and leisure. ❖ Land and buildings used for agriculture and forestry. ❖ Waste treatment (except landfill and hazardous waste facilities), minerals working and processing (except for sand and gravel). ❖ Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).

Water-compatible Development	<ul style="list-style-type: none"> ❖ Flood control infrastructure, water transmission infrastructure and pumping stations. ❖ Sewage transmission infrastructure and pumping stations. ❖ Sand and gravel workings. ❖ Docks, marinas and wharves, navigation facilities. ❖ MOD defence installations. ❖ Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location ❖ Water-based recreation (excluding sleeping accommodation). ❖ Lifeguard and coastguard stations. ❖ Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. ❖ Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.
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Table 3 - Flood Risk Vulnerability and Flood Zone 'compatibility'

Vulnerability Classification (Refer Table 2)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zones	Flood Zone 1	✓	✓	✓	✓	✓
	Flood Zone 2	✓	✓	Exception Test	✓	✓
	Flood Zone 3a	Exception Test	✓	*	Exception Test	✓
	Flood Zone 3b	Exception Test	✓	*	*	*

✓ Development is appropriate
 * Development should not be permitted

4.6. Strategic Flood Risk Assessment (SFRA)

The West London Strategic Flood Risk Assessment (West London SFRA) jointly undertaken by the boroughs of Barnet, Brent, Ealing, Harrow, Hillingdon and Hounslow is a comprehensive study that assesses the potential risks and impacts of flooding in the boroughs. The SFRA provides important information to support land use planning, development control, emergency planning, and community resilience.

The SFRA considers a range of potential flood risks, including those from rivers, surface water, and groundwater sources. The study includes detailed flood risk maps that identify areas at risk of flooding and the potential consequences of flooding, such as property damage, business disruption, and loss of life.

The SFRA also provides guidance on flood risk management strategies and measures that can be implemented to mitigate the potential impacts of flooding. This includes measures such as flood defences, land use planning controls, emergency response planning, and public awareness and education campaigns.

The SFRA provides a strategic overview of all forms of flood risk throughout the area, now and in the future. This document, and the associated web-based mapping delivered as part of the SFRA, is designed to help address local requirements, manage development requirements, and manage the risk of flooding posed to both residents and buildings.

The Local Authority's SFRA is an important tool for ensuring that flood risk is considered in land use planning and development decisions. It supports the Local Authority's efforts to manage flood risk and build resilience in the face of potential flooding events.

5.0 Assessment of Flood Risk

5.1. History of Flooding

The West London Strategic Flood Risk Assessment (West London SFRA) provides brief information on past flooding events in the area. The SFRA reported some historical flooding incidents in the wider area, however, there were no recorded flooding events at the site.

In addition, information on historic flooding was obtained from the Environment Agency's online records of historic flood events in the area. Historic flood maps indicate that there were no flooding incidents in the past.

5.2. Risk of Fluvial Flooding

There are no major watercourses in the vicinity of the site. The Environment Agency's Flood Map around the site is shown in **Appendix E Figure 1** which shows that the site lies within the Flood Zone 1 (i.e. low probability flooding). Flood Zone 1 is an area where flooding from rivers is very unlikely. There is less than a 1 in 1000 chance of flooding occurring in any one given year (i.e. a less than 0.1% annual probability of flooding).

Appendix E Figure 2 shows that the site will be subject to flooding when climate change is considered for the future 2070–2125-time frame.

5.3. Risk of Tidal Flooding

There are no watercourses in this area influenced by tidal waves. The risk of tidal flooding is therefore low.

5.4. Risk of Flooding From Artificial Water Bodies

There were no known flood risks from any artificial water bodies near the site.

5.5. Risk of Groundwater Flooding

In recent years, groundwater has been increasingly recognised as a significant source of flooding in the UK. According to the British Geological Survey (BGS), groundwater flooding occurs when the water table in permeable rocks rises high enough to enter basements or cellars, or even emerge above the ground surface. Unlike other types of flooding, groundwater flooding is not always directly linked to specific rainfall events and is typically of longer duration, potentially lasting for weeks or even months.

Within the Strategic Flood Risk Assessment (SFRA), evidence of historical groundwater flooding is very limited. However, it is important to note that the risk of groundwater flooding is highly variable and largely dependent on local geological and hydrological conditions at any given time.

Based on information provided by the landowner, there are no known records of groundwater flooding incidents at or near the site. Taking into account both the available evidence and local knowledge, it is reasonable to conclude that the risk of groundwater flooding to the site is low.

5.6. Risk of Surface Water Flooding

Surface water flooding occurs when the infiltration capacity of the land or the drainage capacity of the local sewer network is exceeded, causing excess rainwater to flow overland. The severity of surface water flooding is influenced by several factors, including the degree of soil saturation prior to the rainfall event, soil and geological permeability, topography (e.g. slope steepness), and the intensity of land use.

The Environment Agency maintains mapping data on the risk of surface water flooding. Relevant maps are included in **Appendix E Figures 3, 4, and 5**. According to these maps, the site lies outside of the predicted flood extents for surface water flooding during the 1 in 30-year, 1 in 100-year, and 1 in 1,000-year rainfall events. The overall risk of surface water flooding is low.

5.7. Risk of flooding from Reservoirs

The Environment Agency's reservoir flood map in **Appendix E Figure 6** indicated that the proposal site is located outside of the maximum extent of flooding from reservoir. According to the Environment Agency, the reservoir flooding is extremely unlikely to happen and reservoirs in the UK have an extremely good safety record; indeed, there has been no loss of life in the UK from reservoir flooding since 1925. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers on a regular basis. It is therefore assumed that these reservoirs are regularly inspected, and essential safety work is carried out. These reservoirs therefore present a managed residual risk.

5.8. Flood Risk from Sewers

Sewer flooding is commonly caused by excess surface water entering the drainage network, which can lead to the surcharging of sewers. The Strategic Flood Risk

Assessment (SFRA) provides limited information regarding sewer flooding in the area. However, no records of sewer flooding incidents have been identified at the site.

It is important to recognise that the absence or presence of historic sewer flooding does not necessarily reflect the current or future risk to a site. Infrastructure upgrades may have been implemented to address previous issues, or conversely, deterioration of local drainage systems in areas with no past incidents could increase the future risk.

According to information provided by the landowner, there is no known history of sewer flooding at the site. Based on this evidence and local knowledge, it is reasonable to conclude that the risk of sewer flooding to the site is low.

5.9. Impact of Climate Change

In July 2021 the 'Flood Risk Assessments: Climate Change Allowances' were updated from the originally published Climate Change allowances on GOV.UK. The guidelines outline the peak river flow climate change allowances by management catchment. The range of Climate Change allowances is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The central allowance is based on the 50th percentile, higher central is based on the 70th percentile and the upper end is based on the 90th percentile.

The proposal site is located within the London Management Catchment and within the Thames River Basin District. The relevant climate change allowances are summarised in **Table 4** below.

Using peak river flow allowances for flood risk assessments

The guideline suggests to consider the flood zone and the appropriate flood risk vulnerability classification to decide which allowances applies to the development or plan.

In flood zones 2 or 3a for:

- Essential infrastructure – use the higher central allowance,
- Highly vulnerable – use central allowance (development should not be permitted in flood zone 3a),
- More vulnerable – use the central allowance,
- Less vulnerable – use the central allowance,

- Water compatible – use the central allowance.

In flood zone 3b for:

- Essential infrastructure – use the higher central allowance,
- Highly vulnerable – development should not be permitted,
- More vulnerable – development should not be permitted,
- Less vulnerable – development should not be permitted,
- Water compatible – use the central allowance.

Table 4 - Peak river flow allowances by Management Catchment and River Basin District

Management Catchment Name / River Basin District	Climate Change allowance	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
London / Thames	Upper end	26%	30%	54%
	Higher central	14%	14%	27%
	Central	10%	7%	17%

Assessment of Climate Change Impact for the Site

The proposal site is located within the London Management Catchment and Thames River Basin District. However, as the proposal site is located in Flood Zone 1, the Climate Change allowances are not relevant for the site.

6.0 Sustainable Drainage Systems (SuDS)

A surface water drainage assessment should be undertaken to demonstrate that surface water runoff from the proposed development can be effectively managed without increasing flood risk elsewhere. A surface water drainage assessment should include the following:

- Assessment of whether the development will increase the overall discharge from the site by calculating the change in area covered by roofs and hard-standing.
- Details of how overland flow from the new development can be intercepted to prevent flooding of adjacent land.
- Details of how additional onsite surface water attenuation can be provided to mitigate against known flooding problems or as a result of incapacity on the drainage systems.
- Demonstration that overland flows will not increase flood risk to both existing development and receiving watercourses.

7.0 Sustainable Drainage Systems Policy

London Borough of Hillingdon strongly encourages the principles of SuDS on all forms of development. The developer should seek the most sustainable SuDS solution in order to reduce flood risk, improve water quality and improve the environment overall. London Borough of Hillingdon, in its role as Lead Local Flood Authority (LLFA), is a statutory consultee in the planning process for major development proposals which have surface water implications.

The LLFA encourages the developers to provide SuDS on major developments while paying due regard to the National Planning Policy Framework (NPPF), Planning practice guidance, Non-statutory technical standards for sustainable drainage systems and the District local plan policies.

7.1. Flood and Water Management Act 2010

The method of drainage of surface water from the site is bound by the Flood and Water Management Act 2010. Schedule 3 Paragraph 5 of the Flood and Water Management Act 2010 states that the following hierarchy is to be applied to surface water runoff in the following order or priority:

- Discharge into the ground (infiltration)
- Discharge to a surface water body (lake, river, drain);
- Discharge to a surface water sewer, highway drain or another drainage system; or Discharge into a combined sewer.

7.2. Drainage Hierarchy

Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy as set out by the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015):

1. rainwater harvesting (including a combination of green and blue roofs),
2. infiltration techniques and green roofs,
3. rainwater attenuation in open water features for gradual release,
4. rainwater discharge direct to a watercourse (unless not appropriate),
5. rainwater attenuation above ground (including blue roofs),
6. rainwater attenuation below ground,
7. rainwater discharge to a surface water sewer or drain,
8. rainwater discharge to a combined sewer.

7.3. Strategic Flood Risk Assessment

The West London Strategic Flood Risk Assessment (West London SFRA) provides a comprehensive overview of flood risk across the area, identifying areas at risk from fluvial, surface water, groundwater, and sewer flooding. It also highlights the

importance of sustainable development practices and guides planning decisions to ensure new developments are located and designed to be safe from flooding.

In line with the borough's SuDS Drainage Policy, all proposed developments are required to incorporate Sustainable Drainage Systems (SuDS) to manage surface water runoff at source, reduce flood risk, improve water quality, and enhance biodiversity. SuDS are designed to manage and reduce the impact of surface water runoff in urban areas. SuDS incorporate several measures to slow down and manage the flow of rainwater. By doing so, they help prevent surface water runoff overwhelming drainage systems and causing flooding downstream.

8.0 Assessment of Sustainable Drainage Systems Options

8.1. Existing Drainage

The site consists of a building with areas of hardstanding and soft landscaping. Roof runoff from the building and surface runoff from hardstanding areas are discharged into the existing drainage serving the property (**Appendix B**). Runoff from the rear patio infiltrates naturally into the soft landscaping within the rear garden.

The nearest Surface Water sewer from the site is on Kewferry Drive (**Appendix F**). It is likely that the Surface Runoff from the site is discharged into this SW sewer located approximately 120m south.

8.2. Greenfield Runoff Estimation

The estimation of the Greenfield Runoff rate has been undertaken using the HR Wallingford's Greenfield Runoff Estimation tool available on the website: http://www.uksuds-.com/greenfieldrunoff_js.htm. The aim of the tool is to provide flow rate information based on a minimum amount of data so that anybody can use the tool. The methodology is built around the concept that a flow rate discharge constraint is needed for storm water runoff from a site, resulting in attenuation volume being needed. In addition, current drainage criteria include the requirement for the 100 year 6hr volume to be controlled. The tool is based on the results of simple model analysis and correlating the results against key known site parameters. As such the results need to be treated as providing indicative information only and should not be used to

produce final designs of drainage systems without additional modelling being carried out.

The peak flow estimation can now be estimated using two different formulae.

- 1) The formula developed in IH124 (IH 1994) and use of the FSSR growth curve information for regions of the UK (FSSR 14),
- 2) The use of FEH statistical correlation equation revised in 2008.

However, only the IH124 method can be used without providing specific parameter values. Therefore, this method has been used for estimating greenfield runoff rate from the proposed development site.

Details about the parameters used in the estimation are provided in **Appendix G** and the results are summarised in **Table 5** below. A catchment area of 0.216ha has been used, which is the total site area.

The Greenfield runoff rate (Q_{bar}) is a term used in hydrology and drainage design. It refers to the rate at which surface water would naturally run off a site in its undeveloped (greenfield) state. This rate is important when designing sustainable drainage systems (SuDS) for developments, as it helps to ensure that post-development runoff does not exceed pre-development levels, which could increase flood risk downstream.

From **Table 5**, it can be seen that the Greenfield runoff rate (Q_{bar}) for the site is 0.90 litre/sec. The proposed development has considered the greenfield runoff rates for addressing surface water discharge requirements from the developed site.

Table 5 – Greenfield Runoff Rates

Events	Greenfield runoff rates (litres/sec) (Estimated)
Q_{bar}	0.90
1 in 1 year	0.80
1 in 10 year	1.60
1 in 30 year	2.30
1 in 100 year	3.20

8.3. Estimation of Permeable and Impermeable Areas

The type of land cover on a development site, particularly hardstanding (i.e., impermeable) and soft landscaping (permeable) areas has a significant impact on surface runoff rates in an urban environment. Hardstanding surfaces such as concrete, tarmac, and paving are impermeable, meaning rainfall cannot infiltrate into the ground. This leads to a higher volume and faster rate of surface runoff. Soft landscaping features such as grassed areas allow water to infiltrate into the ground, reducing the volume and velocity of surface runoff.

The changes in land cover for the proposal site have been summarised in **Table 6**. It can be seen that the proposed development will lead to a reduction in the impermeable area by approximately 32m². This means there will be no increase in the surface runoff as a result of the proposed development.

Table 6 Changes in Land Cover

Land Cover	Pre-development, m ²	Post-development, m ²	Change, m ²
Impermeable Surface Area			
Hard-standing	195	151	
Building footprint and garages	269	281	
Total Impermeable	464	432	(-) 32
Permeable Surface Area			
Soft landscaping	1695	1727	
Total Permeable	1695	1727	(+) 32
Total Area	2159	2159	

8.4. Estimation of peak surface runoff rates

Pre-development Peak Runoff Rates (based on land cover areas)

The Rational Method has been used in order to estimate the peak surface runoff from the site.

The Rational Equation is given by:

$$Q = Ar \times P \times Ri$$

Where, A_r = Effective catchment area, m^2

P = Impermeability factor

R_i = Rainfall Intensity, mm/hr , Q = Peak surface runoff, m^3/s

The peak surface runoff rates for the existing site condition are summarised in **Table 7**. An impermeability factor of 0.90 has been used for the site. Information on the maximum rainfall intensity for a range of return period events has been taken from the Micro Drainage Models developed for the site which is provided in **Appendix H**.

The pre-development impermeable surface area in **Table 6** has been used as a catchment area for the calculations.

Table 7 Estimation of Peak Runoff Rates from the site (Post-development condition) based on the land cover area

Return Periods	Max Rainfall Intensity, R_i mm/hr	Catchment Area, A m^2	Impermeability factor, P	# Peak Runoff, Q , m^3/sec	Peak Runoff, Q , litres/sec
1/ 1 year	33.349	464	0.9	0.00387	3.87
1/2 year	43.078	464	0.9	0.00500	5.00
1/5 year	55.358	464	0.9	0.00642	6.42
1/10 year	64.417	464	0.9	0.00747	7.47
1/30 year	81.909	464	0.9	0.00950	9.50
1/50 year	91.59	464	0.9	0.01062	10.62
1/100 year	106.579	464	0.9	0.01236	12.36
1/100 year + 40% CC	149.21	464	0.9	0.01731	17.31

$Q = (R_i/1000 \times A \times P)/3600$, # R_i taken from MicroDrainage models (**Appendix H**).

Post-development Peak Runoff Rates (with attenuation storage)

The Greenfield runoff rate for the site is 0.90 litre/sec (**Table 5**). Therefore, an outflow control rate of 0.90 litre/sec has been used with the implementation of the attenuation storage system. The surface runoff rates for the site post-development are summarised in **Table 8**.

Table 8 Summary of Peak Runoff Rates from the site (Post-development condition with the provision of attenuation storage)

Return Periods	Peak Runoff Rates, Q, litre/sec
1/ 1 year	0.90
1/2 year	0.90
1/5 year	0.90
1/10 year	0.90
1/30 year	0.90
1/100 year	0.90
1/100 year + 40% CC	0.90

8.5. Hierarchy of SuDS Measures

The surface runoff from the site will be improved by implementing appropriate SuDS. The requirements for SuDS will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and instead provides a positive benefit to the level of risk in the area. It will also ensure that appropriate measures are taken to increase the flood resilience of new properties and developments in surface water flood risk areas, such as those identified as being locally important flood risk areas.

The SuDS hierarchy and management train has been discussed in the SuDS Manual (C753) which aims to mimic the natural catchment processes as closely as possible. The general hierarchy of the SuDS measures is provided in **Table 9**.

Table 9 General Hierarchy of SuDS Measures

Measures	Definition/Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area on site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

8.6. Potential for Infiltration SuDS (Soakaway)

The British Geological Survey's geological maps show that the bedrock of the site comprises London Clay Formation consisting of Clay, Silt and Sand (**Appendix C**). London Clay has a very low permeability, rendering it unsuitable for infiltration techniques. As such, infiltration SuDS are not considered viable for the site.

8.7. General Assessment of SuDS Measures for the site

The feasibility of Sustainable Drainage Systems (SuDS) measures depends on several factors, including underlying soil conditions, site topography, existing and proposed land use, and other site-specific constraints.

Table 10 presents the feasibility assessment of several SuDS measures for the site.

Table 10 General Assessment of SuDS measures for the site

SuDS Measures	Issues/Description	Feasibility for the site
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	Infiltration SuDS such as Soakaways improve the surface runoff from the site by allowing water to infiltrate through the surface, rather than flowing over it.	No. As indicated by the geological formation mostly comprising London Clay, the underlying soil has low permeability.

		Therefore, the potential of infiltration SuDS is low.
<p>Site and Regional Control</p> <p>Infiltration/detention basins/ balancing ponds/ wetlands/underground storage/swales/retention ponds.</p>	<p>Permeable paving improves surface runoff by allowing rainwater to infiltrate through gaps or porous materials rather than flowing over the surface.</p> <p>Open surface pond helps to prevent flooding by attenuating the surface runoff from the site.</p> <p>An underground surface storage , as one of the key SuDS measures, helps to reduce surface runoff rates and mitigate flood risk by providing temporary storage and controlled discharge of stormwater.</p>	<p>Yes. There is a potential for permeable paving in the access drive.</p> <p>No. The potential for open surface pond is low due to limited space available.</p> <p>Yes. There is a potential for an underground surface water attenuation storage system to improve the surface runoff from the site.</p>

8.8. Proposed Sustainable Drainage Systems (SuDS)

Based on the general assessment of potential Sustainable Drainage Systems (SuDS) options, it is found that an underground attenuation storage would be feasible at the site. The storage system has been designed using the design event of 1 in 100-year, 6-hour design storm event, including a 40% allowance for climate change. In addition, permeable paving is proposed in the access drive to further improve the surface runoff from the site. The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

9.0 Outline Drainage Design

9.1. Proposed Drainage System

Attenuation Storage

As outlined above, an underground attenuation storage is considered feasible for the site. The storage helps to manage peak flows and reduce flood risk.

The proposed drainage scheme will incorporate an underground storage system for attenuation, with a controlled outflow discharge using a flow control device such as a Hydrobrake. The attenuation storage has been designed with a surface area of 52m² and a depth of 0.40 m, which provides sufficient capacity to manage runoff from the site.

Therefore, the size of the proposed attenuation system is:

Length, L = 10.50m, Width, W= 5.00m, Depth, D=0.40m

The Greenfield runoff rate has been calculated at 0.90 litres/second (refer to **Table 5**). Therefore, a maximum discharge rate of 0.90 litre/second has been adopted for all rainfall events up to and including the 1% Annual Exceedance Probability (AEP) event, with a 40% allowance for climate change. This ensures that no surface flooding will occur as a result of the development. The proposed SuDS layout plan is provided in **Appendix I**.

In accordance with the SuDS drainage hierarchy policy, the controlled outflow from the attenuation storage will be discharged into the existing Surface Water sewer located on the site via a 150mm linear drainage system, as illustrated in **Appendix I**.

Hydraulic Modelling

The proposed drainage scheme has been modelled by using Micro Drainage Source Control to understand the evolving flow regime under flood conditions and the potential for flooding. The catchment area used for the modelling is 0.043ha (432m²) which is the total area of the hardstanding post development as summarised in **Table 6**.

The attenuation storage has been modelled using the 1 in 100 year (1%AEP) plus 40% climate change event. Both summer and winter profiles of the storm events have been considered for a range of duration, from 15 minutes to 8640 minutes.

Information on key input parameters (i.e. rainfall and model details) have been provided in **Appendix J**. A summary of the model output for the 1 in 100 year plus 40% climate change event is provided in **Table 11** below.

Table 11 indicates that a maximum volume of 20.80m³ will be generated by the 1 in 100 year plus 40% Climate Change 120 minutes Winter event, and there will be no overflow and flooding for this event. Therefore, the attenuation storage system will provide full storage for the surface runoff generated from the design event of 1 in 100 year (1%AEP) plus 40% climate change.

Table 11 – Summary of Model Output (1 in 100 year plus 40% climate change)

Events	Rainfall mm/hr	Max Volume M ³	Discharge Volume M ³	Overflow Volume M ³	Flooded Volume M ³
120 min (Winter) 1 in 100 year plus 40% CC	95.070	20.80	25.60	0.0	0.0

The layout (i.e. shape) and dimensions (i.e., surface area and depth) of the attenuation storage may be slightly adjusted to accommodate site-specific conditions, provided that the required attenuation volume is delivered within the site boundary.

9.2. Exceedance Flow Paths

It is inevitable that as a result of heavy or extreme rainfall, the capacities of sewers and other drainage systems will be exceeded on occasion. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, when the outfall becomes restricted due to flood levels in the receiving water, or due to poor maintenance of the SuDS features.

The proposed attenuation storage system has been designed to accommodate the 1 in 100-year storm event, including a 40% allowance for climate change. In the event

of an extreme rainfall event exceeding this design threshold, surface water runoff may exceed the inlet capacity of the drainage system. In such cases, exceedance flows across the rear garden area will follow the natural topography of the site, draining primarily to the north in accordance with existing ground gradients. Flow paths across the front yard area will be directed southwards towards the road (Chalgrove Crescent), as this represents the only open route for overland flow in that area. The anticipated exceedance flow routes are illustrated in **Appendix K**.

10.0 SuDS Management and Maintenance Plan

The owners of the site will be fully responsible for regular repair and maintenance of the proposed SuDS measures as required for the lifetime of the development. The SuDS at this site have been designed for easy maintenance to comprise:

Geo-cellular Storage System

Remedial work for repairing damage will be carried out whenever necessary. The repair and maintenance will include regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required. **Table 12** provides further details on the regular maintenance of the Geo-cellular storage system.

Table 12 Regular Maintenance and remedial measures for Geo-cellular storage system

Regular Maintenance	Actions/Remedial measures
Monthly	<ul style="list-style-type: none"> • Inspect and identify any areas that are not operating correctly. If required, take remedial action. (for 3 months following installation) • Debris removal from catchment surface (where may cause risks to performance) • Inspect systems as specified by the manufacturer • Where rainfall infiltrates into blocks from above, check surface of filter for

	blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.
Six monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period).
Annually	<ul style="list-style-type: none"> Remove sediment from pre-treatment structures (e.g. upstream silt- traps or Vortex flow control upstream) and geocellular system where required (High pressure water jetting) Inspect and document the presence of wildlife.
Following all significant storms	<ul style="list-style-type: none"> Inspect and carry out essential recovery works to return the feature to full working order.

Flow control structures

Remedial work for repairing any damage to flow control structures/devices will be carried out whenever necessary. **Table 13** provides further details on the regular maintenance of the flow control structures/devices.

Table 13 Regular Maintenance and remedial measures for flow control structures

Regular Maintenance	Actions/Remedial measures
Monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation).
Six monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action. Remove sediment from pre-treatment structures.

Following all significant storms	<ul style="list-style-type: none"> Inspect and carry out essential recovery works to return the feature to full working order.
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Permeable Paving

The landowners will be fully responsible for regular maintenance of the proposed permeable paving. **Table 14** provides further details on the regular maintenance of the proposed Permeable Paving.

Table 14 Regular Maintenance and remedial measures for permeable paving

Regular Maintenance	Actions/Remedial measures
Monthly	<ul style="list-style-type: none"> Refer to manufacturer specifications For sealed systems, inspection of outfalls should be undertaken.
Six Monthly	<ul style="list-style-type: none"> Brushing and vacuuming to manufacturer requirements. Re-grit where necessary after brushing.
As Required	<ul style="list-style-type: none"> Inspect/check all inlets, outlets, inspection chambers, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required (for 3 months following installation) Removal of weeds where required Stabilizing and mowing of contributing areas where required.
Following all significant storm events	<ul style="list-style-type: none"> Inspect and carry out essential recovery works to return the feature to full working order

11.0 Assessment of Impact on flow of floodwater

The proposed development is for the erection of a new dwelling following demolition of the existing dwelling. In order to ensure that the proposed development will not increase flood risk elsewhere the mitigations will ensure that all flood water, surface water and rainwater is processed on-site and not redirected elsewhere through the use of appropriate SuDS measures as mentioned above. The development will not give rise to backwater affects or divert water towards other properties.

12.0 Conclusion

The planning proposal is for the erection of a new dwelling following demolition of the existing dwelling at Albuhera, Farm Road, Northwood, Middlesex HA6 2NZ.

In accordance with the NPPF Guidelines, the proposed development use is categorised as 'more vulnerable'. As the site is located in Flood Zone 1 (i.e. low probability flooding), the proposed development is considered appropriate at this location.

There are no major watercourses in the vicinity of the site.

According to the information available from the Local Authority's SFRA and the Environment Agency, there were no records of flooding events at the site.

The Environment Agency's Flood Maps show that the site lies within the Flood Zone 1 (i.e. low probability flooding). Flood Zone 1 is an area where flooding from rivers is very unlikely. There is less than a 1 in 1000 chance of flooding occurring in any one given year (i.e. a less than 0.1% annual probability of flooding).

The Environment Agency's flood risk map also indicates that the site will be remain in Flood zone 1 when climate change is considered for the future 2070-2125-time frame.

According to the Environment Agency's surface water flood maps, the site lies outside of the predicted flood extents for surface water flooding during the 1 in 30-year, 1 in 100-year, and 1 in 1,000-year rainfall events. This implies that the risk of surface water flooding is low.

The flood risk from other sources including underground water, sewer and reservoir is low.

The surface runoff will be improved by implementing appropriate SuDS measures.

Due to the underlying London Clay formation, infiltration SuDS such as soakaways is considered inappropriate for the site. Based on the general assessment of potential Sustainable Drainage Systems (SuDS) options, an underground attenuation storage is considered feasible for the site, which will be utilised for the temporary storage of surface water runoff from the development. In addition, permeable paving will be provided for the access drive.

The outflow from the storage will be controlled using a flow control device such as a Hydrobrake. The attenuation storage has been designed with a surface area of 52 m² and a depth of 0.40 m, providing sufficient capacity to temporarily store the surface runoff from the site.

The Greenfield runoff rate has been calculated at 0.90 litre/second. Therefore, a maximum discharge rate of 0.90 litre/second has been adopted for all rainfall events up to and including the 1% Annual Exceedance Probability (AEP) event, with a 40% allowance for climate change.

A maximum volume of 20.80m³ will be generated by the 1 in 100 year plus 40% Climate Change 120 minutes Winter event, and there will be no overflow and flooding for this event. Therefore, the attenuation storage system will provide full storage for the surface runoff generated from the design event of 1 in 100 year (1%AEP) plus 40% climate change.

There is a Surface Water sewer on the site . Therefore, in accordance with the SuDS drainage hierarchy policy, the controlled outflow from the attenuation storage will be discharged into this sewer via a 150mm linear drainage system.

In addition, permeable paving will be implemented on the access drive to further improve the surface runoff from the site.

The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

The development will not give rise to backwater affects or divert water towards other properties.

This report demonstrates that the proposal will be safe, in terms of flood risk, for its design life and will not increase the flood risk elsewhere.

Appendix A Site Location Maps

Appendix B Existing Site and Proposed Plans

Appendix C Geological Map

Appendix D Topographic Map

Appendix E Environment Agency's Flood Maps

Appendix F Sewer Asset Map Data

Appendix G Greenfield Runoff Rates Estimation

Appendix H Rainfall Runoff Models

Appendix I Proposed Sustainable Drainage Systems (SuDS) Plan

Appendix J Attenuation Storage Modelling Summary

Appendix K Exceedance Flow Routes