



Flood Risk Assessment and Drainage Strategy

Land East of Lodge Road, Hurst

Mactaggart and Mickel Strategic Land

Prepared by:

SLR Consulting Limited

5th Floor, 35 Dale Street, Manchester, M1 2HF

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P01	19 July 2024	Paul Bainbridge	Dan Eddon	Dan Eddon
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P04	5 June 2025	Alexa Hay	Robert Walker	Robert Walker
P05	11 July 2025	Christian Milner	Robert Walker	Andrew Dannatt
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Basis of Report

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Acronyms and Abbreviations

EA	Environment Agency
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
PPG	Planning Policy Guidance
SFRA	Strategic Flood Risk Assessment



1.0 Introduction

1.1 Terms of Reference

SLR has been appointed by Mactaggart & Mickel Strategic Land (the Client) to prepare a Flood Risk Assessment (FRA) and Drainage Strategy (DS) to support the outline planning application for the proposed development at Land East of Lodge Road, Hurst (the Site).

The Parameters Plan and Illustrative Masterplan for the proposed development are enclosed at Appendix A.

The Site is located at National Grid Reference (NGR) SU794736 as shown by Figure 1-1.

Figure 1-1: Site Location Plan



1.2 Background and Aims

This report has been prepared to consider the risk of flooding to the proposed development and to recommend, where appropriate, mitigation measures. In addition, the impact of the proposed development on the risk of flooding elsewhere has been considered.

The provisions of National Planning Policy Framework¹ (NPPF) and the Planning Practice Guidance² (PPG) have been considered in preparing the FRA.

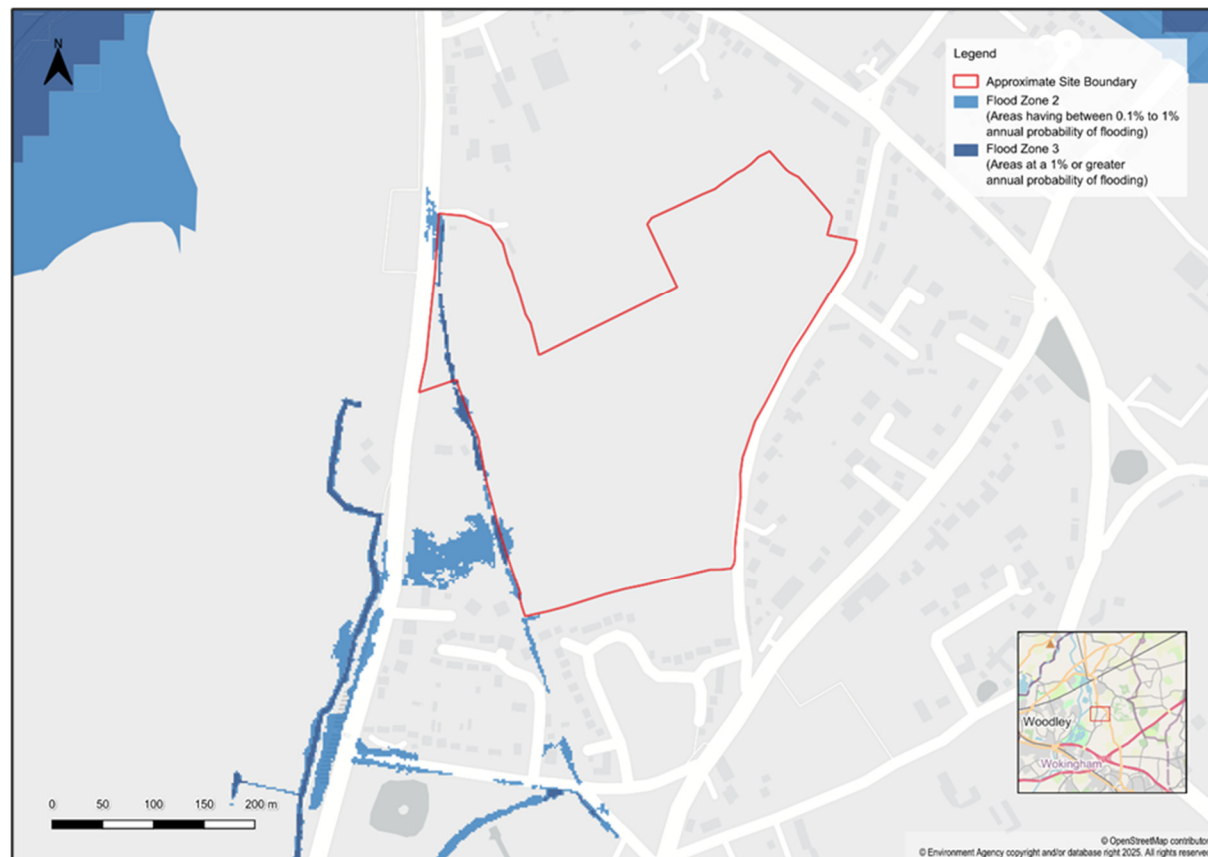
¹ https://assets.publishing.service.gov.uk/media/67aafe8f3b41f783cca46251/NPPF_December_2024.pdf

² <https://www.gov.uk/government/collections/planning-practice-guidance>



The *Flood Map for Planning*³ indicates that the Site lies partially within an area at risk of flooding. Therefore, with reference to footnote 63 of the NPPF, any planning application for the Site must be accompanied by an FRA. An extract of the Flood map for planning is provided by Figure 1-2.

Figure 1-2: Extract of the Flood Map for Planning



This report provides an assessment of flooding risk to the site and surrounding area and follows the Government guidance regarding development and flood risk.

1.3 Best Practice

This report has been prepared in accordance with the advice provided by current best practice guidance relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)⁴, the British Standards Institution (BSI) BS8533⁵ and the Environment Agency's National Standing Advice on Development and Flood Risk⁶.

It has been prepared under the direction of a Technical Director at SLR who specialises in flood risk, drainage and associated planning matters.

³ <https://flood-map-for-planning.service.gov.uk/>

⁴ CIRIA Report C624, Development and flood risk – guidance for the construction industry

⁵ BS8533:2017, Assessing and managing flood risk in development – Code of Practice (December 2017)

⁶ Department for Environment, Food & Rural Affairs and Environment Agency (2015). Flood risk assessment: standing advice (February 2022)



2.0 Site Details

2.1 Existing Site Description

The site lies approximately 8km east of the centre of Reading, south of the village of Twyford. This site is currently undeveloped pasture land extending to an area of approximately 10.68 hectares.

The eastern boundary of the site is bounded by Tape Lane, to the west lies Lodge Road (B3030). Residential properties and allotments are located directly adjacent the southern site boundary. Residential properties are also located adjacent the northern boundary of the site, beyond which lies Broadwater Lane (A321).

2.2 Existing Drainage, Watercourses and Other Waterbodies

The following waterbodies have been identified in the vicinity of the proposed development:

- The Hatchgate Ditch, partly culverted, flows along part of the western site boundary, adjacent to Lodge Road. This watercourse appears to flow in a northerly direction and is designated as a Main River.
- An unnamed watercourse is location to the west of Lodge Road and appears to flow in a northerly direction.
- An unnamed watercourse lies to the south of Sawpit Road (Sawpit Road is located approximately 180m from the site southern boundary. This watercourse is culverted at the junction of Sawpit Road and Lodge Road.

Further details of the watercourses in the vicinity of the Site are provided by the Drainage Strategy drawing enclosed at Appendix B.

Thames Water public sewer maps are included in Appendix C. In Tape Lane adjacent to the eastern site boundary there are two Thames Water combined public sewers, one is flowing in a northerly direction towards Broadwater Lane. There is a proposed Thames Water foul rising main travelling in a northerly direction adjacent to the western site boundary. This rising main connects into the Thames Water's foul public sewer in Lodge Road which also travels in a northerly direction. These sewers are indicated on the Drainage Strategy drawing enclosed at in Appendix B.

2.3 Topography

A topographic site survey is enclosed at Appendix C. The site is relatively level with an approximately +/- 1m level difference across the site. The site appears to fall gradually from around 38.5 to 37.0m in a westerly direction towards the Hatchgate Ditch.

2.4 Geology

The British Geological Survey (BGS) map advises that the superficial deposits is predominantly *Kempton Park Gravel Member - Sand* with the gravel underlain by the Lambeth Group (clay, silt and sand). Due to the proximity of the site to local watercourses and high permeability geology underlain by moderate to low permeability geology, there is potential for high groundwater level (in continuum with the water levels in the watercourse) and saturated ground.

The site is not located within a Groundwater Source Protection Zone.



3.0 Development Proposals

3.1 Description of Development Proposal

The outline application is for up to 99 new homes, green infrastructure, open space, pedestrian and cycle links, recreational facilities and other associated infrastructure including off-site highway works and access points on Lodge Road and Tape Lane with required improvements (all matters reserved except access).

A copy of the proposed parameters plan and illustrative masterplan are enclosed at Appendix A.

3.2 Anticipated Lifetime of Development

In line with PPG and best practice guidance (BS8533), a 100-year lifetime has been adopted for this development.

3.3 Planning Context

The Site lies within the Wokingham Borough Council administrative area. The Core Strategy setting out the strategy for managing development until 2026 was adopted by the council on 29 January 2010.

Core policies that relate to flood risk and drainage matters are:

Core Strategy Policy CP1

Planning permission will be granted for development proposals that:

- 4) *Ensure the provision of adequate drainage;*
- 9) *Avoid increasing (and where possible reduce) risks of or from all forms of flooding (including from groundwater);*

Core Strategy Policy CP3

- b) *Provide a functional, accessible, safe, secure and adaptable scheme; c) Have no detrimental impact upon important ecological, heritage, landscape (including river valleys) or geological features or water courses.*

The Wokingham Borough Development Plan, Adopted Managing Development Delivery Local Plan, Enhancing the Borough's environment and character through exceptional development was adopted in February 2014. It contains a number of policies that relate to flood risk and drainage:

Policy CC09: Development and Flood Risk (from all sources)

1. *All sources of flood risk, including historic flooding, must be taken into account at all stages and to the appropriate degree at all levels in the planning application process to avoid inappropriate development in areas at risk of flooding. Proposals must be consistent with the guidance in paragraphs 99-104 of the National Planning Policy Framework (NPPF); the Technical Guidance to the NPPF and demonstrate how they have used the Strategic Flood Risk Assessment (SFRA) to determine the suitability of the proposal.*
2. *Development proposals in Flood Zones 2 or 3 must take into account the vulnerability of proposed development.*
3. *Development must be guided to areas of lowest flood risk by applying the sequential approach taking into account flooding from all sources and shall ensure flood risk is not worsened for the application site and elsewhere, and ideally that*



betterment of existing conditions is achieved. The sequential test will not be required if at least one of the following applies:

- a) Replacement of an existing single residential property. However, the replacement property should, where possible, be located on the part of the site at lowest risk*
- b) Conversions and change of use unless it involves a change to a more vulnerable class*
- c) Minor development, as defined in footnote 10 of the Technical Guidance Note to the NPPF.*

4. In exceptional circumstances, new development in areas of flood risk will be supported where it can be demonstrated that:

- a) The development provides wider sustainability benefits to the community that outweigh flood risk*
- b) The development will:
 - i. Be safe for its lifetime, taking account of the vulnerability of its users*
 - ii. Not increase flood risk in any form elsewhere and, where possible, will reduce flood risk overall*
 - iii. Incorporate flood resilient and resistant measures into the design**
- c) Appropriate evacuation and flood response procedures are in place to manage the residual risk associated with an extreme flood event.*

5. Where required, suitable and appropriately detailed flood risk information will need to accompany a planning application. A Flood Risk Assessment (FRA) is required for:

- a) All proposals in areas of known historic flooding from all sources*
- b) Where there is evidence of a risk from all sources of flooding identified in the Strategic Flood Risk Assessment*
- c) Those proposals set out in footnote 20 to paragraph 103 of the NPPF*

Policy CC10: Sustainable Drainage

1. All development proposals must ensure surface water arising from the proposed development including taking into account climate change is managed in a sustainable manner. This must be demonstrated through

- a) A Flood Risk Assessment, or*
- b) Through a Surface Water Drainage Strategy.*

2. All development proposals must

- a) Reproduce greenfield runoff characteristics and return run-off rates and volumes back to the original greenfield levels, for greenfield sites and for brownfield sites both run-off rates and volumes be reduced to as near greenfield as practicably possible.*
- b) Incorporate Sustainable Drainage Systems (SuDS), where practicable, which must be of an appropriate design to meet the long term needs of the development and which achieve wider social and environmental benefits*
- c) Provide clear details of proposed SuDS including the adoption arrangements and how they will be maintained to the satisfaction of the Council [as the Lead Local Flood Authority (LLFA)]*



- d) Not cause adverse impacts to the public sewerage network serving the development where discharging surface water to a public sewer.*

The measures set out in this flood risk assessment will demonstrate how the proposed development will comply with national and local planning policy.



4.0 Potential Sources of Flooding

4.1 Screening Study

There are a number of potential sources of flooding and these include:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from surface water or pluvial flooding;
- Flooding from groundwater;
- Flooding from sewers; and
- Flooding from reservoirs, canals, and other artificial sources.

The flood risk from each of these potential sources is discussed below.

4.1.1 Flooding from rivers or fluvial flooding

With reference to the *Flood Map for Planning, Flood Zones 2 and 3*, reproduced as Figure 1-2, the Site is shown to lie partially within Flood Zones 2 and 3.

The flood risk from this source is therefore considered in further detail in Section 5.0.

4.1.2 Flooding from the sea or tidal flooding

The Site is remote from the coast and therefore the risk of tidal flooding is considered low.

Therefore, the risk of flooding from this source has not been considered further.

4.1.3 Flooding from surface water or pluvial flooding

With reference to *Check your long term flood risk mapping*⁷ for surface water the Site is shown to be partially at risk of surface water flooding.

The flood risk from this source is therefore considered in further detail in Section 5.0.

4.1.4 Flooding from groundwater

As discussed in Section 2.4, the Site is underlain by permeable strata with potentially elevated groundwater levels.

The flood risk from this source is therefore considered in further detail in Section 5.0.

4.1.5 Flooding from sewers

As shown by the Thames Water public sewer maps provided in Appendix C, there are no public surface water or combined water sewers in the vicinity of the Site that could give rise to a significant flood risk.

Therefore, the risk of flooding from this source is considered low and has not been considered further.

⁷ <https://check-long-term-flood-risk.service.gov.uk/map>



4.1.6 Flooding from reservoirs, canals and other artificial sources

With reference to the *Check your long term flood risk mapping* the Site is not at significant risk of flooding from the failure of a reservoir.

There are no canals or other artificial sources within the vicinity of the Site.

The flood risk from these sources has not therefore been considered further.

4.2 Summary of Sources of Flooding

A summary of the potential sources of flooding and the flood risk arising from them is provided by Table 4-1.

Table 4-1: Potential Sources of Flooding

Potential Source of Flooding	Flood Risk at the Site
Fluvial (Rivers) or Tidal (Sea) Flooding	Yes
Surface Water	Yes
Groundwater	Yes
Sewers	No
Reservoirs, Canals and other Artificial Sources	No



5.0 Assessment of Flood Risk

5.1 Potential Sources of Flood Risk

The flood screening assessment reported in Section 4.0 and summarised in Table 4-1 indicates that the Site is at risk from:

- fluvial flooding;
- surface water flooding; and
- groundwater flooding

These are considered in detail below.

5.2 Data Sources

The following sources have been considered in assessing the flood risk to the Site:

- The *Flood Map for Planning* website;
- The *Check your long term flood risk* website;
- Wokingham Borough Council, Level 1 Strategic Flood Risk Assessment (Level 1 SFRA)⁸, Final Report May 2023 and interactive maps;
- Environment Agency data; and
- Detailed hydraulic modelling of both the fluvial and surface water flood risk.

5.3 Flood Map for Planning

5.3.1 Flood Zones 2 and 3

As discussed in Section 4.1.1 and shown by Figure 1-2, the southern part of the western fringes of the Site is shown to be at risk of fluvial flooding. It would appear the source of the flooding is from the Hatchgate Ditch.

However, the Environment Agency does not hold detailed hydraulic modelling for this watercourse and therefore a bespoke hydraulic model has been developed to better define the flood risk to the Site.

5.3.2 Surface Water

Isolated areas of the Site are shown to be at risk of surface water flooding for the 1 in 30 (3.3%), 1 in 100 (1%) and 1 in 1,000 (0.1%) annual likelihood of flooding storm events.

However, to better define the surface water flood risk to the Site, a bespoke hydraulic model has been developed to inform this flood risk assessment.

⁸ <https://www.wokingham.gov.uk/sites/wokingham/files/2024-05/WBC%20Level%201%20SFRA%202023%20-%20Main%20report.pdf>



5.4 Check your long term flood risk website

5.4.1 Rivers and sea map

The *check your long term flood risk* mapping⁹ indicates that the Site is not at risk of flooding from Rivers and the sea, however, this mapping has been superseded by both the *Flood map for planning* and the hydraulic model developed to inform this flood risk assessment.

5.4.2 Surface water map

The surface water maps use the same data set as those included in the *Flood map for planning* discussed above.

The surface water flood risk is expressed as areas at High, Medium, Low and Very Low risk of flooding that is defined as:

- High risk means that this area has a chance of flooding of greater than 3.3% each year
- Medium risk means that this area has a chance of flooding of between 1% and 3.3% each year; and
- Low risk means that this area has a chance of flooding of between 0.1% and 1% each year
- Very low risk means that this area has a chance if flooding of less than 0.1% each year

Therefore, isolated areas of the Site are shown to be at High, Medium and Low risk of surface water flooding.

5.5 Strategic Flood Risk Assessment

Level 1 SFRA was prepared to provide a comprehensive and robust evidence base on flood risk issues to support the review and update of the Wokingham Borough Council's planning policies.

The Level 1 SFRA is supported by a number of interactive maps that illustrate the flood risk within the Borough from various sources. The Site is covered by Map C3.

5.5.1 Fluvial flooding

The Site is shown to be in Flood Zone 1; however, this mapping has been superseded by both the *Flood Map for Planning* and the hydraulic model developed to inform this flood risk assessment.

5.5.2 Surface Water flooding

Only a very small part of the Site is shown to fall within the '*risk of flooding from surface water, surface water extent*' for the 0.1% Annual Exceedance Probability¹⁰ (AEP) event, with the extent very similar to that shown for Flood Zone 2 discussed above.

However, the surface water mapping shown by Map C3 has been superseded by both the *Flood Map for Planning* and the hydraulic model developed to inform this flood risk assessment.

⁹ <https://www.gov.uk/check-long-term-flood-risk>

¹⁰ The likelihood that an event of a given probability will be exceeded in any year. Often referred to as a 'Return Period expressed in years, i.e. a 1 in 100 year Return Period event is equivalent to a 1% AEP event.



5.5.3 Groundwater Flooding

Appendix A Map C3 includes both the '*EA Areas Susceptible to Groundwater Flooding*' and the '*JBA Groundwater Emergence Map (5m Resolution)*' data sets.

The *EA Areas Susceptible to Groundwater Flooding* data set indicates that greater than 75% of the Site is susceptible to groundwater flooding on the basis of the geological and hydrogeological conditions. It should be noted that it does not show the likelihood of groundwater flooding occurring, i.e. it is a hazard not risk-based dataset.

The *JBA Groundwater Flood Emergence Map* shows the level of groundwater below the Site to be less than 0.025m. Flood risk could therefore increase when groundwater is already high or emerged, causing additional overland flow paths, or areas of still ponding.

A Site investigation¹¹ was completed in 2023 by Messrs Hydrock. The executive summary states that groundwater levels recorded post-fieldwork ranged from 0.1m to 1.3m below ground level. This would tend to support the *EA Areas Susceptible to Groundwater Flooding* and *JBA Groundwater Flood Emergence Map* data sets assessment of the groundwater flood risk to the Site

It is therefore concluded that there is a risk of groundwater flooding, although flooding will only occur to any significant depth where it can pond in areas of locally low lying land. The extent of groundwater flooding across the Site is therefore likely to be very similar to that of surface water flooding.

5.6 Environment Agency Data

The Environment Agency has confirmed that they do not hold detailed flood mapping that covers the Site and the data that informed the *Flood Map for Planning* is not suitable to assess the fluvial flood risk to the proposed development.

A detailed hydraulic model has therefore been developed to better define the fluvial and surface water flood risk to the Site.

5.7 Hydraulic Model

5.7.1 Fluvial Model

To better define the fluvial flood risk to the Site, and in particular that arising from the Hatchgate Ditch, a linked 1D/2D hydraulic model has been developed using the TUFLOW¹² modelling software completed in accordance with the Environment Agency's *River modelling: technical standards and assessment*¹³ guidelines. A full description of the model construction is provided by the Flood Risk Modelling Report enclosed at Appendix D and estimation of the model inflows at Appendix E.

The following AEP flood events were simulated using the hydraulic model:

- 3.3%
- 1%
- 1% plus 46% allowance for the impact of climate change
- 0.1%

¹¹ Hydrock, 2023. *Land East of Lodge Road, Hurst, Ref 26519-HYD-XX-XX-RP-GE-1001*

¹² <https://www.tuflow.com/products/tuflow/>

¹³ <https://www.gov.uk/government/publications/river-modelling-technical-standards-and-assessment>



- 0.1% plus 46% allowance for the impact of climate change

The impact of climate change on fluvial flood flows over the lifetime of the development is discussed at Section 6.0.

As shown by Figure FRA001 enclosed at Appendix F, the maximum flood extents for the 1% AEP event indicates only limited out-of-bank flooding adjacent to the western boundary of the southern development parcel and does not impinge on the development shown by the illustrative masterplan.

However, as shown by Figure FRA002, when considering the impact of climate change, the extent of the 1% AEP flood envelope increases to encompass the western fringes of the southern development parcel and sections of the internal access road. The maximum depth of flooding within the parts of the Site to be developed for this event is 0.20m.

Figure FRA003 indicates that the 0.1% AEP flood envelope is slightly greater the 1% AEP flood event allowing for the impact of climate change.

Figure FRA004 shows the impact of climate change on the 0.1% AEP flood event with more extensive flooding of the access road and the western fringes of the southern development parcel. The maximum depth of flooding within the parts of the Site to be developed for this event is 0.26m.

The flood extents predicted by the modelling are discussed in the context of the proposed development at Section 7.4.

5.7.2 Pluvial (surface water) Model

To better define the pluvial (surface water) flood risk to the Site, a rain-on-grid model hydraulic model has been developed using the TUFLOW modelling software completed in accordance with the Environment Agency's *River modelling: technical standards and assessment* guidelines. A full description of the model construction is provided by the Flood Risk Modelling Report enclosed at Appendix D and estimation of the net rainfall at Appendix E.

The following AEP rainfall events were simulated using the hydraulic model:

- 3.3%
- 1%
- 1% plus 40% allowance for the impact of climate change
- 0.1%
- 0.1% plus 40% allowance for the impact of climate change

The impact of climate change on pluvial flood flows over the lifetime of the development is discussed at Section 6.0.

Figure FRA005 enclosed at Appendix F shows that pluvial flooding for the 1% AEP event is limited to several isolated area of shallow flooding within the northern development parcel and adjacent to the northern part of the western boundary. The areas of flooding are limited to locally low-lying areas (topographic depressions) and there are no overland flood flow paths that develop across the Site.

When considering the impact of climate change on the 1% AEP flood event, Figure FRA006 shows that the size of the isolated areas of flooding increases slightly and additional isolated areas are shown to flood. Again, no overland flood flow paths develop across the Site. The maximum depth of flooding within the parts of the Site to be developed for this event is 0.20m.



Figure FRA007 shows that the extent of the 0.1% AEP flood envelope is broadly similar to that of the 1% AEP flood envelope when considering the impact of climate change, however, there is a notable increase in flood extent along the western boundary of the southern development parcel that impinges on the development shown by the illustrative masterplan.

When considering the impact of climate change on the 0.1% AEP event, as shown by Figure 008, there is a notable increase in the extent of pluvial flooding, however, the maximum depth of flooding within the parts of the Site to be developed still does not exceed 0.20m and no overland flood flow paths develop across the Site.

It is notable that extent of pluvial flooding for the 0.1% AEP event including an allowance for climate change along the western fringes of the Site is broadly similar to that for the 1% AEP event including an allowance for climate change.

The flood extents predicted by the modelling are discussed in the context of the proposed development at Section 7.4.

5.8 Flood Zone

The definition of fluvial and tidal flood zones is provided in PPG *Table 1: Flood zones* and is summarised in Table 5-1.

5.8.1 Fluvial flooding

A comparison of the extent of Flood Zones 2 and 3 between those shown by the *Flood map for planning* and the results of the hydraulic modelling are shown Figure Appendix J-1 to the Flood Risk Modelling Report enclosed at Appendix D. It is clear that the extent of Flood Zones 2 and 3 has increased, however, the majority of the Site is in Flood Zone 1.

As shown by Figure FRA001 enclosed at Appendix F, none of the proposed built development is in Flood Zone 3, however, as shown by Figure FRA003, sections of the internal access roads are in Floods Zone 2, along with several dwellings along the western fringes of the southern development parcel.

5.8.2 Pluvial (surface water) flooding

A comparison of the definition of the Flood Zones and the Low, Medium and High surface water flood risk areas suggests that High and Medium risk surface water flooding would be broadly equivalent to a fluvial **Flood Zone 3**, Low risk surface water flooding to **Flood Zone 2** and Very Low risk surface water flooding risk to **Flood 1**.

When considering the flood risk from surface water flooding, there are several isolated areas within the northern development parcel that would be considered to lie with the equivalent of fluvial **Flood Zone 3** as shown by Figure FRA005.

The fluvial equivalent of **Flood Zone 2** for pluvial flooding is shown by Figure FRA007. This shows that parts of the northern development parcel are in Flood Zone 2, along with the western fringes of the southern development parcel and some very limited section of the access road.

5.8.3 Groundwater flooding

The information on the groundwater flood risk provided by the SFRA does not provide a likelihood or risk of groundwater flooding occurring. However, given the proximity of groundwater to the ground surface it would not be unreasonable to equate this risk to **Flood Zone 3**.



Figure 5-1: Flood Zones

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: - land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or - land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).



6.0 Climate Change

6.1 Peak River Flows

The most recent advice on climate change is provided by the Environment Agency¹⁴.

The Site lies within the '*Loddon and tributaries Management Catchment*' and an extract of the peak river flow allowances is provided in Table 6-1.

Table 6-1: Loddon and tributaries Management Catchment peak river flow allowances (percentage increases)

Epoch	Central	Higher	Upper
2020s	7%	11%	23%
2050s	4%	10%	25%
2080s	14%	23%	46%

As discussed in Section 3.2 the proposed development has an anticipated lifetime of 100 years.

As part of the Site lies in Flood Zones 2 and 3, it is considered appropriate to adopt the Upper allowance for the impact of climate change of a **46%** increase in peak flows.

This has been adopted in the hydraulic model described at Section 5.7.1.

6.2 Peak Rainfall Intensity Allowance

An extract of the information provided by the Climate Change Allowances website¹⁵ for the '*Loddon and tributaries Management Catchment*' is reproduced as Table 6-2.

The Upper End allowance of **40%** has been adopted in the hydraulic model described at Section 5.7.2 and when considering the management of surface water runoff from the Site described at Section 9.0.

Table 6-2: Loddon and tributaries Management Catchment peak rainfall allowances

Epoch	Central allowance	Upper end allowance
3.3% annual exceedance rainfall event		
2050s	20%	35%
2070s	25%	35%
1% annual exceedance rainfall event		
2050s	20%	40%
2070s	25%	40%

¹⁴ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

¹⁵ <https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3080>



7.0 Policy Status for Proposed Development

7.1 Flood Risk Vulnerability

With reference to NPPF *Annex 3: Flood Risk Vulnerability Classification*, Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels are classified as a 'More Vulnerable' use.

7.2 Flood Zone Incompatibility

PPG *Table 2: Flood risk vulnerability and flood zone 'incompatibility'* (reproduced as Table 7-1) 'More Vulnerable' development is considered appropriate within Flood Zones 1 and 2 and in Flood Zone 3 subject to the application of the Exception Test.

Table 7-1: Flood risk vulnerability and flood zone 'incompatibility'

Flood Risk Vulnerability Classification (PPG Table 2)		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (functional floodplain)	Exception Test Required	x	x	x	✓

Key: ✓ Development is appropriate x Development should not be permitted

7.3 Sequential Test

A sequential test completed for the proposed development has failed principally due to the high groundwater flood risk.

7.4 Exception test

As discussed in Section 7.2, the exception test should be applied to those elements of the proposed development that are in fluvial Flood Zone 3, or the equivalent of Flood Zone 3, when considering pluvial (surface water) and groundwater flooding.

Paragraph 178 of the NPPF requires that to pass the exception test it should be demonstrated that:

a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and

b) 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.

Part a) of the exception test is largely a planning matter and evidence will be provided demonstrate how this is passed.



Consideration of Part b) of the exception test is set out below.

7.4.1 Exception Test – Surface Water (Pluvial) Flooding

the development will be safe for its lifetime taking account of the vulnerability of its users

The flood risk from surface water flooding is considered at Section 5.7.2. As shown by Figures FRA005 to FRA008, the flooding is limited to isolated locally low-lying areas where rainfall will naturally pond during a storm, rather than overland flow paths across the Site.

Therefore, where these isolated areas are within parts of the Site that are to be developed, the incident rainfall will be captured and managed by the proposed sustainable drainage strategy set out at Section 9.0.

The exception is the western boundary of the southern development parcel where the 0.1% AEP surface water flood event when considering the impact of climate change impinges on the fringes of the proposed built development. This flooding arises from the Hatchgate Ditch rather than as a result of isolated ponding of floodwaters. However, as the flood risk from fluvial flooding in this area is greater than from surface water flooding, it is addressed through the consideration of the exception test for fluvial flooding at Section 7.4.3.

without increasing flood risk elsewhere

The proposed surface water drainage strategy set out at Section 9.0 describes how for all storm events up to and including the 1% (1 in 100) AEP storm event allowing for the impact of climate change, runoff from the Site will be attenuated to that of the undeveloped site for the 100% (1 in 1) storm event.

where possible, will reduce flood risk overall

The proposed drainage strategy will result in a reduction in surface water runoff from the Site for all storm events greater than the 100% (1 in 1) AEP storm event and therefore will reduce the flood risk overall.

Conclusion

In respect of surface water (pluvial) flooding, the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere and will reduce flood risk overall.

7.4.2 Exception Test – Groundwater Flooding

the development will be safe for its lifetime taking account of the vulnerability of its users

The risk of flooding from groundwater is addressed at Section 5.5.3.

There is a risk of groundwater emergence during periods of prolonged rainfall, however, any such emergency will follow the general slope of the Site to the south west toward the Hatchgate Ditch.

Groundwater flooding will therefore only occur within locally low-lying areas in a very similar manner to the risk of surface water flooding. These locally low-lying areas that are potentially prone to groundwater (and surface water flooding) will be addressed as part of the sustainable drainage strategy as discussed in Section 9.0.



without increasing flood risk elsewhere

The Hydrock Report confirms that the near surface groundwater body in the Kempton Park Gravel Member is 'perched' on the underlying lower permeability Lambeth Group. The site investigation confirms that thickness of the Kempton Park Gravel Member varies between 1.9m and 3.2m thick, with an average thickness of 2.47m.

The proposed development will reduce the direct groundwater recharge by directing surface water runoff to the Hatchgate Ditch, rather than allowing it to infiltrate to ground. Therefore, the proposed development will reduce the risk of groundwater flooding, albeit the reduction is unlikely to be significant given the extent of the Kempton Park Gravel Member in the vicinity of the Site.

Another potential effect of the development would be to obstruct near surface groundwater flow through the construction of below ground building foundations and the like. This could potentially increase groundwater levels up groundwater gradient of the Site. However, given that the existing groundwater gradient is likely to be very shallow following the local topography, the depth and relatively high permeability of the Kempton Park Gravel Member and the proposed density of development, the effect is likely to be negligible.

The proposed development is therefore unlikely to have a significant impact on the groundwater regime underlying the Site and hence the groundwater flood risk elsewhere.

where possible, will reduce flood risk overall

The proposed development is unlikely to significantly reduce the groundwater flood risk overall.

Conclusion

In respect of groundwater flooding, the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere.

7.4.3 Exception Test – Fluvial Flooding

the development will be safe for its lifetime taking account of the vulnerability of its users

Paragraph 002 of the Flood risk and coastal change section of the PPG defines the '*design flood*' as '*the river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year) plus an appropriate allowance for climate change*'. The safety of a development has therefore been considered in the context of the design flood.

The extent of the design flood is shown by Figure FRA002.

Paragraph 005 of the PPG Flood risk and coastal change section of the PPG requires that when assessing the safety implications of flood risk for development proposed in a planning application, the following should be considered:

- the characteristics of a possible flood event, including residual risks from flood risk management infrastructure e.g. the type and source of flooding and frequency, depth, velocity, speed of onset and duration;
- the safety of people within a building if it floods and also the safety of people around a building and in adjacent areas, including people who are less mobile or who have a physical impairment. This includes the ability of residents and users to safely access and exit a building during a design flood and to evacuate before an extreme flood (0.1% annual probability of flooding with allowance for climate change);
- the structural safety of buildings: and



- the impact of a flood on the essential services provided to or from a development.

Characteristics of the flood event.

The characteristics of the design flood are set out in the Flood Risk Modelling Report enclosed at Appendix D and are summarised in Table 7-2 for the area of the Site at risk of flooding shown by Figure FRA002.

Table 7-2: Summary of Design Flood Characteristics

Flood Metric (Design Flood)	Characteristic
Type and source of flooding	Fluvial flooding from Main River
Frequency	1% annual probability
Depth ¹	0.20m
Velocity ¹	0.22 ms ⁻¹
Speed of onset	Flooding of the Appeal Site starts 7.5 hours after the start of the rainfall event and reaches a peak at 16 hours
Duration	The duration of flooding from the onset until it recedes from the Site is 22 hours

Notes

¹ Excludes the areas of the Site within the 8m buffer to the Highgate Ditch where no development will take place apart from the construction of the Site access.

The safety of people within a building

As shown by Figure FRA002, the extent of the design flood is limited to sections of the internal road network along the western boundary of the Site and several proposed dwellings along the western fringe of the southern development parcel. The flood depths within the footprint of these dwellings varies between 0.06m and 0.12m.

Paragraph 8.2.5 of the SFRA (CD9.17) states that:

'the EA advises that minimum finished floor levels should be set 300mm above the 1% AEP plus climate change peak flood level, where the appropriate new climate change allowances have been used. An additional allowance may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.'

Section 3.5 of the Flood Risk Modelling Report Revision enclosed at Appendix D addresses the freeboard that should be provided above the design flood level to cater for uncertainty in the hydraulic model. The analysis concludes that the modelling has a '*3 star Confidence rating*' and as such a minimum 0.6m freeboard should be provided, i.e. finished floor levels should be set a minimum of 0.6m above the design flood level.

The maximum design flood level within the Site is 37.63mAOD and therefore in my opinion the minimum finished floor level of the dwellings should be set at **38.23mAOD**.

For comparison, and to address the 'additional allowance' point in the SFRA, Table 7-3 provides a summary of the modelled outputs in comparison to the recommended freeboard allowance.



Table 7-3: Modelled Outputs vs Freeboard

Model Scenario	Flood Level (mAOD)	Freeboard (m)
Baseline Modelling		
1% AEP plus 46% Climate Change Allowance (design flood)	37.63	0.60
0.1% AEP	37.65	0.58
0.1% AEP plus 46% Climate Change Allowance (extreme flood)	37.69	0.54
Sensitivity Analysis on Design Flood		
50% culvert blockage	37.66	0.57
75% culvert blockage	37.67	0.56
20% increase in roughness	37.65	0.58
0.3m surcharge on downstream boundary (culvert)	37.64	0.59
0.6m surcharge on downstream boundary (culvert)	37.65	0.58

By adopting a 0.6m freeboard allowance, the occupants of the buildings would not be at significant risk, i.e. they would be safe during times of flood.

The ability of residents and users to safely access and exit a building during a design flood and to evacuate before an extreme flood (0.1% annual probability of flooding with allowance for climate change)

With reference to Table 4 of the Supplementary note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose - Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1¹⁶, based on the depth of flooding and the velocity of the floodwaters predicted by the hydraulic model for the design flood (summarised in Table 7-2), the maximum 'Flood Hazard Rating' is 0.60 which results in a 'Hazard to People Classification' of 'Very low hazard – Caution'.

Whilst the *Flood Hazard Rating* increases for the extreme flood, the 'Flood Hazard Rating' it remains less than 0.75 and as such the 'Hazard to People Classification' remains 'Very low hazard – Caution' albeit over a wider area within the Appeal Site.

The 'Flood Hazard Rating' for the design and extreme floods is shown by Figures FRA009 and FRA010 respectively enclosed at Appendix F.

Whilst a number of the dwellings shown on the illustrative masterplan are shown to be within the extreme flood envelope, as shown by Table 7-3, the floor levels are set well above the extreme flood level. The areas of built development within the Site that are at risk of flooding during an extreme flood are therefore confined to the internal access roads.

The maximum depth of flooding along the internal access road during the extreme flood is 0.18m and the maximum velocity is 0.17ms⁻¹. Emergency service vehicles can readily traverse floodwaters of this depth and velocity along with the majority of motor vehicles. With this depth of flooding and low velocity of floodwater, there is no significant risk of vehicles being destabilised or washed away.

The maximum depth and velocity of floodwaters along the internal access road during the design flood is 0.13m and 0.09ms⁻¹. To set this in context, this is effectively still water that would reach just above the ankle of an adult and so with care could be traversed on foot

¹⁶ Environment Agency and HR Wallingford, 2008



should the need arise. The height of the underside of the average small family car is circa 0.2m and so again, with care the floodwaters could be traversed in a car should the need arise. This is principally why the '*Hazard to People Classification*' is considered '*Very low hazard – Caution*'.

With care, residents and users of the proposed development therefore would be able to safely access and exit a building during a design flood and to evacuate before an extreme flood. It is clear from Table 7-2 that the onset of flooding occurs slowly.

The structural safety of buildings

As the finished floor level of the buildings will be a minimum of 0.60m above the design flood level and 0.54m above the extreme flood level, there will be no issue with the structural safety of buildings.

the impact of a flood on the essential services provided to or from a development

Essential services to a development might include:

- Electrical supply;
- Gas supply;
- Water supply; and
- Telecoms

These services are normally installed in below ground ducting, or directly in the ground. Ducting is not sealed against the ingress of water and therefore under normal operating conditions, it can be expected that the ducting, and hence the service, will be inundated from time to time.

Therefore, the limited depth and duration of flooding predicted by the hydraulic modelling for the design flood would have no greater impact on the essential services that experienced under their normal operating conditions.

The only exception might be if there are to be above ground service cabinets for telecoms or sub-station for the electricity supply, in which case they should be set above the design flood level.

without increasing flood risk elsewhere

When considering the impact on the flood risk elsewhere through the displacement of floodwaters or obstruction of flood flows, the impact is assessed against the design flood.

As shown by Figure FRA002 enclosed at Appendix F, the part of the Site at risk of flooding during the design flood is confined to part of the internal road network and several dwellings along the southern part of the western boundary.

Therefore, provided there is no land raising within design flood envelope without suitable compensation elsewhere, the proposed development would not increase the flood risk elsewhere by virtue of the reduction in floodplain storage or the obstruction of flood flows..

where possible, will reduce flood risk overall

The proposed development will not reduce the fluvial flood risk overall.

7.4.4 Exception Test Conclusions

To conclude, the proposed development passes the exception test as it:

- will be safe for its lifetime taking account of the vulnerability of its users;
- will not increasing flood risk elsewhere; and



- will reduce flood risk overall.



8.0 Other Issues

8.1 Environment Agency Consultation

In their consultation response to the planning application for the proposed development, the Environment Agency raised an objection stating that the submitted flood risk assessment (rev P02) did not adequately assess the flood risks posed by the development. A copy of the consultation response is enclosed at Appendix C.

The reasons for the objection are addressed below.

- *Provide a design flood level for the 1% Annual Exceedance Probability flood extent plus an appropriate allowance for climate change (1%AEP+CC), therefore it is unclear what impact the development may have on flood risk, and whether or not the development would be safe for its lifetime.*

The design flood level is provided in Section 7.4.3.

- *Take the impacts of climate change on fluvial flood risk into account.*

The impact of climate change is discussed in Section 6.0.

- *Demonstrate that finished floor levels will be set above the 1% annual exceedance probability (AEP) flood level with an appropriate allowance for climate change.*

Recommended finished floor levels are

- *Demonstrate that the development would not adversely impact floodplain storage*

The impact on the flood risk elsewhere and in particular that on flood plain storage is discussed in Section 7.4.3.

- *Demonstrate that the requirement for a buffer strip of at least 8m to the main river has been met.*

A drawing showing the 8m buffer strip is included in Appendix B, confirming that apart from the proposed crossing of the culverted section of the Highgate Ditch, the proposed development is outside the 8m buffer margin.

- *Consider the impact of the proposed new crossing over the main river.*

A CCTV survey of the culverted section of the Hatchgate Ditch confirmed that there was sufficient cover to the culvert to allow the access to proposed development to be constructed without effecting its structural integrity. A preliminary design of the proposed culvert crossing is enclosed at Appendix B.

8.2 Section 19 Report

Concern has been expressed about the potential increase in surface water runoff from the development exacerbating an existing flooding problem that is referenced in a draft Section 19 (S19) report. The S19 Report has not been formally published but has been reviewed in preparing this flood risk assessment.

The S19 report is summarised in Appendix C and indicates that the nearest flooded area addressed in the report is approximately 0.47km from the site, at the junction of Hogmoor Lane and Poplar Lane, northeast of the site.

As the proposed development drains to the west towards the Highgate Ditch and lies in a separate drainage sub-catchment it is unlikely that runoff from the Site contributes to flooding in the area described in the S19 report.



In addition, as discussed in Section 7.4.1, the proposed development will reduce the rate of surface water runoff from the Site in response to the more extreme storm events.



9.0 Surface Water Management Strategy

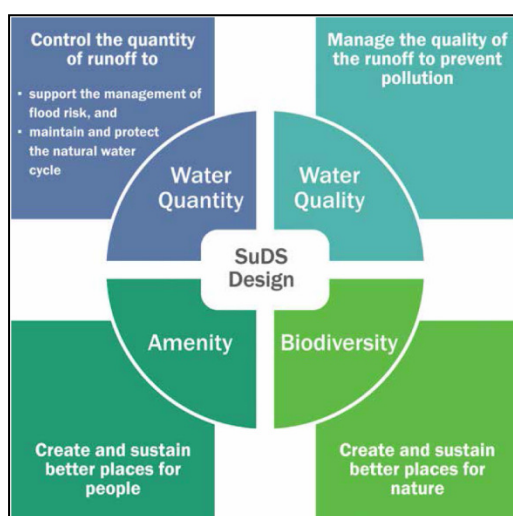
9.1 Sustainable Drainage Systems

To satisfy the requirements of current best national and local surface water management guidance, SuDS should be incorporated into the design proposals to manage, attenuate and treat surface water runoff before discharging from the Site.

Current best practice guidance relating to sustainable surface water management is outlined in *'The SuDS Manual (C753)'*¹⁷ which provides details on the use of SuDS for managing surface water runoff.

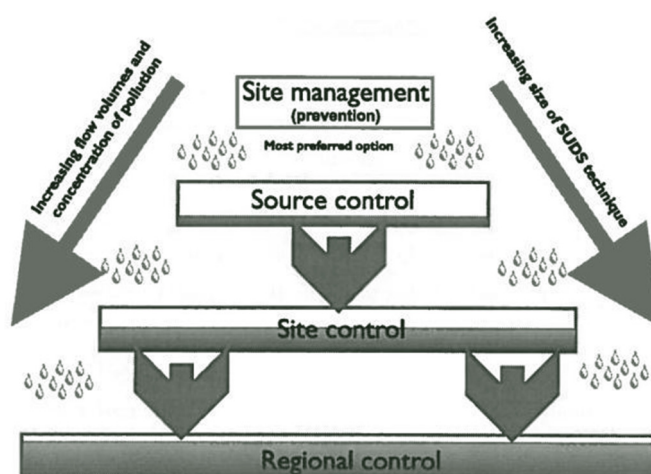
There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' and are depicted in Figure 9-1.

Figure 9-1: Four Pillars of SuDS (after the SuDS Manual)



The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train' and is depicted in Figure 9-2.

Figure 9-2: SuDS Management Train



¹⁷ CIRIA, 2015. *The SuDS Manual. C753*



The 'Management Train Approach' advocated a hierarchy of drainage techniques to incrementally reduce pollution, flow rates and volumes of storm water discharge from the site, and is as follows:

- **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).
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable pavement and green roofs).
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one / several soakaways, below ground storage units or detention ponds for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

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

- 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 providing biodiversity and wildlife habitat enhancements; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

9.2 Proposed Discharge Arrangement

With reference to The SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is as follows:

1. Infiltration to ground;
2. Discharge to surface water;
3. Discharge to surface water sewer; or
4. Discharge to combined sewer.

Table 9-1 summarises the suitability of disposal methods suitability in the context of the existing Site and the proposed development.



Table 9-1: Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
Infiltration to ground	As discussed in Section 5.5.3, there is a high groundwater table beneath the Site. This would preclude the use of infiltration as a means of surface water disposal.	N
Discharge to surface waters	The open section of the Highgate Ditch along the western boundary of the Site would provide a suitable point of discharge for surface water runoff.	Y
Discharge to Sewer	Thames Water has confirmed that there are no surface water or combined sewers in the vicinity of the Site to which a connection could be made.	N

9.3 Disposal Method

As set out in Table 9-1, the only viable means of draining the development is to make a connection to the Highgate Ditch that flows along the western boundary of the Site.

9.4 Catchment Areas

The catchment plan enclosed at Appendix B provides details of the proposed catchments that will drain to the proposed drainage network.

To estimate the runoff from the proposed development, the following coefficients have been applied to the surface types areas shown by the parameters plan enclosed at Appendix A to provide a net impermeable area:

- greenfield areas - 0.2
- development parcels - 0.7
- All proposed roads have – 1.0

The 0.7 coefficient applied to the development parcels takes into account the potential for urban creep and proportion that will be permeable such as private gardens, public open spaced, landscaping, etc.

The contributing areas to the northern and southern drainage networks shown by the drainage strategy enclosed at Appendix B are summarised in Table 9-2 and Table 9-3 respectively.



Table 9-2: Catchment Details – Northern Network

Northern Network							
Pipe Ref	Imp Road Area	Imp Areas (plot)	Imp Areas (plot) (coefficient applied 0.7)	Perm Areas (grass)	Perm Areas (grass) (coefficient applied 0.2)	Swale / Pond area	Total into pipe
1.000	0.020	0.747	0.523	0.793	0.159		
	0.048			0.038	0.008		
	0.194						
	0.056						
	0.109						
	0.027						1.374
1.001	0.024			0.029	0.006	0.013	0.043
1.002	0.015			0.020	0.004	0.013	0.032
1.003	0.020			0.024	0.005	0.013	0.038
1.004	0.010			0.007	0.001	0.013	0.024
1.005	0.030			0.042	0.008	0.013	0.051
1.006	0.027			0.044	0.009	0.012	0.048
1.007	0.024			0.043	0.009	0.012	0.045
1.008	0.015			0.027	0.005	0.012	0.032
1.009	0.014			0.026	0.005	0.012	0.031
1.010	0.020						0.020
1.011	0.035			0.025	0.005		
	0.132			0.015	0.003		0.422
				1.237	0.247		0.040
1.012							0.003
1.013							
1.014							
1.015							
1.016							0.379
1.017							
Total Drained Area (ha)							2.583



Table 9-3: Catchment Details - Southern Network

Southern Network							
Pipe Ref	Imp Road Area	Imp Areas (plot)	Imp Areas (plot) (coefficient applied 0.7)	Perm Areas (grass)	Perm Areas (grass) (coefficient applied 0.2)	Swale / Pond area	Total into pipe
1.000	0.021	0.048	0.034	0.027	0.005		
	0.046	0.433	0.303	0.113	0.023		
	0.036	0.263	0.184	0.120	0.024		
	0.098						0.774
1.001						0.065	0.065
1.002							
1.003				0.175	0.035		
				0.307	0.061		0.096
1.004				0.480	0.096		0.096
1.005				0.463	0.093		
				0.337	0.067		0.160
1.006				0.514	0.103		0.103
1.007							
1.008							
1.009							
1.010	0.042			0.361	0.072	0.119	
				0.263	0.053		0.244
2.000	0.200	0.866	0.606	0.377	0.075		
	0.050	0.690	0.483				
	0.064						1.479
Total Drained Area (ha)							3.016

9.5 Urban Creep

A 10% allowance for urban creep has been included in the coefficient applied to development parcels.

9.6 Estimate of Allowable Discharge

The Site is currently entirely greenfield. The existing greenfield runoff rate from the Site, QBAR, has been estimated as 17.85ls^{-1} using HR Wallingford online tool¹⁸. This is equivalent to $1.67\text{ls}^{-1}\text{ha}^{-1}$. Details of the analysis are enclosed at Appendix B.

9.7 The SuDS Design Philosophy

The SuDS philosophy for a development site is the promotion of Prevention, Source Control and Site Control Techniques as set out below:

¹⁸ www.uksuds.com



- Surface water treatment using the 'Management Train' approach to remove and isolate potential contamination with the runoff at all SuDS facilities prior to conveyance to the existing watercourse.
- Surface water discharge to be attenuated to greenfield runoff rate (defined as QBAR).
- Prevention measures, for example the inclusion of water butts.
- Site Control features, in the form of above-ground attenuation storage, to accommodate the additional surface water runoff generated by the development site.

Potential SuDS methods that may be appropriate to the proposed development are summarised in the Table 9-4.

Table 9-4: SuDS Feasibility Assessment

SuDS Method	Feasibility, Given Site and Project
Basins and Ponds – Above Ground Storage	Basins and ponds increase biodiversity and amenity of the area; provide attenuation; and improve water quality. This method does occupy large areas of developable land and needs to be constructed at the lower levels of the site. Dry basins will be incorporated within the park area to attenuate runoff from surrounding areas and for exceedance flows.
Filter Strips, Swales and Raingardens	Filter strips and raingardens can be used within private or public areas to reduce and treat runoff. Raingardens are recommended where possible for increased runoff treatment.
Swales	Swales are shallow, flat bottomed, vegetated open channels designed to convey and treat surface water runoff. When incorporated into the site design they can be used to enhance the natural landscape and provide aesthetic and biodiversity benefits. A swale is proposed within the park land to attenuate excess runoff from the public highway and for exceedance flows.
Permeable Paving	Permeable paving is a form of pavement construction that allows road runoff to infiltrate through the surface layer to underlying treatment and storage media. They are an efficient means of managing and treating surface water runoff close to its source. Permeable paving with a 30% voids aggregate is proposed across the site within public and private highways and private footpaths.
Tanked / Geocellular Attenuation Systems	Tanked / geocellular attenuation systems provide high storage capacity and can be incorporated within road pavements and under landscaping. However, they do not provide runoff treatment or improve amenity and biodiversity so other forms of SuDS should be used where possible.

9.8 Water Quantity Design Standard

9.8.1 Control of Runoff Volume

Section 3.3.1 of The SuDS Manual sets out volume control criteria for:

- Frequent rainfall events.
- Extreme rainfall events.

Frequent rainfall events

The SuDS Manual requires *'the prevention of runoff from the [Site] for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events)'*. This is known as *Interception* and *'Interception of about 5mm is normally achievable.'*



With reference to Section 24.8 of The SuDS Manual:

'Inception can be delivered using one or a combination of process:

- *Rainwater harvesting*
- *Infiltration*
- *Evapotranspiration using temporary shallow ponding or storage within the soil or upper aggregate layers.'*

It is anticipated that the interception storage requirements would be met by the permeable paving and permeable sub-base stone where utilised.

Extreme rainfall events

For extreme rainfall events, the drainage system should be designed such that *'the volume of runoff from the Site (or development) area [does] not exceed the volume of runoff from the equivalent area in its natural undeveloped or "greenfield" state'*.

However, where controlling runoff to greenfield volumes is considered unachievable (in this case because the underlying soils are impermeable), the addition volume should be released at a low rate that will not increase the downstream flood risk.

The difference between the predicted development runoff volume and the estimated greenfield runoff volume is referred to as the Long-Term Storage.

Section 24.10 of the CIRIA guidance provides alternative methods for estimating and managing the Long-Term Storage. Provided runoff from the site is released at a rate of $2\text{ls}^{-1}\text{ha}^{-1}$ or Q_{BAR} whichever is the higher value, then there is no requirement to manage the Long-Term Storage separately from the main drainage system.

As detailed in Section 9.6, as runoff from the Site will be attenuated Q_{BAR} , the provision of long term storage is not required.

9.8.2 Control of Peak Rate of Runoff

Section 3.3.2 of The SuDS Manual provides guidance on the peak rate of runoff criteria for:

- Events likely to impact on morphology, ecology or capacity of the receiving surface waters, or the capacity of receiving sewers.
- Extreme events.

Events likely to impact on morphology, ecology or capacity of the receiving surface waters, or the capacity of receiving sewers

Surface water runoff is to be discharged to the Highgate Drain at a rate equivalent to Q_{BAR} and therefore will have no significant impact on the morphology, ecology or capacity of the receiving surface waters

Extreme events

In line with Section 3.3.2 of The SuDS Manual, the drainage system *'should be designed so that peak runoff rates for extreme rainfall events (...) are constrained to the greenfield rates of runoff for the same event.'*

Surface water runoff is to be attenuated to Q_{BAR} and so this requirement is met.

9.8.3 Proposed SuDS Management Train

Based on the SuDS Strategy discussed at Section 9.7, the proposed SuDS Management Train is summarised in Table 9-5.



Table 9-5: Summary of SuDS Management Train

SuDS Management Train Mechanism	Application	Potential Suitable SuDS Features
Source Control	For the interception of surface water runoff at the source such as property buildings, car parking and internal access roads / pavements.	Water butts on downpipes to dwellings and raingardens
Conveyance	To convey surface water runoff from 'Source Control' to 'Site Control'.	Runoff will be directed to the Highgate Ditch via piped drainage system that includes sections of swale.
Site Control	Provides the required surface water detention / storage prior to controlled discharge to the Highgate Ditch.	Detention basin and attenuation ponds

9.9 Preliminary Surface Water Drainage Strategy

9.9.1 Overview

The proposed drainage strategy is shown by the drawing is enclosed at Appendix B.

The northern most development plot will be drained via an on-plot gravity sewer system which will incorporate on-plot attenuation measures (below / above ground attenuation, permeable paving) prior to discharging to a swale.

The flow into the swale will be attenuated (attenuation rate to be determined at detailed design). The swale will serve the main road which will run through the development. Immediately downstream of the swale flow will be attenuated to 7.7ls^{-1} .

A manhole and pipe system will then discharge to the southern drainage network before ultimately discharging to the Hatchgate Ditch located along the western site boundary. This network is defined in flow as Network 1 and the simulation results are provided in Appendix B. The peak simulated flow from Network 1 is 7.0ls^{-1} .

All development areas south of the main access road will be directed to a swale and basin / pond system, comprising of one detention basin and one attenuation pond connected by a swale.

The main difference between the detention basin and the attenuation pond is that the attenuation pond will be designed to retain a permanent depth of water, whereas the detention basin will be dry apart from when it is attenuating surface water runoff.

The upstream detention basin in this system (Basin 1) will serve the development plot to the south of the main road through the site. The flow from Basin 1 will be attenuated to 19.0ls^{-1} prior to discharging to the swale.

The swale will then convey flows to the attenuation pond (Pond 1). Flows from Pond 1 will be attenuated to 10.4ls^{-1} . This network then discharge via a pipe and manhole system to the Highgate Ditch. Upstream of this connection point, a flow of 6.2ls^{-1} from Network 1 enters this system. This results in a total maximum peak flow entering the Highgate Ditch of 17.7ls^{-1} and therefore does not exceed the greenfield runoff rate of 17.85ls^{-1} .

New development should be designed in accordance with current best practice to provide adequate capacity so as not to flood for the critical 1 in 30-year storm event. Flood water



generated for up to the critical 1 in 100-year plus climate change storm event should be constrained within areas so as not to cause damage to buildings, essential services, adjoining developments, and services.

The simulation results confirm that Networks 1 and 2 do not flood in response up to and including the 1% AEP storm event allowing for the impact of climate change.

9.9.2 Proposed SuDS / Attenuation Features

Based on the current proposed layout of the development, SuDS have been incorporated where practical and are summarised as follows:

- Swale 1 (Network 1) is 1.2m deep with a 0.5m bed and 1 in 3 side slopes. Total length of swale is 176 metres, total width is 6.5m.
- Swale 2 (Network 2) is 1.2m deep with a 0.5m bed and 1 in 3 side slopes. Total length of swale is 79m.
- Detention Basin 1 (Network 2) is 2.14m deep with 1 in 3 sides slopes. Area of pond is 791m². Pond volume is 808m³.
- Attenuation Pond 1 (Network 2) is 1.3m deep with 1 in 3 sides slopes. Area of pond is 1,196m². Pond volume is 1,855m³.
- 3,375m³ of additional storage is required within the northern development parcel that drains into Swale 1. It is anticipated that this will be provided in the form of a combination of permeable paving and below ground storage.
- 504m³ of additional storage is required within the southern development parcel that drains into Pond 2. It is anticipated that this will be provided in the form of a combination of permeable paving and below ground storage.

The additional storage has not been explicitly modelled in the drainage simulation and will need to be developed as part of the future detailed drainage design.

In accordance with Susdrain¹⁹ guidance, an assessment has been completed to ensure the 100-year storm event drains down sufficiently for the storage structure to be able to accommodate a subsequent 10-year storm event. A summary of this assessment on Detention Basin 1 and Attenuation Pond 1 is provided below:

Detention Basin 1

- 100-year 360-minute (Winter) event results in 230m³ stored in Basin 1.
- 10-year 360-minute (Winter) event results in 578m³ stored in Basin 1.
- Total Basin volume is 808m³ and therefore can accommodate these volumes.

Attenuation Pond 1

- 100-year 360-minute (Winter) event results in 1,013m³ in Pond 1.
- 10-year 360-minute (Winter) event results in 519m³ in Pond 1.
- Total Pond volume is 1,855m³ and therefore can accommodate these volumes.

As discussed above, the attenuation volumes required for development plots on Network 1 and Network 2 are indicative only and represent below ground attenuation measures and permeable paving that will form part of the detailed drainage design. These measures will

¹⁹ https://www.susdrain.org/files/resources/fact_sheets/03_14_fact_sheet_attenuation.pdf



therefore be assessed in accordance with the Susdrain guidance when they have been individually designed as part of the future detailed design process.

9.10 Water Quality Design Criteria

The drainage of built development has the potential to reduce water quality through increases in suspended solids, metals and hydrocarbons in the surface water runoff. The risks associated with a number of typically drained surfaces (land uses) are assessed in Section 26 of the SuDS Manual and expressed in Table 26.2 as a potential '*Pollution hazard level*'. A review of proposed land use has been completed in reference to Table 26.2 of SuDS Manual to determine the appropriate *Pollution Hazard Levels*.

The *Pollution hazard levels* appropriate to each land use are summarised in Table 9-6.

Table 9-6: Pollution Hazard Level for Proposed Development

Proposed Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Residential Roofs	Very Low	0.2	0.2	0.05
Hardstanding and access road	Low	0.5	0.4	0.4

Table 26.3 of the SuDS Manual provides indicative '*Mitigation indices*' for a range of SuDS components where runoff is to be discharged to surface waters and are summarised in Table 9-7.

Table 9-7: Indicative SuDS Mitigation Indices for Discharges to Surface Waters

SuDS Component	SuDS Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Swale	0.5	0.6	0.6
Detention basin	0.5	0.5	0.6
Combined SuDS Indices ¹	0.75	0.85	0.9

Notes

¹ Total SuDS mitigation index = mitigation index₁ + 0.5 (mitigation index₂)

As the total *SuDS mitigation indices* are equal to or greater than the *Pollution Hazard Indices* the water quality requirements are deemed to have been met.

9.11 Exceedance

The surface water drainage network has been designed to accommodate runoff for up to the 1 in 100-year plus climate change event, within the site boundary. There is 9m³ of flooding at the head of Network 1 for 1% AEP storm event allowing for the impact of climate that will be held in the surrounding landscaped area. This limited flood volume will be designed out as part of the detailed design process.



In the event of rare extreme rainfall events, the capacities of proposed drainage infrastructure may become exceeded. Indicative flood exceedance routes are indicated on the Drainage Strategy provided in Appendix B.

The analysis concludes that proposed buildings are not at risk of flooding and that flood volumes can be safely held within the site area until flood levels subside.

9.12 Approvals

To construct the drainage outfall to the Highgate Ditch and the access road across the culverted section of the Ditch, a Flood Risk Activities Permit will be required.



10.0 Draft Maintenance Strategy

This section is intended to provide an overview of the operation and maintenance of the drainage features included in the drainage strategy. Where proprietary products are specified, priority should be given to the manufacturer's instructions.

The recommended operations and frequencies are typical and should be reviewed with experience.

Where sewers and SuDS features are offered for adoption, the adopting authority will have their own maintenance strategy in place.

This document will evolve through the design and construction phases of the scheme and should be included in a final strategy as part of the Health and Safety file on handover of the final scheme.

10.1 Adoption

The entire surface water and foul drainage networks will be offered for adoption to Thames Water. It is therefore likely that the maintenance regime will be altered to suit the adopting authority's procedures. Highway drainage in the Southern Link Road will be the responsibility of the Local Highways Authority.

10.2 Components

The following components have been included in the preliminary drainage strategy:

- Pipes
- Gullies
- Swales
- Permeable Paving
- Flow Control Units
- Detention Basin
- Attenuation Pond

The maintenance strategy should be implemented to ensure the drainage network is cleaned regularly and the routine maintenance regime should be documented.

Until such time as the network is adopted formally, the maintenance will be the responsibility of an on-site management team that is appointed by the developer. It is recommended that a general inspection of the drainage networks is carried out twice a year as a minimum and after any major storm. This consists of a visual inspection survey of the surface visible features such as headwalls to ensure the system is working.

Significant sediment deposition is likely in areas used for storage, so a post-storm clean-up operation may be required to remove litter, vegetation, sewerage debris and larger objects.

During the winter months, drainage features such as gullies and channels should be cleared of ice, snow, debris, or litter.

Sediment / material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols; especially where run-off is taken from potentially contaminated areas such as filter drains and associated chambers.



10.3 Inspection, Manhole and Catchpit Chambers

Access points should be located at the head of each run, at the change in direction and at the change in pipe size in accordance with the Sewer Sector Guidance (SSG) and Building Regulations Part H.

The appropriate health and safety equipment must be used when accessing manholes. Confined space certificates must be held by any personnel entering a manhole and the appropriate permits should be obtained from the Maintenance Manager prior to any access.

The manhole chambers on site should be designed in accordance with the SSG and Building Regulations Part H guidance which includes appropriately sized covers and access ladders, however untethered entry is not recommended. A suitable hoist and harness system should be used.

10.4 Pipes

Pipes are proprietary products and the materials can vary throughout the network. As such manufacture's recommendations for installation and maintenance should be followed.

Pipes are intended to be the main conveyance throughout the development and where oversized they form the attenuation volume required by the limitation of the discharge rate. They are intended to be dry except for during rainfall events. These have been designed to be self-cleaning where possible for smaller diameter pipes, and for larger diameters the risk is reduced due to the overall pipe size.

Access for maintenance is provided through access chambers and manholes.

A regular inspection and maintenance regime is important to identify areas which may have been obstructed/clogged and may not be draining correctly thus exposing the development to a greater level of flood risk.

Table 8: Typical Pipe and Chamber Maintenance Requirements

Maintenance Schedule	Required Actions	Typical Frequency
Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required)	Initial Inspection should be provided as post construction CCTV survey.	Not applicable.
Regular Maintenance / Inspection	Inspect for evidence of poor operation via water level in chambers, if required, take remedial action.	3-monthly, 48 hours after large storms.
	Check and remove large vegetation growth near pipe runs	Monthly or as required.
Remedial Action	Rod through poorly performing runs as initial remediation.	As required.
	If continued poor performance jet and CCTV survey poorly performing runs	As required.



10.5 Gullies / Kerb Drainage

Channels and gullies should be inspected and cleaned in accordance with the manufacturer's recommendations. Channel units can be cleaned using a high-pressure hose; this can be fed into the channel system through access units strategically placed along the channel run. The throat section of channel units should always be kept clear to ensure uninterrupted flow of surface water into the drainage channel and any debris within the throat should be removed.

Locking bolts should be replaced and sufficiently tightened, taking care that the bolt heads do not stand above the top surface of the cover or grate. If covers are allowed to move within their frame, this may cause damage to the frame or seating.

Sediment/material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols; especially where run-off is taken from potentially contaminated areas such as the car park channels.

Kerb Drainage is a proprietary product therefore the manufacturers maintenance regimes should be followed where possible. Whether or not kerb drainage is a suitable for this scheme will be determined as part of the detailed drainage design process.

Table 9: Typical Gully and Kerb Drainage Maintenance Requirements

Maintenance Schedule	Required Actions	Typical Frequency
Monitoring (to be undertaken more regularly within the first year of operation and adjusted as required)	Initial inspection	Not applicable.
Regular Maintenance / Inspection	Litter and debris removed	Monthly or as required.
	Inspect for evidence of poor operation via water level in chambers, if required, take remedial action.	Monthly or as required.
	Inspect slit accumulation rates and establish appropriate brushing frequencies. Slit can also be caused by adjacent landscaping area which should be reprofiled to provide a flat area or berm adjacent to the paving.	3-monthly, 48 hours after large storms.
	Inspect for evidence of poor operation and/or weed growth, if required, take remedial action.	Monthly or as required.
Remedial Action	Inspect sumps and outlet pipes and rod through poorly performing channels and outlets as initial remediation.	As required
	If continued poor performance jet and CCTV survey poorly performing runs	As required.



10.6 Permeable Paving

Maintenance regimes for permeable paving will depend on whether the system is bound or unbound. Concrete block paving (CBPP) systems under normal operating conditions have been found to operate satisfactorily with limited maintenance²⁰. However, it is recommended that some form of sweeping/visual inspections are carried out annually to ensure any defects are picked up early.

Most permeable paving systems are proprietary, and manufacturer's instructions and recommendations for installation and maintenance should be followed.

10.7 Hydrobrake Chamber

The hydrobrakes chamber should be maintained in a manner similar to that of the standard chambers. Manufacturer's instructions should be followed in respect any additional maintenance requirements for the hydrobrakes themselves.

10.8 SuDS Features

Table 10: Typical Detention Basin, Pond and Swale Maintenance Requirements

Maintenance Schedule	Required Actions	Minimum Frequency
Regular Maintenance	Remove litter and debris removal	Monthly
	Cut grass in and around basin	Half yearly (spring – before nesting, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (or as required)
	Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, liner, structures, pipework etc. for evidence of physical damage.	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices.	Annually
	Tidy all dead growth before start of growing season.	Annually
	Remove sediment from inlet, outlets and forebay.	Annually (or as required)
	Manage plants in outlet pool – where provided.	Annually
	Removing sedimentation that has become entrained into the outflow	Six monthly or as required
Occasional Maintenance	Re-seed areas of poor vegetation growth.	As required
	Prune and trim any trees and remove cuttings.	Every 2 years or as required
	Remove sediment from inlets, outlets, forebay and main basin when required.	Every 5 years or as required

²⁰ Marshalls, 2023



Maintenance Schedule	Required Actions	Minimum Frequency
	Periodic measuring of the bore size	Every 3 years or as required
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing.	As required
	Realignment of rock armour	As required
	Repair/rehabilitation of inlets, outlets, and overflows.	As required
	Relevel uneven surfaces and reinstate design levels.	As required



11.0 Proposed Foul Drainage

The proposed foul drainage strategy for the proposed development is to discharge the on-site foul flows to the existing Thames Water public combined sewer located in Tape Lane. As the site is relatively flat, coupled with the distance of the southern-most development area of the site, foul flows will need to be pumped to this combined sewer.

In accordance with Sewer Sector Guidance Appendix C, the peak design flow for dwellings is calculated at 4,000 litres per dwelling per day (0.05 litres per second per dwelling). Peak flow for this development is therefore $0.05 \times 99 \text{ dwellings} = 4.9 \text{ l s}^{-1}$.

A pre-development enquiry has been submitted to Thames Water to seek an agreement in principle for the proposed connection point.



12.0 Compliance with Policy

12.1 Core Strategy Policy CP1

Paragraph 4) of CP1 requires the provision of adequate drainage. The proposed drainage strategy is described in Section 9.0

Paragraph 9) of CP1 states that planning permission will be granted for development proposals that avoid increasing (and where possible reduce) risks from all forms of flooding (including from groundwater)

As discussed in Section 7.4, the exception test is passed and the proposed sustainable drainage strategy will reduce the flood risk from surface water flooding.

It is therefore concluded that the provisions of Policy CP1 are met.

12.2 Core Strategy Policy CP3

Paragraph b) of CP3 states that planning permission will be granted for development proposals that provide a functional, accessible, safe, secure and adaptable scheme.

In the context of flood risk, as the exception test is passed the provisions of Policy CP3 are met.

12.3 Managing Development Delivery Local Plan Policy CC09

12.3.1 Part 1)

The information provided in this flood risk assessment meets the requirements of Part 1) of the Policy.

12.3.2 Part 2)

The application of the exception test discussed in Section 7.4 demonstrates that the vulnerability of proposed development has been considered and therefore meets the requirements of Part 2) of the Policy.

12.3.3 Part 3)

The proposed development does not pass the sequential test and therefore does not meet the requirements of Part 3) of the Policy.

12.3.4 Part 4)

Evidence to demonstrate that the requirements of Part 4a) of the policy have been met has been provided by others

The application of the exception test discussed at Section 7.4 demonstrated that the requirements of Part 4b) of the Policy is met.

If required, appropriate evacuation and flood response procedures can be developed to demonstrate that the requirements of Part 4c) of the Policy can be met.

12.3.5 Part 5)

The flood risk assessment meets the requirements of Part 5) of the Policy.



12.3.6 Conclusion

In conclusion, it is only Part 3 of the Policy that is unlikely to be met by the proposed development.

12.4 Managing Development Delivery Local Plan Policy CC10

12.4.1 Part 1)

This flood risk assessment and drainage strategy meets the requirements of Part 1) of the Policy

12.4.2 Part 2)

The drainage strategy set out at Section 9.0 meets the requirements of Part 2) of the Policy.

12.4.3 Conclusions

The proposed development meets the requirements of Policy CC10.

12.5 Section 14 of the NPPF

The key policies set out in Section 14 of the NPPF in so far as they relate to flood risk are the application of the sequential and exception tests.

As discussed at Section 7.3, the proposed development does not pass the sequential test.

As discussed at Section 7.4, the proposed development passes the exception test.

Therefore, the proposed development only partially meets the requirements of Section 14 of the NPPF.

12.6 Conclusion

The proposed development meets the local and national planning policy requirements that relate to flood risk and drainage matters apart from Part 3) of Managing Development Delivery Local Plan Policy CC09 and part the Section 14 of the NPPF that relates to the application of the sequential test.



13.0 Conclusions

13.1 Background

This flood risk assessment has been commissioned to support an outline application for the proposed development at Land East of Lodge Road, Hurst.

With reference to the *Flood Maps for Planning*, the Site is located within Flood Zones 1, 2 and 3 as defined by PPG Table 1.

The Site is also at risk of surface water and groundwater flooding.

A bespoke hydraulic model has been developed to better define the fluvial and surface water flood risk to the Site.

13.2 Vulnerability Classification and Flood Zone Compatibility

The proposed dwellings are considered a '*Highly vulnerable*' form of development and are considered appropriate in Flood Zones 1 and 2 and in Flood Zone 3 subject to the application of the exception test.

13.3 Sequential and Exception Tests

The proposed development fails the sequential test principally due to the risk of groundwater flooding.

The proposed development passes the exception test for all sources of flooding.

13.4 Flood Risk Management

The finished floor level of the dwellings will be set 0.6m above the design flood level established by detailed hydraulic modelling.

The hazard to the access and egress route for both the design and extreme flood events would be considered *Very Low hazard – Caution*.

13.5 Offsite Impacts

The proposed development will have no impact on the flood risk elsewhere.

13.6 Surface Water Drainage

A preliminary drainage strategy has demonstrated that runoff from the proposed development can be managed using SuDS to ensure the proposed discharge to the Highgate Ditch does not increase the flood risk elsewhere.

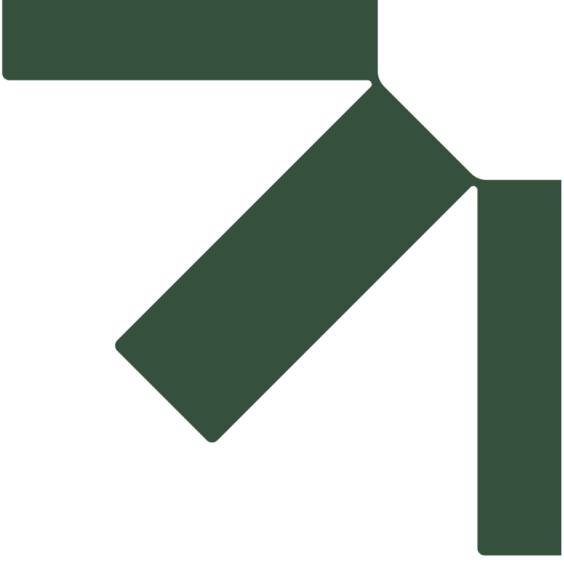
13.7 Foul Drainage

The proposed development will drain to the public Thames Water sewer network.

13.8 Compliance with Policy

The proposed development meets the local and national planning policy requirements that relate to flood risk and drainage matters apart from Part 3) of Managing Development Delivery Local Plan Policy CC09 and part the Section 14 of the NPPF that relates to the application of the sequential test.





Appendix A Parameters Plan and Illustrative Masterplan

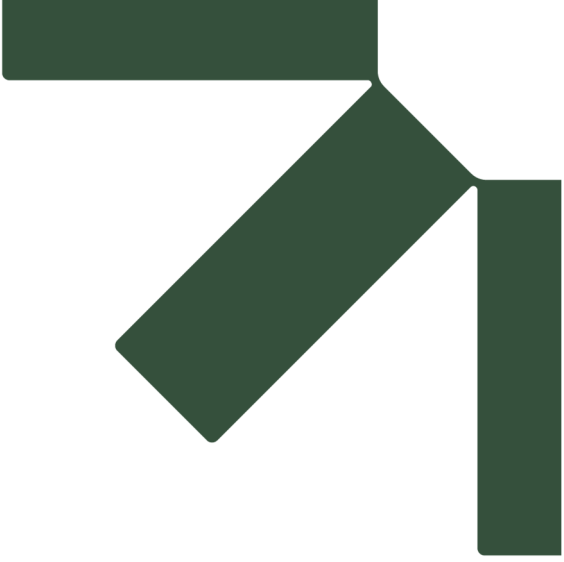
Flood Risk Assessment and Drainage Strategy

Land East of Lodge Road, Hurst

Mactaggart and Mickel Strategic Land

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Appendix B Preliminary Drainage Strategy

Flood Risk Assessment and Drainage Strategy

Land East of Lodge Road, Hurst

Mactaggart and Mickel Strategic Land

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Appendix B1. Proposed Drainage Strategy Drawing

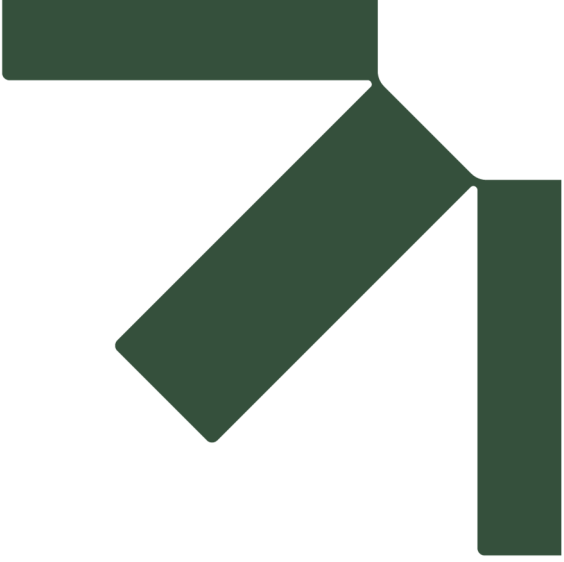
Appendix B2. Catchment Plan

Appendix B3. Proposed Flow Hydraulic Calculations (Network 1 and Network 2)

Appendix B4. Greenfield Runoff Rate Calculation

Appendix B5. 8m Top of Bank Offset.

Appendix B6. Proposed Culvert Crossing



Appendix C Background Information

Flood Risk Assessment and Drainage Strategy

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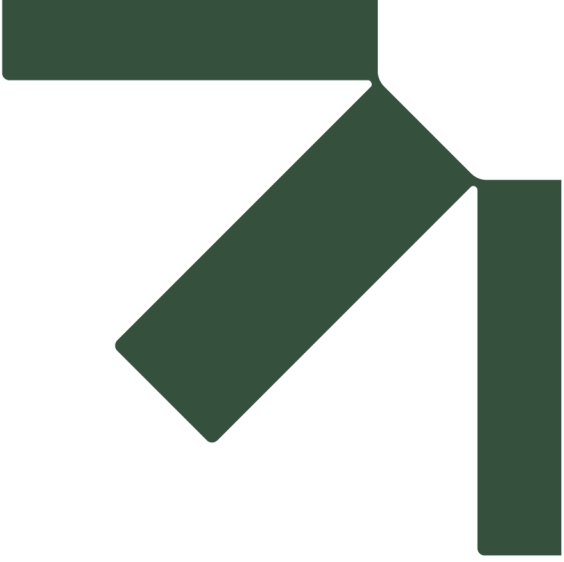
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Appendix C1. Thames Water Public Sewer Records

Appendix C2. Existing Topographical Survey

Appendix C3. Site Visit Note

Appendix C4. EA Planning Response



Appendix D Flood Risk Modelling Report Rev 04

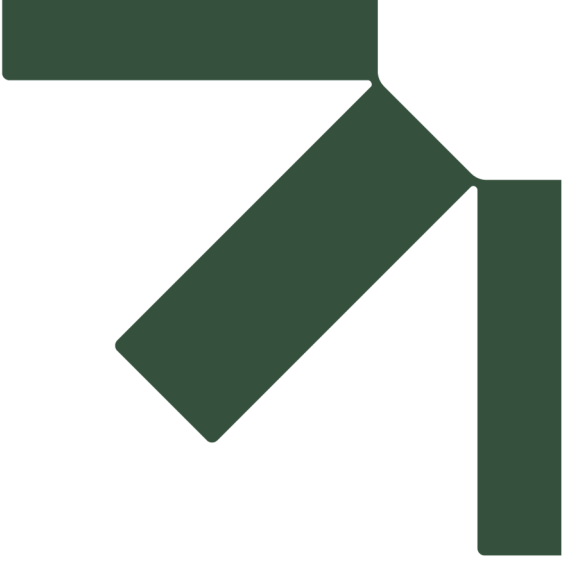
Flood Risk Assessment and Drainage Strategy

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Appendix E Hydrology Report

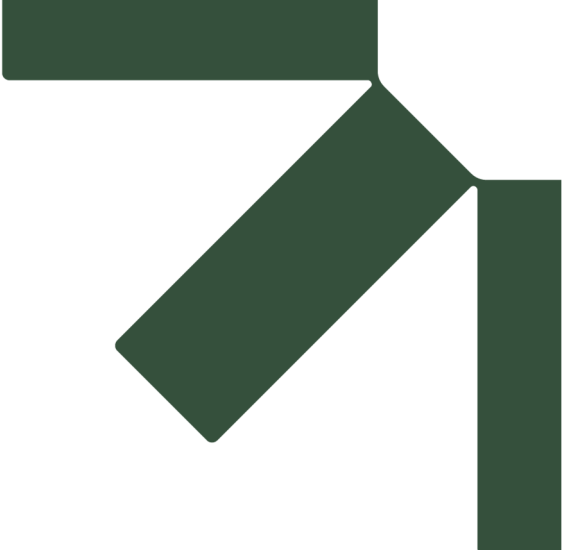
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Appendix F Figures

Flood Risk Assessment and Drainage Strategy

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Making Sustainability Happen