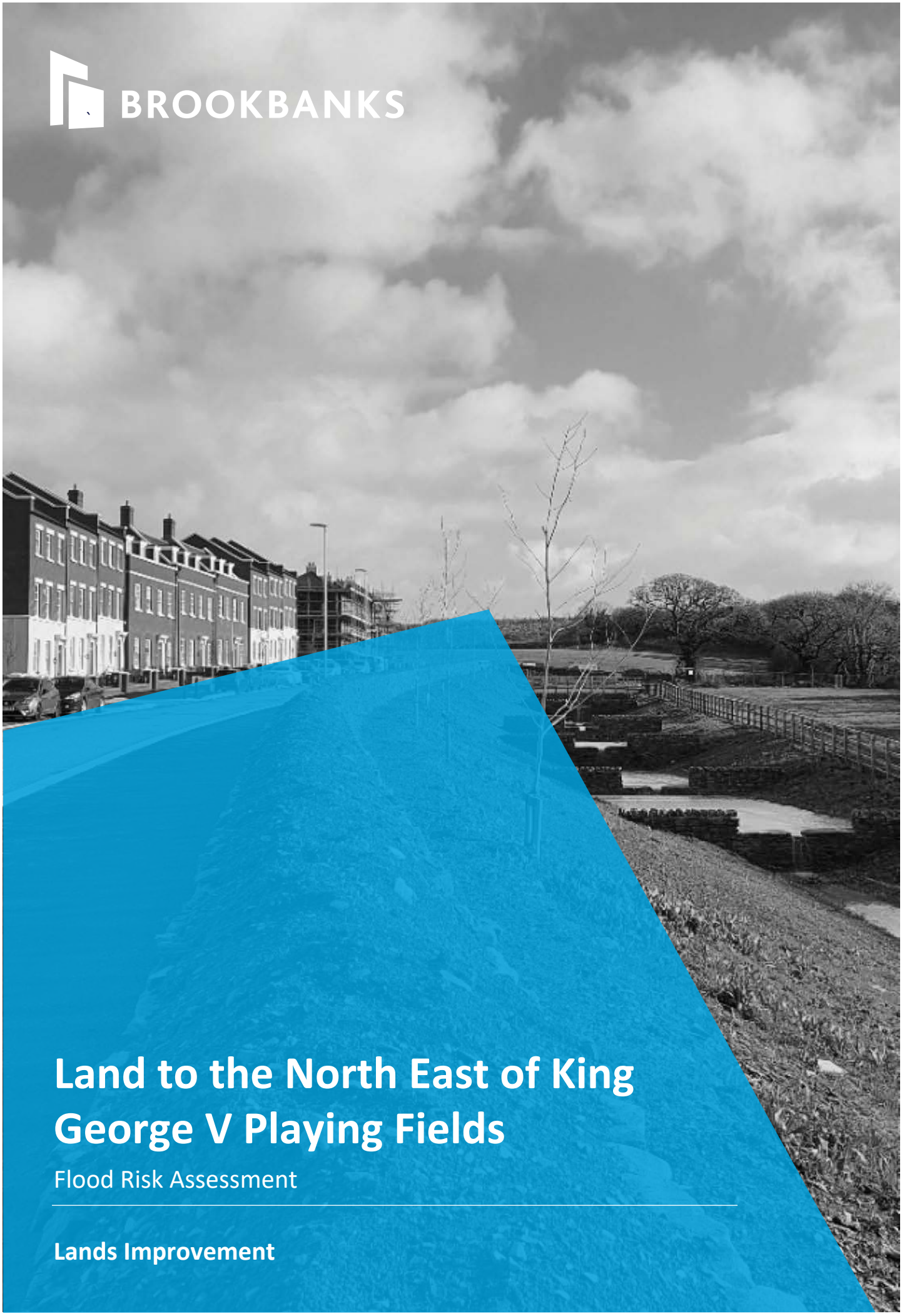
BROOKBANKS



Land to the North East of King George V Playing Fields

Flood Risk Assessment

Lands Improvement

Document Control Sheet

Document Title	Flood Risk Assessment
Document Ref	10710 FRA01 Rv0
Project Name	Land to the North East of King George V Playing Fields
Project Number	10710
Client	Lands Improvement

Document Status

Rev	Issue Status	Prepared / Date	Checked / Date	Approved / Date
0	Final	AM 26.01.21	SM 29.01.21	RM 16.02.21

Issue Record

Name / Date & Revision	01.02.21	16.02.21				
Lands Improvement	-	0				
Marrons Planning	-	0				

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1 Introduction

1.1 Brookbanks is appointed by Lands Improvement to complete a Flood Risk Assessment (FRA) for a proposed residential development for up to 121 dwellings on land to the north east of King George V Playing Fields, hereafter referred to as the Site.

1.2 The objective of the study is to demonstrate the development proposals are acceptable from a flooding risk and drainage viewpoint.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Surface water drainage
- Foul water drainage

2 Background Information

Location and Details

2.1 The Site is located to the south of Cuffley, Hertfordshire. The site is 4.89ha in size and is currently in agricultural use. It is bound by existing residential development to the north and north-west; the grounds of Cuffley Primary School also adjoin the Site along its northern boundary. The railway line and Northaw Road East (B156) form strong eastern and western boundaries, respectively. The southern boundary is defined by a mature hedgerow and tree belt lining the Hertfordshire Way footpath. Beyond the footpath to the south west of the Site is King George V Playing Field, which contains three sports pavilions, a recreation area with hard surfaced Multi Use Games Areas (MUGA), sports pitches and a small area of formal play equipment.

2.2 The Site also includes a 0.63ha rectangular parcel of land, in agricultural use, which is located to the south west of King George V Playing Field. Northaw Road East forms the western boundary of the land, beyond which lies a small number of residential properties and buildings associated with agricultural use. Further agricultural land lies to the south whilst tennis courts, sports pavilions and a bowling green are located to the north east and south east of the Site.

2.3 The Site is currently undeveloped, and the land is not thought to have been historically subject to any significant built development.

2.4 The Site location and boundary is shown indicatively on **Figure 2-1**.

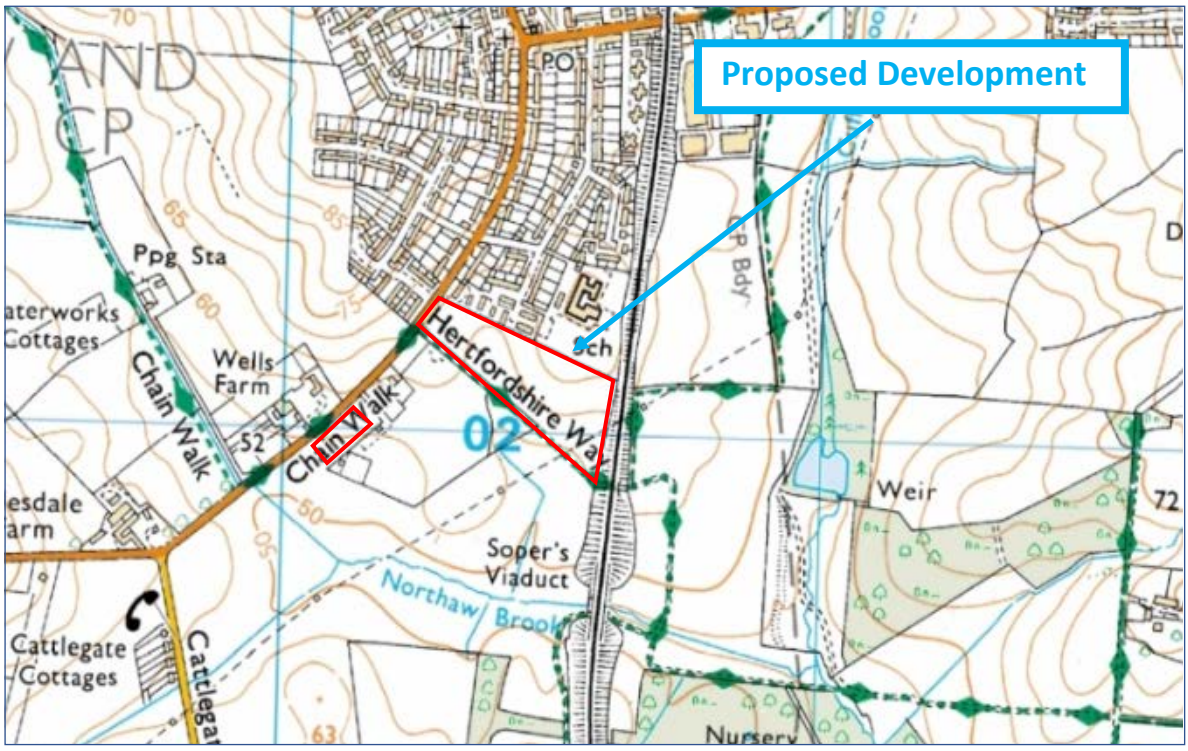


Figure 2-1: Site Location

Development Criteria

2.5 The following development is proposed at the site:

"Residential development of up to 121 dwellings, associated infrastructure and a change of use from agricultural land to an extension of the King George V playing fields. All matters reserved except for the new vehicular access to serve the site, the provision of surface water discharge points and the levels of the development platforms".

Sources of Information

2.6 The following bodies have been consulted while completing the study:

- Thames Water - Surface & foul water drainage
- Environment Agency - Flood risk and storm drainage
- Hertfordshire County Council LLFA - Flood risk, drainage and associated policy

2.7 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- Level 1 & 2 Strategic Flood Risk Assessment - Welwyn Hatfield Borough Council

3 Baseline Conditions

Topography & Site Survey

3.1 Topography across the Site is characterised by moderate gradients falling in a south easterly direction from a localised high point of approximately 69.11m AOD. Higher ground levels are shown in the north, adjacent to the existing school and residential properties along South Drive.

3.2 A topographical survey of the Site was carried out in August 2014, the plans of which are included within **Appendix A.**

Geology & Hydrogeology

3.3 With reference to the British Geological Survey map, the Site is shown to be underlain by bedrock geology comprising clay, silt and sand belonging to the London Clay Formation. Areas of superficial deposits identified on the Site comprise sand and gravel, belonging to the Dollis Hill Gravel Member.

3.4 The Sites rectangular parcel to the south-west is shown to comprise clay, silt and sand belonging to the Lambeth Group.

3.5 The published site geology is illustrated on **Figure 3-1**.

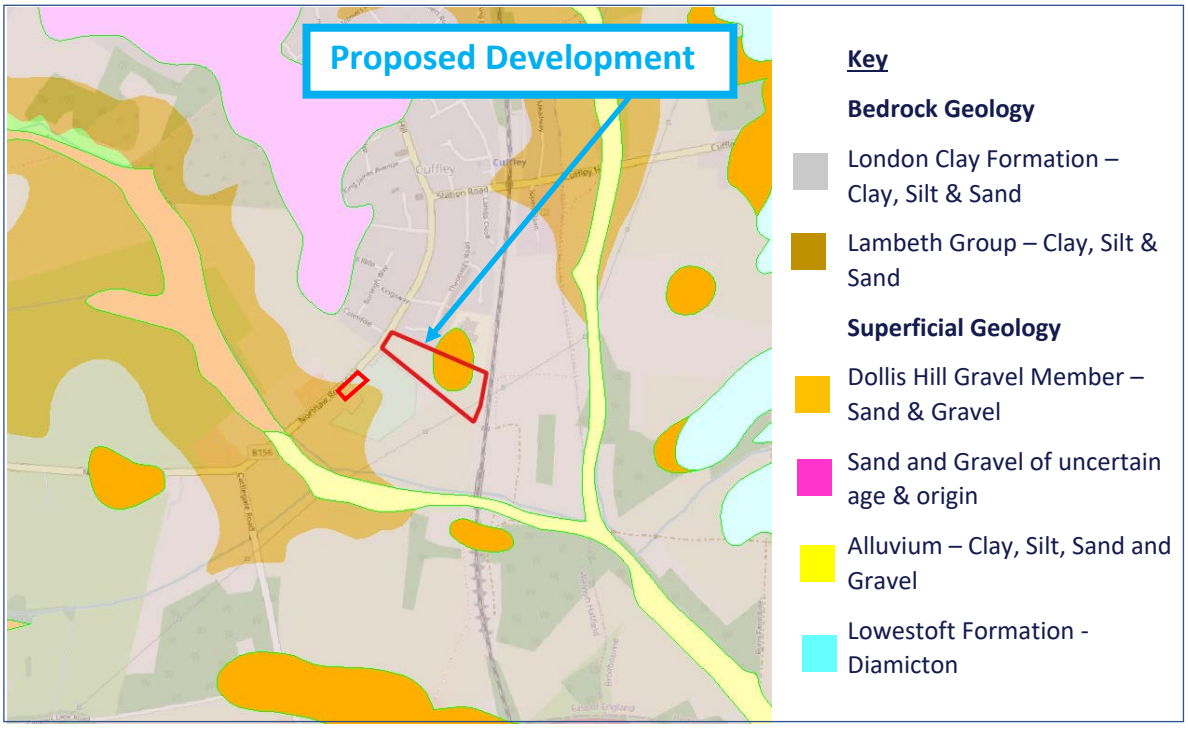


Figure 3-1: BGS Published Geology

3.6 The underlying bedrock geology forms an unproductive aquifer across the whole site and the superficial deposits form an unproductive aquifer (**Figure 3-2**).

3.7 The EA provides the following definitions for Aquifers:

Unproductive Strata *- These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.*

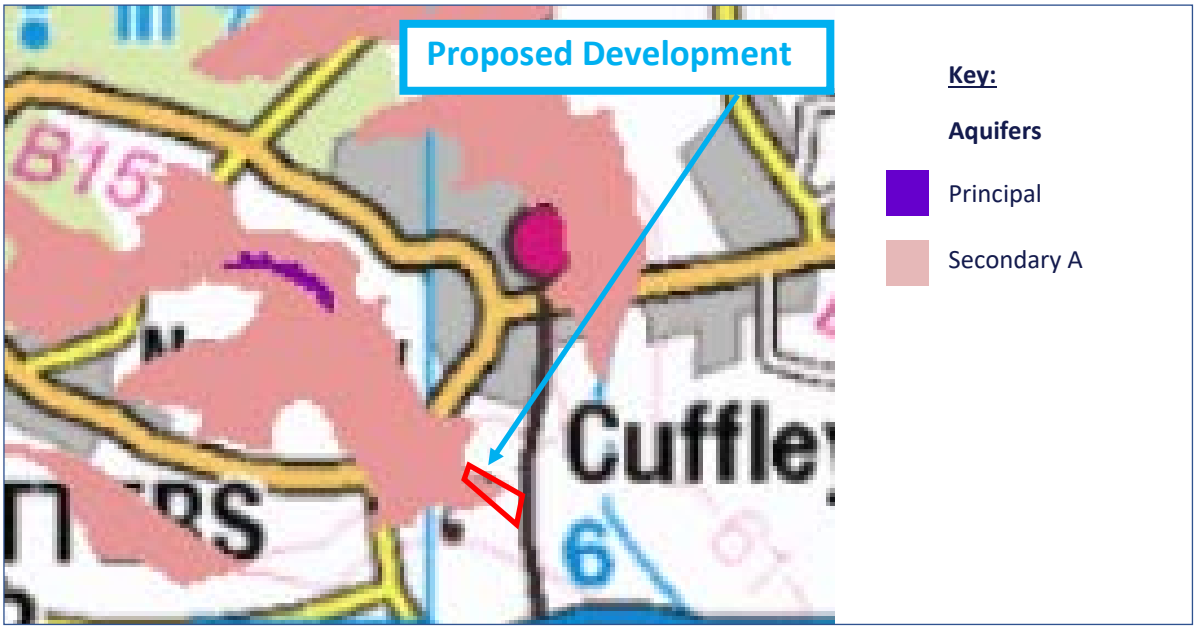


Figure 3-2: EA Aquifer Map

3.8 The EA Groundwater Vulnerability Zones (GVZ) Mapping summarises the overall risk to groundwater, taking into account groundwater vulnerability, the types of aquifer present (superficial and/or bedrock) and their designation status, as discussed previously.

3.9 The site is shown (**Figure 3-3**) to be situated within an 'Unproductive' and 'Low' aquifer, in terms of groundwater vulnerability.

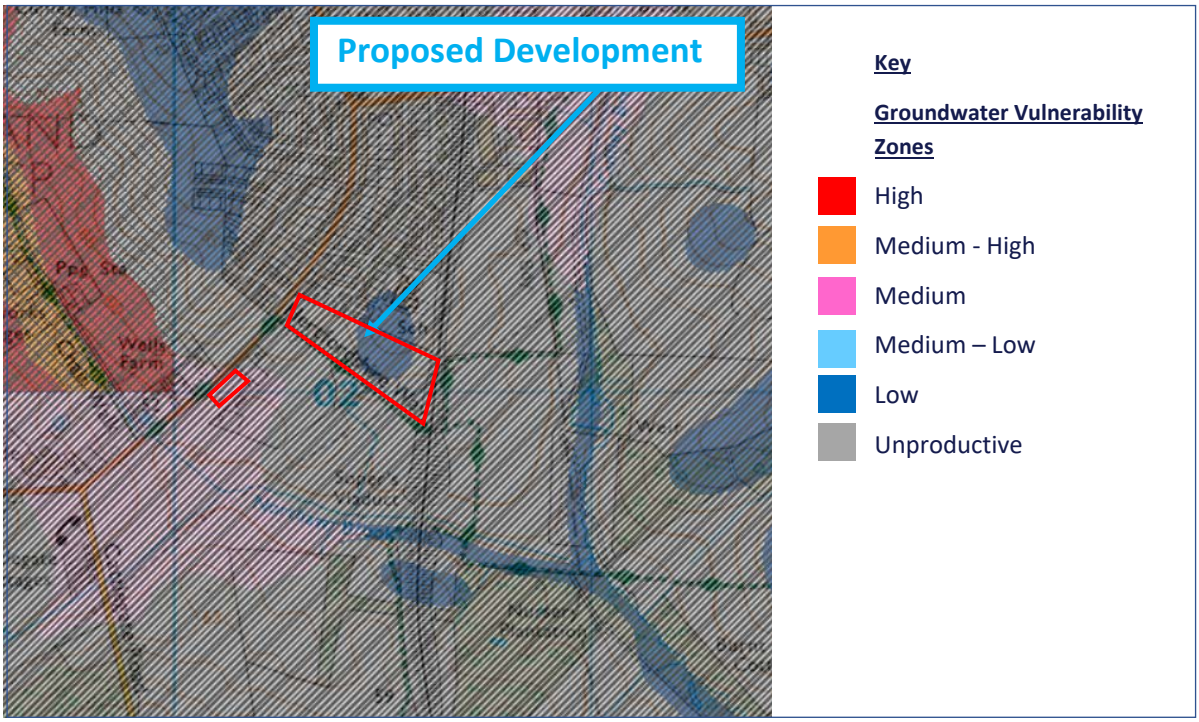


Figure 3-3: EA Groundwater Vulnerability Zones Map

3.10 The EA provides the following definition for the underlying GVZ:

Low *- these are low priority groundwater resources that have a high degree of natural protection. This reduces their overall risk of pollution from surface activities. However, activities in these areas may be a risk to surface water due to increased run-off from lower permeability soils and near-surface deposits. Activities in these areas should be adequately managed.*

Drainage Network and FEH Catchment Data

3.11 Reference to the online Flood Estimation Handbook shows the Site to be surrounded by the Cuffley Brook at the East and the Northaw Brook at the south.

3.12 The River Lee is situated approximately 6.5km to the east of the Site boundary. The following watercourses form part of the River Lee-Stort/Thames catchment area: Northaw Brook situated approximately 225m to the south, Hempshill Brook located 400m to the west and Cuffley Brook approximately 425m to the east.

3.13 Along the southern boundary of the Site a field drain is identified, conveying flows generally in a south easterly direction. Approximately two thirds of the way long the Site boundary the watercourse is culverted under the track and flows southerly to meet the watercourse discussed in paragraph 3.12 above.

3.14 With reference to the Flood Estimation Handbook CD dataset V3 the Site is shown to lie within the immediate catchment of Northaw Brook. Having an URBEXT2000 value of 0.0215 the catchment can be described as "essentially rural".

3.15 **Figure 3-4** below illustrates the watercourses and feature described above.

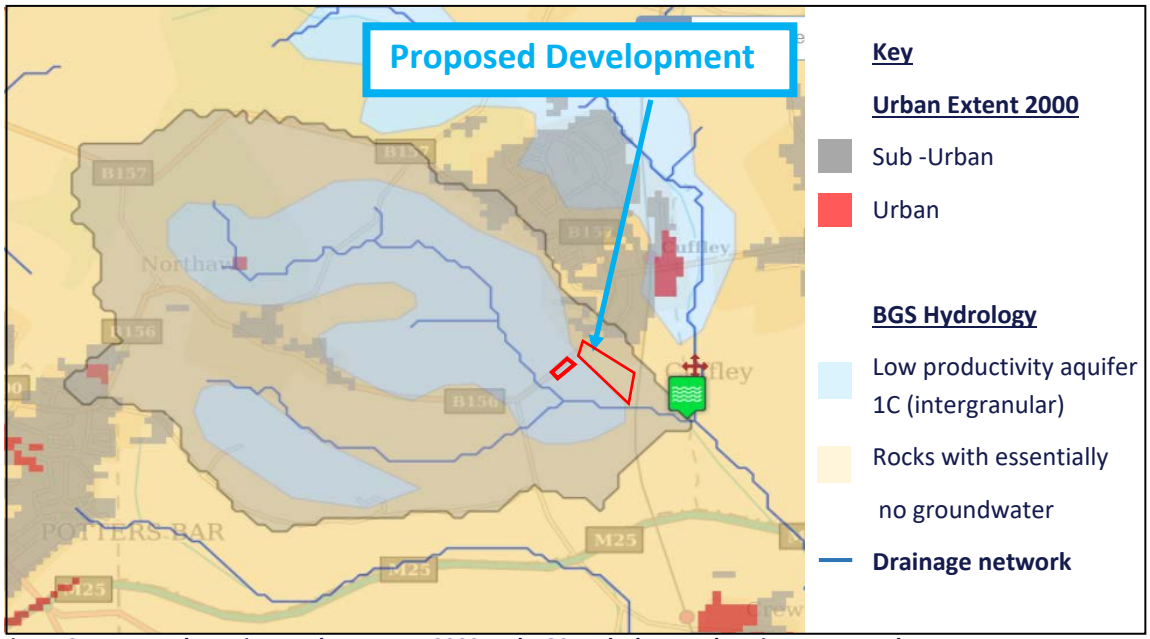


Figure 3-4: FEH web service – Urban Extent 2000 and BGS Hydrology and Drainage Network

3.16 In addition, a site walkover carried out in 2014 shows the presence of a ditch approximately 75m to the south of the Sites boundary. Surface water flows from this ditch are directed southwards into Northaw Brook which flows eastwards into Cuffley Brook (a tributary of the River Lee).

4 Planning Policy

National Planning Policy

4.1 The National Planning Policy Framework (NPPF), updated in February 2019, sets out Governmental Policy on a range of matters, including Development and Flood Risk. The policies were largely carried over from the former PPS25: Development & Flood Risk, albeit with certain simplification. The allocation of development sites and local planning authorities' development control decisions must be considered against a risk-based search sequence, as provided by the document.

4.2 Allocation and planning of development must be considered against a risk-based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows in **Table 4-1.**

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Table 4-1: NPPF Flood Risk Parameters

4.3 The Guidance states that Planning Authorities should "apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."

4.4 According to the NPPF guidance, residential development at the proposed site, being designated as "More Vulnerable" classifications, should lie outside the envelope of the predicted 1 in 100-year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year events and within Flood Zone 1.

4.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test", the site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits.
- The development will be safe, not increase flood risk and where possible reduce flood risk.

Regional & Local Policy

4.6 Cuffley lies within the Borough of Welwyn Hatfield in Hertfordshire, in which Hertfordshire County Council (HCC) is the Lead Local Flood Authority (LLFA).

4.7 A **Preliminary Flood Risk Assessment** (PFRA) was produced in 2011 by HCC. The PFRA identifies flood risk from local flood sources and extreme events occurrence. Indicative Flood Risk Areas consist of an area where flood risk is most concentrated, and over 30,000 people are predicted to be at risk of flooding.

4.8 In Hertfordshire in one of the most densely populated counties and approximately 53,400 properties are at risk of surface water flooding in which 3,800 are located at Welwyn Hatfield.

4.9 **Regional Flood Risk Assessment:** Published a document in May 2008. The document is a high-level review of flood risk and strategy for Herefordshire. In this document, concerns over the effects of flood risk and potential of climate change are identified across the Eastern of England.

4.10 As with many RFRA's, this document outlines the broad understanding of flooding risk across areas of potential higher growth however makes no specific reference to the proposed site at Cuffley.

4.11 **Strategic Flood Risk Assessment**: To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Plan and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

4.12 Welwyn Hatfield District published their Level 1 and 2 Strategic Flood Risk Assessment in May 2016. The document generally underpins national guidance and provides recommendations to developers with regards to SuDS and design which will be explored further in this report under the Storm Drainage section.

4.13 The SFRA identifies no major flooding risk within the site boundaries.

4.14 The proposed development at Cuffley has been designated within the Strategic Housing Land allocation. The Strategic Housing Land Availability Assessment (SHLAA) states that "the main issues are to ensure that cumulative development does not impact the quantity or quality of water received by the Hemphill Brook or Cuffley Brook. This is especially important as water from this location would pass into the Broxbourne Borough Council's administrative area."

4.15 The SFRA also recommend for developments in Flood Zone 1, that is not a significant constraint to development within the FZ1. However, there are a number of locations where flooding from ordinary watercourses or drains are not shown in EA maps and this should be reviewed and assesses as appropriate. Therefore:

- A FRA is required for all developments over 1 ha.
- Reference should be made to the Local Flood Risk Management Strategy and consideration given to requirements for the management of local flood risk.

4.16 The guidance generally promotes good practice methodology in line with the more current SFRA's and Water Management SPD's. As such, the development proposals contained in this FRA are in full compliance with the Local Plan.

4.17 Hertfordshire County Council published the **Local Flood Risk Management Strategy** (LFRMS) in February 2019. The LFRMS offers Guiding Principals in managing flood risk and a structure of managing strategy, in addition to that provided in the SFRA.

4.18 The LFRMS outlines local flood risk, description of historic flood impacts and potential future flood risk in Herefordshire.

4.19 The LFRMS outlines 6 key principles that are used for flood risk management in Hertfordshire. These principles are:

- Taking a risk-based approach to local flood risk management
- Working in partnership to manage flood risk in the county.
- Improving our understanding of flood risk to better inform decision making.
- Supporting those at risk of flooding to manage that risk.
- Working to reduce the likelihood of flooding where possible.
- Ensuring that flood risk arising from new development is managed.

4.20 The Local Flood Risk Management Strategy Policies relevant to the development site are outlined below:

- **Policy 13**: Discharge hierarchy for SuDS
- **Policy 14**: Runoff rates for greenfield sites

- **Policy 18:** SuDS to be designed at or near the surface.
- **Policy 20**: SuDS to have a design life compatible with the development and to include a management and maintenance plan.
- **Policy 21**: SuDS to have wider benefits.

4.21 The policies detailed above will be delivered through a series of local measures and actions.

4.22 **Catchment Flood Management Plans**: A Catchment Flood Management Plan (CFMP) is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

4.23 The Thames Catchment Flood Management Plan (December 2009) outlines that the local authority of Welwyn Hatfield has between 100 to 250 properties with annual probability of river flood of 1%.

4.24 The Thames CFMP identifies the following key flooding characteristic of WHBC:

- The Lee and its tributaries are a fluvial river system.
- The centre of this district is urbanised and development is generally set back from the river;
- The north west and eastern corner of the catchment is predominantly rural;
- The main river crossing through WHBC is the River Lee. The Mimram drains the north of this borough and the Colne the southern corner;
- The rivers in district are relatively natural.

4.25 And states the flood risk in the tributaries consist of:

- Overtopping of river banks.
- Overflow of surface water drains.
- Rapid surface water runoff from urban areas.
- In-channel blockages and constrictions.
- Possible foul and groundwater flood risk problems.

4.26 The Site is shown to be situated within the Sub-area 5 "Urbanized places with some flood defences" which the vision and preferred policy is as follows:

*"**Policy 6**: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.*

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists) but would only be implemented in specific locations within the area, after more detailed appraisal and consultation."

4.27 **Development Flood Risk Assessment:** At a local site by site level, the NPPF and guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). The NPPF requires that developments covering an area of greater than one hectare prepare a FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

4.28 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

5 Flood Risk

Flood Mechanisms

5.1 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified as follows in **Table 5-1**.

Mechanisms	Potential	Comment
Fluvial	N	No major watercourses lie within an influencing distance of the proposed development. A land drain is situated approximately 75m to the south of the site boundary.
Coastal & Tidal	N	No tidal watercourses lie within an influencing distance of the proposed development.
Overland Flow (Pluvial)	Y	The risk of overland flow relates primarily to the developed land to the north of the site, existing site topography and a land drain to the south of the site.
Groundwater	N	Geology underlying the site is of a potentially low permeability. No groundwater flooding was identified within the SFRA and therefore the risk of same is considered low.
Sewers	Y	An adopted foul sewer is present within the site boundary however Thames Water report of no problems in their adjacent network.
Reservoirs, Canals etc	N	No artificial sources lie within an influencing distance of the proposed development.

Table 5-1: Flooding Mechanisms

5.2 Where potential risks are identified in **Table 5-1**, above, more detailed assessments have been completed and are outlined and discussed further within the following sections.

Fluvial Flooding

5.3 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

5.4 The following watercourses form part of the River Lee-Stort/Thames catchment and are within proximity of the Site:

- Northaw Brook situated approximately 225m to the south,
- Hempshill Brook located 400m to the west, and
- Cuffley Brook approximately 425m to the east.

5.5 The nearest surface water feature to the Site is a land drain situated approximately 75m to the south. Surface water flows are directed into Northaw Brook which flows into Cuffley Brook, a tributary of the River Lee.

5.6 The mapping below on **Figure 5-1** shows that the site to lies within Flood Zone 1; being an area of Low

Probability of flooding less than 1 in 1000yr.

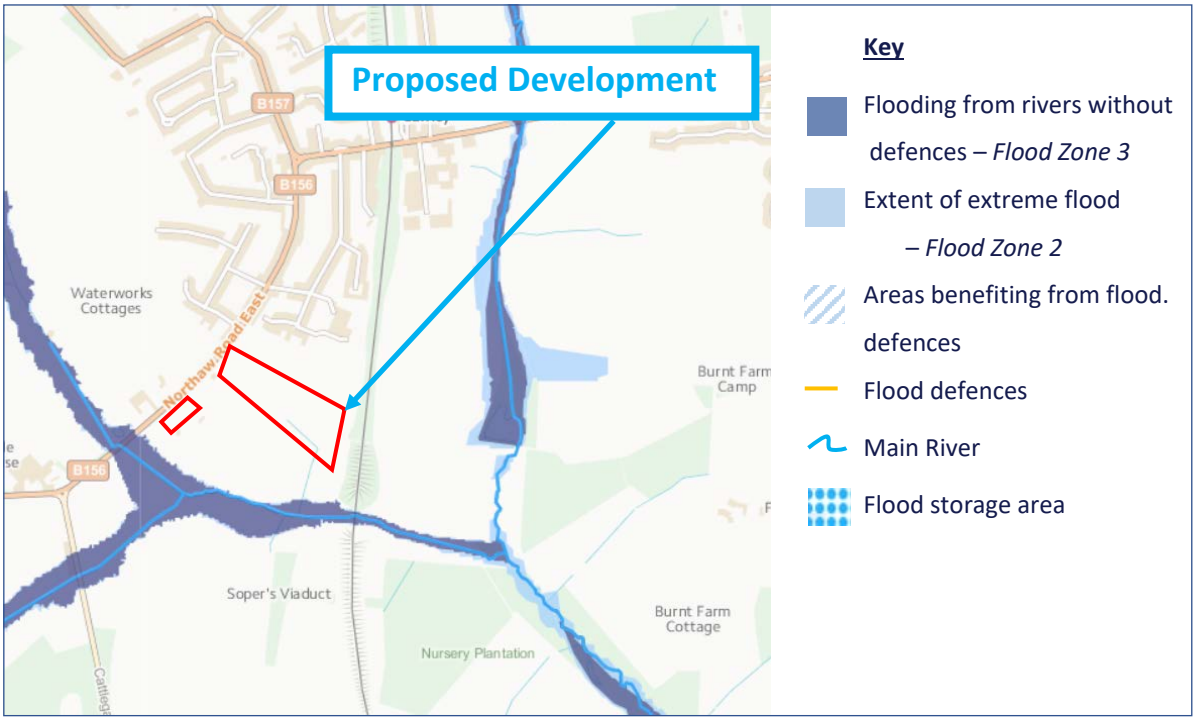


Figure 5-1: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000-year floodplains

5.7 Site inspection evidence in relation to the length of drain to the south of the Site provides no suggestion of fluvial flooding, which given the characteristics of the feature and the localised rural catchment is to be expected.

Coastal Flooding

5.8 The site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no risk of tidal or coastal flooding at this location.

Overland Flow (Pluvial)

5.9 Overland flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage systems in paved areas to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

5.10 The Environment Agency, in partnership with lead local flood authorities, produced a series of surface water flood maps for many parts of the UK.

5.11 **Figure 5-2**, illustrates areas of low to high risk from surface water flooding:

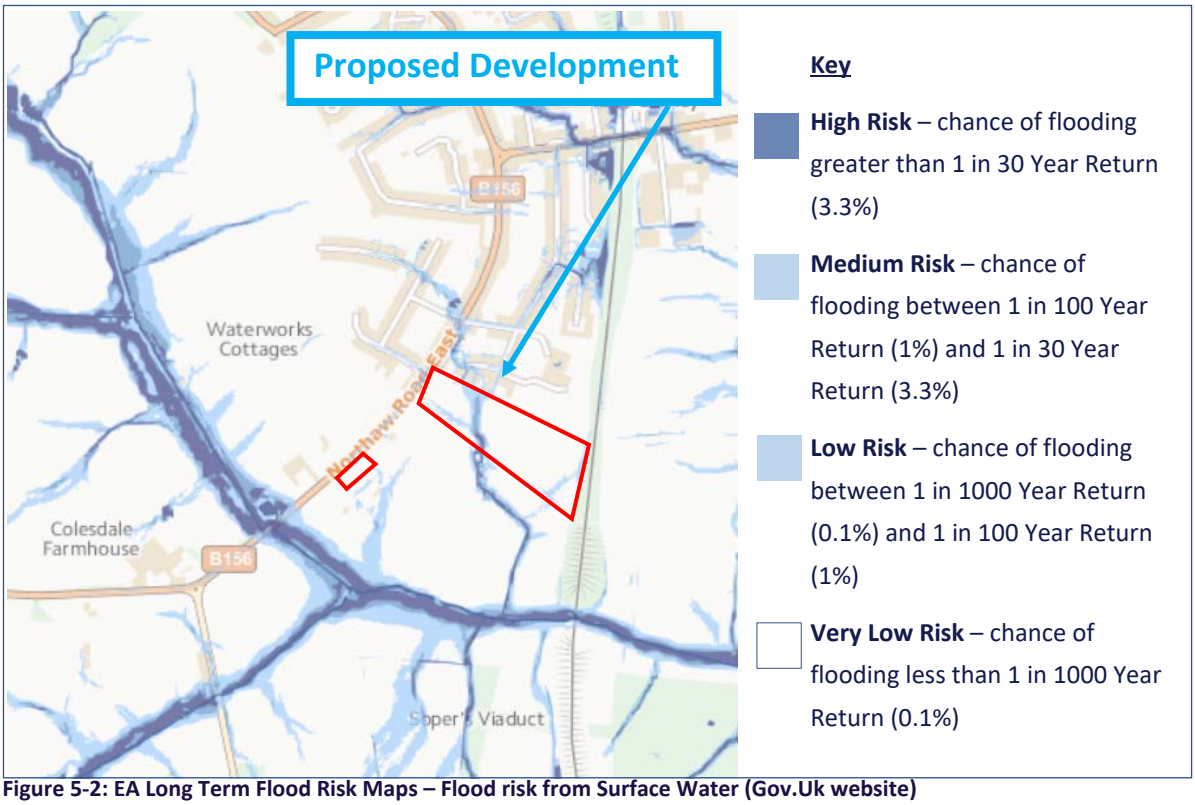


Figure 5-2: EA Long Term Flood Risk Maps – Flood risk from Surface Water (Gov.Uk website)

5.12 The mapping provided by the EA identifies a small area of surface water flooding within the Site boundary, as a result of runoff from the built development to the north of the Site. The surface water flooding is shown to follow the topography of the Site towards the ditch to the south which flows into Northaw Brook. The majority of the proposed development will be directed within areas that potentially have a very low risk of flooding from surface water.

5.13 Initial investigations suggest that the risk of overland flow relates primarily to the topography of the site; low areas of the site naturally store water limiting the surface runoff in concentrated areas. As part of the development, the topography will be altered, providing a rationalised surface for water runoff.

5.14 The following figures are extracts from the SFRA and are based on additional information obtained from Hertfordshire Highways flooding database. **Figure 5-3** shows there to be a low frequency of flooding events along the roads adjacent to the west and north of the Site.

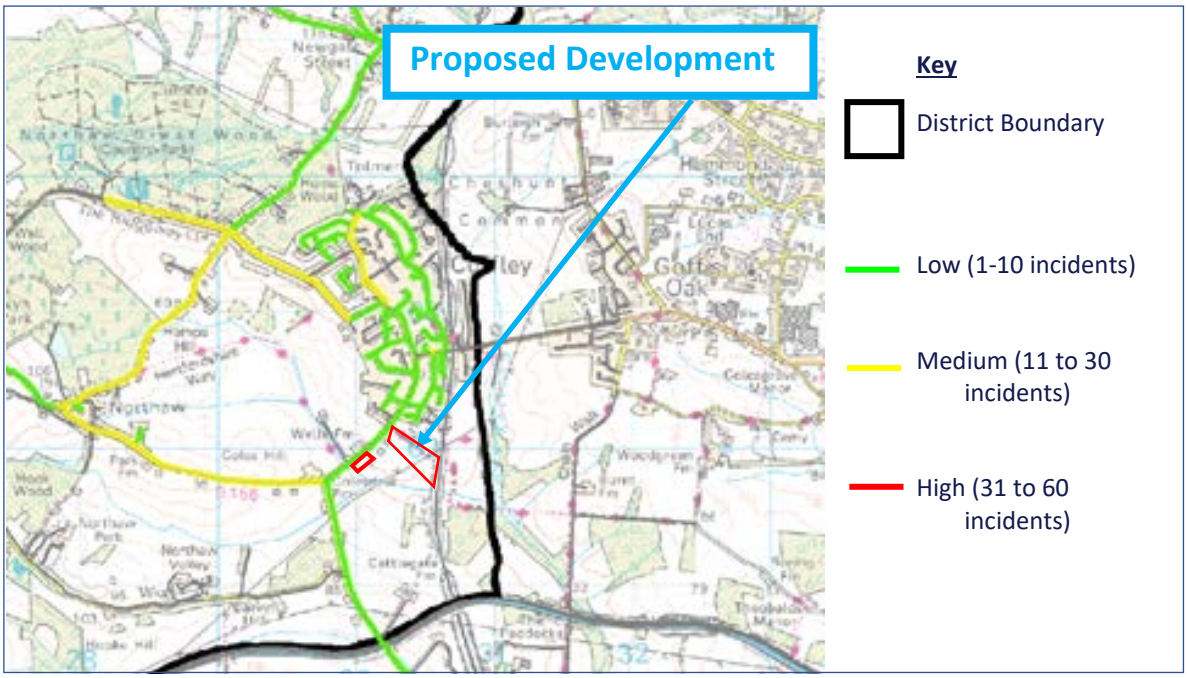


Figure 5-3: Frequency of Road Flooding Events

5.15 **Figure 5-4** shows there to be a low frequency of flooding events along Northaw Road West and Cattlegate Road, to the south-west of the Site.

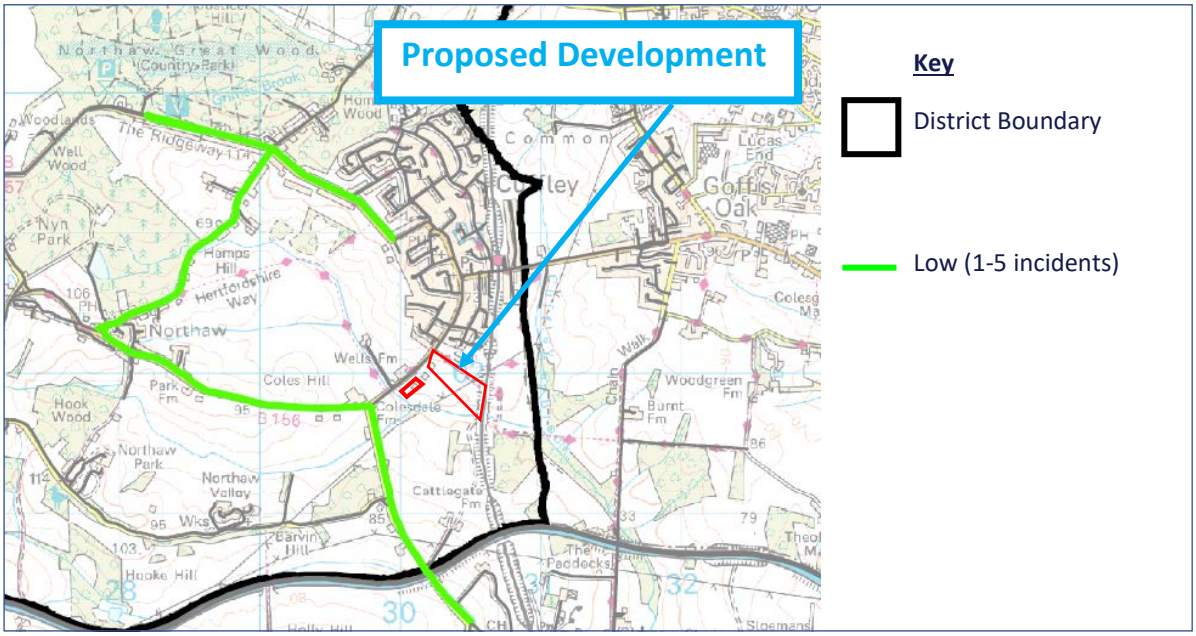


Figure 5-4: Flooding Frequency Ditch Problems

5.16 **Figure 5-5** shows there to be a low frequency of flooding events due to blocked gullies, along the adjacent roads to the north and west of the Site.

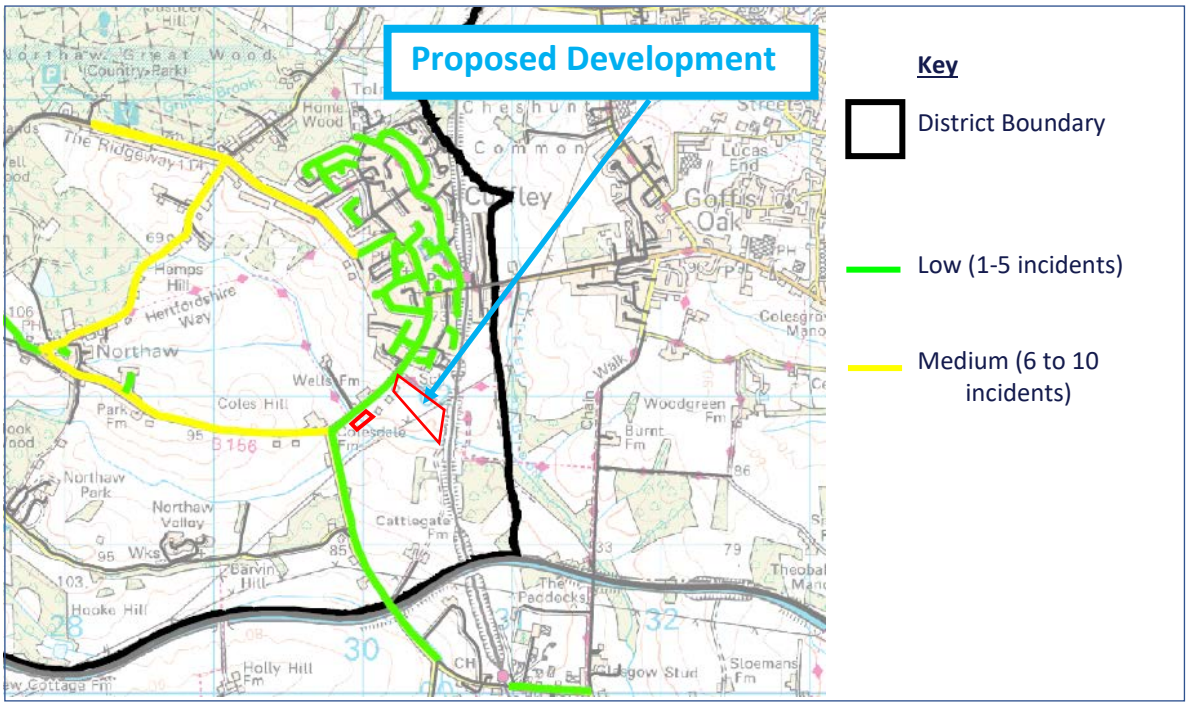


Figure 5-5: Flood Frequency Blocked Gully

5.17 **Figure 5-6** shows there to be a low frequency of flooding events to footways to the north the Site.

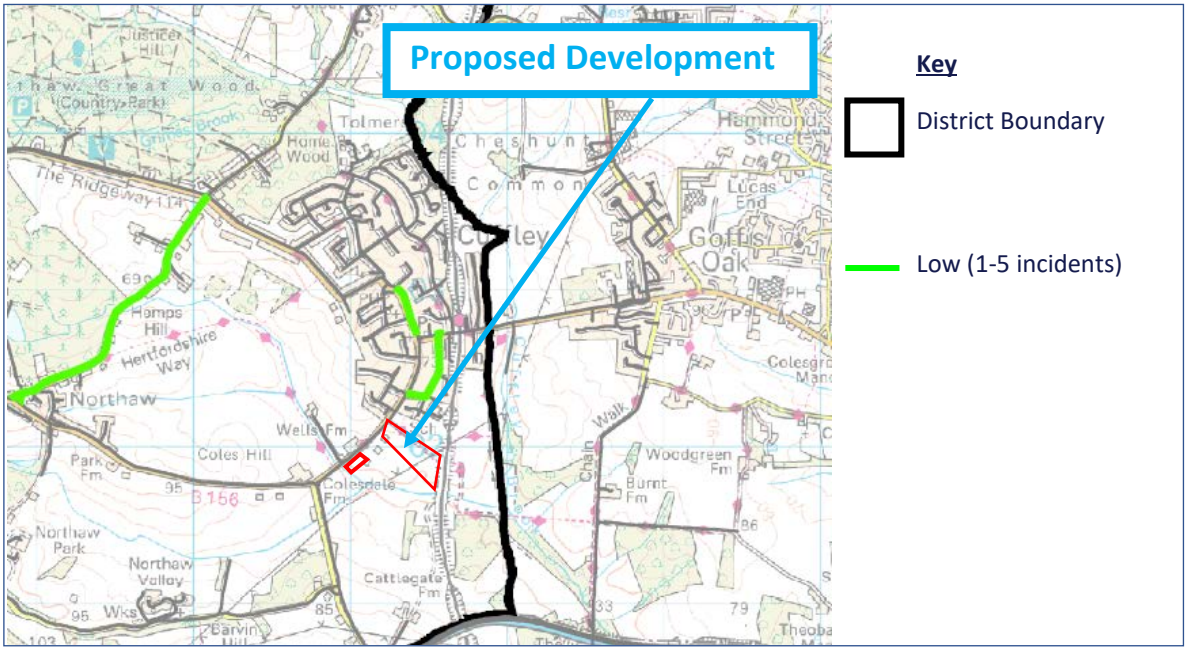


Figure 5-6: Flooding Frequency Footway Flooded

5.18 Figure 5-7 shows there to be a low frequency of reported property damage to the north and west of the Site.

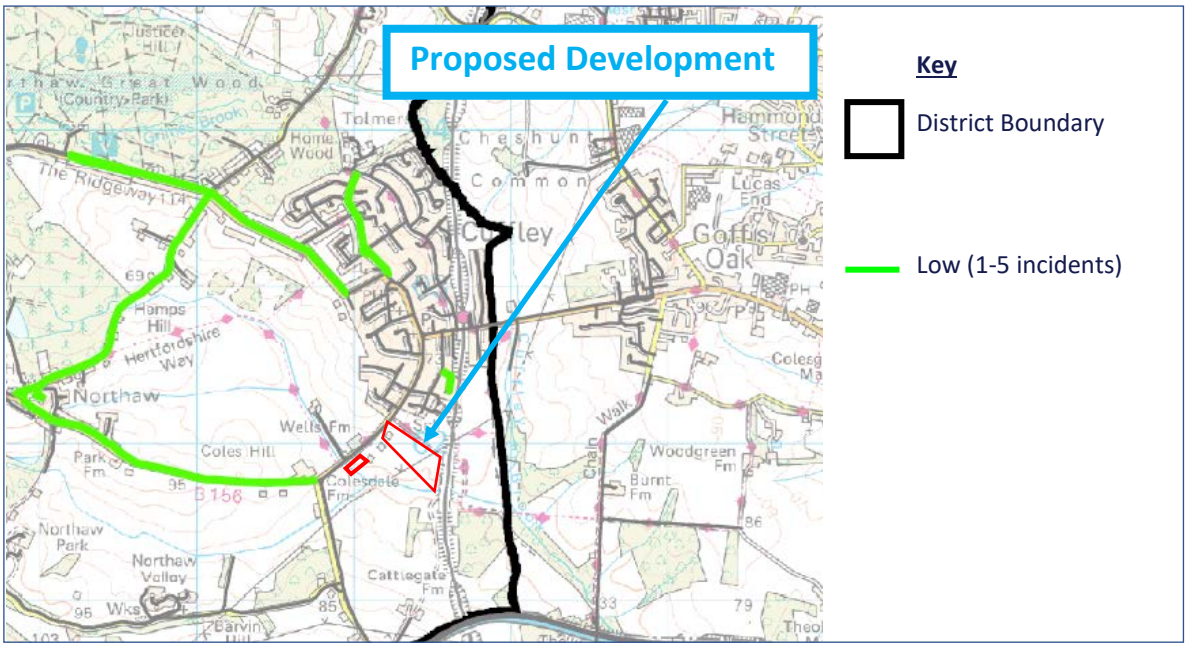


Figure 5-7: Flooding Frequency Property Damage

5.19 Recognising the risk of overland flow mechanisms, published guidance in the form of the Design and Construction Guidance for Foul and Surface Water Sewers and the Environment Agency document Improving the Flood Performance of New Buildings: Flood Resilient Construction et al advocate the design of developments that implement infrastructure routes through the development that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors.

5.20 Further to protect the Proposed Development, current good practice measures defined by guidance will be incorporated. However, given the nature of the development this is unlikely to be onerous or to have any material effect on layout.

5.21 Given the baseline site characteristics and further mitigating measures to be implemented residual flood risk from an overland flow mechanism is considered of a low probability.

Groundwater

5.22 Groundwater flooding is characterised by low-lying areas often associated with shallow unconsolidated sedimentary aquifers which overly non-aquifers. These aquifers are reported to be susceptible to flooding, especially during the winter months, due to limited storage capacity.

5.23 Groundwater related flooding is fortunately quite rare, although where flooding is present, persistent issues can arise that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen effect on the local geology or hydrogeology.

5.24 GEG have undertaken Site investigations in 2014 and have presented the findings in the Phase II Geo-Environmental Assessment dated June 2015 ref GEG-14. Groundwater monitoring was carried out in October and November 2014. The investigation found that groundwater was not encountered in the majority of the exploratory holes during the investigation with the exception of an isolated slow seepage in a trial pit within the centre of the site. Monitoring revealed that groundwater was encountered at depths of 1.15m to 3.47m

5.25 Hertfordshire have advised in their preapplication advice that they have no record of groundwater flooding incidents in the vicinity of the site.

5.26 Positive drainage systems incorporated into the proposed development will further reduce the risk as a result

of permeable pipe bedding materials and filter drains incorporated within elements of the built development.

5.27 Given the baseline Site characteristics (clay geology and a Non-Aquifer) and further mitigating measures to be implemented, residual flood risk from a ground water mechanism is considered to be a low probability.

Sewerage Systems

5.28 Flooding related to sewerage systems is a result of there being insufficient capacity within an existing sewerage system (combined and surface water sewers) or from there being a blockage within the system.

5.29 Investigations with Thames Water provide no evidence of present or historic sewer flooding at the Site.

5.30 The SFRA produced by Welwyn Hatfield Borough Council further reviewed sewer records from Thames Water by accessing their DG5 Asset Register. It resulted in inadequate data which the EA advised to ignore as being a source of flooding in the SFRA.

5.31 Positive drainage measures incorporated on site, coupled with sustainable drainage systems (SuDS) will ensure that no increase in surface water will result from the site. Flood risk associated with sewer flooding is therefore considered to be a low probability.

Artificial Water Bodies - Reservoirs & Canals

5.32 Non-natural or artificial sources of flooding comprises of reservoirs, canals and lakes where water is retained above the natural ground level. However unlikely, reservoirs, canals and other artificial sources have a potential to cause flooding due to the release of large volumes of water, resulting from a dam or bank failure.

5.33 The Environment Agency has produced mapping to indicate a worst-case scenario of flooding that would be caused, as a result of unlikely structural failure or damage of a reservoir.

5.34 The mapping indicates that the Site lies a distance from any risk of Reservoir flooding.

Figure 5-8: EA Long Term Flood Risk Maps – Flood risk from Reservoirs (Gov.Uk website)

Summary

5.35 In terms of fluvial and tidal flood risk, the proposed development can be seen to lie within Flood Zone 1, and hence has a low probability of flooding from this mechanism.

5.36 Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

5.37 Accordingly, the proposed development land is in a preferable location for residential development when appraised in accordance with the NPPF Sequential Test and local policy. The Site should be considered preferable to other potential developments that may lie wholly within Flood Zone 2 or Flood Zone 3.

Objectives

5.38 The key development objectives that are recommended in relation to flooding are:

- Work collaboratively with the LLFA and Environment Agency to identify potential flooding.
- Compliance with the Design and Construction Guidance for Foul and Surface Water Sewers and EA guidance in relation to flood routing through the Proposed Development in the event of sewer blockages.

6 Surface Water Drainage

Surface Water Drainage, SuDS and Flood Mitigation Parameters

6.1 Brookbanks have consulted Hertfordshire Lead Local Flood Authority through the pre-application process. A virtual meeting was held in November 2020 with details confirmed in a Surface Water Advisory Note dated 14 December 2020 included as **Appendix B.** The appendix also includes correspondence from the EA providing no objection to the proposals.

6.2 The proposed drainage strategy options are presented in Brookbanks drawings **10710-DR-01** and **10710-DR-02** included as **Appendix A.**

6.3 The drainage strategy has been divided into two catchment areas to mimic the existing situation as closely as possible.

6.4 The following paragraphs detail the principles of the surface water drainage strategy.

Existing Drainage

6.5 To understand the baseline provision for surface water drainage in the area, a copy of the Thames Water sewerage network records has been obtained. Correspondence from Thames Water . Public surface water sewers are present within the residential areas to the north of the proposed development.

6.6 The Site is presently not serviced by a positive surface water drainage network. It is believed that surface water runoff currently discharges to the drainage ditch to the south of the Site which flows into Northaw Brook.

Drainage Options

6.7 Current guidance[1] requires that new developments implement means of storm water control, known as SuDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of surface water runoff.

6.8 It is proposed to implement a SuDS scheme consistent with local and national policy at the proposed development.

6.9 When appraising suitable surface water discharge options for a development site, Part H of the Building Regulations 2002 (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

b) a watercourse; or where that is not reasonably practicable,

[1] NPPF, CIRIA C522, C609, C753 et al.

c) a sewer. "

6.10 Dealing with the search order in sequence:

Infiltration

6.11 Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of same can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

6.12 Infiltration testing was undertaken in accordance with BRE Digest 365 as part of the Site Investigation Works undertaken in 2014 and reported in GEG Phase 2 Interpretative Report ref GEG-14-1356 dated June 2015.

6.13 As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such. Site ground investigations specific to flood risk have confirmed that the underlying geology is unsuitable for a wholly infiltration-based drainage strategy and as such, source control measures will therefore be primarily restricted to detention and conveyance systems placed close to source by way of measures such as lined permeable pavements and conveyance strips.

6.14 As such, source control measures will therefore be primarily restricted to detention and conveyance systems placed close to source by way of measures such as lined permeable pavements and conveyance strips.

Discharge to watercourse

6.15 Next in the search sequence, defined by Part H, is discharge to a watercourse or suitable receiving water body. Where coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

6.16 The drainage ditch and tributary of Northaw Brook situated approximately 75m to the south of the Site is considered an appropriate receptor for storm water discharge and as such, has the potential to receive flows from the proposed development, once restricted to the pre-existing 'greenfield' rates of run-off.

Discharge to sewer

6.17 Last in the search sequence is discharge to a sewer. In the context of SuDS this is the least preferable scheme as it relies on 'engineered' methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

6.18 The nearest storm water sewer identified in the Thames Water records is located at the junction of Colesdale road and Northaw Road East, to the west of the Site. Another sewer is located to the north of the Site at South Drive.

6.19 The search sequence outlined above indicates that the ditch to the south of the Site is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and detention features to control peak discharges to no greater than the baseline conditions.

6.20 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the Site utilises a multi SuDS system including detention features and where appropriate, source control in the form of porous paving, filter strips and bio retention areas as the primary storm water management scheme.

6.21 Accordingly, two plans showing two conceptual drainage options for the Site are contained within **Appendix A** as drawings **10710-DR-01 and 10710-DR-02.**

6.22 Coupled with the storm water control benefits, the use of SuDS can also provide betterment on water quality. National guidance in the form of CIRIA 753 outlines that by implementing SuDS, surface water from the site

can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology.

Source Control

6.23 At the head of the drainage network, across the Site, source control measures will be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems. As Site specific infiltration testing has confirmed the underlying geology is not suitable for a wholly infiltration-based drainage strategy, source control will be limited to detention type systems, albeit that systems will be unlined and therefore provide for an element of infiltration.

6.24 The common aims of source control are:

- Reduction in peak discharges to the agreed site wide run-off rate from the development areas,
- Provide water quality treatment where appropriate.

6.25 Through work on other similar strategically sized projects, Brookbanks has shown that peak discharges of circa 35% in residential areas can readily be achieved using source control measures without unacceptable impacts on net developable land or prohibitive financial implications.

6.26 Through consultation at outline planning stage, it has been agreed that the nature of source control measures to be implemented will need to remain flexible, providing a 'toolkit' of options to reach an agreed target for peak discharge reduction and water treatment.

6.27 The peak flow calculated to determine the volume of water that needs to be managed and discharged from the site and the 1 in 1 and the 1 in 100 + 40% Climate change return periods that should be considered.

Preliminary Drainage Proposals

6.28 Preliminary assessment of the requirements for storm drainage have been based on the following criteria as shown in **Table 6-1**.

Criteria	Measure/Rate/Factor
Application Site Area	4.89 ha
Developed Area	3.26 ha
Landscaped Area	1.63 ha
Percentage Impermeable Area - Residential	0.55
Sewer design return period[(2)]	1 in 1 year
Sewer flood protection[(2)]	1 in 30 years
Fluvial / Development flood protection [(1)]	1 in 100 years
C (1km)*	-0.025
D1 (1km)*	0.274
D2 (1km)*	0.279

[2] Design and Construction Guidance for Foul and Surface Water Sewers

D3 (1km) *	0.294
E (1km) *	0.322
F (1km)*	2.512
Minimum cover to sewers [1]	1.2 m
Minimum velocity [1]	1.0 m/sec
Pipe ks value [1]	0.6 mm
Allowance for climate change [3]	40%

Table 6-1: Drainage Criteria and Measure

Site Control Detention Basins

6.29 National policy[1] requires that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

"The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data".

6.30 On undeveloped and ungauged catchments of less than 0.5km2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697. This methodology requires that, for catchments of less than 50ha, the IoH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

6.31 The baseline IoH run-off rates are shown on **Table 6-2** below:

Event	IoH 124 (50ha)	IoH 124 Scaled to 1ha
1 in 1 year (l/s)	165.1	3.30
Qbar (l/s)	194.2	3.88
1 in 100 year (l/s)	619.4	12.39

Table 6-2: IoH124 baseline discharge rates

6.32 To determine the permitted rates of run-off from the development, the future impermeable catchment areas must be derived. This has been based on a BCL measured ratio from previous projects. Calculations below show these ratios and areas and how this correlate to the rates of discharge.

[3] NPPF requirements for residential development

6.33 The calculations for this are shown in **Table 6-3** below:

Catchment	Land Use	Developable Area (ha)	Impermeable Area (ha)	Existing 100 Year Run-off (l/s)	Proposed 100 Year Run-off (l/s)
A	Residential	0.27	0.15	1.81	1.8
B	Residential	3	1.65	20.14	4.70
		3.27	**1.8**	**21.95**	**6.5**

Table 6-3: Run-off calculation

6.34 Using these methods, development at the site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

6.35 Assessments have thereafter been completed to determine the characteristics of proposed SuDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for both the 1 in 1 and 1 in 100 years + 40% climate change.

6.36 There are 2 options that have been modelled for the discharge of surface water. Option 1 utilises two outfall points, whereas Option 2 utilise a single outfall. Both ultimately discharge into the existing ditch to the south of the Site.

6.37 The summary calculations are contained in **Appendix C**.

Option 1

6.38 Calculations demonstrate that storm water detention storage have determined the volumes required to attenuate storm water discharges from the Site during the critical 1 in 100 year + 40% climate change storm event. Peak discharges will be limited to the equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing a circa 69% reduction on peak greenfield rates. **Table 6-4** below summarises the overall detention requirements.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3) +40%CC
A-0.27	0.15	1.8	98
B 3.0	1.65	6.4	1345

Table 6-4: Option 1 Summary run-off & detention assessment output

Option 2

6.39 Calculations demonstrate that storm water detention storage have determined the volumes required to attenuate storm water discharges from the Site during the critical 1 in 100 year + 40% climate change storm event. Peak discharges will be limited to the equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing a circa 69% reduction on peak greenfield rates Table **6-5**, below summarises the overall detention requirements. Option 2 has been modelled using the cascading basins

option in MicroDrainage.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3) +40%CC
A-0.27	0.15	1.8	98
B-3.0	1.65	7	1396

Table 6-5: Option 2 Summary run-off & detention assessment output

6.40 In accordance with legislative requirements, the detention proposals have been assessed for the potential effects of climate change. The 1 in 100-year (1% AEP) return events have been modelled for 40% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are contained within Appendix C. Climate change assessments show each detention feature to perform adequately by retaining the additional flows within the system without overflow.

6.41 A side overflow weir will be provided on the detention features, at a level above the 1 in 100 year + 40% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

6.42 A schematic layout for the drainage system has been developed that shows the strategic conveyance and detention features close to the existing water bodies, this can be found within drawings **10710-DR-01 and 10710-DR-02** contained in **Appendix A.**

6.43 The basin, being an above ground naturally landscaped feature, will be designed to enhance the biodiversity and landscape character of the site, while also acting as functional features to control storm discharges from the Site and improve water quality.

6.44 The storm water management system will provide features that are designed to provide extended detention of storm water collected from within the development. This approach will maximise the passive treatment characteristics of the system and improve water quality discharged to the wider Northaw Brook catchment. Source control by way of permeable pavements may be employed, where appropriate, in high-risk parking areas that provide for the efficient removal of silts and hydrocarbons ahead of discharge to the proposed network.

6.45 Furthermore, based on FRA work undertaken to support previous applications, it is recognised and accepted that in addition to the strategic attenuation basins, the implementation of source control measures can achieve a minimum 15% betterment in peak run-off from each development parcel, thus should this be a viable option, a further betterment may be achieved.

Change of use

6.46 With regards to the change of land use, the existing agricultural field has no positive drainage measures and prevailing levels suggest that surface water generally makes its way south to the Hempshill Brook. There are no anecdotal records of flooding within this field and it is not proposed that any positive drainage measures are installed to serve the playing fields as part of this application. However, the area could feasibly be drained by a series of narrow filter strips and either attenuated and linked into the Bowls Club drainage, or a positive route (swale or pipe) could be formed from the field to the Hempshill Brook to the south.

6.47 The land presently falls to the south at a gradient of approximately 1 in 30 as described above. To implement usable playing fields, it is likely that minor earthworks will be required to provide a suitable platform.

However, this activity is not a prohibitive engineering constraint to this change of land use from agricultural land to playing fields.

Water Quality

6.48 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

6.49 The SuDS Manual C753 describes a 'Simple Index Approach' for assessing the pollution risk of surface run-off to the receiving environment using indices for likely pollution levels for different land uses and SuDS performance capabilities.

6.50 CIRIA document C753 Table 26.2, as shown in **Table 6-6** below, indicates the minimum treatment indices appropriate for contributing pollution hazards for different land use classifications. To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index.

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g., cul-de-sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4

Table 6-6: CIRIA 753 Table 26.2 Pollution Hazard Indices

6.51 For a residential type of development, roof water requires a very low treatment of 0.2 for total suspended solids, 0.2 for heavy metals and 0.05 for hydrocarbons, and run-off from low traffic roads such as cul-de-sacs and individual property driveways requires low treatment of 0.5 for total suspended solids, 0.4 for heavy metals and 0.4 for hydrocarbons.

6.52 The Site will employ two SuDS features, porous paving or alternative solutions (where applicable) and a detention basin as these are widely accepted to be of high pollutant removal efficiency (CIRIA 609). This provides for two stages of treatment onsite.

6.53 To provide the correct level of treatment, an assessment needs to be made of the mitigation provided by each SuDS feature. Table 26.3 of The SuDS Manual CIRIA document C753 shown as **Table 6-7** for discharges to surface waters and groundwater respectively indicate the treatment mitigation indices provided by each SuDS feature.

Type of SuDS component	Total suspended solids (TSS)	Metals	Hydrocarbons
Permeable pavement	0.7	0.6	0.7

Filter strip	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Detention basin	0.5	0.5	0.6
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the one in 1-year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 6-7: CIRIA 753 Table 26.3 SuDS Mitigation Indices for discharges to surface waters.

6.54 Where more than one mitigation feature is to be used, CIRIA guidance states that the total mitigation index shall be calculated as follows:

Total SuDS mitigation index = Mitigation Index 1 + 0.5 x Mitigation Index 2

6.55 At present, the site and surrounding area does not benefit from any additional measures of stormwater treatment.

6.56 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development to have a positive impact on the surrounding natural environment.

6.57 The site will employ SuDS features, such as porous paving and detention basins. These are widely accepted to be of high pollutant removal efficiency (CIRIA 609). This provides for one stage of treatment onsite. Coupled with this however, the on-site field drain should also be an additional stage of treatment as the sedimentation process is not limited to artificial drainage systems but is taken from the natural processes observed within the water cycle. This gives 2-3 stages of treatment, providing an extensive system by which to effectively decrease pollutant load within stormwater run-off.

6.58 As the site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Groundwater

6.59 As discussed in Section 5 the risk of flooding from groundwater is considered to be low. However, in the pre-application discussions held with the LLFA it has been highlighted that there is potential risk of a localised high groundwater table at the location of the proposed SuDS basins. It is considered that this could be addressed as follows:

- Undertake groundwater monitoring a the proposed locations to establish the local groundwater levels;
- Consider the use of pond liners to prevent the ingress of groundwater; or
- Locally elevate the area to ensure that the attenuation feature is above the maximum likely groundwater level (any such proposal should ensure that it does not result in reliance of embankments)

Exceedance Flows

6.60 Careful regard must be made in respect of potential exceedance flows, being events that are more extreme than current design criteria. Various national guidance has been published on the matter of exceedance flows and measures that should be incorporated into a development to ensure the safety of occupiers and those using the infrastructure.

6.61 The principal aim is to direct any exceedance flows away from properties and along defined corridors. At a local level, this may mean water being conveyed along a length of highway, if the predicted flow depths and velocities are acceptable. More strategically, the implementation of conveyance corridors is important in avoiding deep and high velocity flows that present a high risk. The drainage system being promoted provides a good opportunity to incorporate exceedance flow routes into the design.

6.62 Careful and considered design in other areas, can also reduce the risk. For example, the strategic SuDS system being promoted, provides a layered and disbursed system of treatment across the site, thereby avoiding a traditional and more risky design that might, for example, have all storm water being collected in a strategic spine sewer that conveys flows to a large basin at the bottom of the catchment. This latter system concentrates peak discharges into a single corridor, that if blocked can have unacceptable consequences.

6.63 Clearly, many of the measures for dealing with exceedance flows must be dealt with at the detailed design stage. However, the strategic layout for proposed development at Cuffley provides the framework of a network that can effectively deal with any future exceedance problems.

6.64 As highlighted in Section 5 that there is an existing surface water flow path that is shown to cross the site primarily due to the topography. As part of the development, the topography will be altered, providing a rationalised surface for water runoff and the flow route will be carefully managed through landscaped areas where possible. Further consideration will be given as the design progresses.

Construction Phase

6.65 To avoid potential pollution incidents during the construction phase of the development, Construction Environmental Management Plans (CEMP) will be prepared for the development. The CEMP will include full details of

- Register of environmental aspects (effects of the proposals)
- Roles and responsibilities
- Communication and co-ordination
- Training and awareness
- Operational control
- Checking and corrective action, and
- Environmental control measures.

Maintenance and Adoption

6.66 The conceptual drainage proposals have been developed in a manner that will allow the site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by

removing the low-level silts, oils which could be attributed to track/parking area run off of this nature. Final design will provide for appropriate geometry and planting to maximise this benefit.

6.67 The surface water management features will be constructed and operational prior to the first use of the site, derived on a phase-by-phase requirement.

6.68 The proposed surface water system will be designed to adoptable standards in line with the current DCG guidance, the network will be offered for adoption to Thames Water under a S104 agreement.

6.69 Under the DCG filter drains and permeable paving will not be offered for adoption and will therefore be maintained by a private management company.

6.70 It is usual for the following maintenance regime to be implemented:

Maintenance Schedule	Required Action	Typical Frequency
Porous Paving		
Regular Maintenance	Brushing and vacuuming	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required
Remedial Actions	Remediate any landscaping which through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks and replace lost jointing material	
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial Inspection	Monthly for 3 months after installation

	Inspect for evidence of poor operation and/or weed growth- if required, take remedial action.	Three-monthly, 48 h after large storms after first 6 months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually
Filter Strip		
Regular Maintenance	Remove litter and debris	Monthly or as required.
	Cut the grass	
	Manage Vegetation	
	Inspect flow spreader and filter strip for clogging, silt accumulation and even gradients	
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types if required	As required
Remedial Actions	Repair erosion or other damage by re-turfing or re-seeding	As required
	Relevel uneven surfaces	
	Scarify and Spike topsoil layer to improve infiltration performance, break up silt deposits	
	Remove build up of sediment as appropriate	
	Remove and dispose of oils or petrol residues using safe standard practices.	
Detention Basins		
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)

	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, 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 inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	Reseed 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 (likely to be minimal requirements where effective upstream source control is provided)
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of riprap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Table 6-8: Regular maintenance proposals

6.71 The conceptual drainage masterplan proposals outlined in this report will be used for final drainage design and detailing. The surface water management system will be constructed and operational in full prior to first use of the relevant phase of development.

Summary

6.72 A strategy for surface water drainage at the Site has been developed to meet both national and local policy. The above options outline the viability of the Site to employ means of drainage to comply with NPPF guidance, together with the Welwyn Hatfield Borough Council SFRA and other national and local guidance.

6.73 The proposed residential development drainage system will manage storm water by way of a SuDS management train and ensure peak discharges from the developed land are reduced to circa 69% below the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Objectives

6.74 The key objectives for the site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the proposed residential Site to the agreed rate below the baseline conditions, during storm events up to the 1 in 100-year event.
- Development of surface water management proposals that maintain water quality and biodiversity of the site.
- Implementation of the surface water management system prior to first occupation of dwellings.

7 Foul Drainage

Background

7.1 A copy of the Thames Water sewerage network records has been obtained to confirm the presence of adopted foul sewers in the vicinity of the Site. Adopted foul sewers service the existing residential development areas to the north and west of the Site.

7.2 A 150mm foul sewer shown in the north of the Site (adjacent to South Drive) crosses the Site to the south (adjacent to the sports field). The nearest potential point of connection shown is manhole 301A in the south of the Site.

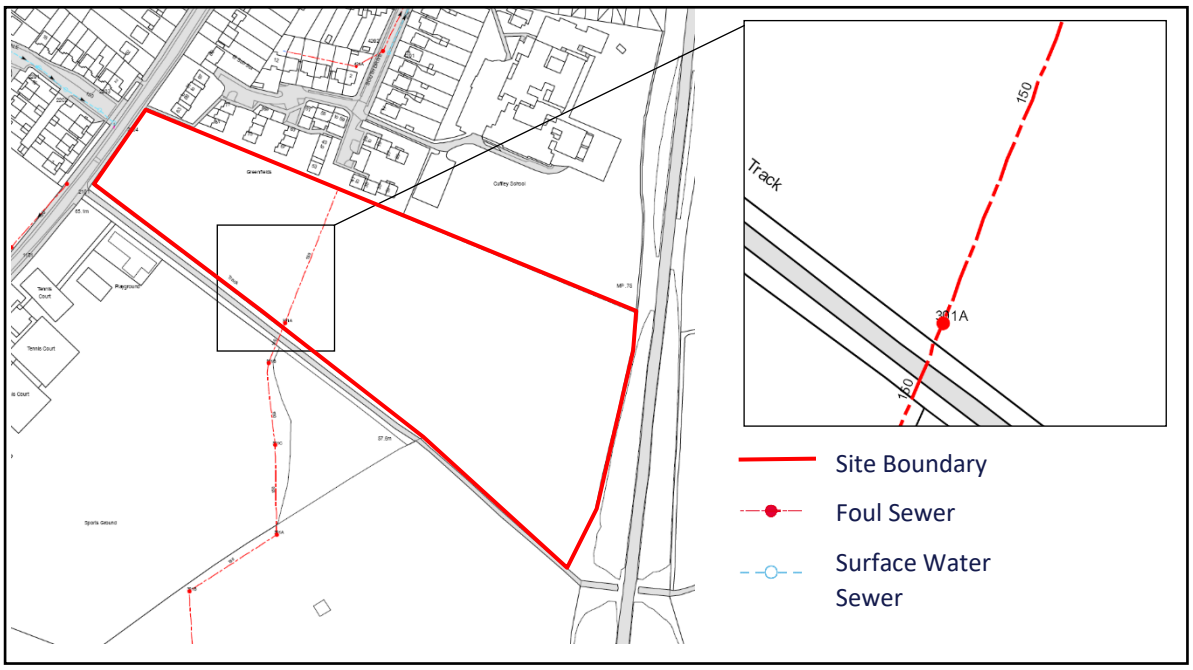


Figure 7-1: Thames Water Asset Location Search Sewer Map

Design Criteria / Network Requirements

7.3 Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:

Domestic peak = *4,000 litres / dwelling / day (peak)*

7.4 Assessed in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers requirements, the development will have a design peak discharge of approximately 5.60l/s.

Network Requirements / Options

7.5 Discussions with Thames Water in 2014 have confirmed that there was sufficient capacity within the existing

foul sewer to accept flows from the proposed development.

7.6 A new pre-development enquiry will need to be undertaken in order to confirm the current capacity of the network.

7.7 In addition to this, a 6m easement has been issued by Thames Water on the existing foul sewer which crosses the development Site. This easement has been considered, with regards to the formulation of the illustrative Masterplan for the purpose of proving the layout.

7.8 Any proposed development within this zone will require approval from Thames Water.

7.9 Correspondence from Thames Water is provided within Appendix D.

Treatment Requirements

7.10 Discussions with Thames Water have outlined that the existing foul water network conveys flows towards Cuffley Brook Sewage Pumping Station which it is understood directs flows onto Deephams Sewage Treatment Works, approximately 9.6km to the south-east of the Site.

7.11 In 2014 Thames Water confirmed that the Sewage Treatment Works had sufficient headroom to accommodate the flows from the proposed development.

7.12 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 et al., to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. The five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

7.13 Where development programming requirements necessitate the reinforcement of facilities ahead of allocation in an AMP period, mechanisms are available to ensure the infrastructure can be delivered in a timely fashion, to meet the development programme.

Implementation Proposals

7.14 The proposed drainage network across the site will be designed to current Design and Construction Guidance for Foul and Surface Water Sewers standards, employing a point of connection agreed with Thames Water. The system will be offered for the adoption of Thames Water under S104 of the Water Industry Act 1991.

Summary

7.15 A site drainage strategy has been developed that meets with current regulatory requirements by discharging drainage to a sewerage network with capacity to accommodate the flows.

7.16 A 3m easement has been issued by Thames Water either side of the existing foul sewer which crosses the development Site, to ensure access for any future repair and maintenance of the pipe. Any proposed development within this zone will require approval from Thames Water.

7.17 Once development is complete, the network conveying flows from the Site will be adopted by Thames Water and be maintained as part of their statutory duties.

Objectives

7.18 The key development objectives required for the site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Thames Water network which is designed and maintained to an appropriate standard.

8 Summary and Limitations

Summary

8.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site for the proposed developments.

8.2 Assessment of fluvial flood risk shows the land to lie within Flood Zone 1 and hence be a preferable location for residential development when considered in the context of the NPPF Sequential Test. Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

8.3 Means to discharge storm and foul water drainage have been established that comply with current guidance and requirements of the LLFA and Thames Water.

8.4 Surface water discharged from development will be disposed of by way of SuDS measures to the existing ditch within the site. Foul water will discharge to the existing network, following formal confirmation from Thames Water.

8.5 A 3m easement has been issued by Thames Water either side of the existing foul sewer which crosses the development Site, to ensure access for any future repair and maintenance of the pipe. Any proposed development within this zone will require approval from Thames Water.

8.6 The Environment Agency (EA) has confirmed that with the measures proposed for this Site, flood risk grounds would not be a basis for objection to this application.

8.7 The site is fully able to comply with NPPF guidance together with associated local and national policy guidance.

Limitations

8.8 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

8.9 Third party information has been used in the preparation of this report, which Brookbanks, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, Brookbanks accepts no liability for same.

8.10 The benefits of this report are provided solely to Lands Improvement for the proposed development Land to the north east of King George V Playing Fields in Cuffley only.

8.11 Brookbanks excludes third party rights for the information contained in the report.

Appendix A –Existing Topographical Survey & Proposed Drainage Strategy Option 1 & 2

LandScope Engineering Ltd
The Chart House
Pickliescott
Church Stretton
Shropshire
SY6 6NT

Tel:01694 731930
Fax:01694 751343
email:enquiries@land-scope.com

Topographical Survey

Land surrounding Cuffley Football Club

Sheet 2 of 10
August 2014

Scale
1:200

Horizontal Datum: Supplied by client
Vertical Datum: Supplied by client
Units: Metres

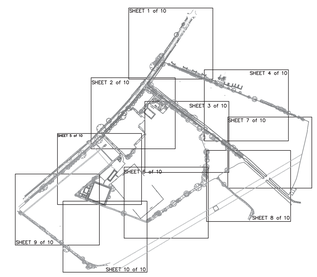
0 5 10 15 20
metres

Survey Notes

1) This drawing contains elements from drawing S-08-431-01 as supplied by client.

2) The survey control is based on the following stations within the above drawing
S2 E530199.246 N202117.783 Level 62 .74
S3 E530247.144 N202176.436

Sheet Layout



Legend

Survey Control Station	Tree with elevation, height in metres and spread to scale
Spot Level N.B. Spot levels at road edge relate to channel line	Gate
Major Contour 1m Interval	Top of bank
Minor Contour 0.5m Interval	Bottom of bank
Overhead Telecoms	Tree Canopy
Overhead Electric	Foliage/Hedge edge

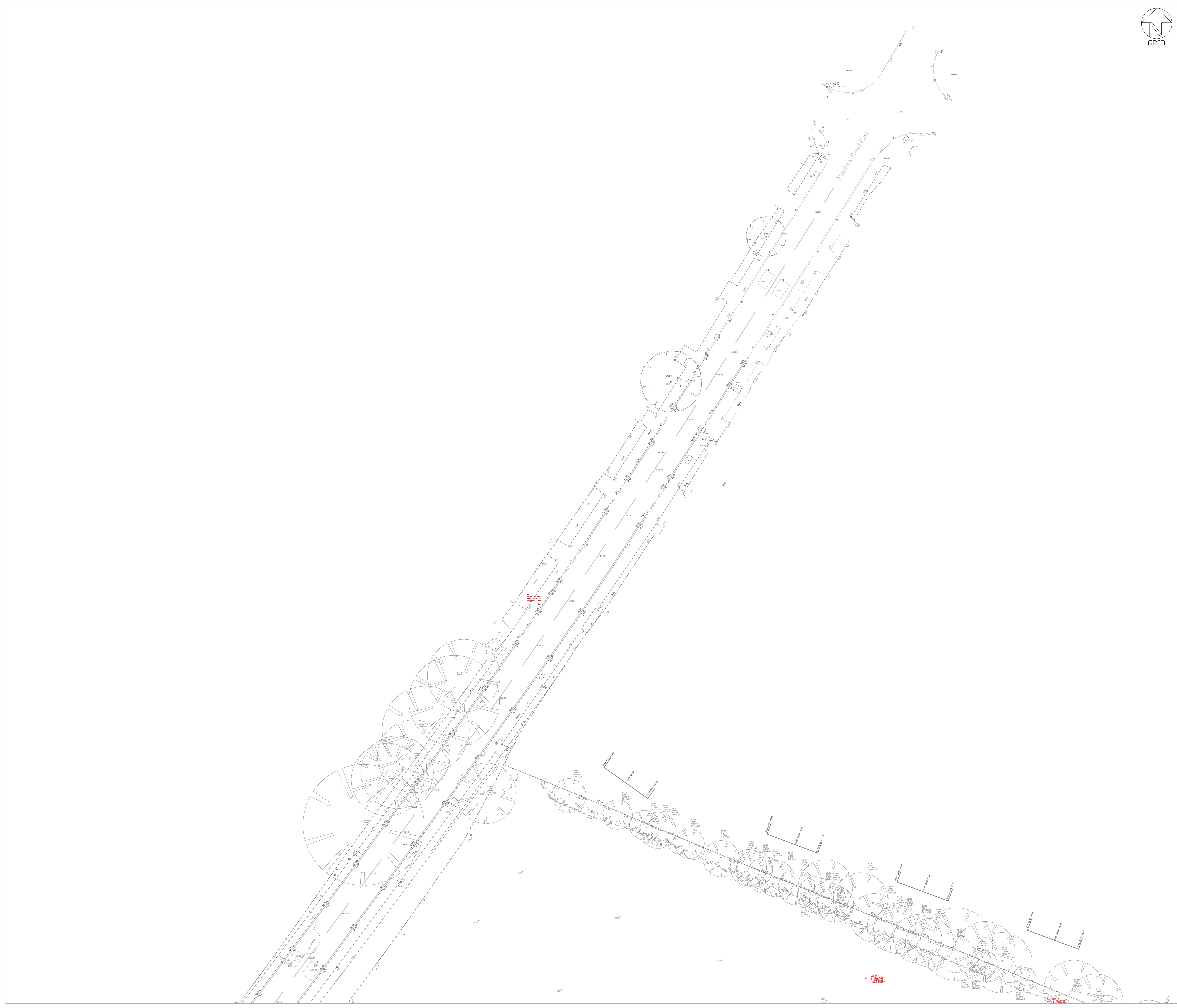
Abbreviations

PP	Post and Panel Fenceline	ER	Earth Rod	TPO	Telegraph Pole
PR	Post and Rail Fenceline	MW	Monitoring Well	EPO	Electricity Pole
PW	Post and Wire Fenceline	CR	Cable Riser	RS	Road Sign
SM	Post and Steel Mesh Fenceline	EPO	Electric Pole	BO - C	Bollard - Concrete
mH	Height in Metres			BO - S	Bollard - Steel
		GSV	Gas Valve	BO - W	Bollard - Wooden
IC	Inspection Cover	GM	Gas Meter	LB	Litter Bin
CL	Cover Level	GR	Gas Riser	FI	Pillar
IL	Invert Level			RS	Road Sign
G	Gully	AV	Air Valve	TS	Tree Stump
DP	Down Pipe	WST	Stop Tap	TCB	Telephone Call Box
RWP	Rain Water Pipe	WSV	Sluice Valve	FP	Flag Pole
FWP	Foul Waste Pipe	WM	Water Meter	TP	Tactile Paving
VC	Vent Cover	WO	Wash Out	FP	Fuel Pump
RE	Rodding Eye			TL	Traffic Induction Loop
VP	Vent Pipe	SL	Street Light	LA	Ladder
FWS	Foul Water Sewage	PLM	Pipeline Marker	FB	Flower Bed
SWS	Surface Water Sewage	CAB	Street Cabinet	DK	Dropped Kerb

Prepared for: **Lands Improvement**
10 Lower Grosvenor Place
London
SW1W 0EN

Surveyed by: C. Whiteley, R. Baker
Date: 14th - 22nd August 2014

Drawing Reference	Rev	Date	Description	Filename	Drawn By	Checked By	Approved By
1667_200_2	0	29/08/14	First issue	1667_0	CWh/RBa	MBe	MBe



LandScope Engineering Ltd
The Chart House
Picklescott
Church Stretton
Shropshire
SY6 6NT

Tel:01694 731930
Fax:01694 751343
email:enquiries@land-scope.com

Topographical Survey

Land surrounding Cuffley Football Club

Sheet 1 of 10
August 2014

Scale
1:200

Horizontal Datum: Supplied by client
Vertical Datum: Supplied by client
Units: Metres

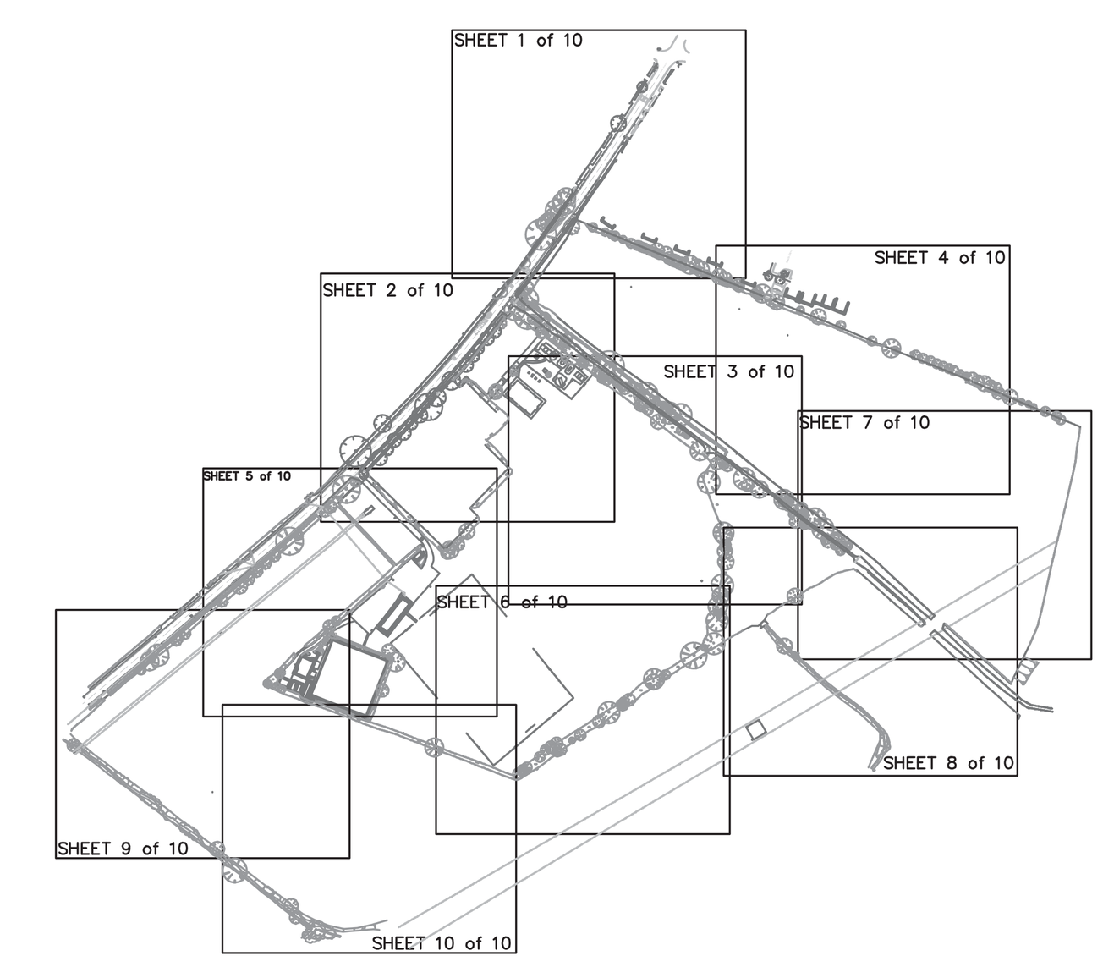
0 5 10 15 20
metres

Survey Notes

1) This drawing contains elements from drawing S-08-431-01 as supplied by client.

2) The survey control is based on the following stations within the above drawing
S2 **E**530199.246 N202117.783 Level 62 .74
S3 E530247.144 N202176.436

Sheet Layout



Legend

1 E=1000.000 N=2000.000 Height=100.000	Survey Control Station	117.18 3mH	Tree with elevation, height in metres and spread to scale
× 101.84	Spot Level N.B. Spot levels at road edge relate to channel line		Gate
2.0m	Major Contour 1m Interval	255.84 255.76	Top of bank
1.5m	Minor Contour 0.5m Interval	250.06 249.75	Bottom of bank
T	Overhead Telecoms		Tree Canopy
E	Overhead Electric		Foliage/Hedge edge

Abbreviations

PP	Post and Panel Fenceline	ER	Earth Rod	TPO	Telegraph Pole
PR	Post and Rail Fenceline	MW	Monitoring Well	EPO	Elecricity Pole
PW	Post and Wire Fenceline	CR	Cable Riser	RS	Road Sign
SM	Post and Steel Mesh Fenceline	EPO	Electric Pole	BO - C	Bollard - Concrete
mH	Height in Metres			BO - S	Bollard - Steel
		GSV	Gas Valve	BO - W	Bollard - Wooden
IC	Inspection Cover	GM	Gas Meter	LB	Litter Bin
CL	Cover Level	GR	Gas Riser	PI	Pillar
IL	Invert Level			RS	Road Sign
G	Gully	AV	Air Valve	TS	Tree Stump
DP	Down Pipe	WST	Stop Tap	TCB	Telephone Call Box
RWP	Rain Water Pipe	WSV	Sluice Valve	FP	Flag Pole
FWP	Foul Waste Pipe	WM	Water Meter	TP	Tactile Paving
VC	Vent Cover	WO	Wash Out	FP	Fuel Pump
RE	Rodding Eye			TIL	Traffic Induction Loop
VP	Vent Pipe	SL	Street Light	LA	Ladder
FWS	Foul Water Sewage	PLM	Pipeline Marker	FB	Flower Bed
SWS	Surface Water Sewage	CAB	Street Cabinet	DK	Dropped Kerb

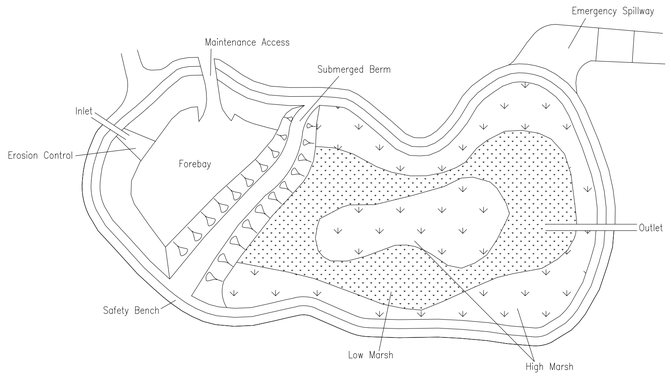
Prepared for: **Lands Improvement**
10 Lower Grosvenor Place
London
SW1W 0EN

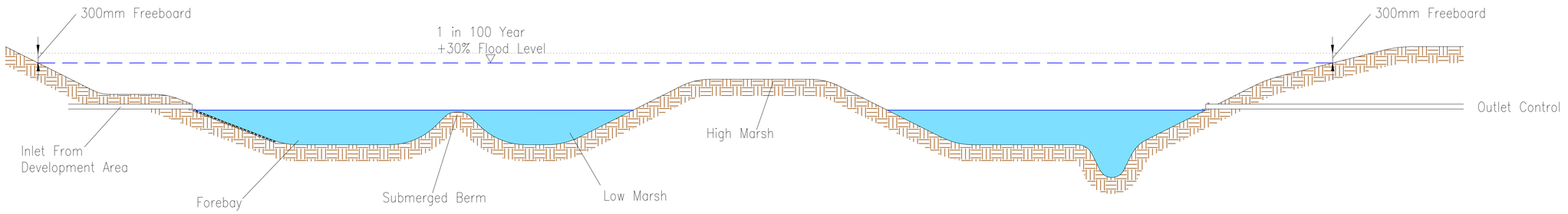
Surveyed by: C. Whiteley, R. Baker
Date: 14th - 22nd August 2014

Drawing Reference	Rev	Date	Description	Filename	Drawn By	Checked By	Approved By
1667_200_1	0	29/08/14	First issue	1667_0	CWh/RBa	MBe	MBe

Original Drawing Size A1

Location Plan - Scale 1:1250





NOTES:

1. Do not scale from this drawing.
2. All dimensions are in metres unless otherwise stated.
3. Brookbanks Consulting Ltd has prepared this drawing for the sole use of the client. The drawing may not be relied upon by any other party without the express agreement of the client and Brookbanks Consulting Ltd. Where any data supplied by the client or from other sources has been used, it has been assumed that the information is correct. No responsibility can be accepted by Brookbanks Consulting Ltd for inaccuracies in the data supplied by any other party. The drawing has been produced based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.
4. No part of this drawing may be copied or duplicated without the express permission of Brookbanks Consulting Ltd.

KEY:

- Site Boundary
- Proposed Developable Area
- Existing Watercourse
- Potential Culvert
- SuDS Basin
- SuDS Basin - 300mm Freeboard
- Proposed Outfall Route
- Proposed Swale
- Existing Surface Water Flow (To be managed through roads and landscaping level design)

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR COMMENCE SITE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT HIS OWN RISK.

P:\10710\CAD\BCL\Working Drawings\10710-DR-01 - Drainage Strategy - Option 1.dwg

-	First Issue	LF	SM	RM 28.01.21

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6150 Knights Court, Solihull Parkway, Birmingham, B37 7WY
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W brookbanks.com

Lands Improvement

Land at Cuffley Hertfordshire

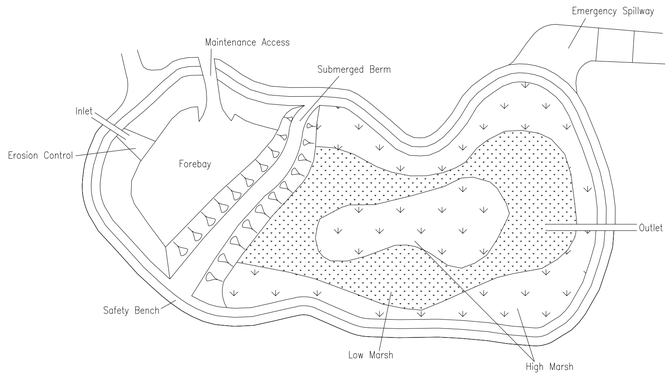
Surface Water Drainage Strategy Option 1

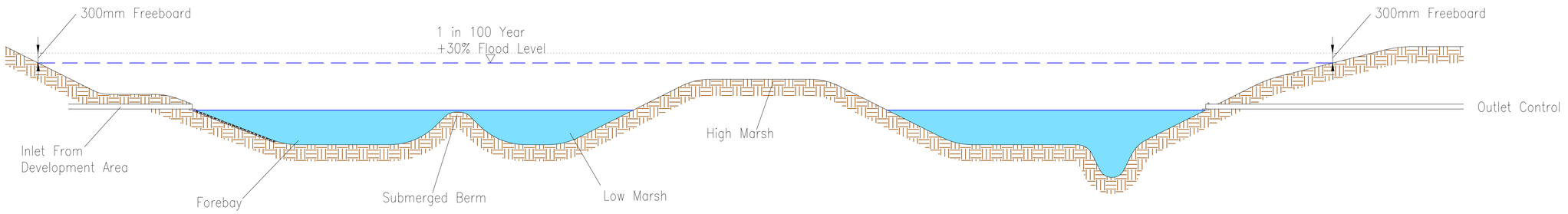
Status		Status Date
Draft		Jan 2021
Drawn	**Checked**	**Date**
LF	SM	28.01.21
Scale	**Number**	**Rev**
1:1250	10710-DR-01	-

0 25 50 75 100 125
METRES

Original Drawing Size A1

Location Plan - Scale 1:1250





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KEY:

- Site Boundary
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- Existing Watercourse
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- SuDS Basin
- SuDS Basin - 300mm Freeboard
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P:\10710\CAD\BCL\Working Drawings\10710-DR-02 - Drainage Strategy - Option 2.dwg

-	First Issue	LF	SM	RM 28.01.21

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Lands Improvement

Land at Cuffley
Hertfordshire

Surface Water
Drainage Strategy
Option 2

Status		Status Date
Draft		Jan 2021
Drawn	**Checked**	**Date**
LF	SM	28.01.21
Scale	**Number**	**Rev**
1:1250	10710-DR-02	-

0 25 50 75 100 125
METRES

Appendix B – LLFA & EA Correspondence

Director of Environment & Infrastructure:
Mark Kemp

Hertfordshire

Richard Moorcroft
Lands Improvement
Brookbanks Consulting Ltd
6150 Knights Court
Solihull Parkway
Birmingham Business Park
B37 7WY

Lead Local Flood Authority
Post Point CHN 215
Hertfordshire County Council
County Hall, Pegs Lane
HERTFORD SG13 8DN

Contact David Uncle
Email FRMConsultations@hertfordshire.gov.uk

Date 14 December 2020

RE: Preapp/2020/WHBC/08 – Land to the east of Northaw Road East and north east of Northaw & Cuffley Lawn Tennis Club, Cuffley, EN6 4RD

Dear Richard,

Thank you for using our Surface Water Advisory Service regarding the site at Land to the east of Northaw Road East and north east of Northaw & Cuffley Lawn Tennis Club, Cuffley, EN6 4RD.

Following our site visit conducted on 19 November 2020 and Teams meeting held on 30 November 2020, we can provide the following advice.

We understand it is proposed to discharge at a total rate of 6.96 l/s to the ordinary watercourse south of the site. Two strategies are provided, with one proposing a singular outfall to the ordinary watercourse and the other proposing an outfall from each of the detention basins.

We are pleased that as a greenfield site, the applicant is proposing to use above-ground SuDS such as permeable paving and detention basins. We would advise the applicant that we would have no issue with both the singular and double outfall approaches. Indeed, the approach using two outfalls may help facilitate a source control approach.

As a greenfield site, we would expect the applicant to prioritise source control whereby runoff is managed where it is generated, such as through the use of permeable paving and other above-ground SuDS to provide attenuation and SuDS management and treatment throughout the site in a decentralised approach.

We are pleased the applicant states it may be feasible to implement swales and filter drains/strips etc in the site. We would encourage using these where possible and indicate their locations on the drainage layout.

We note that a surface water flow path appears to cross the site from South Drive at the north of the site. We would advise the applicant that they should seek to manage the flow path within the site as part of the drainage strategy. In our meeting it was understood that the applicant should determine and manage the flow path volumes as well as demonstrate that the surface water system on site will be able to manage this.

We note that the applicant states the basins are designed considering a 1 in 100 year + 30% climate change storm. We are pleased the applicant has provided initial post-development calculations in support of the drainage strategy for the 1 in 100 year + 30% climate change event.

However, we note that in line with the current standards, we would require a 40% allowance for climate change. We agreed that the calculations will be updated to consider a 40% climate change allowance, with appropriate additional attenuation volume provided.

We understand the applicant is seeking advice on flooding vulnerability on site, particularly regarding groundwater. We would advise the applicant that we have no record of flooding incidents in the immediate vicinity of the site. Based on the summary table provided, we note groundwater levels up to 1.15mBGL at the location of borehole WS02. Based on the potential for shallow groundwater on site we would recommend that the applicant carries out groundwater test at the locations of the proposed basins.

Please note that any works taking place which may affect the flow within an ordinary watercourse may require prior written consent from Hertfordshire County Council under Section 23 of the Land Drainage Act 1991. This includes any permanent and/or temporary works regardless of any planning permission.

For further advice on what we expect to be contained within the FRA to support a planning application, please refer to our Developers Guide and Checklist on our surface water drainage webpage:

https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/surface-water-drainage/surface-water-drainage.aspx

If you would like us to review any additional pre-application information in response to the above required information before going through the formal process via the LPA, this will be subject to the £110 hourly rate.

Please note

Any advice given by Flood Risk Officers for pre-application enquiries does not constitute a formal response or decision with regards to future planning consents. This decision is the responsibility of the relevant local planning authority.

Any views or opinions expressed are given in good faith, and to the best of ability, without prejudice to the formal consideration of any planning application, which will be subject to public consultation and ultimately decided by the relevant local planning authority. The Flood Risk Management Team cannot guarantee that new issues will not be raised following submission of a planning application and consultation upon it.

You should be aware that officers cannot give guarantees about the final formal decision that will be made on your planning or related applications. However, the advice note will be taken into account by the Flood Risk Management Team in consideration of any future related formal planning application, subject to the provision that circumstances, and information may change or come to light that could alter the response.

It should be noted that the consideration given to pre-application advice may decline over time where more up to date data, new information and any change to industry best practice and national policy may occur.

Yours sincerely,

David Uncle
SuDS Officer
Environmental Resource Planning

creating a better place

Environment Agency

Mr Richard Moorcroft
Brookbanks Consulting
Knights Court (6150) Solihull Parkway
Birmingham Business Park
Birmingham
B37 7WY

Our ref: NE/2014/121698/01-L01
Your ref: 10316/FRA/01

Date: 1 December 2014

Dear Richard

Charged enquiry: Flood Risk Assessment review for Land At Northaw Road, Cuffley.

We have reviewed the draft Flood Risk Assessment (FRA) (Lands End Ref 10316/FRA/01 dated 31/10/14) and we are very pleased to see that you are proposing ponds, swales and permeable paving and a better than Greenfield run off rate.

Should this FRA accompany a full planning application we would have no objection on flood risk grounds, and would apply conditions to ensure the surface water drainage system is carried out as proposed.

To discharge the conditions, we would need to see the below points, some of these have been partly covered within the information submitted in the FRA.

a) A clearly labelled drainage layout plan showing pipe networks and any attenuation areas or storage locations. This plan should show any pipe 'node numbers' that have been referred to in network calculations and it should also show invert and cover levels of manholes.
b) Confirmation of the critical storm duration.
c) Where infiltration forms part of the proposed storm water system such as infiltration trenches and soakaways, soakage test results and test locations are to be submitted in accordance with BRE digest 365.
d) Where on site attenuation is achieved through ponds, swales, geocellular storage or other similar methods, calculations showing the volume of these are also required.
e) Where an outfall discharge control device is to be used such as a hydrobrake or twin orifice, this should be shown on the plan with the rate of discharge stated.
f) Calculations should demonstrate how the system operates during a 1 in 100 chance in any year critical duration storm event, including an allowance for climate change in line with the ‘Planning Practice Guidance: Flood Risk and Coastal Change’. If overland flooding occurs in this event, a plan should also be submitted detailing the location of overland flow paths and the extent and depth of ponding.

I hope that you have any found this helpful, should you have any queries please feel free to contact me.

Yours sincerely

Mr Kai Mitchell
Sustainable Places Planning Advisor

Tel: 01707 632388
E-mail SPHatfield@environment-agency.gov.uk

Appendix C – Drainage Calculations

IH 124 Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 630 Urban 0.000
Area (ha) 50.000 Soil 0.450 Region Number Region 6

Results l/s

QBAR Rural	194.2
QBAR Urban	194.2
Q100 years	619.4
Q1 year	165.1
Q2 years	171.1
Q5 years	248.6
Q10 years	314.6
Q20 years	389.0
Q25 years	417.1
Q30 years	440.1
Q50 years	508.8
Q100 years	619.4
Q200 years	728.2
Q250 years	763.1
Q1000 years	1002.0

Cascade Summary of Results for Catchment A.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment B - Option 2.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.686	0.686	1.8	66.5	O K
30 min Summer	0.738	0.738	1.8	73.3	O K
60 min Summer	0.785	0.785	1.8	79.7	O K
120 min Summer	0.819	0.819	1.8	84.4	O K
180 min Summer	0.826	0.826	1.8	85.5	O K
240 min Summer	0.823	0.823	1.8	85.0	O K
360 min Summer	0.802	0.802	1.8	82.0	O K
480 min Summer	0.775	0.775	1.8	78.3	O K
600 min Summer	0.751	0.751	1.8	75.0	O K
720 min Summer	0.729	0.729	1.8	72.1	O K
960 min Summer	0.690	0.690	1.8	67.0	O K
1440 min Summer	0.618	0.618	1.8	57.9	O K
2160 min Summer	0.499	0.499	1.8	44.2	O K
2880 min Summer	0.393	0.393	1.8	33.1	O K
4320 min Summer	0.242	0.242	1.8	18.9	O K
5760 min Summer	0.155	0.155	1.7	11.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	243.617	0.0	68.3	26
30 min Summer	136.001	0.0	76.3	41
60 min Summer	75.923	0.0	85.3	70
120 min Summer	42.384	0.0	95.3	128
180 min Summer	30.138	0.0	101.6	186
240 min Summer	23.661	0.0	106.4	244
360 min Summer	16.825	0.0	113.5	360
480 min Summer	13.209	0.0	118.8	412
600 min Summer	10.949	0.0	123.1	474
720 min Summer	9.392	0.0	126.7	536
960 min Summer	7.385	0.0	132.8	670
1440 min Summer	5.262	0.0	141.9	946
2160 min Summer	3.749	0.0	151.8	1328
2880 min Summer	2.947	0.0	159.1	1680
4320 min Summer	2.113	0.0	171.0	2376
5760 min Summer	1.668	0.0	180.2	3048

Cascade Summary of Results for Catchment A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.108	0.108	1.6	7.8	O K
8640 min Summer	0.086	0.086	1.4	6.2	O K
10080 min Summer	0.075	0.075	1.3	5.4	O K
15 min Winter	0.749	0.749	1.8	74.7	O K
30 min Winter	0.805	0.805	1.8	82.5	O K
60 min Winter	0.857	0.857	1.8	89.9	O K
120 min Winter	0.897	0.897	1.8	95.8	O K
180 min Winter	0.909	0.909	1.8	97.6	Flood Risk
240 min Winter	0.909	0.909	1.8	97.7	Flood Risk
360 min Winter	0.894	0.894	1.8	95.3	O K
480 min Winter	0.867	0.867	1.8	91.4	O K
600 min Winter	0.838	0.838	1.8	87.1	O K
720 min Winter	0.813	0.813	1.8	83.5	O K
960 min Winter	0.764	0.764	1.8	76.8	O K
1440 min Winter	0.666	0.666	1.8	63.9	O K
2160 min Winter	0.492	0.492	1.8	43.4	O K
2880 min Winter	0.335	0.335	1.8	27.3	O K
4320 min Winter	0.152	0.152	1.7	11.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.389	0.0	187.5	3688
8640 min Summer	1.196	0.0	193.7	4408
10080 min Summer	1.054	0.0	199.1	5136
15 min Winter	243.617	0.0	76.5	26
30 min Winter	136.001	0.0	85.4	40
60 min Winter	75.923	0.0	95.6	68
120 min Winter	42.384	0.0	106.7	126
180 min Winter	30.138	0.0	113.8	182
240 min Winter	23.661	0.0	119.2	240
360 min Winter	16.825	0.0	127.1	350
480 min Winter	13.209	0.0	133.0	456
600 min Winter	10.949	0.0	137.8	500
720 min Winter	9.392	0.0	141.9	568
960 min Winter	7.385	0.0	148.7	722
1440 min Winter	5.262	0.0	158.9	1028
2160 min Winter	3.749	0.0	170.0	1432
2880 min Winter	2.947	0.0	178.2	1764
4320 min Winter	2.113	0.0	191.6	2380

Cascade Summary of Results for Catchment A.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	0.088	0.088	1.5	6.3	O K
7200 min Winter	0.072	0.072	1.2	5.1	O K
8640 min Winter	0.062	0.062	1.1	4.4	O K
10080 min Winter	0.055	0.055	0.9	3.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	1.668	0.0	201.8	2952
7200 min Winter	1.389	0.0	210.0	3672
8640 min Winter	1.196	0.0	217.0	4400
10080 min Winter	1.054	0.0	223.0	5136

Cascade Rainfall Details for Catchment A.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 530950 201600 TL 30950 01600
C (1km)	-0.025
D1 (1km)	0.274
D2 (1km)	0.279
D3 (1km)	0.294
E (1km)	0.322
F (1km)	2.512
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.150

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.050	4	8	0.050	8	12	0.050

Cascade Model Details for Catchment A.SRCX

Storage is Online Cover Level (m) 1.200

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	68.7	0.400	101.1	0.800	139.9	1.200	184.9
0.100	76.2	0.500	110.2	0.900	150.5		
0.200	84.1	0.600	119.7	1.000	161.6		
0.300	92.4	0.700	129.6	1.100	173.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0065-1800-0900-1800
Design Head (m)	0.900
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	65
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	1.8	Kick-Flo®	0.563	1.5
Flush-Flo™	0.276	1.8	Mean Flow over Head Range	-	1.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.1	3.000	3.1	7.000	4.6
0.200	1.8	1.400	2.2	3.500	3.4	7.500	4.8
0.300	1.8	1.600	2.3	4.000	3.6	8.000	4.9
0.400	1.8	1.800	2.5	4.500	3.8	8.500	5.1
0.500	1.6	2.000	2.6	5.000	4.0	9.000	5.2
0.600	1.5	2.200	2.7	5.500	4.1	9.500	5.4
0.800	1.7	2.400	2.8	6.000	4.3		
1.000	1.9	2.600	2.9	6.500	4.5		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.686	0.686	1.8	66.5	O K
30 min Summer	0.738	0.738	1.8	73.3	O K
60 min Summer	0.785	0.785	1.8	79.7	O K
120 min Summer	0.819	0.819	1.8	84.4	O K
180 min Summer	0.826	0.826	1.8	85.5	O K
240 min Summer	0.823	0.823	1.8	85.0	O K
360 min Summer	0.802	0.802	1.8	82.0	O K
480 min Summer	0.775	0.775	1.8	78.3	O K
600 min Summer	0.751	0.751	1.8	75.0	O K
720 min Summer	0.729	0.729	1.8	72.1	O K
960 min Summer	0.690	0.690	1.8	67.0	O K
1440 min Summer	0.618	0.618	1.8	57.9	O K
2160 min Summer	0.499	0.499	1.8	44.2	O K
2880 min Summer	0.393	0.393	1.8	33.1	O K
4320 min Summer	0.242	0.242	1.8	18.9	O K
5760 min Summer	0.155	0.155	1.7	11.5	O K
7200 min Summer	0.108	0.108	1.6	7.8	O K
8640 min Summer	0.086	0.086	1.4	6.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	243.617	0.0	68.3	26
30 min Summer	136.001	0.0	76.3	41
60 min Summer	75.923	0.0	85.3	70
120 min Summer	42.384	0.0	95.3	128
180 min Summer	30.138	0.0	101.6	186
240 min Summer	23.661	0.0	106.4	244
360 min Summer	16.825	0.0	113.5	360
480 min Summer	13.209	0.0	118.8	412
600 min Summer	10.949	0.0	123.1	474
720 min Summer	9.392	0.0	126.7	536
960 min Summer	7.385	0.0	132.8	670
1440 min Summer	5.262	0.0	141.9	946
2160 min Summer	3.749	0.0	151.8	1328
2880 min Summer	2.947	0.0	159.1	1680
4320 min Summer	2.113	0.0	171.0	2376
5760 min Summer	1.668	0.0	180.2	3048
7200 min Summer	1.389	0.0	187.5	3688
8640 min Summer	1.196	0.0	193.7	4408

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.075	0.075	1.3	5.4	O K
15 min Winter	0.749	0.749	1.8	74.7	O K
30 min Winter	0.805	0.805	1.8	82.5	O K
60 min Winter	0.857	0.857	1.8	89.9	O K
120 min Winter	0.897	0.897	1.8	95.8	O K
180 min Winter	0.909	0.909	1.8	97.6	Flood Risk
240 min Winter	0.909	0.909	1.8	97.7	Flood Risk
360 min Winter	0.894	0.894	1.8	95.3	O K
480 min Winter	0.867	0.867	1.8	91.4	O K
600 min Winter	0.838	0.838	1.8	87.1	O K
720 min Winter	0.813	0.813	1.8	83.5	O K
960 min Winter	0.764	0.764	1.8	76.8	O K
1440 min Winter	0.666	0.666	1.8	63.9	O K
2160 min Winter	0.492	0.492	1.8	43.4	O K
2880 min Winter	0.335	0.335	1.8	27.3	O K
4320 min Winter	0.152	0.152	1.7	11.3	O K
5760 min Winter	0.088	0.088	1.5	6.3	O K
7200 min Winter	0.072	0.072	1.2	5.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.054	0.0	199.1	5136
15 min Winter	243.617	0.0	76.5	26
30 min Winter	136.001	0.0	85.4	40
60 min Winter	75.923	0.0	95.6	68
120 min Winter	42.384	0.0	106.7	126
180 min Winter	30.138	0.0	113.8	182
240 min Winter	23.661	0.0	119.2	240
360 min Winter	16.825	0.0	127.1	350
480 min Winter	13.209	0.0	133.0	456
600 min Winter	10.949	0.0	137.8	500
720 min Winter	9.392	0.0	141.9	568
960 min Winter	7.385	0.0	148.7	722
1440 min Winter	5.262	0.0	158.9	1028
2160 min Winter	3.749	0.0	170.0	1432
2880 min Winter	2.947	0.0	178.2	1764
4320 min Winter	2.113	0.0	191.6	2380
5760 min Winter	1.668	0.0	201.8	2952
7200 min Winter	1.389	0.0	210.0	3672

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	0.062	0.062	1.1	4.4	O K
10080 min Winter	0.055	0.055	0.9	3.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	1.196	0.0	217.0	4400
10080 min Winter	1.054	0.0	223.0	5136

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 530950 201600 TL 30950 01600
C (1km)	-0.025
D1 (1km)	0.274
D2 (1km)	0.279
D3 (1km)	0.294
E (1km)	0.322
F (1km)	2.512
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.150

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.050	4	8	0.050	8	12	0.050

Model Details

Storage is Online Cover Level (m) 1.200

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	68.7	0.400	101.1	0.800	139.9	1.200	184.9
0.100	76.2	0.500	110.2	0.900	150.5		
0.200	84.1	0.600	119.7	1.000	161.6		
0.300	92.4	0.700	129.6	1.100	173.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0065-1800-0900-1800
Design Head (m)	0.900
Design Flow (l/s)	1.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	65
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	1.8	Kick-Flo®	0.563	1.5
Flush-Flo™	0.276	1.8	Mean Flow over Head Range	-	1.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.1	3.000	3.1	7.000	4.6
0.200	1.8	1.400	2.2	3.500	3.4	7.500	4.8
0.300	1.8	1.600	2.3	4.000	3.6	8.000	4.9
0.400	1.8	1.800	2.5	4.500	3.8	8.500	5.1
0.500	1.6	2.000	2.6	5.000	4.0	9.000	5.2
0.600	1.5	2.200	2.7	5.500	4.1	9.500	5.4
0.800	1.7	2.400	2.8	6.000	4.3		
1.000	1.9	2.600	2.9	6.500	4.5		

Cascade Summary of Results for Catchment B - Option 2.SRCX

Upstream Structures	Outflow To	Overflow To
Catchment A.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.701	0.701	7.0	748.2	O K
30 min Summer	0.772	0.772	7.0	833.4	O K
60 min Summer	0.848	0.848	7.0	925.3	O K
120 min Summer	0.925	0.925	7.0	1021.6	O K
180 min Summer	0.969	0.969	7.0	1077.8	O K
240 min Summer	0.999	0.999	7.0	1116.0	O K
360 min Summer	1.037	1.037	7.0	1165.0	O K
480 min Summer	1.058	1.058	7.0	1193.6	O K
600 min Summer	1.071	1.071	7.0	1210.4	O K
720 min Summer	1.078	1.078	7.0	1219.4	O K
960 min Summer	1.082	1.082	7.0	1224.1	O K
1440 min Summer	1.065	1.065	7.0	1201.8	O K
2160 min Summer	1.023	1.023	7.0	1146.8	O K
2880 min Summer	0.979	0.979	7.0	1090.9	O K
4320 min Summer	0.900	0.900	7.0	990.7	O K
5760 min Summer	0.822	0.822	7.0	893.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	243.617	0.0	578.2	27
30 min Summer	136.001	0.0	554.1	42
60 min Summer	75.923	0.0	984.7	72
120 min Summer	42.384	0.0	1068.5	130
180 min Summer	30.138	0.0	1090.4	190
240 min Summer	23.661	0.0	1088.9	250
360 min Summer	16.825	0.0	1079.2	368
480 min Summer	13.209	0.0	1068.6	488
600 min Summer	10.949	0.0	1058.5	608
720 min Summer	9.392	0.0	1048.8	726
960 min Summer	7.385	0.0	1030.5	964
1440 min Summer	5.262	0.0	996.6	1442
2160 min Summer	3.749	0.0	1798.4	1924
2880 min Summer	2.947	0.0	1872.1	2216
4320 min Summer	2.113	0.0	1832.7	2940
5760 min Summer	1.668	0.0	2157.2	3752

Cascade Summary of Results for Catchment B - Option 2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Summer	0.737	0.737	7.0	790.5	O K
8640 min Summer	0.650	0.650	7.0	688.2	O K
10080 min Summer	0.574	0.574	7.0	600.5	O K
15 min Winter	0.777	0.777	7.0	838.8	O K
30 min Winter	0.855	0.855	7.0	934.3	O K
60 min Winter	0.937	0.937	7.0	1037.6	O K
120 min Winter	1.022	1.022	7.0	1146.6	O K
180 min Winter	1.072	1.072	7.0	1210.8	O K
240 min Winter	1.105	1.105	7.0	1255.0	O K
360 min Winter	1.148	1.148	7.0	1312.9	O K
480 min Winter	1.174	1.174	7.0	1348.2	O K
600 min Winter	1.191	1.191	7.0	1370.4	O K
720 min Winter	1.201	1.201	7.0	1383.9	Flood Risk
960 min Winter	1.210	1.210	7.0	1396.2	Flood Risk
1440 min Winter	1.199	1.199	7.0	1381.7	O K
2160 min Winter	1.163	1.163	7.0	1332.2	O K
2880 min Winter	1.107	1.107	7.0	1257.8	O K
4320 min Winter	1.001	1.001	7.0	1118.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.389	0.0	2244.6	4552
8640 min Summer	1.196	0.0	2317.5	5280
10080 min Summer	1.054	0.0	2377.0	6048
15 min Winter	243.617	0.0	554.9	27
30 min Winter	136.001	0.0	530.1	41
60 min Winter	75.923	0.0	1072.6	70
120 min Winter	42.384	0.0	1098.4	130
180 min Winter	30.138	0.0	1094.2	188
240 min Winter	23.661	0.0	1089.2	246
360 min Winter	16.825	0.0	1080.6	364
480 min Winter	13.209	0.0	1073.7	480
600 min Winter	10.949	0.0	1067.7	596
720 min Winter	9.392	0.0	1062.4	714
960 min Winter	7.385	0.0	1053.8	944
1440 min Winter	5.262	0.0	1042.7	1396
2160 min Winter	3.749	0.0	2000.3	2040
2880 min Winter	2.947	0.0	2047.3	2288
4320 min Winter	2.113	0.0	1899.0	3160

Cascade Summary of Results for Catchment B - Option 2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	0.891	0.891	7.0	978.9	O K
7200 min Winter	0.773	0.773	7.0	834.6	O K
8640 min Winter	0.634	0.634	7.0	669.4	O K
10080 min Winter	0.520	0.520	7.0	539.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Winter	1.668	0.0	2416.2	4088
7200 min Winter	1.389	0.0	2513.9	4976
8640 min Winter	1.196	0.0	2596.5	5696
10080 min Winter	1.054	0.0	2664.6	6360

Cascade Rainfall Details for Catchment B - Option 2.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 530950 201600 TL 30950 01600
C (1km)	-0.025
D1 (1km)	0.274
D2 (1km)	0.279
D3 (1km)	0.294
E (1km)	0.322
F (1km)	2.512
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.650

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.550	4	8	0.550	8	12	0.550

Cascade Model Details for Catchment B - Option 2.SRCX

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	953.9	0.400	1082.2	0.800	1218.5	1.200	1362.9
0.100	985.2	0.500	1115.5	0.900	1253.9	1.300	1400.3
0.200	1017.0	0.600	1149.3	1.000	1289.7	1.400	1438.2
0.300	1049.4	0.700	1183.7	1.100	1326.1	1.500	1476.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0121-7000-1200-7000
Design Head (m)	1.200
Design Flow (l/s)	7.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	121
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	7.0	Kick-Flo®	0.755	5.6
Flush-Flo™	0.351	7.0	Mean Flow over Head Range	-	6.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.3	1.200	7.0	3.000	10.8	7.000	16.1
0.200	6.6	1.400	7.5	3.500	11.6	7.500	16.7
0.300	7.0	1.600	8.0	4.000	12.4	8.000	17.2
0.400	7.0	1.800	8.5	4.500	13.1	8.500	17.7
0.500	6.8	2.000	8.9	5.000	13.7	9.000	18.2
0.600	6.6	2.200	9.3	5.500	14.4	9.500	18.7
0.800	5.8	2.400	9.7	6.000	15.0		
1.000	6.4	2.600	10.1	6.500	15.6		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.721	0.721	6.4	746.8	O K
30 min Summer	0.793	0.793	6.4	831.2	O K
60 min Summer	0.869	0.869	6.4	921.0	O K
120 min Summer	0.945	0.945	6.4	1013.5	O K
180 min Summer	0.988	0.988	6.4	1065.8	O K
240 min Summer	1.015	1.015	6.4	1100.3	O K
360 min Summer	1.049	1.049	6.4	1142.4	O K
480 min Summer	1.066	1.066	6.4	1164.7	O K
600 min Summer	1.075	1.075	6.4	1175.8	O K
720 min Summer	1.078	1.078	6.4	1179.6	O K
960 min Summer	1.075	1.075	6.4	1175.3	O K
1440 min Summer	1.044	1.044	6.4	1136.3	O K
2160 min Summer	0.991	0.991	6.4	1070.2	O K
2880 min Summer	0.944	0.944	6.4	1011.8	O K
4320 min Summer	0.865	0.865	6.4	916.0	O K
5760 min Summer	0.788	0.788	6.4	824.9	O K
7200 min Summer	0.703	0.703	6.4	726.0	O K
8640 min Summer	0.624	0.624	6.4	636.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	243.617	0.0	525.7	27
30 min Summer	136.001	0.0	506.4	42
60 min Summer	75.923	0.0	901.4	72
120 min Summer	42.384	0.0	978.3	130
180 min Summer	30.138	0.0	998.4	190
240 min Summer	23.661	0.0	997.1	250
360 min Summer	16.825	0.0	987.9	368
480 min Summer	13.209	0.0	977.5	488
600 min Summer	10.949	0.0	967.5	606
720 min Summer	9.392	0.0	958.0	724
960 min Summer	7.385	0.0	940.0	964
1440 min Summer	5.262	0.0	906.1	1408
2160 min Summer	3.749	0.0	1646.9	1736
2880 min Summer	2.947	0.0	1712.9	2112
4320 min Summer	2.113	0.0	1668.2	2944
5760 min Summer	1.668	0.0	1977.3	3760
7200 min Summer	1.389	0.0	2057.4	4544
8640 min Summer	1.196	0.0	2124.2	5280

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.553	0.553	6.4	557.7	O K
15 min Winter	0.799	0.799	6.4	837.3	O K
30 min Winter	0.878	0.878	6.4	932.0	O K
60 min Winter	0.961	0.961	6.4	1033.4	O K
120 min Winter	1.046	1.046	6.4	1138.5	O K
180 min Winter	1.093	1.093	6.4	1198.8	O K
240 min Winter	1.125	1.125	6.4	1239.4	O K
360 min Winter	1.164	1.164	6.4	1290.1	O K
480 min Winter	1.186	1.186	6.4	1318.6	O K
600 min Winter	1.198	1.198	6.4	1334.7	O K
720 min Winter	1.204	1.204	6.4	1342.5	Flood Risk
960 min Winter	1.206	1.206	6.4	1344.9	Flood Risk
1440 min Winter	1.183	1.183	6.4	1315.4	O K
2160 min Winter	1.122	1.122	6.4	1236.5	O K
2880 min Winter	1.066	1.066	6.4	1164.1	O K
4320 min Winter	0.963	0.963	6.4	1035.1	O K
5760 min Winter	0.857	0.857	6.4	906.5	O K
7200 min Winter	0.738	0.738	6.4	766.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.054	0.0	2178.7	6048
15 min Winter	243.617	0.0	507.4	27
30 min Winter	136.001	0.0	489.3	41
60 min Winter	75.923	0.0	982.0	70
120 min Winter	42.384	0.0	1005.7	128
180 min Winter	30.138	0.0	1001.6	186
240 min Winter	23.661	0.0	996.4	246
360 min Winter	16.825	0.0	987.4	362
480 min Winter	13.209	0.0	979.9	478
600 min Winter	10.949	0.0	973.3	596
720 min Winter	9.392	0.0	967.3	710
960 min Winter	7.385	0.0	957.2	940
1440 min Winter	5.262	0.0	943.6	1384
2160 min Winter	3.749	0.0	1829.7	1980
2880 min Winter	2.947	0.0	1863.9	2248
4320 min Winter	2.113	0.0	1725.0	3164
5760 min Winter	1.668	0.0	2214.6	4096
7200 min Winter	1.389	0.0	2304.3	4976

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	0.610	0.610	6.4	621.2	O K
10080 min Winter	0.504	0.504	6.4	504.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	1.196	0.0	2379.9	5632
10080 min Winter	1.054	0.0	2442.3	6360

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 530950 201600 TL 30950 01600
C (1km)	-0.025
D1 (1km)	0.274
D2 (1km)	0.279
D3 (1km)	0.294
E (1km)	0.322
F (1km)	2.512
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.650

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.550	4	8	0.550	8	12	0.550

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	924.2	0.400	1047.3	0.800	1178.1	1.200	1316.6
0.100	954.3	0.500	1079.3	0.900	1212.0	1.300	1352.4
0.200	984.8	0.600	1111.7	1.000	1246.4	1.400	1388.7
0.300	1015.8	0.700	1144.7	1.100	1281.2	1.500	1425.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0116-6400-1200-6400
Design Head (m)	1.200
Design Flow (l/s)	6.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	116
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	6.4	Kick-Flo®	0.751	5.1
Flush-Flo™	0.354	6.4	Mean Flow over Head Range	-	5.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.1	1.200	6.4	3.000	9.8	7.000	14.7
0.200	6.0	1.400	6.9	3.500	10.6	7.500	15.2
0.300	6.3	1.600	7.3	4.000	11.3	8.000	15.7
0.400	6.3	1.800	7.7	4.500	11.9	8.500	16.2
0.500	6.2	2.000	8.1	5.000	12.5	9.000	16.6
0.600	6.0	2.200	8.5	5.500	13.1	9.500	17.0
0.800	5.3	2.400	8.9	6.000	13.7		
1.000	5.9	2.600	9.2	6.500	14.2		

Appendix D – Thames Water Correspondence

Asset Location Search

George Ogden
Brookbanks Consulting Limited
Knights Court
6150Solihull Parkway
BIRMINGHAM
B37 7WY

Search address supplied 530485 202074 , Land At
Northaw Road East
Cuffley

Your reference GO/ES/

Our reference ALS/ALS Standard/2014_2829118

Search date 6 August 2014

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

Asset Location Search

Search address supplied: 530485 202074 , Land At, Northaw Road East, Cuffley,

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Asset Location Search

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an ‘as constructed’ record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Affinity Water Ltd
Tamblin Way
Hatfield

Asset Location Search

AL10 9EZ
Tel: 0845 7823333

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

Thank you for your payment covering the cost of this enquiry. We have enclosed a VAT Receipt for your records.

Asset Location Search

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0800 316 9800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

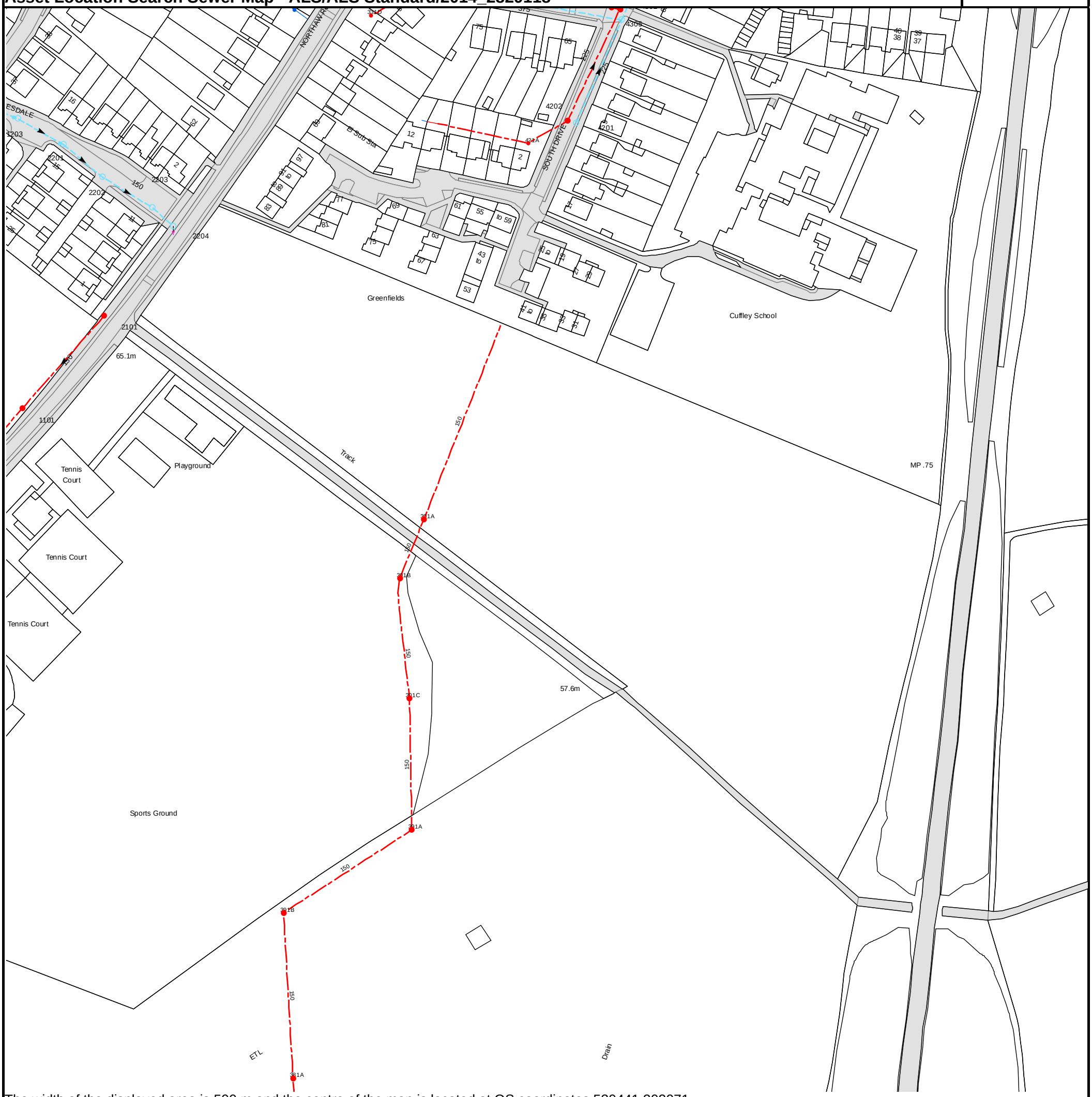
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2014_2829118



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 530441,202071

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
2101	65.98	64.79
2204	n/a	n/a
2203	67.66	66.4
2202	69.63	67.84
2201	72.21	69.31
421A	n/a	n/a
4201	65.74	64.9
4202	65.53	64.54
1203	74.64	72.29
4305	66.2	64
331D	n/a	n/a
331B	n/a	n/a
4302	66.1	63.62
381A	n/a	n/a
391B	n/a	n/a
391A	n/a	n/a
301C	n/a	n/a
301B	n/a	n/a
301A	n/a	n/a
1101	63.52	62.49

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to him at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0845 070 9148** quoting your invoice number starting CBA or ADS.	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Invoice

George Ogden

Brookbanks Consulting Limited
6150 Knights Court
Solihull Parkway
Birmingham
B37 7WY

Thames Water Utilities Ltd.
PO Box 3189
Slough
SL1 4WW

Customer Reference: GO/ES/

Customer Number: ADS104513

Purchase Order No:

Invoice No: ADS14370080
Our Ref: ALS/ALS Standard/2014_2829118

Posting Date: 06-08-2014
Due Date: 20-08-2014

Search Address Supplied: 530485 202074 , Land At, Northaw Road East, Cuffley,

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Description of Charges	Qty	Unit Price	VAT (20%)	Amount (Inc VAT)
Asset Location Search	1	£47.40	£9.48	£56.88

Thank you for your payment of 111111 £56.88

OUTSTANDING AMOUNT (Inc. VAT) £0.00

Please send any outstanding amount to Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.

For queries please contact the Property Searches Customer Support Team on Tel: 0845 070 9148.

VAT Reg. No GB 537456915

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

F.A.O: Miss G Ogden

Brookbanks Consulting Ltd,
6150 Knights Court,
Solihull Parkway,
Birmingham Business Park,
Birmingham,
B37 7WY

Developer Services Waste
Clearwater Court 3rd West
Vastern Road, Reading, RG1 8DB

Your ref
Our ref 1012049666/50024655

Name Shaun Picart
Phone 0845 850 2777
Fax 0118 373 8973
E-Mail

Date: 02/09/2014

Dear Mrs Ogden,

Re: Pre-Development Enquiry For Proposed Development At L/a Northaw Road East, Cuffley, EN6 4LY

I refer to your application for the above site requesting that a pre-development capacity check is undertaken.

Thankyou for providing the correct fee and information regarding the site. I can now respond as follows;

With regard to clean water supplies, this comes within the area covered by the Affinity Water Company. For your information the address to write to is - Veolia Water Company The Hub, Tamblin Way, Hatfield, Herts, AL10 9EZ - Tel - 0845 782 3333.

Foul Drainage

From the information you have provided, I can confirm that the existing foul water sewer does have sufficient capacity to accommodate the proposed foul water discharge from the proposal as specified in your application.

Please note: There are public sewers crossing the development site. In order to protect public sewers and to ensure that Thames Water can gain access to those sewers for future repair and maintenance, approval should be sought from Thames Water where the erection of a building would come within 3 metres of, a public sewer.

Surface Water Drainage

Please note that discharging surface water to the public sewer network should only be considered after all other methods of disposal have been investigated and proven to be not viable. In accordance with the Building Act 2000 Clause H3.3, positive connection to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. The disposal hierarchy being: 1st Soakaways; 2nd Watercourses; 3rd Sewers.

In respect of surface water it is recommended that you should ensure that storm flows are attenuated or regulated into the receiving drainage system through on

Thames Water Utilities Ltd
Developer Services
Clearwater Court 3rd West
Vastern Road
Reading RG1 8DB

T 0845 850 2777
F 0207.713.3888
I www.thames-water.com

or off site storage. Connections to public sewers are not permitted for the removal of groundwater.

All connection requests are subject to a full Section 106 (Water Industry Act 1991) application before the Company can confirm approval to the connection itself. Please also note that capacity in the public sewerage system cannot be reserved.

Please note that the views expressed by Thames Water in this letter are in response to this pre development enquiry at this time and do not represent our final views on any future planning applications made in relation to this site.

We reserve the right to change our position in relation to any such planning applications.

Yours faithfully

Shaun Picart
Development Engineer

Head Office Address

6150 Knights Court,

Solihull Parkway,

Birmingham Business Park,

Birmingham.

B37 7WY

T +44(0)121 329 4330

mail@brookbanks.com

brookbanks.com