**Flood Risk Assessment and Drainage Strategy**

April 2020

EAS

# Former Turnford Surfacing Site

## Land off Rye Road, Hoddesdon
## Broxbourne Borough Council

**Elvidge & Jones**

EAS

## Document History

**JOB NUMBER:** 704/2020
**DOCUMENT REF:** Flood Risk Assessment and Drainage Strategy
**REVISIONS:** B – For Submission

| Revision | Comments | By | Checked | Authorised | Date |
|---|---|---|---|---|---|
| A | Client Draft | ML | SA | SA | 24/01/2020 |
| B | For Submission | ML | SA | SA | 22/04/2020 |
| C | | | | | |
| D | | | | | |
| E | | | | | |
| | | | | | |



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG **Tel 01920 871 777** **e: contact@eastp.co.uk** **www.eastp.co.uk**

EAS

## Contents






TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG **Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk**

# 1 Introduction

1.1 This Flood Risk Assessment has been prepared in support of an application by E & J Properties Ltd for the redevelopment of the former Turnford Surfacing site, Rye Road, Hoddesdon, Hertfordshire, EN11 0EG, for residential development.

1.2 The site is approximately 1.2 hectares in size. There are currently no buildings onsite and the site comprises hard-standings with a concrete surface throughout. It is therefore assumed that 100% of the existing site can be considered as impermeable area. From Autumn 2016 until early 2019, the site was occupied by Wren Kitchens who used it as a storage and distribution deport for their packaged kitchens in London and the southeast. Earlier, the owner was Bardon Aggregates who bought it from Turnford Surfacing in 2008/9 and then sold it to the current owners. Because of the recession the owners did not make full use of the site until it was sold to Wren. Turnford Surfacing had used the site for a tarmac batching plant which received planning permission in October 1988. A location plan is included in **Appendix A**.

1.3 The proposed scheme will redevelop the site to provide up to 104 residential dwellings, which is expected to include:

- 29 one bedroom apartments
- 62 two bedroom apartments
- 13 three bedroom townhouses

1.4 In addition to the residential dwellings a proposed community/commercial space with a GFA of 115sqm is proposed at the site front which may take the form of a café. The proposed development layout is contained in **Appendix B**.

1.5 This report was sent to the Environment Agency (EA) and Hertfordshire County Council SuDS Team for pre-application consultation In October 2015. The EA did not have any comments on the proposals, and the Herts CC SuDS Team comments have been addressed. Following publication of new climate change guidance in February 2016, the EA were once again consulted on how to apply these new allowances to the site. This has been discussed in more detail in Section 4.

1.6 The contents of this FRA are based on the advice set out in The National Planning Policy Framework (NPPF) last published 2019 and the Technical Guidance to the NPPF published March 2012, and the Planning Practice Guidance (PPG), published March 2014. New climate change guidance was published by the government in February 2016 and has been used to inform this report.

1.7 This report is based on the following data: Environment Agency Flood Maps, on-site observation, BGS geological information, OS mapping, topographic survey, and outline drainage calculations.

1.8 This FRA is set out as follows:

Section 2 – outlines current policy guidance.

Section 3 – site description, including site levels, proximity to watercourses etc.

Section 4 – describes the development proposals

Section 5 – outlines potential sources of flooding.

Section 6 – describes the existing site hydrology and outlines a surface water drainage strategy.

Section 7 – concludes the study and makes recommendations on how to best take the scheme forward with regards to flood risk issues.



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS

Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

# 2 Policy Context

### Introduction

2.1 This section sets out the policy context. The contents of this SuDS Statement are based on the advice set out in The National Planning Policy Framework (NPPF) published in February 2019 and updated June 2019, and the Planning Practice Guidance (PPG) published March 2014, which is updated on an ad hoc basis.

2.2 Paragraph 164 footnote 50 of the NPPF states:

*"A site-specific flood risk assessment should be provided for all developments in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use."*

2.3 The flood risk zones are defined as:

- Flood Zone 1- This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river flooding (<0.1%)
- Flood Zone 2- This zone comprises land assessed as having between a 1 in a 100 and 1 in 1,000 annual probability of river flooding.
- Flood Zone 3a- This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), and for tidal flooding at least a 0.5% annual probability of flooding from tidal sources.
- Flood Zone 3b- This zone comprises land where water has to flow or be stored in times of flood.

2.4 Paragraph 155 discusses the suitability of development location, particularly with regard to future risks induced by climate change:

*"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere".*

2.5 Paragraph 156 of the National Planning Policy Framework (NPPF) states:

*"Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards".*

2.6 Paragraphs 165 NPPF discusses the application of sustainable drainage systems:

*"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

- *Take account of advice from the lead local flood authority;*
- *Have appropriate proposed minimum operational standards;*
- *Have maintenance arrangements in place to ensure an acceptable standard of operation of the lifetime of the development; and*
- *Where possible, provide multifunctional benefits."*

**Local Policy**

2.7 The Broxbourne Local Plan 2018-2033 is currently under examination by the Secretary of State, with the main consultation running until the 19 February 2020.

2.8 The Emerging Local Plan contains one policy of direct relevance to the proposals. This is Policy HOD2: Turnford Surfacing which states that "*The Council seeks the redevelopment of the Turnford Surfacing Site in accordance with an updated* Development Brief*.*"

2.9 The emerging Local Plan has three main policies which need to be complied with in this Flood Risk Assessment and Drainage Strategy and will be discussed throughout this report:

2.10 Policy W2 Water Quality

*I. Proposals should not result in a deterioration of surface or groundwater quality.*

*II. A drainage strategy or plan must be submitted with all applications showing how:*

*a) rain water runoff will be managed on site both during and following heavy rainfall; and*

*b) how foul and surface water will be managed and disposed of.*

*III. Drainage on the site must clearly delineate, and provide separation between, foul and surface flows.*

2.11 Policy W4 Sustainable Drainage Systems

*I. Sustainable Drainage systems should be designed and implemented in ways that deliver multiple benefits, including improvements in water quality, biodiversity, amenity and recreation. Where practicable, SuDS should be designed to ensure the sustainable drainage networks have the additional capacity required to cope with infrequent adverse weather conditions and therefore reduce flood risk.*

*II. Development should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible.*

*III. Development must utilise the most sustainable forms of drainage systems in accordance with the SuDS hierarchy. The Council will resist the use of underground holding tanks.*

*IV. The provision of balancing ponds as part of an area of public open space for recreation or wildlife should be designed to ensure the safety of users of the space.*

*V. Where SuDS are provided as part of a development, applicants should detail how it will be managed and maintained in the long term.*

*VI. The Council will require retrofitting of sustainable drainage systems (SuDS) and other water management measures where-ever possible, to improve water quality and reduce the responsiveness of catchments in the Borough to high intensity rainfall events.*

2.12 Policy W5 Flood Risk

*I. The functional floodplain will be protected from development. Wherever possible, developed areas within Flood Zone 3b should be returned to Greenfield status with an enhanced level of biodiversity.*

*II. Overland flow routes and flood storage areas will be protected from all development.*

*III. Development proposals, including the raising of land, in areas at risk from flooding will only be considered if they pass the flood risk sequential test and if necessary, the exception test and they do not:*

*a) increase the risk of flooding elsewhere;*

*b) impede flood water flows, unless by design;*

*c) endanger river channel stability;*

*d) reduce the capacity of the floodplain.*

**Redevelopment on Floodplains**

*IV. Any proposal for intensification or redevelopment of a site within Flood Zone 3, as currently defined, must include on-site flood storage and flood resilient features.*

2.13 A Strategic Flood Risk Assessment (SFRA) was published by Broxbourne Borough Council in May 2016 to inform development control in the local area. The SFRA reviews all types of flooding in the local area, and draws from all available sources including the Environment Agency, the Council flood incident database, and Thames Water data. As such it provides essential evidence of existing flooding and drainage issues.

2.14 The SFRA discusses historic flood events which affected the borough, mainly as a result of a flashy catchment (i.e. watercourses rapidly responding to heavy rainfall), culverted and artificially straightened sections of watercourses and localised blockages. The construction of the River Lee Flood Relief Channel has successfully reduced the flood risk to many parts of the borough although more recent events in October 1987, October 1993 and October 2000 caused the Flood Relief Channel to operate at full capacity.

2.15 A review of surface water flooding in Broxbourne summarises the main causes as:

- Lack of maintenance of gullies;
- Heavy reliance on outlets into watercourses for surface water drainage;
- Urban extensions which also rely on drainage into watercourses; and
- Reliance on soakaways which are not suitable for catchments with high water tables.

2.16 A number of improvements to the maintenance programme to clean gullies and secure drainage funding have been made by Hertfordshire Highways to contribute towards resolving surface water flooding in the borough.

2.17 Groundwater flooding has been observed at several locations throughout Broxbourne. Table 4-3 shows the Environment Agency records of groundwater flooding. One location near to the site is GW_2 at Paddick Close, Rye Park. The cause of groundwater flooding in this instance was the geology of gravel overlaying London Clay. This resulted in basement flooding. Paddick Close is located approximately 2km to the south west of the site. It is therefore recommended that some ground investigation is carried out to establish the groundwater level beneath the site at the earliest opportunity and include mitigation measures in the development design if levels are high.

2.18 Thames Water sewer flooding records at postcode level are included at Table 4-4 of the SFRA. This shows that postcode area 'EN11' has no records of flooding from sewers in the 10 years prior to 2007.

2.19 A Level 2 SFRA was undertaken in April 2017 which included further specific information relating to this site. All points raised in the L2 SFRA have been considered and met as part of this work.

**Turnford Surfacing Site Development Brief June 2011**

2.20 Broxbourne Borough Council has prepared a Development Brief to guide development proposals for the Turnford Surfacing site. The document proposed the re-development of the site for housing and highlights how the design and layout of all the buildings must take account of flood risk. Suggested mitigation measures include the elevation of buildings, flood proofing and locating habitable rooms above the flood level. These considerations have been included within this FRA to demonstrate how the proposals will comply with Broxbourne Borough Council's requirements.

## 3 Existing Site Assessment

### Site Description

3.1 A location plan is included in **Appendix A.** The site is located adjacent to Rye Road, between the western bank of the River Lee and the railway line, to the east of Hoddesdon in Hertfordshire. Access to the site is via Rye Road, which forms the southern boundary.

3.2 To the west of the site, beyond the railway line, is the New River, some business premises and residential estates of Hoddesdon. To the north is Rye Meads Nature Reserve and to the east is the River Lee Navigation and the Lee Valley Walk. Beyond this, around 500m east of the site, is a sewage works. To the south east is Rye House Karting Centre and Speedway and to the south is Hoddesdon Industrial Centre.

3.3 The site is approximately 1.2 hectares in size. There are currently no buildings onsite and the site comprises hard-standings with a concrete surface throughout. It is therefore assumed that 100% of the existing site can be considered as impermeable area. From Autumn 2016 until early 2019, the site was occupied by Wren Kitchens who used it as a storage and distribution deport for their packaged kitchens in London and the southeast. Earlier, the owner was Bardon Aggregates who bought it from Turnford Surfacing in 2008/9 and then sold it to the current owners. Because of the recession the owners did not make full use of the site until it was sold to Wren. Turnford Surfacing had used the site for a tarmac batching plant which received planning permission in October 1988.

### Local Watercourses

3.4 The site is immediately to the west of the River Lee and around 500m west of Toll House Stream, which flows through the sewage treatment works and the nature reserve. The River Stort (Navigation) and River Stort is located around 1km to the south east of the site. All of these watercourses are considered to be 'Main Rivers' on the EA flood map.

3.5 The New River passes the site around 55m west of the site boundary.

3.6 There are several large lakes in the vicinity which are part of the River Lee flood relief channel, some of which are 'online' with levels controlled by a series of sluice gates and weirs. There are also the lakes within the Rye Meads Nature Reserve around 250m north of the site.

### Site Levels

3.7 Reference to the topographic survey included in **Appendix D** indicates that the site is typically flat with levels of around 29.6m AOD. However, the levels adjacent to Rye Road increase to 31.0m AOD. The lowest site levels within the main development site are around 29.4m AOD, in the north eastern corner.

3.8 The road within the site, which is adjacent to the eastern boundary, is set approximately 1m below the typical site level. The road has a level of 28.50m AOD at its lowest point.

3.9 It is noted that a 2.0m high tree lined bund forms the northern boundary of the development area and extends south by 140m on the eastern boundary and 50m on the western boundary.

The bund on the eastern boundary raises site levels to around 31.0m AOD which is typically 2m above the site level and 3m above the towpath level.

**Geology**

3.10 With reference to the British Geological Survey online mapping, the site is located within an area of Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated) – Chalk bedrock geology. To the east of the site are superficial deposits of Alluvium – Clay, Silt, Sand and Gravel while the majority of the site to the west has superficial deposits of West Kempton Park Gravel Formation – Sand and Gravel. The bedrock of chalk indicates that the ground may have a high level of permeability which would make infiltration methods viable. However, due to the site's previous industrial use, infiltration is not recommended as a means of drainage due to the potential to mobilise any existing contaminants within the underlying geology.

**Existing Site Drainage**

3.11 The Thames Water sewer records included at **Appendix E** show an existing Thames Water surface water sewer crossing the site. The sewer has a 375mm diameter and an outfall to the River Lee. The 2010 FRA notes that the surface water sewer drains a number of warehouses on the business estate to the west of the site in addition to the existing site. The Thames Water sewer records also indicate a foul water rising main (300mm) flowing to the south along Plumpton Road and two foul water rising mains (450mm diameter) flowing along Rye Road. It appears that they may encroach onto the site along the southern boundary.

3.12 The topographic survey (**Appendix D**) shows there to be several inspection chambers around the site. This indicates the presence of an existing onsite drainage system. It is assumed the site drains unattenuated to the Thames Water surface water sewer which crosses the site and discharges into the River Lee.

# 4 Potential Sources of Flooding

**Fluvial**

4.1 A copy of the Environment Agency's Flood Map for the area along with detailed mapping is included in **Appendix C**. The mapping shows that the majority of the site is located in Flood Zone 2 ('Medium' risk, between 1 in 100 and 1 in 1000 annual probability of flooding). The very eastern edge of the site is shown to be located in Flood Zone 3, some of which is within an area benefitting from defences. Flood Zone 3 is defined as 'High' risk, with a greater than 1 in 100 annual probability of flooding. However, as discussed below, comparison between topographic levels and modelled flood levels indicate the majority of the site to be above the 1 in 1000-year flood level. As the site is mostly in Flood Zone 2 and none of the development will be located in Flood Zone 3, Natasha Smith (EA Sustainable Places Planning Advisor) confirmed that the EA will not be reviewing the FRA as part of the application. The email from Natasha Smith is included in **Appendix C**.

4.2 The main flood source is the River Lee Navigation. The EA data indicates the defence standard of protection along this section of the River Lee Navigation (Asset ID 146050) is up to 1 in 10 years. This indicates that although the flood extents and levels provided are labelled as 'defended', the nearby defences in this case are unlikely to provide any protection to modelled events above the 1 in 10 year return period as all modelled return periods would be higher than the defence standard. It is assumed that the 'defended' scenarios account for upstream storage within the River Lee Flood Relief Channel rather than local flood defences near the site.

4.3 The historic flood map enclosed within the EA Product 4 data (**Appendix C**) shows the site was flooded during the 1947 and 1968 events. Following the major flooding resulting from the 1947 event, works have taken place to improve the flood defences in the area such as constructing the lakes and channels of the River Lee Flood Relief Channel and the Nazeing Drain Flood Relief Channel. The EA mapping does not indicate any further flooding at the site since the construction of the Flood Relief Channel, therefore the site has been located in Flood Zone 2 as a result of the historic flood extent.

4.4 The flood extent maps contained in the EA Product 4 data indicates that in the 'defended' scenario, taking account of the River Lee Flood Relief Channel and local defences, events up to and including the 1 in 75 year flood would not reach the site. It was noted during a site visit in July 2015 that the road adjacent to the eastern site boundary is set around 1m below the typical site level at around 28.50m AOD. This is shown in more detail on the topographic survey at **Appendix D**. However, this access road has been removed as part of the proposals and finished ground levels across the site are set at 29.70m AOD.

4.5 The flood data provided by the EA gives levels for both in-channel flows taken from a 1D model and out of bank flows taken from a 2D model, and there appears to be slight differences in levels between the two datasets. Consultation with the EA (telephone call between Louisa Wade EAS and a member of the Hertfordshire and North London EA modelling team on 14th August 2015) confirmed that the 2D modelled flood levels are the most detailed data and these should be used where possible to assess the flood risk to the site, rather than the 1D in-channel river levels. As such, the 2D model nodes along the eastern edge of the site, which have been used to create the flood extent, have been used for this assessment.

4.6 The highest flood levels of the 2D model nodes within the site boundary were taken from the Product 4 EA data (**Appendix C**) and reproduced onto the topographic survey to illustrate the actual Flood Zone 2 and 3 extent. Table 1 shows the flood levels used to create the extents and the flood extents are shown in **Appendix F.**

| Flood Zone | Return Period | Flood Level |
|---|---|---|
| 2 | 1 in 1000 year | 29.17m AOD |
| 3 | 1 in 100 year | 28.58m AOD |

Table 1: Present day flood levels used to assess site (taken from EA modelled data Appendix C)

4.7 It is clear from the drawings in **Appendix F** that the present day 1 in 100 year and 1 in 1000 year flood extends slightly into the site boundary along the eastern edge where the land is lowest. This is the area where the existing access road is located, which has a low level of approximately 28.50m AOD. A ditch is located along the north east boundary of the site which has a level of around 28.20m AOD. The level of the access road is around 1m lower than the general site level.

4.8 As part of the proposed development, the existing access road will be moved further in to the site and the built area of the site will be set at 29.70m AOD, whilst the public open space will be lowered to provide flood compensation see paragraph 5.5 for more details and **Appendix G**. This is above even the 1 in 1000-year flood level of 29.17m AOD and indicates that the site can be considered to be at 'Low' risk of flooding from the River Lee.

### Climate Change Allowances

4.9 The government published new guidance on climate change allowances in February 2016 which must now be applied to all proposed developments. The new guidance considers the peak river flow by river basin district and applies different allowances across the country. The EA were consulted on the correct climate change allowance to use for the site, and their response has been included in **Appendix C**. This states that that 'higher central' 35% allowance should be used for the proposed development as it is a 'more vulnerable' use in Flood Zone 2. A follow up phone call with the EA confirmed that the climate change flood level for a 1 in 100 year (+35%CC) event could be determined through a stage-discharge graph.

4.10 The stage-discharge graph was calculated by using the modelled in-channel 1D levels and flows, and extrapolating the curve based on the difference between the 1 in 100 year and 1 in 100 year (+20%CC) modelled levels. A 1 in 100 year (+35%CC) in-channel level of 29.325m AOD was estimated. However, as the EA advised that the 2D modelled levels are more accurate for the floodplain, the difference between the modelled 1 in 100 year (+20%CC) and the extrapolated 1 in 100 year (+35%CC) was applied to the highest 2D flood level on site for a 1 in 100 year (+20%CC) event. The highest 2D level on site was a 1 in 100 year (+20%CC) flood level of 28.79m AOD. When the difference was applied, this gave a 1 in 100 year (+35%CC) level of **29.045m AOD**. This is the flood level used for assessing floodplain compensation, which has been discussed further in Section 5. The stage-discharge graph and resulting flood levels are included in **Appendix C.**

4.11 Whilst it was previously agreed that the stage-discharge graph was sufficient, as this is a major application and there is an increase in the number of units provided on site since previous correspondence with the EA, it was felt that re-running the modelling with 35% allowance for climate change was necessary to confirm the accuracy of the stage-discharge method.

4.12 In order to determine a more accurate 1 in 100 year (+35%CC) flood level at the site, it was necessary to re-run the River Lee 2D Flood Mapping Study M01 model. There were two versions of the model, one with the prefix '_095' which was the defended model and one with the prefix '_087' which was the catchment wide model. In the 1D Flood Modeller program, all inflows of both models for the 1 in 100 year event were scaled up by 1.35, to create the 1 in 100 year (+35%CC) inflows. No other changes were made and then both models were re-run. The resulting 2D flood level results were compared at the site and the '_095' defended model resulted in the highest levels onsite. The levels onsite were between 28.86m AOD to 28.96m AOD. These were compared to the EA's 1 in 100 year (+20%CC) flood levels onsite and were between 0.16m and 0.17m higher. Compared to the 1 in 1000 year event, the 1 in 100 year (+35%CC) were around 0.19m lower. This sensibility check verified that the 1 in 100 year (+35%CC) levels are reasonable for the site. The different flood levels are shown in the table below.

| **Modelled Event** | **Flood Level Northern end of site (m AOD)** | **Flood Level Southern end of site (m AOD)** |
|---|---|---|
| 1 in 100 year | 28.58 | 28.54 |
| 1 in 100 year (+20%CC) | 28.79 | 28.70 |
| 1 in 100 year (+35%CC) | 28.96 | 28.86 |
| 1 in 1000 | 29.15 | 29.05 |

Table 2: Modelled flood levels based on outputs from 1D Floodmodeller Program

4.13 The model outputs show that the stage-discharge graph overestimated the flood levels but as this was the agreed methodology with the EA and the finished ground levels on site will be set significantly higher than the flood levels calculated by either method, the stage-discharge levels have been used to determine the floodplain compensation.

4.14 As mentioned previously, the 'defended' flood extent mapping of the site is more likely to represent the 'undefended' scenario (i.e. the actual flood risk) as the flood defences in this area only have a 10-year standard of protection. This means that any flood event greater than 1 in 10 years will not be influenced by the presence of the defences. It is clear from the EA mapping that any floodwater would likely flow out of banks towards the east where there is lower land and several large lakes/wetlands, rather than to the west towards the site.

4.15 Although the EA flood map indicates the site to be within Flood Zone 2, comparison of the modelled flood levels on the River Lee show most of the site to be at a higher elevation than the 1 in 1000 year flood level, except along the eastern boundary. Therefore, it can be concluded that the site will remain safe and dry for all foreseeable fluvial flood events on the River Lee.

### Surface Water

4.16 Reference to the surface water flood risk map provided by the EA indicates the site to be located in an area with 'very low' risk of flooding, as shown in **Appendix C**. This means the chance of flooding each year is less than 1 in 1000 (0.1%). This is likely due to the presence of an effective surface water drainage system on the existing site which intercepts the surface water before it pools and becomes a flood risk. The proposed development will also include an effective drainage system.

4.17 The Level 1 SFRA identifies local drainage issues in Salisbury Road, which is approximately 250m to the west of the site. The flooding issues are related to soakaways in the area which became saturated, resulting in localised property and highway flooding. This is a localised issue relating to drainage rather than overland flows and therefore is not considered to impact the proposed development site.

4.18 Therefore, the risk of flooding from surface water is considered to be low.

### Overland Flowpaths

4.19 The vector map, also on the EA website, does not show any surface water flow vectors within the red line boundary. Figure 1 is a screen capture from the EA website, showing the likely flowpaths around the site. No overland flowpaths are shown to cross the site.

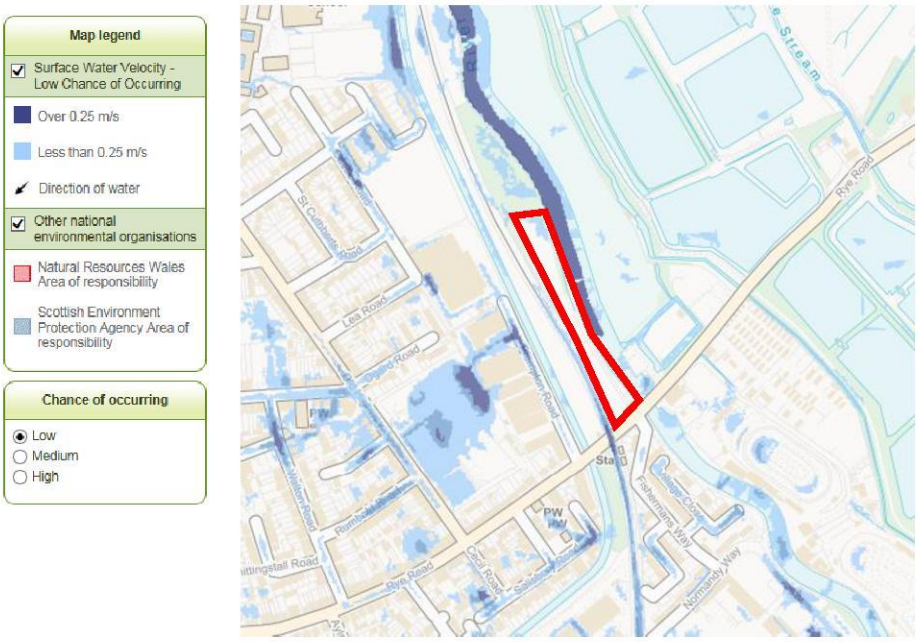



Figure 1: Long Term Flood Risk map (source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

4.20 However, it is possible to see the surface water vectors directing water along the northern site boundary and towards the river. This is likely due to the bund which is located at the northern end of the site which obstructs flows going south and diverts them towards the river to the east.

4.21 To gain a better understanding of likely flowpaths onsite, the topographic survey (**Appendix D**) was analysed. The site is typically flat but rises slightly to the south at the boundary with Rye Road and the north where the bund is located. As discussed previously, the lowest section onsite is along the eastern boundary, at the existing access road. Levels on the road in the vicinity of the existing surface water sewer, to the east of the site, are around 28.50m AOD. It is therefore reasonable to assume that during periods of heavy rainfall; runoff would be directed to this area if it is not collected in the onsite drainage system. However, under normal operation of the onsite drainage system, runoff would likely be collected and discharged to the River Lee before it reached a level to pose a significant flood risk to the site.

**Groundwater**

4.22 The EA online groundwater maps show the site to be located in a groundwater source protection zone classed as 'Outer Zone 2'. This is defined as "*a 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction.*"

4.23 The EA online mapping shows the site to be located above a Principal Aquifer based on bedrock. Principal Aquifers are defined as: "*These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.*"

4.24 The EA mapping also shows the site to be located above a Secondary A aquifer based on superficial deposits. Secondary A aquifers are described as "*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.*"

4.25 The Groundwater Vulnerability Map on the EA website shows the site to be classed as 'Major Aquifer High'. This is an area which is above a Principal Aquifer which is considered to be vulnerable to pollutants, as the bedrock forming the aquifer may serve to provide a pathway for pollutants to enter the groundwater. It is therefore important to ensure that pathways for contaminants are not created through the proposed drainage measures for the proposed development.

4.26 The 2007 Level 1 SFRA Table 4-3 notes that there was an incident of groundwater flooding to a basement around 1.5km west of the site in Paddick Close, Rye Park. This was a result of the underlying geology of gravel overlying London Clay. There are several other incidents of groundwater flooding within the borough as a result of either high groundwater levels or susceptible geological composition.

4.27 The BGS website shows a historic borehole was taken at the northern end of the site in 1978, labelled as borehole TL31SE188. The borehole record states that groundwater was struck at a depth of 4.50m and rose to 1.70m below ground level. Although this is a historic borehole, it indicates there may be fairly high levels of groundwater present, particularly due to the chalk geology and location of the site adjacent to the River Lee.

4.28 It is recommended that initial ground investigation is carried out prior to any works on site, to determine the groundwater level and ascertain whether any mitigation measures need to be included in the development design.

**Sewer Flooding**

4.29 The 2016 Level 1 SFRA discusses historic sewer flooding with reference to Thames Water DG5 data. This data is provided at postcode level, and there was only one sewer flooding event recorded for the 'EN11 0' area.

4.30 Thames Water sewer records (**Appendix E**) indicate a surface water sewer to cross the site and outfall to the River Lee. There is a residual risk that the sewer may become blocked and surcharge within the site boundary. However, with reference to the topographic levels across the site, any surcharging flows would be directed to the south and towards Rye Road rather than pool on site. Regular inspection and maintenance of the drainage systems will reduce this residual risk to the proposed development.

4.31 The risk of flooding from sewers is considered to be low at the site, however a residual risk remains which can be managed through regular inspections and maintenance of the drainage systems serving the site.

**Artificial**

4.32 The site is shown on the EA website to be located in an area at risk of flooding from reservoirs, with the source being the Rye Meads Lagoons 11,13,15 & 17. The reservoir owner is noted to be Thames Water. These lagoons are located approximately 250m north of the site.

4.33 Should any of the reservoirs breach, the EA mapping shows the resulting flood extent. The EA notes that reservoir flooding is extremely unlikely to occur due to the regular inspections and maintenance of these structures under the Reservoirs Act 1975. In the highly unlikely event that one of these reservoirs fails, the bund surrounding the northern and eastern boundaries of the site would provide some protection against the flows. It is likely that much of the water resulting from a breach would flow into the River Lee rather onto the site therefore the impact to the site would be reduced. Due to the risk being so small, the failure of a reservoir is considered a residual risk to the site.

4.34 The New River, which was constructed in 1631 to take clean water to London, is located approximately 55m to the west of the site. It is at a level which is some way above the development site however the adjacent railway line is at a lower level and would likely direct any overland flows as a result of a breach away from the development.

4.35 It is therefore concluded that the risk of flooding from artificial sources is residual and the actual risk to the site is low.

# 5 Mitigation Measures

## Fluvial Mitigation

5.1 Comparison of site levels against modelled flood levels in Section 4 demonstrates that most of the site is higher than the 1 in 1000 year flood level. Only the very eastern edge of the site (where the existing access road is located) lies within Flood Zone 3a, as shown on the drawing in **Appendix F**.

5.2 The proposed site layout is enclosed in **Appendix B** and the proposed access road will be relocated along the western portion of the site. The site levels will be raised along part of the old access road where Block A will be located but all areas of public open space have been lowered along the eastern boundary to provide floodplain compensation.

5.3 As site levels are proposed to be a minimum of 29.7m AOD across the site, this is 655mm above the 1 in 100 year (+35%CC) flood level of 29.045m AOD therefore further mitigation measures are not required however, it is recommended that finished ground floor levels are raised a nominal 150mm above the surrounding ground level.

5.4 As the areas of public open space along the eastern boundary will be allowed to flood in the proposed scenario during a 1 in 100 year (+35%CC) event, a flood warning procedure should be included in the proposed development to warn future site occupants about the potential flood risk to the access road. This has been discussed later in this section.

## Floodplain Compensation

5.5 Floodplain compensation modelling was carried out to determine where the storage volume can be provided within the site, up to the 1 in 100 year (+35%CC) flood level of 29.045m AOD. The drawings in **Appendix G** show the existing and proposed flood extents for the 1 in 100 year (+35%CC) event. The existing site shows the flood volume to be mainly contained within the access road and around the embankment to the north of the site.

5.6 The proposed site shows the floodplain compensation can be provided along the eastern boundary including within the two areas of open space and to the north of the ditch on the northern boundary of the site as shown within **Appendix G.** An additional 134$m^3$ overall flood volume will be provided within adjacent to the towpath within the open space, with additional volume contained within each 200mm band.

5.7 Finished ground floor levels in the houses will be set at a minimum of 29.7m AOD to ensure that no floodwater can enter the buildings and they will remain safe and dry even in extreme events.

## Surface Water Mitigation

5.8 By raising ground floor levels to a minimum level of 29.7m AOD, this will prevent surface water egress into buildings, and by implementing an effective drainage system at the site, the surface water runoff from the proposed development should be suitably managed and will be unlikely to present a flood risk.

## Groundwater Mitigation

5.9 As noted in Section 4, the site is located above a Principal Aquifer and adjacent to a river. It is recommended that groundwater levels are determined through initial ground investigation at an early stage. If levels are high, it is recommended that mitigation measures are included in the scheme design to protect the ground floor and any proposed basement areas from this potential risk. It is recommended that a geotechnical or structural engineer is consulted for advice on developing in areas with high groundwater levels, to ensure the foundations are structurally sound and the lower levels of the development are suitably waterproofed if necessary.

**Exceedance Area**

5.10 The proposed site levels are flat across the site and therefore in the unlikely event of rainfall greater than the 1 in 100 year + 40% climate change event, any flood depths will be minimal across the site and with finished floor levels raised a minimum of 150mm above the existing ground level it is highly unlikely that the runoff will pool to a level which will extend into any of the buildings. Any additional volume of water that couldn't be contained within the permeable paving would flow towards the River Lee in the footpath near to each of the flow control devices. It is recommended that a dropped kerb is installed in front of the footpath adjacent to Block B to ensure that any exceedance flows will exit the site in this direction rather than flow towards Block B and C. Please see **Appendix N** for approximate exceedance area and route.

**Sequential Test**

5.11 The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Where the Sequential Test has not been applied by the Local Planning Authority, either because the Local Development Document has not been sequentially tested for flood risk, or the site is a 'Windfall Site', it is the responsibility of the Developer to complete this test.

5.12 Comparison of the EA modelled flood levels for the 1 in 1000 year fluvial event with site levels, and discussions in Section 4 show that most of the site is located above both the 1 in 100 year and 1 in 1000 year flood levels. With reference to the discussion above, all 'More Vulnerable' residential development will also be set a minimum of 300mm above the 1 in 100 year (+35%CC) flood level, and floodplain compensation volume has been provided for areas where there is land raising within Flood Zone 3. As such, the proposed dwellings will remain safe for the lifetime of the development.

5.13 As the existing site is shown on the EA Flood Map for Planning as being in Flood Zone 2, a Sequential Test needs to be applied. Since the Council has adopted a development brief for the site and included in the Regulation 18 draft of the emerging Local Plan a specific policy which required the site to be developed for primarily residential purposes, it is assumed that the Council is satisfied that the Sequential Test has been passed. It is further noted that the Council's Urban Capacity Study and the SLAA issued in April 2016 includes the site as Ref. HOD-U-12 with a capacity for 40 dwellings to be delivered during the period 2021-2026.

5.14 All proposed residential buildings are located outside of Flood Zone 3, so an Exception Test is not required.

**Flood Defence Setback**

5.15 The EA require developments to be located a minimum of 8m from a river bank, to provide access for future improvements and maintenance of the banks. If buildings are located within 8m of a 'Main River', a Flood Defence Consent will be required to develop within this area.

5.16 Block A is approximately 4.5m from the bank of the river at its closest point and Block B is approximately 7m, therefore a Flood Defence Consent will be required. The existing tow-path will ensure that the status quo remains and therefore the proposals will have no impact on the maintenance of the river. The current site has little to no biodiversity benefit adjacent to the river but with the introduction of the public open space alongside the tow-path this will establish an area that provides a net biodiversity gain as well as an amenity value for the river which far exceeds the current site.

### Flood Warning Process

5.17 The discussion in Section 4 explained how comparison between modelled flood levels and topographic survey levels indicate that the development site is located above even the 1 in 1000 year flood level. As all the proposed buildings and dwellings will be located here, future occupants of the development will have a safe and dry place of refuge during all foreseeable flood events.

5.18 However, as the public open space within the site will be designed to flood during a 1 in 100 year (+35%CC) event (as shown on the drawings in **Appendix G**) and the surrounding roads are at risk of flooding, it is advisable that residents of the proposed dwellings subscribe to the EA's Flood Warning service to remain informed about the flood risk on the River Lee. It is therefore advised that when Severe Flood Warnings are issued and/or floodwater enters the public open space, residents do not attempt to walk through the flooded areas regardless of the depth of flood water.

5.19 The EA operates a flood forecasting and warning service in areas at risk of flooding from rivers or the sea, which relies on direct measurements of rainfall, river levels, tide levels, in-house predictive models, rainfall radar data and information from the Met Office. This service operates 24 hours a day, 365 days a year.

5.20 The EA website indicates that the site lies within the Flood Warning Area for the River Lee at Hertford and Ware including Stanstead Abbotts.

5.21 Residents of the proposed dwellings should register with the Flood Warning Service by using the link: **https://fwd.environment-agency.gov.uk/app/olr/register**. Alternatively, registration can be completed by telephone via the EA Floodline on 0345 988 1188 or Typetalk 0345 602 6340.

5.22 In the event of a serious flood event on the River Lee, the competent warning authority is the Environment Agency. When a flood is expected the Local Authority and local emergency services will be responsible for public care and safety. There are five action levels associated with each phase of the flood risk:

I. Annual Review

II.  Flood Alert

III.  Flood Warning

IV.  Severe Flood Warning

V. Warnings no Longer in Force

**Annual Review**

5.23 The Flood Warning and Evacuation Plan should be reviewed at least annually by the management of the proposed residential development and each resident. The following actions should be taken in line with Environment Agency guidance:

- Reading the plan and updating the contacts list.
- Contact the Environment Agency Floodline Service on 0345 9881188 to check that the flood risk to the property has not changed, for example flood defences may be built.
- Contact the Environment Agency Flood Warning Service on 08459881188 to register to receive flood alerts direct to your phone.
- Prepare and maintain a flood kit to contain items which are essential for evacuation.
- Each resident of the development should have in place a local friend or family member who they can stay with should evacuation be necessary.
- The flood kit will also be useful for general emergency situations and should be stored where it can be easily accessed and should include:
- A torch
- Blankets or a sleeping bag, warm clothing and waterproofs
- A first-aid kit, including a supply of any essential medication
- A list of useful telephone numbers
- A supply of bottled water
- A stock of non-perishable food items
- A portable radio and supply of batteries
- Wellington boots or similar waterproof boots
- Check your insurance cover – ensure it covers flood damage
- Know how to turn off the gas, electricity and water mains supplies
- Think about what items you would want to move to safety during a flood

- It is important that these emergency measures are in place before a flood event so that should evacuation be required; residents do not spend time organising belongings and household members (such as small children) at a time when an evacuation should be taking place.

- It should be noted that as the proposed residential dwellings are located above even the 1 in 1000 year flood level, it is unlikely that residents will need to leave their homes and evacuate the premises. However, it is useful to ensure that all residents are aware of the risk to the access road, car park and the flood warning procedure through carrying out the annual review.

**Flood Alert**

5.24 The EA will issue a Flood Alert status when flooding is possible. This will be issued by the EA through their website and Flood Warning Direct based upon the weather and river conditions.

5.25 Flood Alert means that flooding is possible and that you need to be prepared.

5.26 At this stage residents should ensure that their neighbours are aware of the Flood Watch alert in case they are not subscribed to Floodline Warning Direct and do not receive the alert.

**Flood Warning**

5.27 Flood Warning means, 'Flooding of homes and businesses is expected. Act now.'

5.28 The flood warning alert will be issued when water levels are rising and further rain is expected. It is advised to keep an eye on the river levels and call the EA Floodline on 0345 988 11 88 periodically for updates. Listen to and watch for weather and flood warnings on local radio and TV stations.

5.29 At this stage it is strongly advised to stop using the public open space and all pedestrian access/egress is via the footpath adjacent to the internal road. It is advised not to walk within the open space while a flood warning or severe flood warning is still in place and pedestrian access/egress is via the footpath adjacent to the internal road. However, it is recommended that residents remain in their homes wherever possible.

**Severe Flood Warning**

5.30 Severe flood warning means that severe flooding is expected. There is extreme danger to life and property and people are advised to act immediately.

5.31 At this stage the local authority, the emergency services and the Environment Agency should be managing the situation, with widespread flooding potentially over a large area, and will endeavour to provide advice on an evacuation route, shelter and assistance to evacuees.

5.32 Call 999 if you are in immediate danger.

5.33 Residents can remain safe and dry in their homes which are located above the flood level.

**Warnings No Longer in Force**

5.34 When warnings are no longer in force, no further flooding is currently expected in your area; however, flood water may still be present. It is recommended that residents contact the Local Authority to ensure it is safe to use the access road again.

**Evacuation Route**

5.35 As discussed previously, the residential dwellings will remain above the modelled flood levels for all foreseeable events and only the public open space to the east will be flooded in an extreme event on the River Lee. Although residents will not be required to evacuate the site during a flood event, if they need to leave their homes, it should be by using the footpath or road within the site boundary then heading west on Rye Road away from the flood extent.

5.36 It is advisable that a Flood Evacuation Plan detailing the route is prepared and distributed to all site occupants and residents as a precautionary measure.

# 6 Drainage Strategy

### Pre-development Runoff Rate

6.1 The existing site comprises 100% impermeable area, given that it is entirely concrete hardstanding. Using the Modified Rational Method detailed in Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed., SPON, the surface water runoff for the existing site has been calculated as follows: -

**Q = CiA** where Q = maximum flow rate (l/s)

C= PIMP/PR

i= rainfall intensity (mm/hr),

A=area (ha)

6.2 It should be noted that a fixed rainfall intensity of 50mm/hr is used in this case, which has been recommended by Butler & Davies (2006) to avoid using inappropriately high intensities for very low concentration times, i.e. small sites.

6.3 Using the Modified Rationale Method (Butler and Davies, 2006), and assuming an impermeable area on the existing site of 12000m$^2$, the total rate of runoff from the impermeable areas of the existing site is estimated to be **166.67 l/s**.

6.4 The runoff calculations are included at **Appendix H**.

6.5 It is assumed the existing site drains unattenuated to the Thames Water surface water sewer which crosses the site. Assuming the site is 100% impermeable and draining at an unattenuated runoff rate of 166.67 l/s, SuDS can be implemented within the proposed development to restrict the runoff to the Greenfield 1 in 100 year rate which is 8 l/s. This will be a significant improvement on the existing situation with a betterment of over 95%.

### Relevant SuDS Policy

6.6 The NPPF states within Flood Zone 2 and 3, "developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques (SuDS)". This can be done by relocating existing development to land in zones with a lower probability of flooding and creating space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

6.7 SuDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, these features can improve water quality and provide biodiversity and amenity benefits.

6.8 The SuDS management train incorporates a hierarchy of techniques and considers all three SUDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefit. In decreasing order of preference, the preferred means of disposal of surface water runoff is:

- Discharge to ground.

- Discharge to a surface water body.
- Discharge to a surface water sewer.
- Discharge to a combined sewer.

6.9 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site pre-development and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:

- Reducing runoff rates, thus reducing the flood risk downstream.
- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.
- Groundwater recharge.
- Contributing to the enhanced amenity and aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

**Site-Specific SuDS**

6.10 The various SuDS methods have been considered in relation to site-specific constraints. Table 1 outlines the constraints and opportunities to each of the SuDS devices in accordance with the hierarchical approach outlined in The SuDS Manual CIRIA C753. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

| Device | Description | Constraints / Comments | Appropriate |
|---|---|---|---|
| Living roofs (source control) | Provide soft landscaping at roof level which reduces surface water runoff. | Not proposed as part of this development | No |
| Infiltration devices & Soakaways (source control) | Store runoff and allow water to percolate into the ground via natural infiltration. | Geology at the site is not expected to be suitable for infiltration due to historic industrial uses at the site and potential mobilisation of contaminants. | No |
| Pervious surfaces (source control) | Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers. | Lined permeable surfacing for the access roads are recommended. | Yes |
| Rainwater harvesting (source control) | Reduces the annual average rate of runoff from the Site by reusing water for non-potable uses e.g. toilet flushing, recycling processes. | Rainwater harvesting systems can be included on each of the individual dwellings in Block B to re-use roof runoff for non-potable uses. | Potentially |
| Swales (permeable conveyance) | Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting). | Not feasible due to spatial constraints on site | No |

| | | | |
|---|---|---|---|
| Filter drains & perforated pipes (permeable conveyance) | Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration. | Not proposed as part of this development | No |
| Infiltration basins (end of pipe treatment) | Depressions in the surface designed to store runoff and allow infiltration. | Geology at the site is not expected to be suitable for infiltration due to historic industrial uses at the site and potential mobilisation of contaminants. | No |
| Wet ponds & constructed wetlands (end of pipe treatment) | Provide water quality treatment & temporary storage above the permanent water level. | Spatial constraints onsite mean this option is not possible. | No |
| Attenuation Underground (end of pipe treatment) | Oversized pipes or geo-cellular tanks designed to store water below ground level. | A storage tank is included to the rear of the townhouses in Block B and C. | Yes |

Table 1: SuDS Devices and Constraints

6.11 Given the industrial uses at the site, contaminants may be present in the underlying ground. Therefore, it is recommended that a ground investigation is carried out at an early stage to identify the presence of any contaminants. Any contaminants already present in the ground may become mobilised through the use of infiltration methods as a means of disposing of runoff. Also, infiltration tests would be required at the site to determine the likely infiltration rate and confirm whether or not this would be a viable method of discharging runoff. Therefore, it is assumed that the means of draining the site will be based on attenuation and discharge rather than infiltration.

6.12 Greenfield runoff rates were estimated using the ICP SUDS method on the MicroDrainage software. The red line boundary of the site covers 1.2 hectares, and the impermeable area is 0.68 hectares which has been used to calculate the runoff rates. The runoff rates for 1 hectare has been estimated, and scaled to the total site area for the 1 in 1 year, 1 in 30 year and 1 in 100 year events:

1 in 100 year – 11.7 l/s/ha = 8.0 l/s

1 in 30 year – 8.3 l/s/ha = 5.6 l/s

1 in 1 year –3.1 l/s/ha = 2.1 l/s

QBAR Rural – 3.7 l/s/ha = 2.5 l/s

6.13 The MicroDrainage results are included at **Appendix I**.

6.14 The proposed impermeable area is 0.68 hectares. A MicroDrainage Quick Storage Estimate was carried out based upon 0.68 hectares impermeable area, for a 1 in 100 year (+40%CC) storm. Discharge was restricted to the Greenfield 1 in 100 year runoff rate, which is a rate of 8 l/s, this is over 95% betterment from the existing runoff rate. The estimated storage volume for the 1 in 100 year (+40%CC) storm is **333-439m$^3$**. The parameters and results are included in **Appendix J**.

### Roads and Hard-Standings

6.15 As previously mentioned, it is recommended that the site is drained through attenuation and discharge rather than infiltration. With reference to the indicative development plans at

**Appendix B** it is proposed that the access roads, car parks and driveways are constructed of permeable surfacing with a permeable subbase. Lined permeable surfacing would provide the filtration benefits of permeable surfacing but not allow the runoff to infiltrate. Runoff would instead be directed to the existing surface water sewer within the site and discharged at a controlled rate.

6.16 The following typical construction would be expected for the main carriageway based on guidance from Marshalls for the popular Priora Paving system):

- 80mm paving course
- 50mm laying course (generally a 6mm aggregate)
- 80mm layer of perforated Asphalt Concrete (DBM)
- A calculated depth of course grade aggregate (generally 250mm of a 30mm aggregate)
- An additional sub-base / capping layer if required.

6.17 The depth of the course graded aggregate layer will be designed to meet both structural and attenuation requirements; hence, once CBR values have been measured which will inform the structural design at a detailed design stage.

6.18 The use of permeable paving in this way would provide storage volume within the site boundary. The results of the Quick Storage Estimate suggest that up to 439m$^3$ volume is required for both the roof areas and roads/hardstandings to be drained during a 1 in 100 year (+40%CC) storm being restricted to Greenfield 1 in 100 year runoff rate. The drainage has been split into three catchments for drainage which is shown in **Appendix L.**

**Catchment 1**

6.19 Catchment 1 takes surface water from Block A, car parking spaces on the western half of the site and 1060m$^2$ of porous surfacing. All drainage will be connected directly into the subbase of the lined porous surfacing before discharging into the Thames Water sewer. The porous surfacing will incorporate a type 3 or similar subbase with a minimum depth of 400mm. The system will drain via a flow control chamber which will be restricted to 3 l/s via a 48mm orifice plate with a suitable filter.

6.20 An allowance for urban creep has not been included because Block A is an apartment block and therefore not expected to be extended.

6.21 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 124.9m$^3$ of storage. The calculations are included within **Appendix K.**

**Catchment 2**

6.22 Catchment 2 takes runoff from the front half of roof runoff from Block C and D, all roof runoff from Block D and the remaining areas of porous surfacing (1110m$^2$) and parking spaces within the eastern half of the site portion of the site.

6.23 The drainage from Catchment 2 will be restricted to 4 l/s and discharge directly to the Thames Water sewer.

6.24 No allowance for urban creep has been included due to the nature of the buildings within Block B, C and D. Block B and C are townhouses and Block D is an apartment block.

6.25 MicroDrainage was used in order to determine the required volume of attenuation for rainfall events up to and including a 1 in 100 +40% climate change storm for the site. MicroDrainage estimated that 225.1m$^3$ of storage was required. The porous surfacing will therefore incorporate a type 3 or similar subbase with a minimum depth of 680mm. The system will drain via a flow control chamber which will be restricted to 4 l/s via a 48mm orifice plate with a suitable filter. The calculations are included within **Appendix K.**

### Catchment 3

6.26 Catchment 3 takes surface water from the rear of Block B and C as well as hardstanding adjacent to Block B. All drainage will be connected via silt traps to the linear cellular storage tank within the rear gardens of Block B and C before discharging into the Thames Water sewer. The tank will be 50m long, 1m wide and 0.8m deep. The system will drain via a flow control chamber which will be restricted to 1 l/s via a Hydrobrake as the required size of orifice (23mm) would represent an unnecessary risk of blockage even with a suitable filter included.

6.27 An allowance for urban creep has not been included because Block B and C are townhouses and therefore not expected to be extended.

6.28 MicroDrainage was used in order to determine the size of the tank required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 36.1m$^3$ of storage. The calculations are included within **Appendix K.**

### All catchments

6.29 All downpipes should discharge into an inspection chamber with a silt trap before connecting into the subbase of the permeable paving via a diffuser unit which will distribute water into the subbase rather than a single concentrated point of discharge.

6.30 All downpipes should also discharge into an inspection chamber with a silt trap before entering the cellular storage tank. Inspection access should be included along the cellular storage in line with the manufacturer's recommendations for inspection and maintenance.

6.31 The details of the sections of permeable paving, cellular storage and flow control devices for all three catchments are included in the MicroDrainage output at **Appendix K**.

6.32 Consent from Thames Water will be required to drain to the surface water sewer.

6.33 An indicative drainage strategy in included in **Appendix M.**

### Roofs

6.34 It is proposed that rainwater recycling is used where possible within the dwellings to re-use water for non-potable uses such as flushing toilets. Using these systems will reduce the volume of water entering the permeable paving. However, the rainwater harvesting systems will have an overflow to the permeable paving and the permeable paving will be designed so that it has sufficient storage volume to accept runoff from both the roofs and roads/hardstandings.

6.35 It is proposed that where possible, water butts are included in the proposed development. These can collect roof runoff for re-use for watering gardens.

**Thames Water Surface Water Sewer Capacity Check**

6.36 A pre-planning enquiry was submitted to Thames Water who confirmed that there was sufficient capacity within the sewer to accept the discharge rate proposed as part of this strategy. A copy of Thames Water's response has been included within Appendix E.

# 7 Management of Development Drainage

7.1 It is proposed that the maintenance of all shared features of the surface water drainage system within the proposed development will be the responsibility of a newly appointed management company set up upon first occupation.

7.2 The drainage channel which accepts roof runoff directly from Block B will be the responsibility of the individual landowners where the channel exists on their land.

7.3 Regular inspections of the permeable paving and underground storage features should be made, to ensure they are effective throughout the lifetime of the development and do not become blocked or damaged over time. Some maintenance activities for the permeable paving and cellular storage tanks detailed in CIRIA C753 'The SuDS Manual' are set out in Table 5.1 and 5.2 below.

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Regular maintenance | Brushing and vacuuming. | Three times per year at end of winter, mid-summer, after autumn leaf fall, or as required based on site specific observations of clogging or manufacturer's recommendations. |
| Occasional maintenance | Stabilise and mow contributing and adjacent areas. | As required. |
| | Removal of weeds. | As required. |
| Remedial actions | Remediate any landscaping which, through vegetation maintenance of 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 considered detrimental to the structural performance of a hazard to the user. | As required |
| | Rehabilitation of surface and upper sub-surface. | As required (if infiltration performance is reduced as a result of significant clogging.) |

| | | |
|---|---|---|
| Monitoring | Initial inspection | Monthly for 3 months after installation. 3 monthly, 48 hours after large storms. |
| | Inspect for evidence of poor operation and/or weed growth. If required, take remedial action. | Annually. |
| | Inspect silt accumulation rates and establish appropriate brushing frequencies. | Annually. |
| | Monitor inspection chambers. | Annually |

*Table 6.1: Maintenance tasks for permeable paving (Source: CIRIA C753, The SUDS Manual)*

| Maintenance Schedule | Required Action | Frequency |
|---|---|---|
| Regular maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action | Monthly for 3 months, then annually |
| | Remove debris from the catchment surface (where it may cause risks to performance) | Monthly |
| | For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration as necessary | Annually |
| | Remove sediment from pre-treatment structures and/or internal forebays | Annually or as required |
| Remedial actions | Repair/rehabilitate inlets, outlet, overflows and vents | As required |
| Monitoring | Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed | Annually |
| | Survey inside of tank for sediment build up and remove if necessary. | Every 5 years or as required |

*Table 6.2: Maintenance tasks for attenuation tanks and oversized pipe (Source: CIRIA C753, The SUDS Manual)*

7.4 It is recommended that during the first 12 months of operation all SuDS and drainage features are visually inspected on a monthly basis to determine any seasonal patterns this includes all SuDS features, inspection chambers, inlets and outlets. This will determine whether or not the recommended service intervals set out by CIRIA in the figures above will be sufficient for maintenance beyond the first year.

7.5 After the first 12 months, the maintenance schedule should be designed to at least meet the requirements set out in the tables above for the permeable paving and the underground storage features.

7.6 All silt traps, gullies and drainage channels should be inspected on a bi-annual basis with further visual checks carried out throughout the year. These assets are likely to need maintenance once or twice a year to clear silt and debris, but this should be based on the first years monitoring and the frequency of maintenance should be adjusted as necessary throughout the lifetime of the development.

# 8 Summary and Conclusion

8.1 This flood risk assessment and outline drainage strategy has been prepared for a planning application at the former Turnford Surfacing Site in Rye Road, Hoddesdon for a 104 unit residential development.

8.2 The site is shown to be located within Flood Zone 2 on the EA flood map, which indicates a 'medium risk' of flooding from the River Lee, with an annual probability of between 0.1% and 1% (or 1 in 1000 and 1 in 100 years). However, comparison between the modelled flood levels and the topographic site levels indicate that the majority of the site is located at a higher elevation than the 1 in 1000 year level. However, comparison of flood levels with the topographic survey shows the eastern edge where the existing road passes within the site boundary is located within Flood Zone 3a, at a greater than 1 in 100 year chance of flooding. However, the proposals include two areas of open space which will be lower than the rest of the development and utilised for flood storage.

8.3 Government guidance requires the site to apply 35% climate change to future development. The 1 in 100 year (+35%CC) flood level has been estimated using a stage-discharge graph to be 29.045m AOD. All ground levels on the site have been set at 29.7m AOD other than the land immediately adjacent to the towpath and the two areas of open space.

8.4 Floodplain compensation will be required, and modelling has been carried out to determine the areas where flood storage volume can be provided in the proposed development. It has been confirmed that ground levels will be set above the 1 in 100 year (+35%CC) fluvial flood and flood water can be stored within land adjacent to the towpath along the eastern boundary including the areas of open space and to the north of the ditch of the northern site boundary. An additional 134m3 of storage will be provided in these areas with a greater volume in each of the 200mm bands in the proposed scenario than in the existing scenario. No flooding of the proposed residential dwellings will occur as a result of a 1 in 100 year (+35%CC) flood.

8.5 Whilst the main part of the site is not at risk of fluvial flooding it is still recommended that residents sign up to the EA's Flood Warning Service to keep informed about flooding on the River Lee particularly as the open space has been designed to flood in major events and accessing the site from the east may not be possible due to the flooding of low lying land to the east of the River. Therefore, when a flood warning or severe flood warning are in force all access/egress both vehicular and pedestrian should be to and from the west along Rye Road.

8.6 The site is located above a Principal Aquifer and near to a river, so there may be high groundwater levels in the vicinity. It is recommended that ground investigation is carried out to determine the groundwater level beneath the site prior to any invasive site works. If high levels are found, it is recommended that measures are included in the scheme design to protect against this potential risk for the ground floor.

8.7 The proposed SuDS drainage strategy will ensure that there is no increase in flood risk to the site or elsewhere as a result of the development proposals and there will be over 95% betterment from the existing runoff rate to the proposed runoff rate. Due to the former industrial uses at the site, infiltration methods are not considered to be suitable and therefore an attenuation and discharge method has been detailed in this report. Lined permeable surfacing will provide the benefits of removing pollutants from runoff along with storage volume. Permeable surfacing can be used beneath the access road and under car parking.

8.8 The drainage has been split in to three catchments which is shown in Appendix L. Each of the catchments will be drained via gravity and controlled by an orifice plate or Hydrobrake flow control device, catchment A to 3 l/s, catchment B to 1 l/s and catchment c to 4 l/s to meet the 1 in 100 year greenfield runoff rate with storage provided for the 1 in 100 year + 40% climate change event. It is proposed that the permeable paving in catchments 1 and 2 will drain through gravity to the existing Thames Water surface water sewer which crosses the site and catchment 3 will also discharge to this sewer via a cellular storage tank and Hydrobrake flow control device.

8.9 In addition, rainwater harvesting systems can be used for each residential dwelling in Block B to reduce the consumption of mains water and the volume of water entering the oversized pipe. Where possible, it is recommended that water butts are installed for the purpose of re-using roof runoff for outside uses such as watering gardens.

8.10 The maintenance of the proposed surface water drainage system will be the responsibility of a management company. Part of the maintenance strategy should be regular inspections of the drainage system to ensure the water is able to discharge effectively and not increase the surface water flood risk at the site. The first 12 months visual inspections should be undertaken on a monthly basis to determine seasonal patterns and the maintenance schedule should be revised as necessary throughout the lifetime of the development.

8.11 We believe that the development proposals comply with the guidance provided by the NPPF and that no reason exists to object to the proposals in terms of flood risk.

EAS

# Appendices



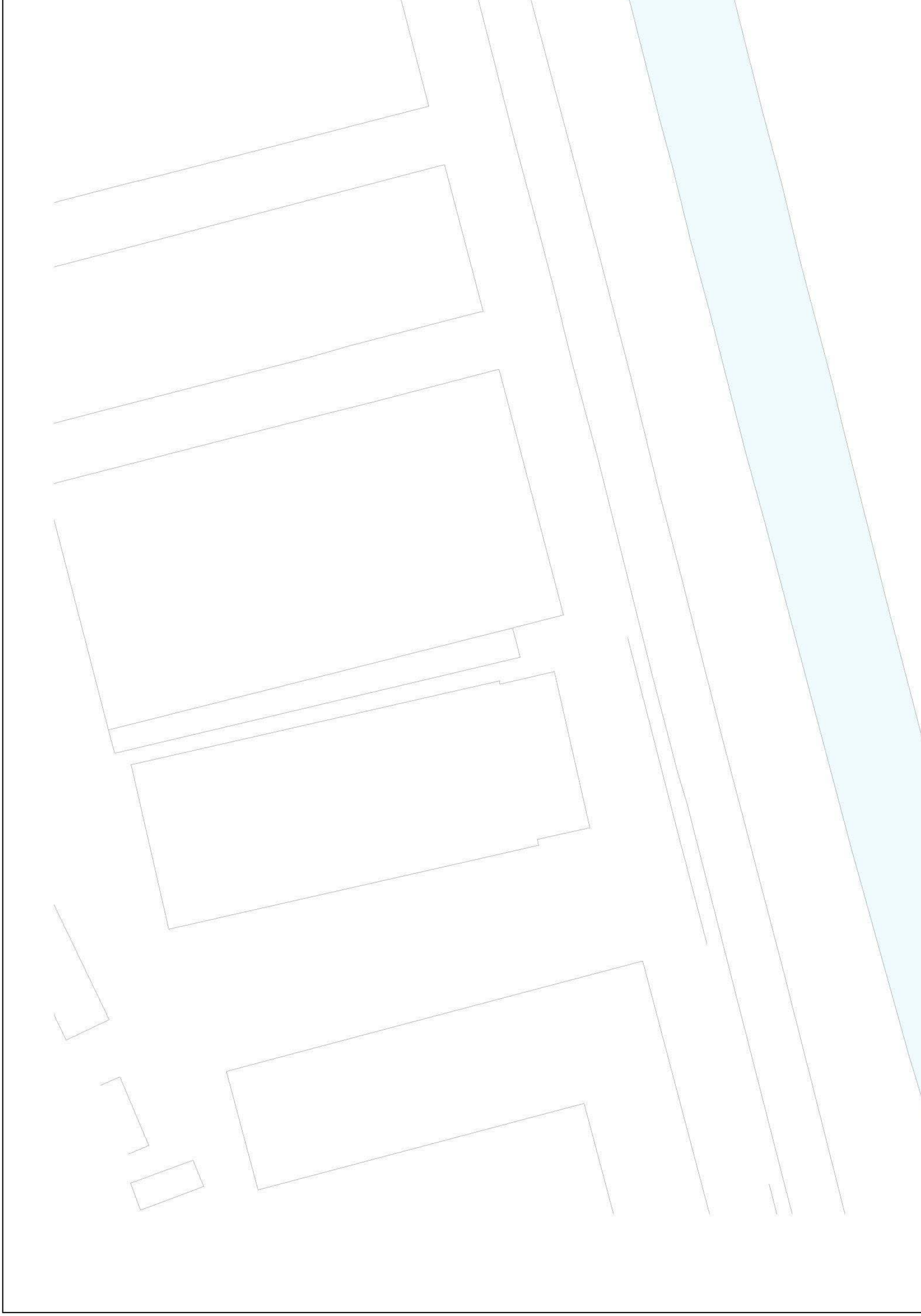


TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

## Appendix: A - Location Plan


ST MARGARETS
CP
Slipways
Nursery
Ryegate
Farm
Terbet
Hill
CP Bdy
Hertfordshire Way
School
School
Sch
Rye Meads
Toll
Sewage
Works
Toll House Stream
River Stort
Gatehouse
Stadium
Wks
Wks
Rye House
Station
Sch
Sch
Cemy
Rye
Park
Lock
(Navigation
River Stort
Towing
Path Stort

## Appendix: B – Development Proposals



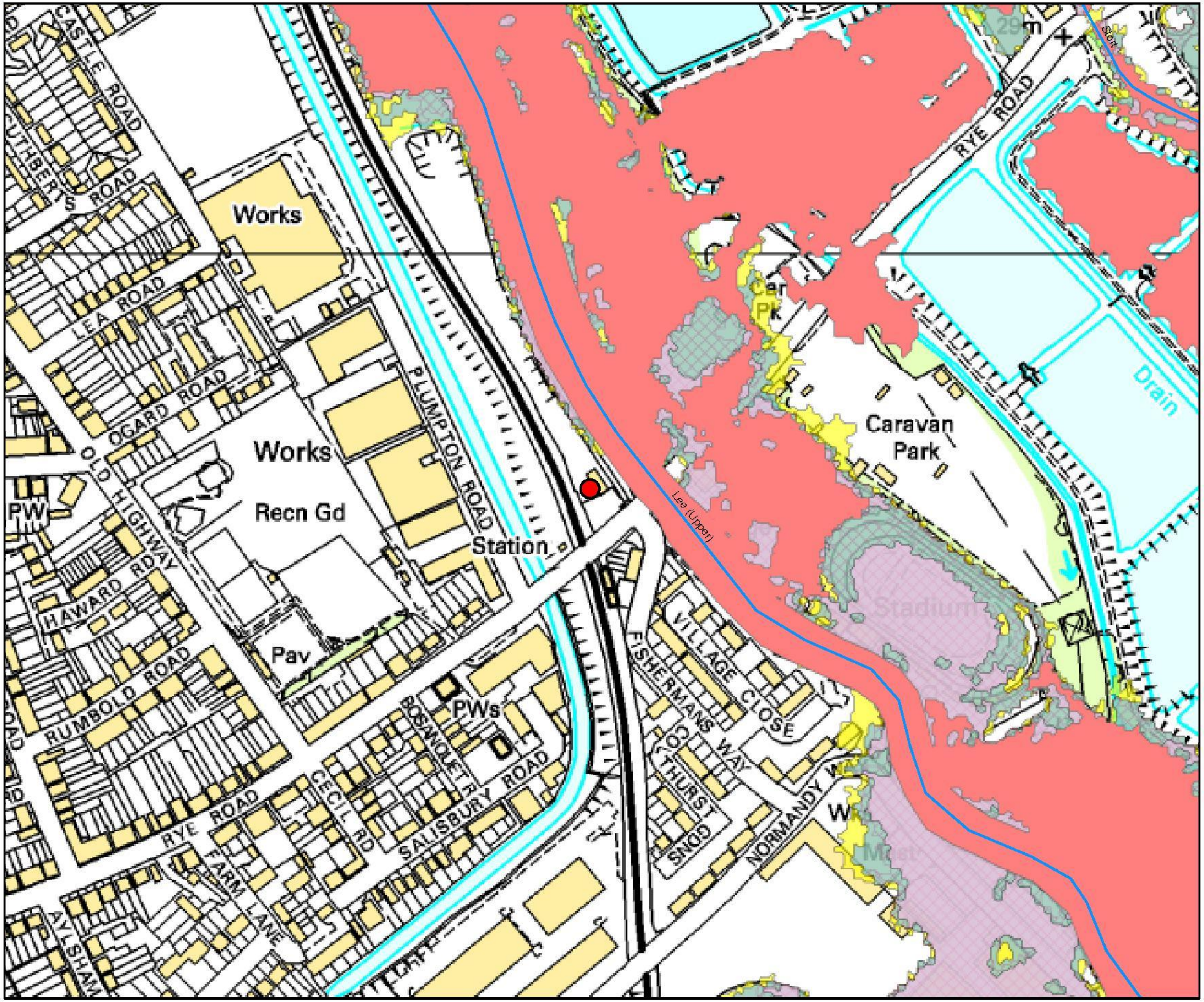
EAS

# Appendix: C – EA Flood Data, Response to Climate Change Queries and Stage-Discharge Graph



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

## Legend

Main Rivers

**Defended Flood Outlines**

- 1 in 75 (1.3%) Defended
- 1 in 100 (1%) Defended
- 1 in 100+20% (*CC) Defended
- 1 in 200 (0.5%) Defended
- 1 in 1000 (0.1%) Defended

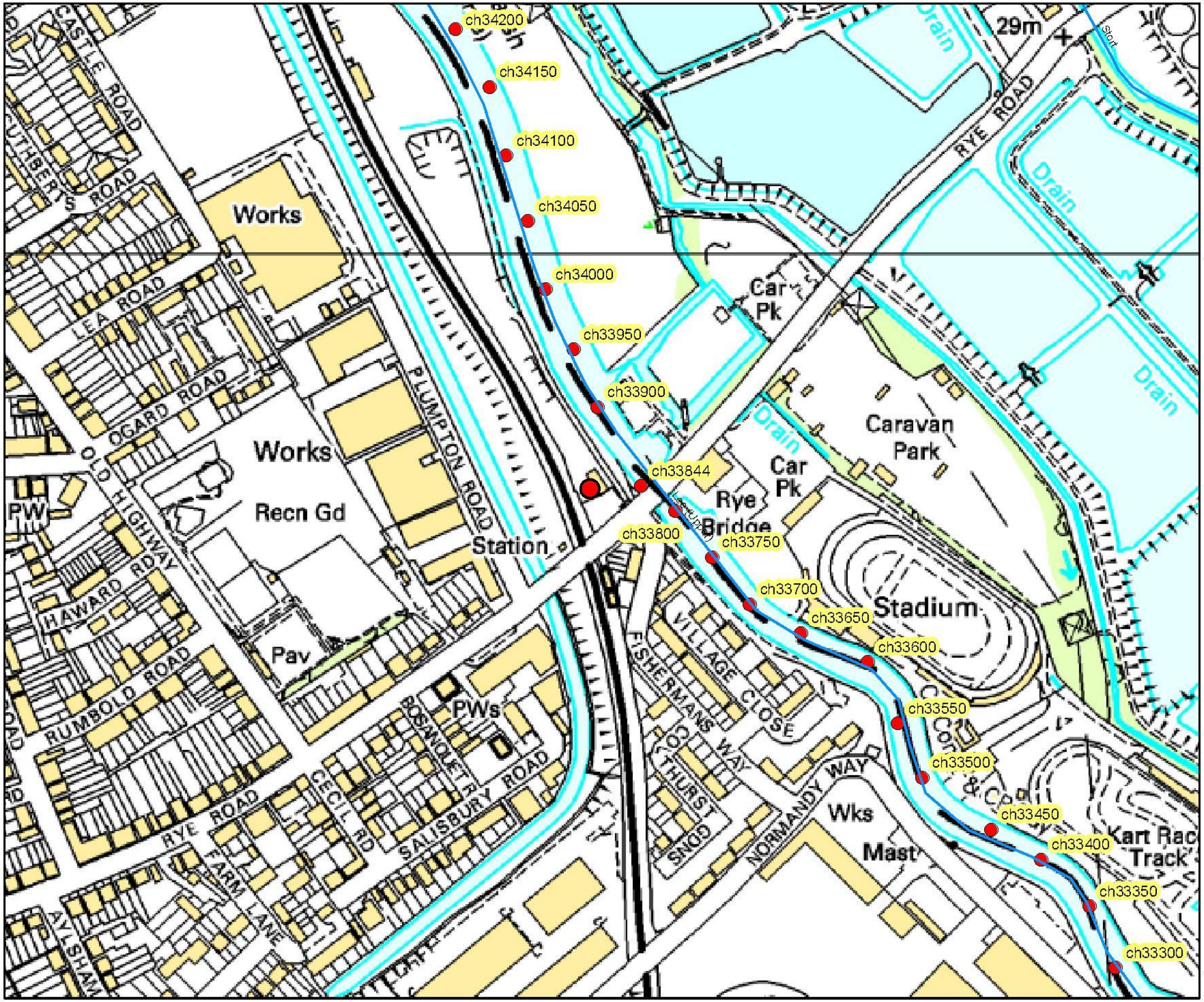
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH





Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

**Legend**

Main Rivers

**1D Node Results**

Node Results

The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.

Modelled outlines take into account catchment-wide defences.

Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

**Environment Agency ref: HNL/47934/LH**

The data in this map has been extracted from the River Lee 2D Modelling study (CH2M Hill, 2014).

**Caution:**
This model has been designed for catchmentwide flood risk mapping. It should be notedthat it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

All flood levels are given in metres Above Ordnance Datum (mAOD)
All flows are given in cubic metres per second (cumecs)

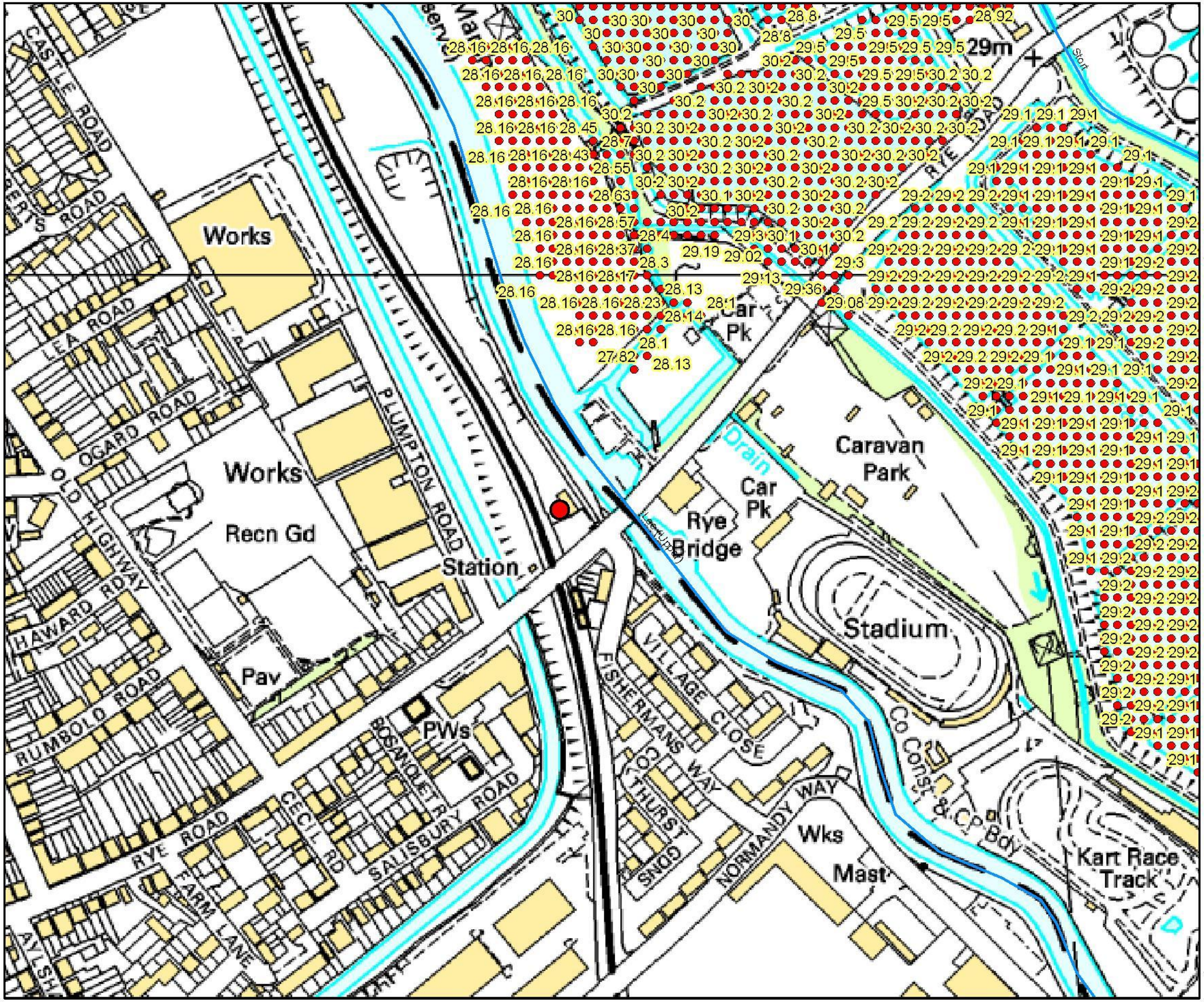
**MODELLED FLOOD LEVEL**

| | | | Return Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Node Label** | **Easting** | **Northing** | **2 yr** | **5 yr** | **10 yr** | **20 yr** | **50 yr** | **75 yr** | **100 yr** | **100 yr + 20%** | **200 yr** | **1000 yr** |
| ch33300 | 538866 | 209468 | 27.89 | 27.9 | 27.91 | 27.92 | 28.2 | 28.27 | 28.44 | 28.72 | 28.58 | 28.87 |
| ch33350 | 538847 | 209514 | 27.89 | 27.91 | 27.92 | 27.93 | 28.22 | 28.29 | 28.46 | 28.74 | 28.6 | 28.89 |
| ch33400 | 538811 | 209548 | 27.9 | 27.92 | 27.93 | 27.95 | 28.24 | 28.31 | 28.48 | 28.75 | 28.61 | 28.89 |
| ch33450 | 538774 | 209571 | 27.9 | 27.93 | 27.95 | 27.97 | 28.25 | 28.33 | 28.5 | 28.76 | 28.62 | 28.9 |
| ch33500 | 538722 | 209609 | 27.9 | 27.94 | 27.96 | 27.99 | 28.27 | 28.35 | 28.51 | 28.78 | 28.64 | 28.93 |
| ch33550 | 538704 | 209650 | 27.91 | 27.94 | 27.96 | 27.99 | 28.28 | 28.35 | 28.52 | 28.78 | 28.64 | 28.93 |
| ch33600 | 538682 | 209695 | 27.91 | 27.95 | 27.98 | 28.02 | 28.3 | 28.37 | 28.54 | 28.81 | 28.67 | 28.98 |
| ch33650 | 538632 | 209717 | 27.91 | 27.96 | 27.99 | 28.03 | 28.31 | 28.39 | 28.56 | 28.83 | 28.69 | 29 |
| ch33700 | 538594 | 209738 | 27.92 | 27.97 | 28 | 28.04 | 28.33 | 28.4 | 28.57 | 28.86 | 28.71 | 29.03 |
| ch33750 | 538566 | 209773 | 27.92 | 27.98 | 28.02 | 28.07 | 28.35 | 28.42 | 28.6 | 28.9 | 28.74 | 29.06 |
| ch33800 | 538539 | 209808 | 27.92 | 27.98 | 28.01 | 28.05 | 28.33 | 28.41 | 28.58 | 28.88 | 28.73 | 29.05 |
| ch33844 | 538513 | 209826 | 27.92 | 27.99 | 28.03 | 28.07 | 28.35 | 28.43 | 28.6 | 28.9 | 28.74 | 29.07 |
| ch33900 | 538481 | 209885 | 27.94 | 28.02 | 28.08 | 28.13 | 28.42 | 28.49 | 28.68 | 29.01 | 28.84 | 29.2 |
| ch33950 | 538463 | 209928 | 27.94 | 28.03 | 28.09 | 28.15 | 28.44 | 28.52 | 28.7 | 29.04 | 28.86 | 29.22 |
| ch34000 | 538442 | 209973 | 27.95 | 28.04 | 28.1 | 28.16 | 28.44 | 28.52 | 28.71 | 29.05 | 28.87 | 29.23 |
| ch34050 | 538429 | 210024 | 27.95 | 28.05 | 28.11 | 28.17 | 28.46 | 28.54 | 28.72 | 29.06 | 28.89 | 29.25 |
| ch34100 | 538413 | 210072 | 27.95 | 28.05 | 28.12 | 28.19 | 28.47 | 28.55 | 28.73 | 29.07 | 28.89 | 29.25 |
| ch34150 | 538400 | 210124 | 27.96 | 28.06 | 28.13 | 28.2 | 28.48 | 28.56 | 28.74 | 29.07 | 28.9 | 29.26 |
| ch34200 | 538375 | 210166 | 27.96 | 28.07 | 28.14 | 28.21 | 28.49 | 28.57 | 28.74 | 29.09 | 28.91 | 29.27 |

**MODELLED FLOWS**

| | | | Return Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Node Label** | **Easting** | **Northing** | **2 yr** | **5 yr** | **10 yr** | **20 yr** | **50 yr** | **75 yr** | **100 yr** | **100 yr + 20%** | **200 yr** | **1000 yr** |
| ch33300 | 538866 | 209468 | 34.53 | 52.26 | 59.6 | 66.23 | 78.73 | 83.21 | 90 | 109.36 | 99.26 | 122.08 |
| ch33350 | 538847 | 209514 | 34.51 | 52.23 | 61.79 | 70.43 | 78.43 | 82.9 | 88.25 | 106.18 | 96.14 | 120.43 |
| ch33400 | 538811 | 209548 | 33.46 | 52.21 | 61.78 | 70.42 | 78.12 | 82.55 | 88.35 | 110.7 | 98.03 | 126.37 |
| ch33450 | 538774 | 209571 | 34.46 | 52.19 | 61.77 | 70.39 | 78.11 | 82.53 | 89.86 | 116.63 | 102.11 | 133.53 |
| ch33500 | 538722 | 209609 | 34.44 | 52.17 | 61.75 | 70.35 | 78.11 | 82.53 | 91.07 | 119.66 | 104.34 | 136.83 |
| ch33550 | 538704 | 209650 | 34.43 | 52.15 | 61.74 | 70.33 | 78.11 | 82.53 | 91.77 | 121.41 | 105.66 | 138.44 |
| ch33600 | 538682 | 209695 | 34.41 | 52.14 | 61.72 | 70.32 | 78.11 | 82.53 | 92.08 | 121.24 | 105.9 | 135 |
| ch33650 | 538632 | 209717 | 34.4 | 52.13 | 61.7 | 70.3 | 78.11 | 82.52 | 92.13 | 122.11 | 106.06 | 136.26 |
| ch33700 | 538594 | 209738 | 34.4 | 52.11 | 61.68 | 70.29 | 78.11 | 82.49 | 91.53 | 117.65 | 103.94 | 130.51 |
| ch33750 | 538566 | 209773 | 34.4 | 52.1 | 61.66 | 70.27 | 78.1 | 82.47 | 91.07 | 117.08 | 103.24 | 132.6 |
| ch33800 | 538539 | 209808 | 34.4 | 52.09 | 61.64 | 70.26 | 78.1 | 82.39 | 90.71 | 115.19 | 102.42 | 128.95 |
| ch33844 | 538513 | 209826 | 34.4 | 52.08 | 61.63 | 70.25 | 78.1 | 82.39 | 90.67 | 114.25 | 102.1 | 127.3 |
| ch33900 | 538481 | 209885 | 34.39 | 52.06 | 61.62 | 70.23 | 77.8 | 81.59 | 87.95 | 106.29 | 97.57 | 116.08 |
| ch33950 | 538463 | 209928 | 34.38 | 52.04 | 61.6 | 70.22 | 76.48 | 79.53 | 85.26 | 105.55 | 95.12 | 119.17 |
| ch34000 | 538442 | 209973 | 34.36 | 52.01 | 61.6 | 70.2 | 76.48 | 79.53 | 84.63 | 104.37 | 93.63 | 118.33 |
| ch34050 | 538429 | 210024 | 34.34 | 51.98 | 61.59 | 70.2 | 76.4 | 79.31 | 83.88 | 103.14 | 92.36 | 119.03 |
| ch34100 | 538413 | 210072 | 34.32 | 51.95 | 61.59 | 70.18 | 76.6 | 79.54 | 84.27 | 107.56 | 94.97 | 122.09 |
| ch34150 | 538400 | 210124 | 34.29 | 51.92 | 61.57 | 70.17 | 77.11 | 80.43 | 86.11 | 111.16 | 98.18 | 125.57 |
| ch34200 | 538375 | 210166 | 34.28 | 51.9 | 61.56 | 70.17 | 77.38 | 80.63 | 87.59 | 109.01 | 97.4 | 122.53 |

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

● 1 in 2 (50%) Defended M01

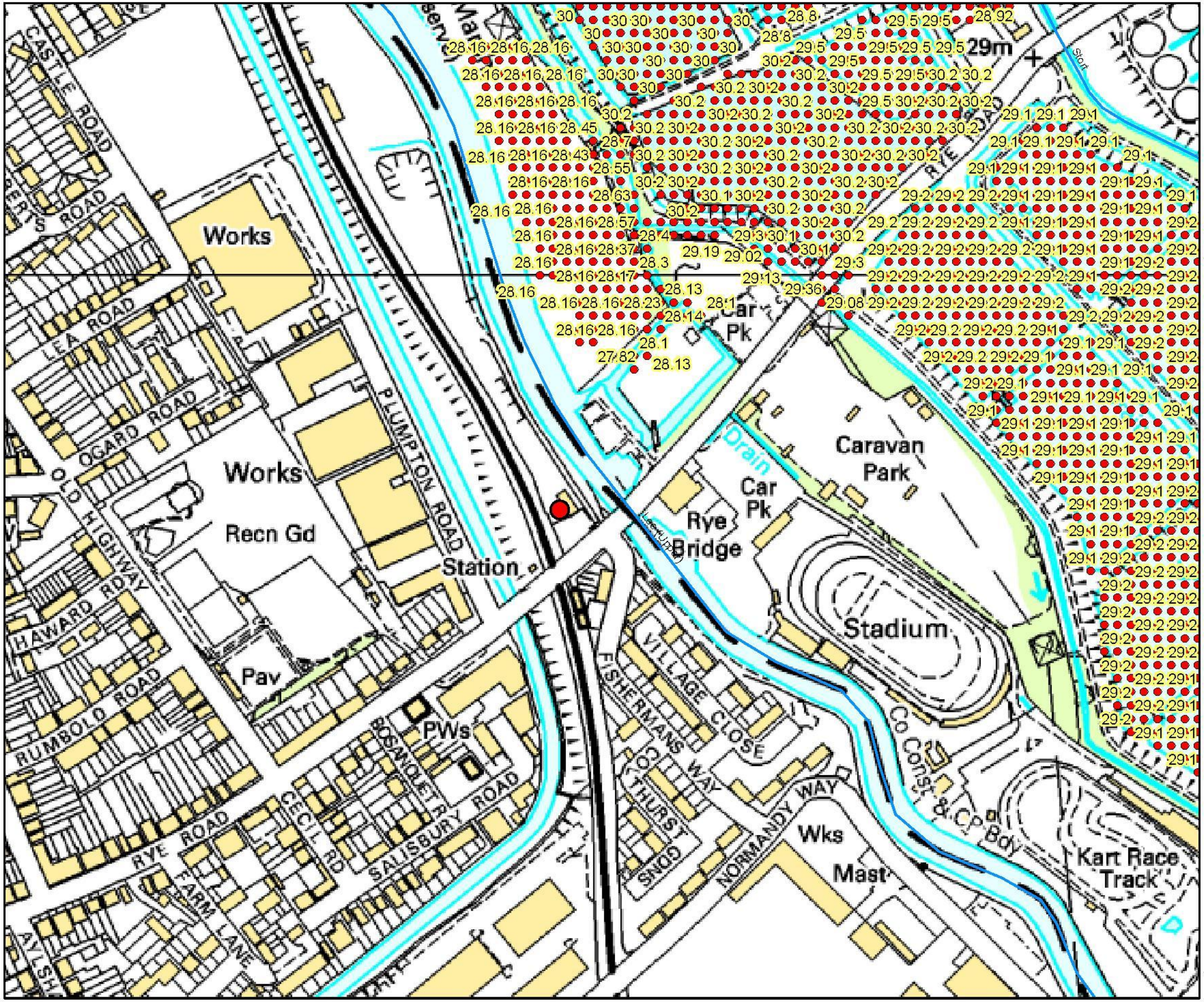
The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.

Modelled outlines take into account catchment-wide defences.

Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

1 in 5 (20%) Defended M01

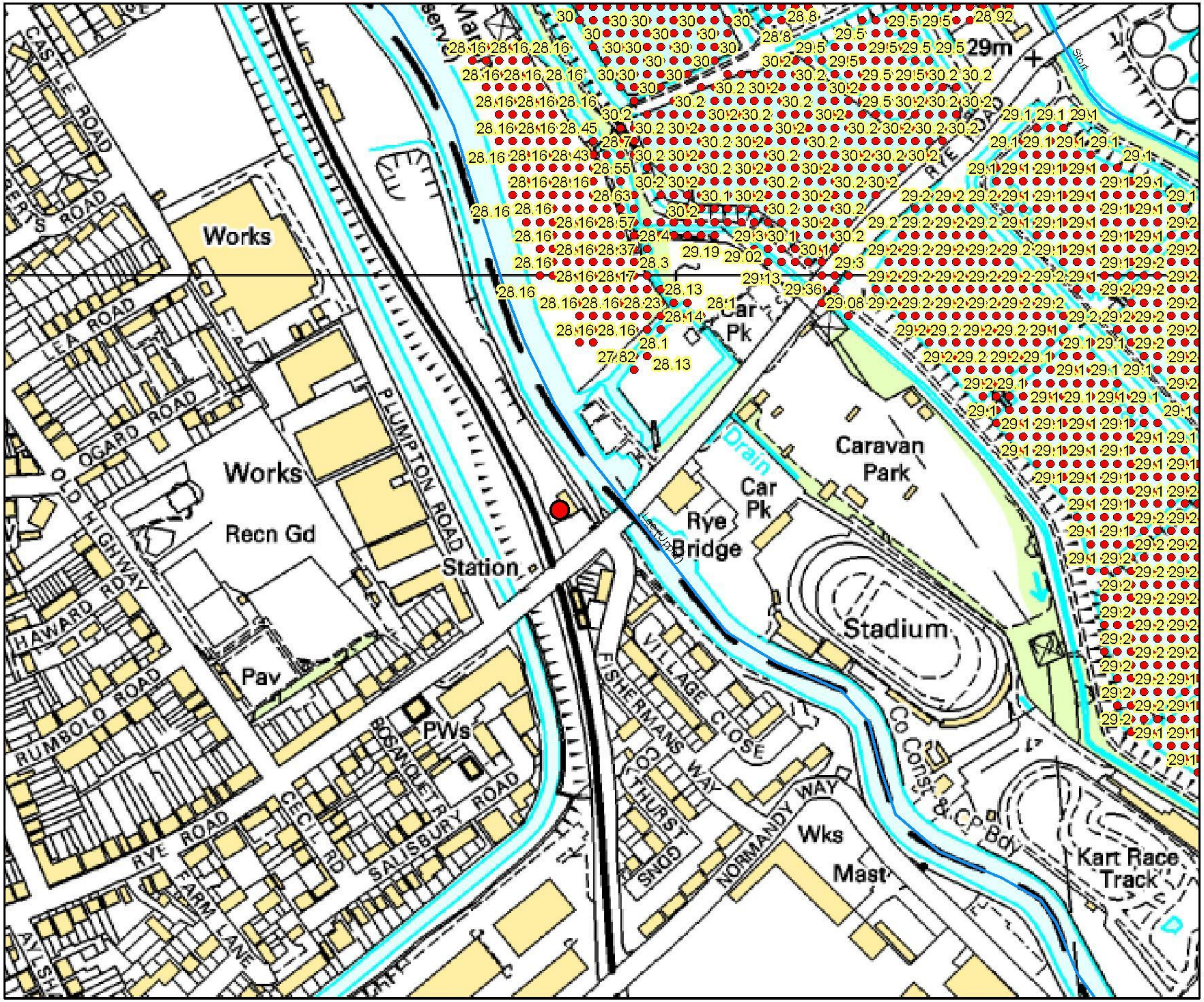
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH





Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

**2D Node Results: Heights**

1 in 10 (10%) Defended M01

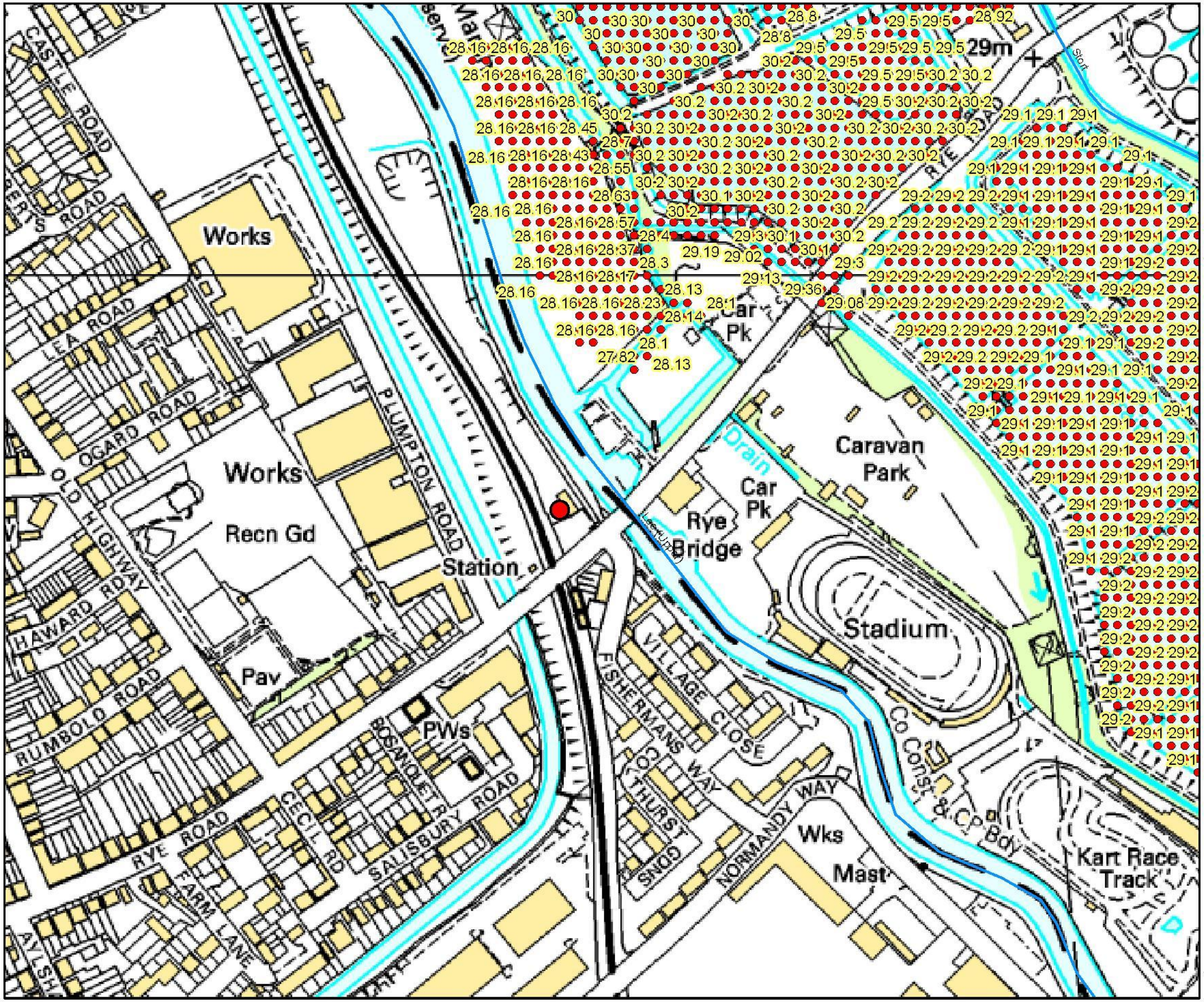
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

1 in 20 (5%) Defended M01

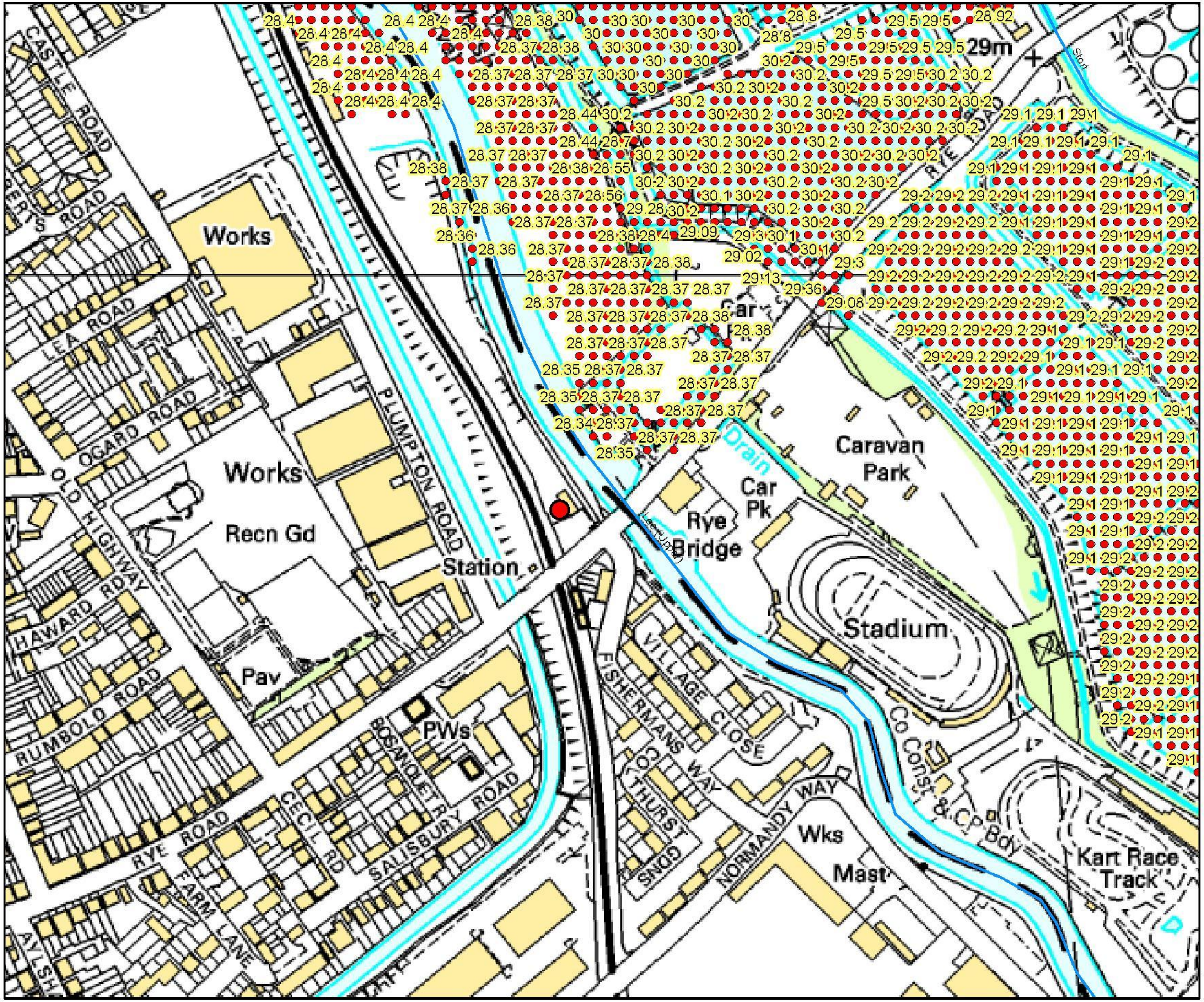
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency


Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

1 in 50 (2%) Defended M01

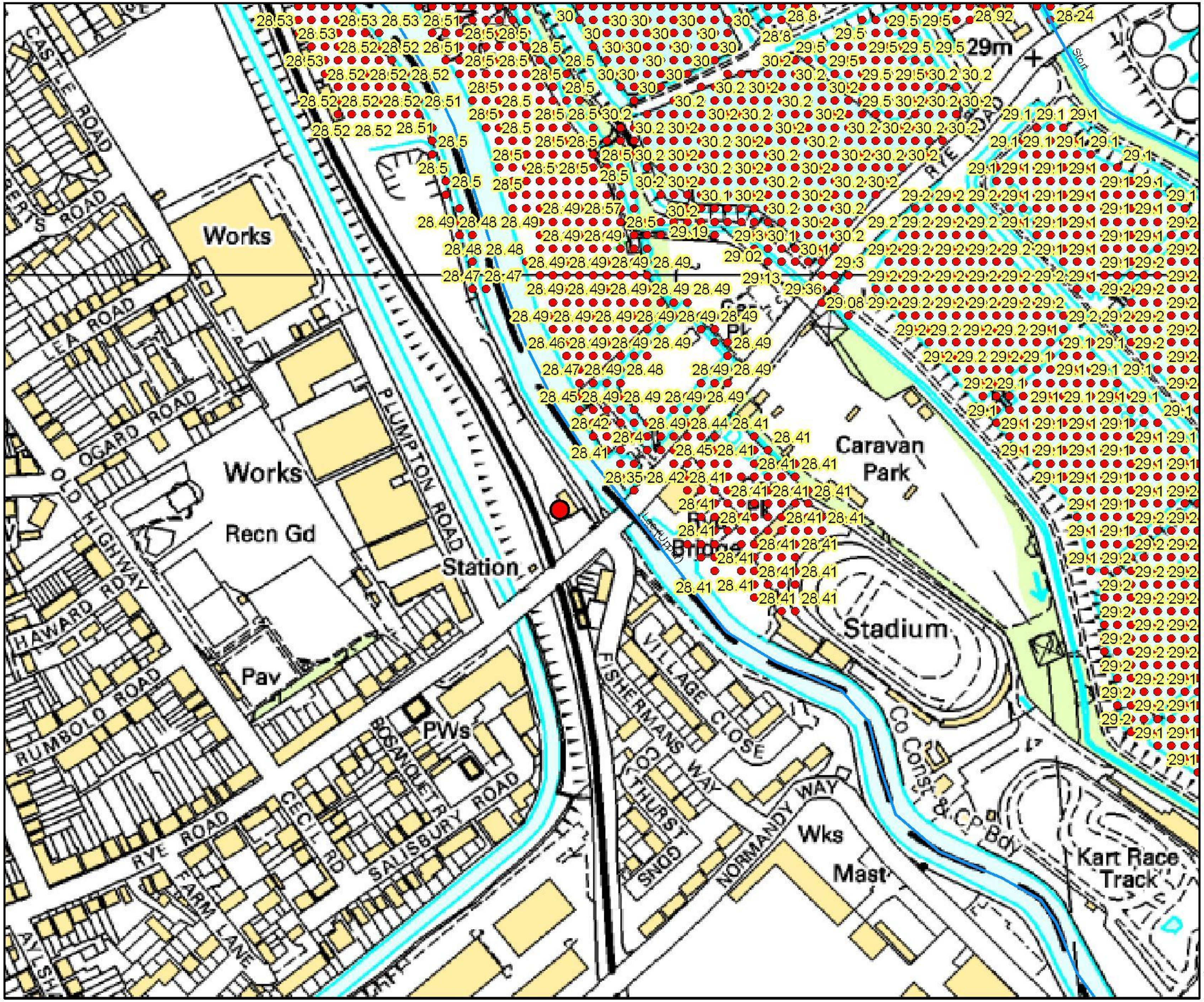
The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.

Modelled outlines take into account catchment-wide defences.

Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH





Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

● 1 in 75 (1.33%) Defended M01

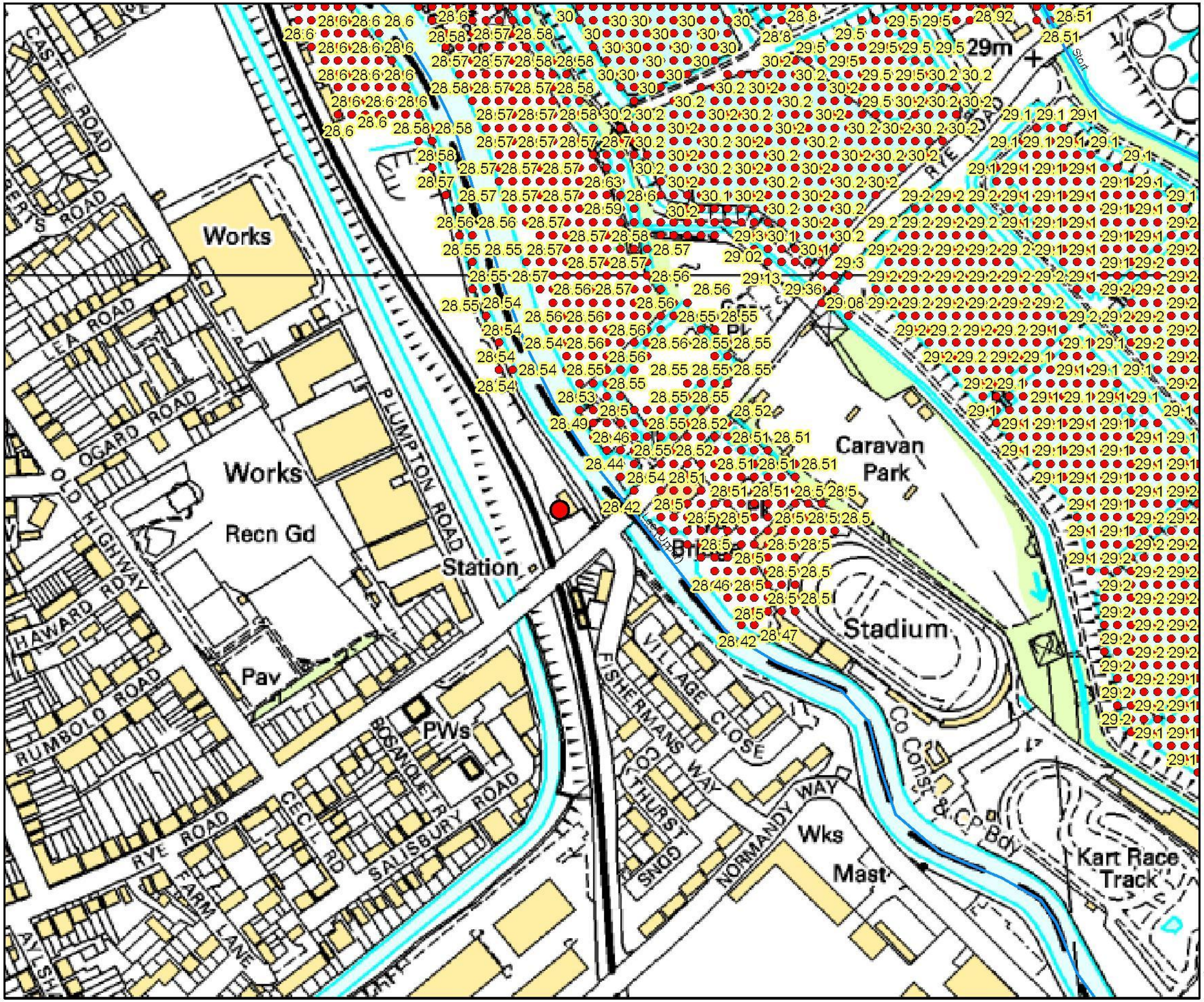
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH





Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

1 in 100 (1%) Defended M01

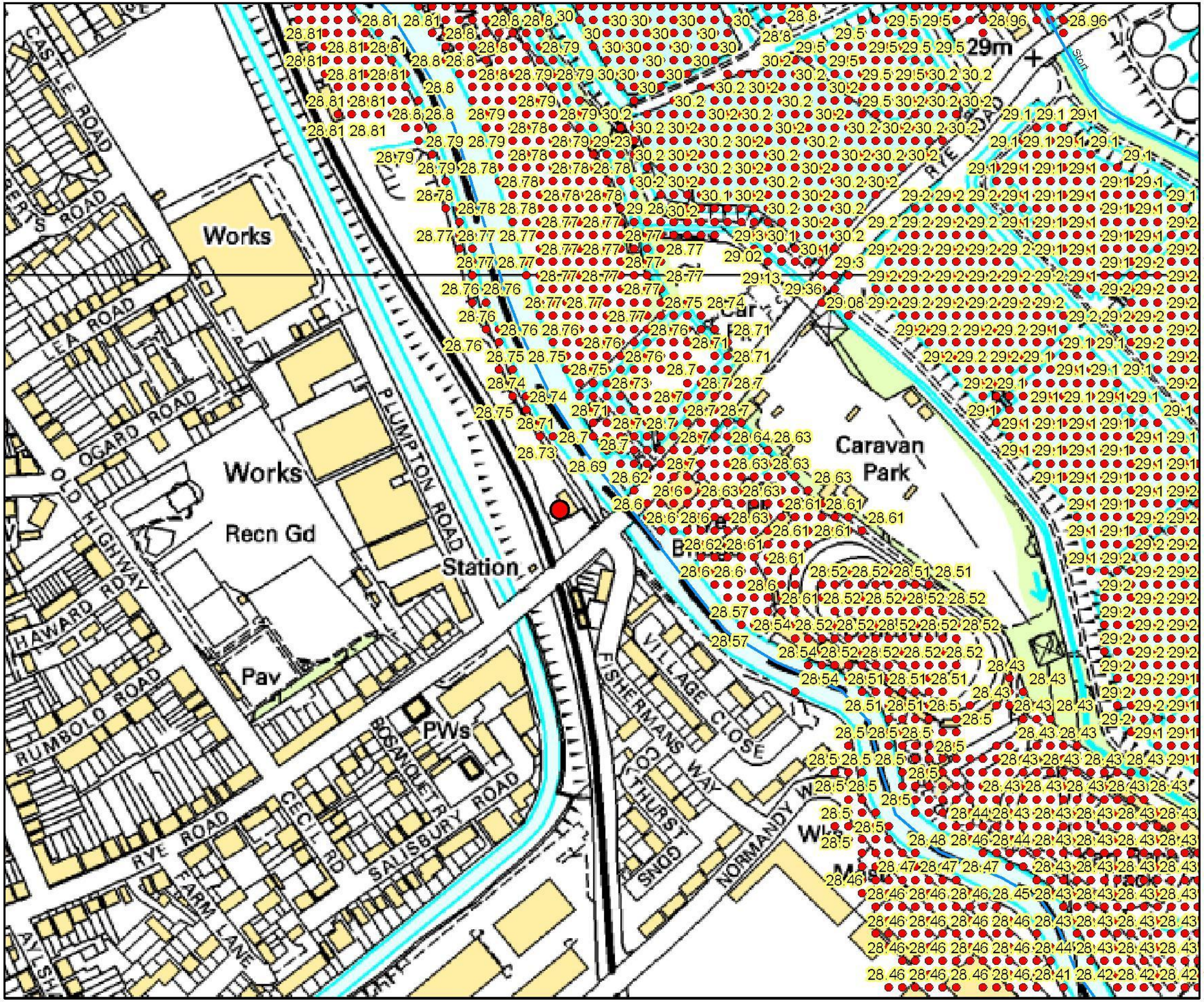
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency


Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

**2D Node Results: Heights**

● 1 in 100+20% (*CC) Defended M01

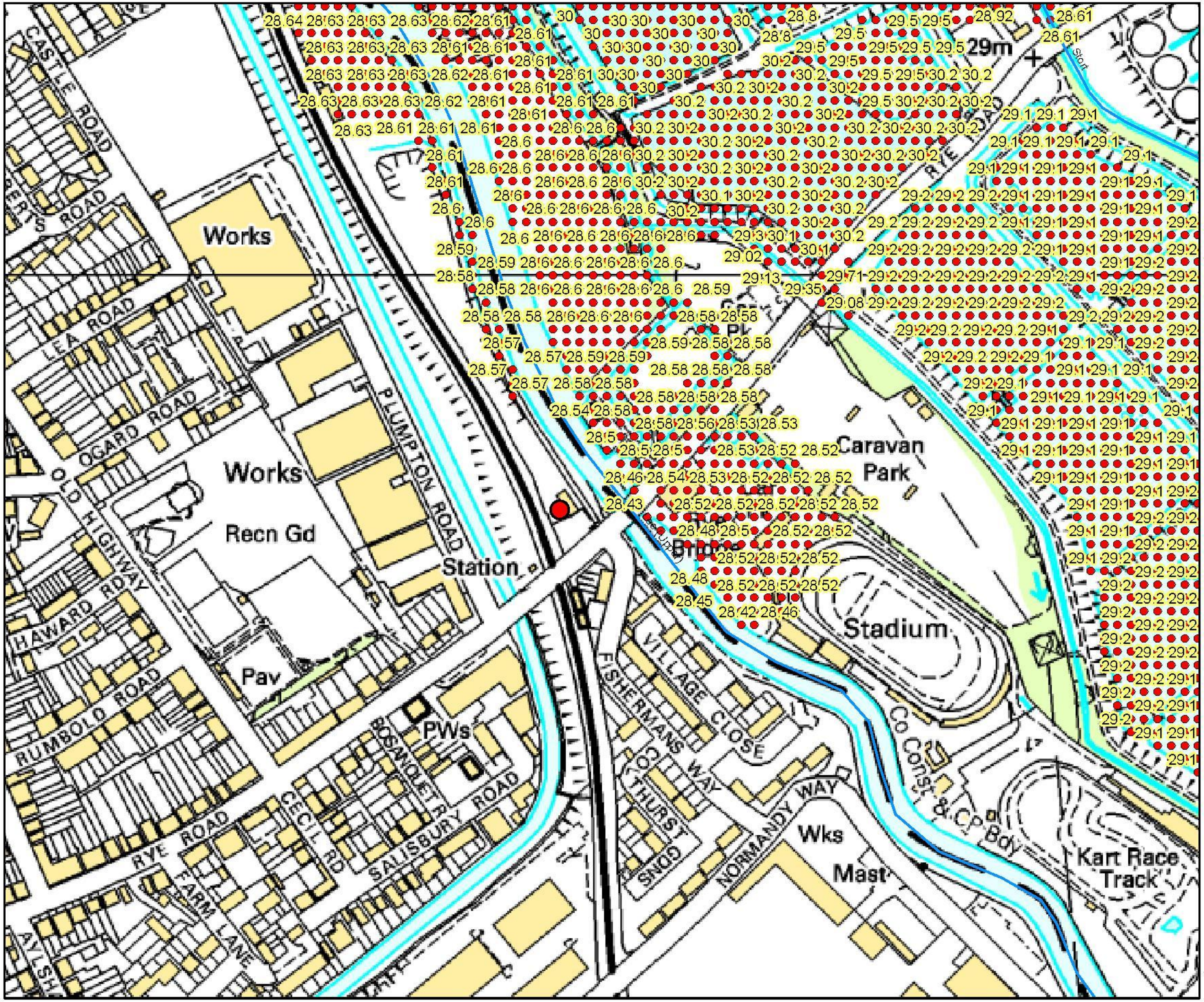
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

## Legend

Main Rivers

## 2D Node Results: Heights

1 in 200 (0.5%) Defended M01

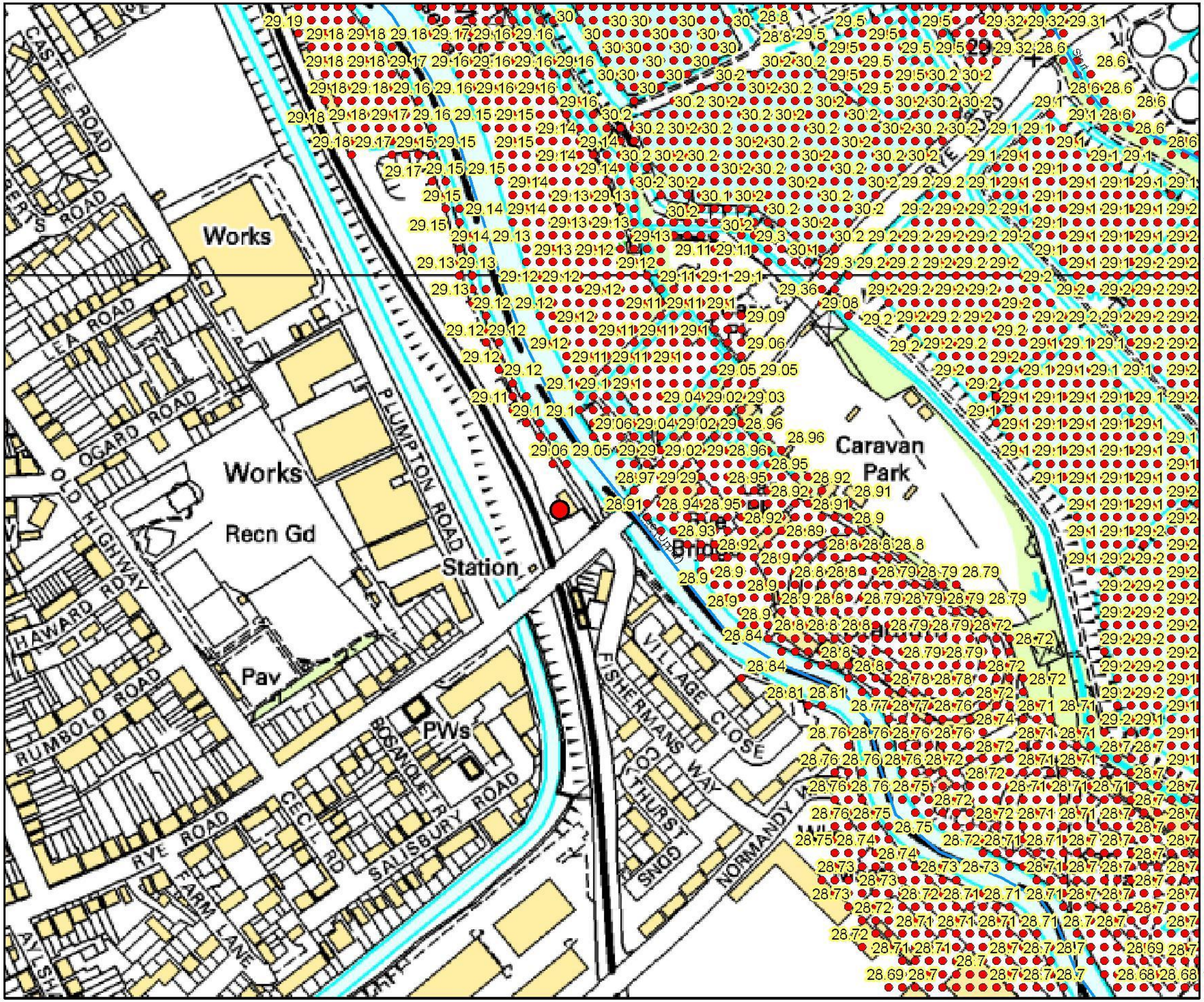
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Detailed FRA centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency


Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX


0 45 90 180
Metres

## Legend

Main Rivers

**2D Node Results: Heights**

1 in 1000 (0.1%) Defended M01

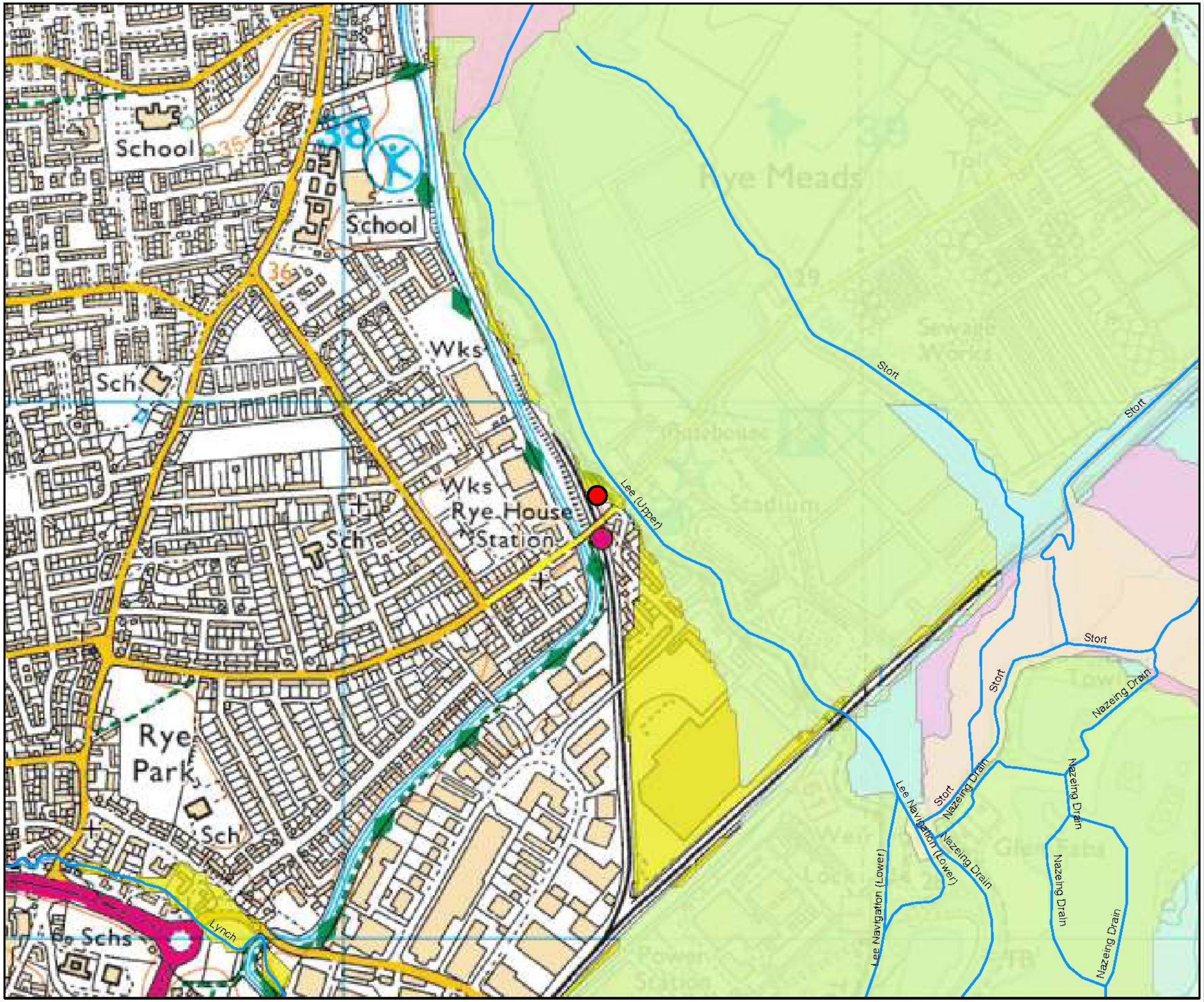
**The data in this map has been extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study, so may need local updates for site-specific decisions. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.**

**Modelled outlines take into account catchment-wide defences.**

**Updates to model M03 were undertaken by the Lower Hall Sluices Operational Scenario Modelling (CH2M Hill, 2014), and updates to model M04 by the Lower Lee Tributaries Economic Appraisal project (CH2M Hill, 2015).**

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Historic Flood Map centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 115 230 460
Metres

## Legend

Main Rivers

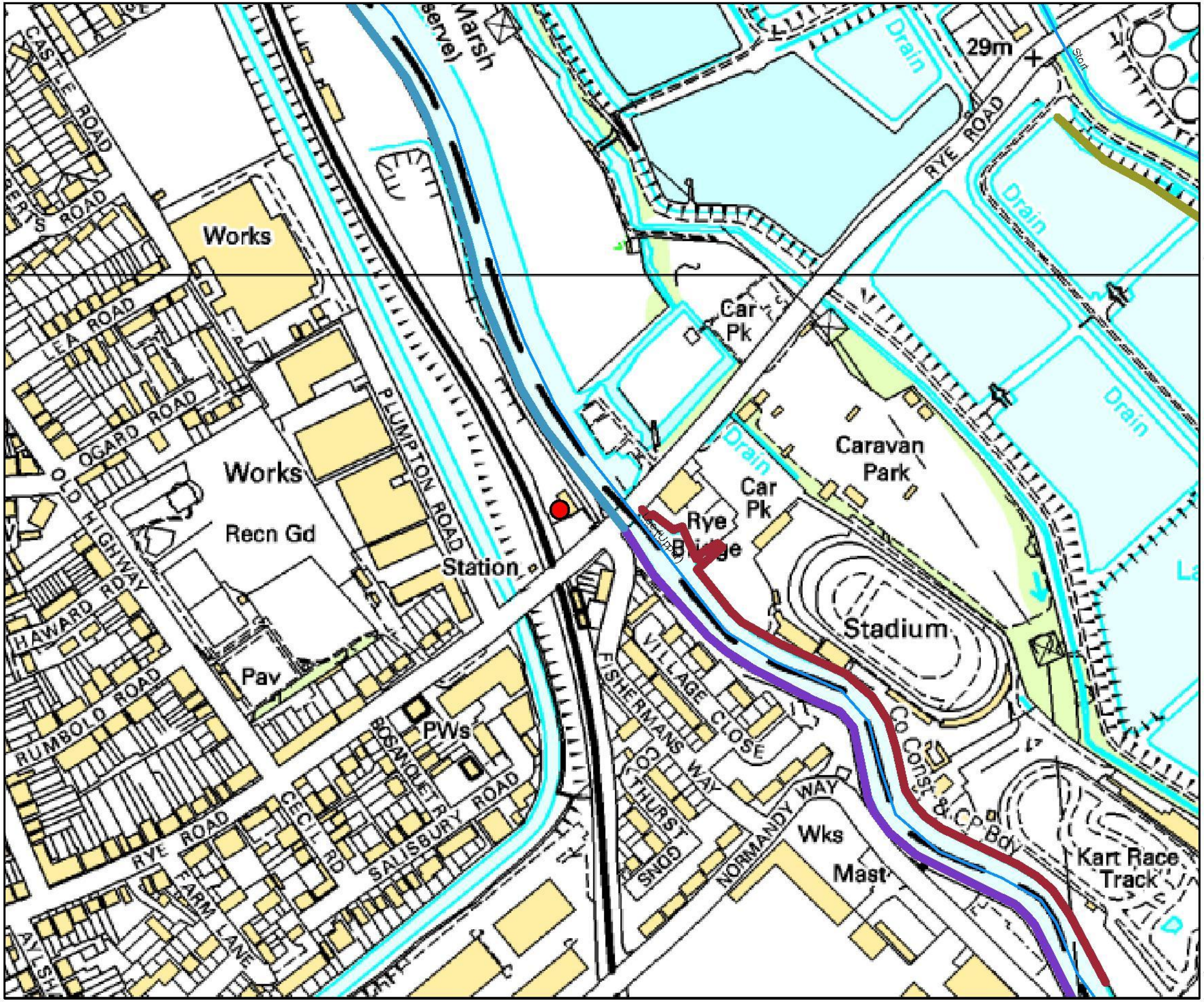
**Flood Event Outlines**

- 2011
- 2001
- 1978
- 1974
- 1968
- 1947

The historic flood event outlines are based on a combination of anecdotal evidence, Environment Agency staff observations and survey.
Our historic flood event outlines do not provide a definitive record of flooding.
It is possible that there will be an absence of datain places where we have not been able to record the extent of flooding.
It is also possible for errors occur in the digitisation of historic records of flooding.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

# Defences centred on 538469, 209838 created 24/07/2015 - Ref HNL/47934/LH




Environment Agency

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

**Legend**

Main Rivers

**Defences**

**Asset_ID**

- 44751
- 146050
- 146909
- 146911

The following information on defences has been extracted from the Asset Information Management System (AIMS)

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

**Environment Agency ref: HNL/47934/LH**

The following information on defences has been extracted from the Asset Information Management System (AIMS)

**Defences**

| Map ID | Asset Reference | Asset Type | Asset Protection | Asset Comment | Asset Description | Asset Location | Design Standard of protection (years) | NGR |
|---|---|---|---|---|---|---|---|---|
| 44751 | 0625151ST0152R03 | defence | Fluvial | 2m wide crested weir in very good stable condition. 13-01-10 AP Changed to NFDS, TC 9 - agreed ASC | Embankment | Rye Meads STW. west of Conveyor | 10 | TL3884610116 |
| 146911 | 0624646LE0101R03 | defence | Fluvial | Steel piling lined defence. | Lined Channel. | US of New Flat Outfall. | 50 | TL3885909455 |
| 146909 | 0624646LE0101L03 | defence | Fluvial | Steel sheet piling lined defence. | Lined Channel. | US of Flat Outfall. | 50 | TL3853609825 |
| 146050 | 0624646LE0102R04 | defence | Fluvial | Steel, concrete and timber protected bank. Various moorings along stretch. | Lined Channel. | Rye Bridge, Hoddesdon. | 10 | TL3852309811 |

creating a better place

Environment Agency

Louisa Wade
EAS
Unit 108
The Maltings
Stanstead Abbotts
SG12 8HG

**Our ref:** NE/2016/124755/01-L01

**Date:** 1 April 2016

Dear Louisa

**Proposed housing development at Rye Works, Hoddesdon – Preliminary Opinion.**

Thank you for your email regarding the above site. I hope the following answers your questions.

**1) Would the EA now need to be consulted on this site?**

We do not need to be formally consulted on this site. This is because the Flood Zones are unlikely to be updated in the near future, so until these updates occur we will work with the existing Flood Zones (regardless of whether they are expected to change or not). Therefore, as the development is located within Flood Zone 2 we will not be consulted and our Flood Risk Standing Advice (FRSA) will apply.

**2) Which of the % climate change allowances should we use?**

For residential development, we work to a 100 year life expectancy. Therefore, the allowances for the 2080s epoch should be used. As the proposed development is of a 'more vulnerable' use in Flood Zone 2, you should assess the central (25%) and higher central (35%) allowances, but we recommended designing to the higher central allowance. Further guidance relating to these allowances can be found at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

**3) If we need to consider the impact of the new climate change allowances, how do we go about obtaining the model from CH2M Hill?**

Our Customers & Engagement team (HNLEnquiries@environment-agency.gov.uk) can provide our 1 in 100 year + 20% climate change model, which can be re-run with the new allowances. From today (1 April) this is classed as Open Data and so can be obtained free of charge

Please contact me if you have any queries.

Yours sincerely

**Natasha Smith**
**Planning Advisor – Sustainable Places Team**

Direct dial 0203 0259119
E-mail SPHatfield@environment-agency.gov.uk

Hi Louisa

Provided no new development is located within Flood Zone 3 we wouldn't have any comments. This should be easily achievable for this development as we would require the area as a buffer zone anyway.

Kind regards

**Natasha Smith**
**Planning Advisor**
Sustainable Places | Environment Agency - Hertfordshire and North London
Apollo Court, 2 Bishops Square Business Park, St Albans Road West, Hatfield, Herts, AL10 9EX
☎ Internal: 725 2332
☎ External: 01707 632332
✉ SPHatfield@environment-agency.gov.uk

**From:** Louisa Wade [mailto:louisa.wade@eastp.co.uk]
**Sent:** 26 October 2015 11:02
**To:** SPHatfield
**Subject:** RE: Charged Advice - Review of Turnford Surfacing Flood Risk Assessment

Hi Natasha,

Following our conversation just now, please can you put it in an email to confirm that when the proposed development is not in FZ3 the EA don't need to comment on the proposals? Our client has concerns about this as has had problems before at a later stage in the planning application which has delayed planning so it would be useful to have something in writing to send over to them.

Many thanks

Louisa

**From:** SPHatfield [mailto:SPHatfield@environment-agency.gov.uk]
**Sent:** 26 October 2015 08:47
**To:** Louisa Wade
**Subject:** RE: Charged Advice - Review of Turnford Surfacing Flood Risk Assessment

Hi Louisa

We don't think it is worthwhile us setting up an agreement for this development as the site is in Flood Zone 2 and so we wouldn't review the FRA as part of a planning application. Our only concern would be in regards to proximity and ensuring we have an 8 metre buffer.

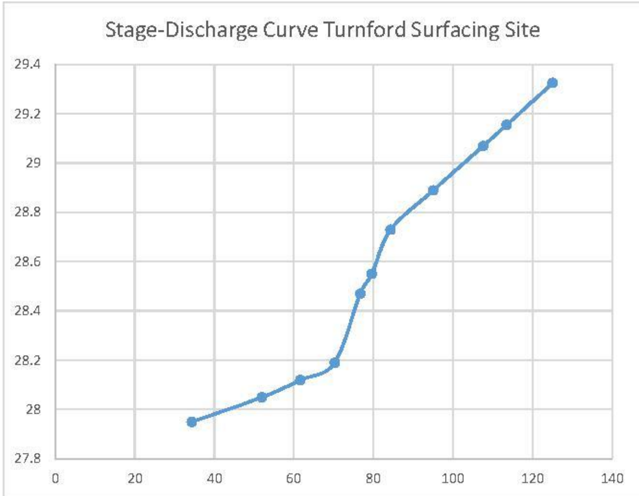
Kind regards

**Natasha Smith**
**Planning Advisor**
Sustainable Places | Environment Agency - Hertfordshire and North London
Apollo Court, 2 Bishops Square Business Park, St Albans Road West, Hatfield, Herts, AL10 9EX
☎ Internal: 725 2332
☎ External: 01707 632332
✉ SPHatfield@environment-agency.gov.uk

**Turnford Surfacing Site, Rye Road, Herts**

EA Flood Data Node ch34100

| Year | Flow | Level | |
|---|---|---|---|
| 2 | 34.32 | 27.95 | EA Modelled |
| 5 | 51.95 | 28.05 | EA Modelled |
| 10 | 61.59 | 28.12 | EA Modelled |
| 20 | 70.18 | 28.19 | EA Modelled |
| 50 | 76.6 | 28.47 | EA Modelled |
| 75 | 79.54 | 28.55 | EA Modelled |
| 100 | 84.27 | 28.73 | EA Modelled |
| 200 | 94.97 | 28.89 | EA Modelled |
| 100+20% | 107.56 | 29.07 | EA Modelled |
| 100+25% | 113.3825 | 29.155 | Rating Curve |
| 100+35% | 125.0275 | 29.325 | Rating Curve |




| Thames More Vulnerable | |
|---|---|
| 2015-2039 | 25% |
| 2040-2069 | 35% |
| 2070-2115 | 70% |

1) Interpolated new CC levels using modelled 1 in 100 and 1 in 100+20% flows and levels

| | | |
|---|---|---|
| 1 in 100 year | 84.27 | 28.73 |
| 1 in 100 year+20%cc | 107.56 | 29.07 |
| Differences | 23.29 | 0.34 |
| Divide differences by 20 | 1.1645 | 0.017 |

So for ever 1.1645 flow, there will be increase of 0.017 level

2) Multiply flow change and level change by required CC % e. 35

40.7575 flow
0.595 level

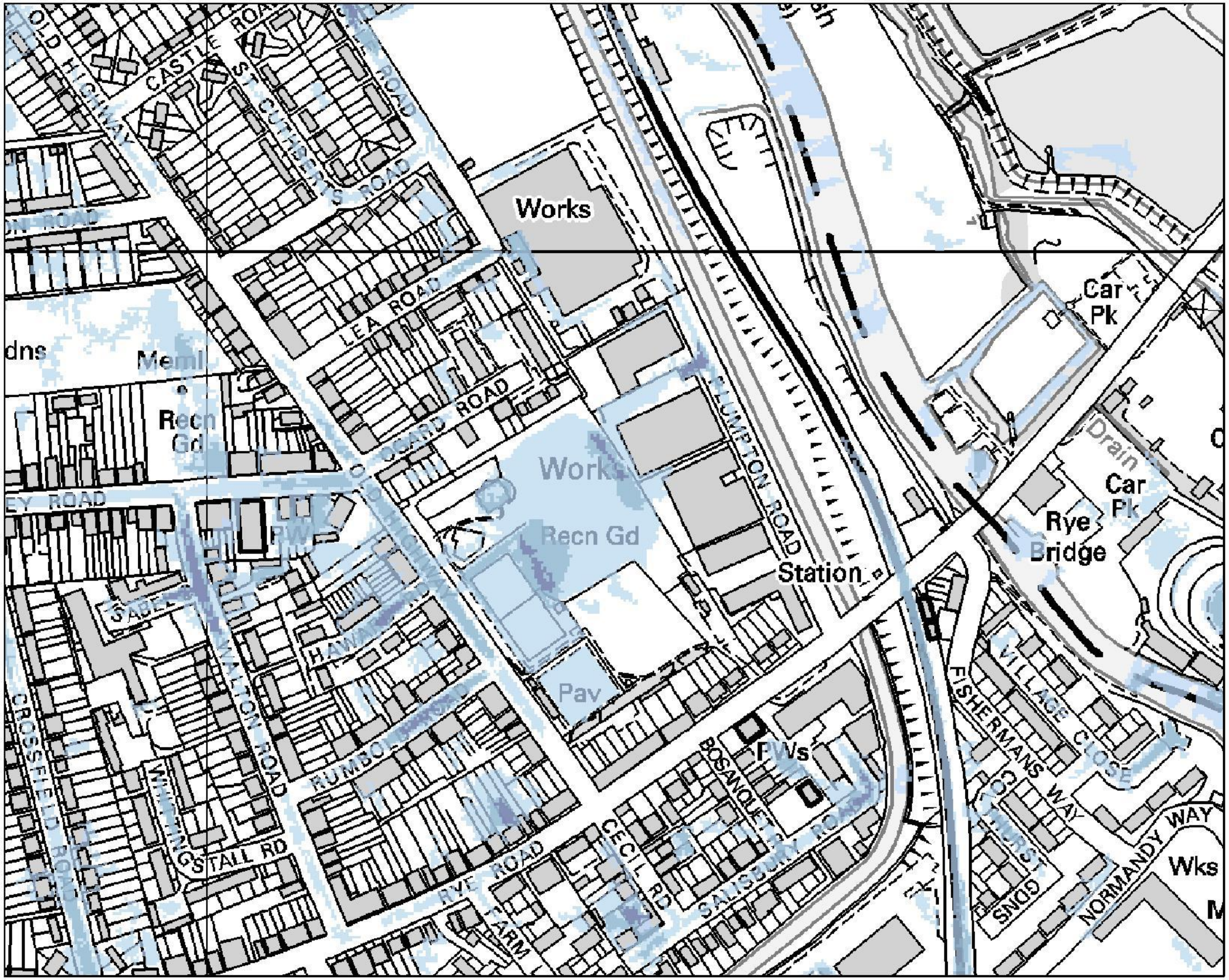
3) Add %CC flow and %CC level onto the 1 in 100 year flow and level:

CC Flow = 125.0275
CC Level = 29.325

**Floodplain Compensation**

We should be using the 2D flood data to assess the site. However, there is no flow data for this, only level data.
Therefore we should take the highest 1 in 100 year (+CC) level onsite from the 2D data(a level of 28.79m AOD) and apply the difference in level from the closest 1D node as per the calculations above in lieu of assessing the level change from the flow data.
The level change in the closest node (ch34100) from 1 in 100 year (+20%CC) and 1 in 100 year (+35%CC is 0.255
Add the change in level to the highest modelled 2D level onsite (28.79m AOD) would give **29.045**
**Use 29.045m AOD as the 1 in 100 (+35%CC) flood level to use for the floodplain compensation calcs**

# Risk of flooding from Surface Water – Centered on EN11 0LB - Created on 27/7/2015 - HNL/47934/LH




Environment Agency

Scale 1:4,000

**Likelihood of flooding from Surface Water**

- High
- Medium
- Low
- Very Low

**Likelihood of flooding from Surface Water**

| | |
|---|---|
| High: | Greater than or equal to 1 in 30 (3.3%) chance in any given year |
| Medium: | Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year |
| Low: | Less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) chance in any given year |
| Very Low: | Less than 1 in 1,000 (0.1%) chance in any given year |

This information is shown on the Risk of Flooding from Surface Water map on our website.



**Contact Us:** National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

# Appendix: D – Topographical Survey

# Appendix: E – Thames Water Sewer Records and response to Pre-Planning Enquiry



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

# Asset Location Search Sewer Map - ALS/ALS Standard/2015_3106123

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

| Manhole Reference | Manhole Cover Level | Manhole Inve |
|---|---|---|
| 1902 | 36.19 | 34.03 |
| 191A | n/a | n/a |
| 1903 | 36.07 | 34.25 |
| 1904 | 36.62 | 35.18 |
| 3850 | 32.7 | 30.02 |
| 4804 | n/a | n/a |
| 5607 | n/a | n/a |
| 5706 | n/a | n/a |
| 17BD | n/a | n/a |
| 1751 | 36.23 | 33.14 |
| 1702 | 36.31 | 32.36 |
| 271A | 36.05 | 33.08 |
| 361A | n/a | n/a |
| 3602 | 36.22 | 33.97 |
| 4801 | n/a | 31.19 |
| 4750 | 34.31 | 31.57 |
| 5703 | n/a | n/a |
| 5710 | 30.36 | n/a |
| 5704 | n/a | n/a |
| 5705 | n/a | n/a |

**The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be gua shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error o 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.

Mr Matt Little
EAS
Unit 23 The Maltings
Roydon Road
Stanstead Abbotts
Herts
SG12 8HG

Wastewater pre-planning

Our ref DS6069507

07 February 2020

## Pre-planning enquiry: Confirmation of sufficient capacity (Surface water only)

Dear Mr Little,

Thank you for providing information on your development:

**Former Turnford Surfacing Site, Rye Road, Hoddesdon, Hertfordshire, EN11 0EG.**

**Proposed development of general housing (13 units) and flats (91 units). Foul water discharge TBC. Surface water discharging to the surface water sewer via a new connection downstream of manhole 4804.**

**Existing surface water run-off rates: 1 year=11.46l/s, 10 year=27.64l/s, 30 year=25.5l/s, 100 year=33.2l/s and 100year+40%CC=46.4l/s.**

**Proposed surface water run-off rates: 1 year=3.2l/s, 10 year=4.7l/s, 30 year=5.4l/s, 100 year=6.4l/s and 100 year+40%CC=7.8l/s.**

**Infiltration is not possible due to contamination.**

We have completed the assessment of the surface water run-off based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network.

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 not be 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.

Only when it can be proven that soakage into the ground or a connection into an adjacent watercourse is not possible would we consider a restricted discharge into the public surface water sewer network.

If the peak surface water run-off discharge is then restricted to Greenfield run-off rates/a maximum of the proposed rates as your drainage strategy indicates, then we would have no objections to the proposals.

Thames Water Planning team would ask to see why it is not practicable on the site to restrict to Greenfield run-off rates if they are consulted as part of any planning application.

In considering your surface water needs, we support the use of sustainable drainage on development sites. You'll need to show the local authority and/or lead local flood authority how you've taken into account the surface water hierarchy that we've included.

Please see the attached 'Planning your wastewater' leaflet for additional information.

### What happens next?

Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.

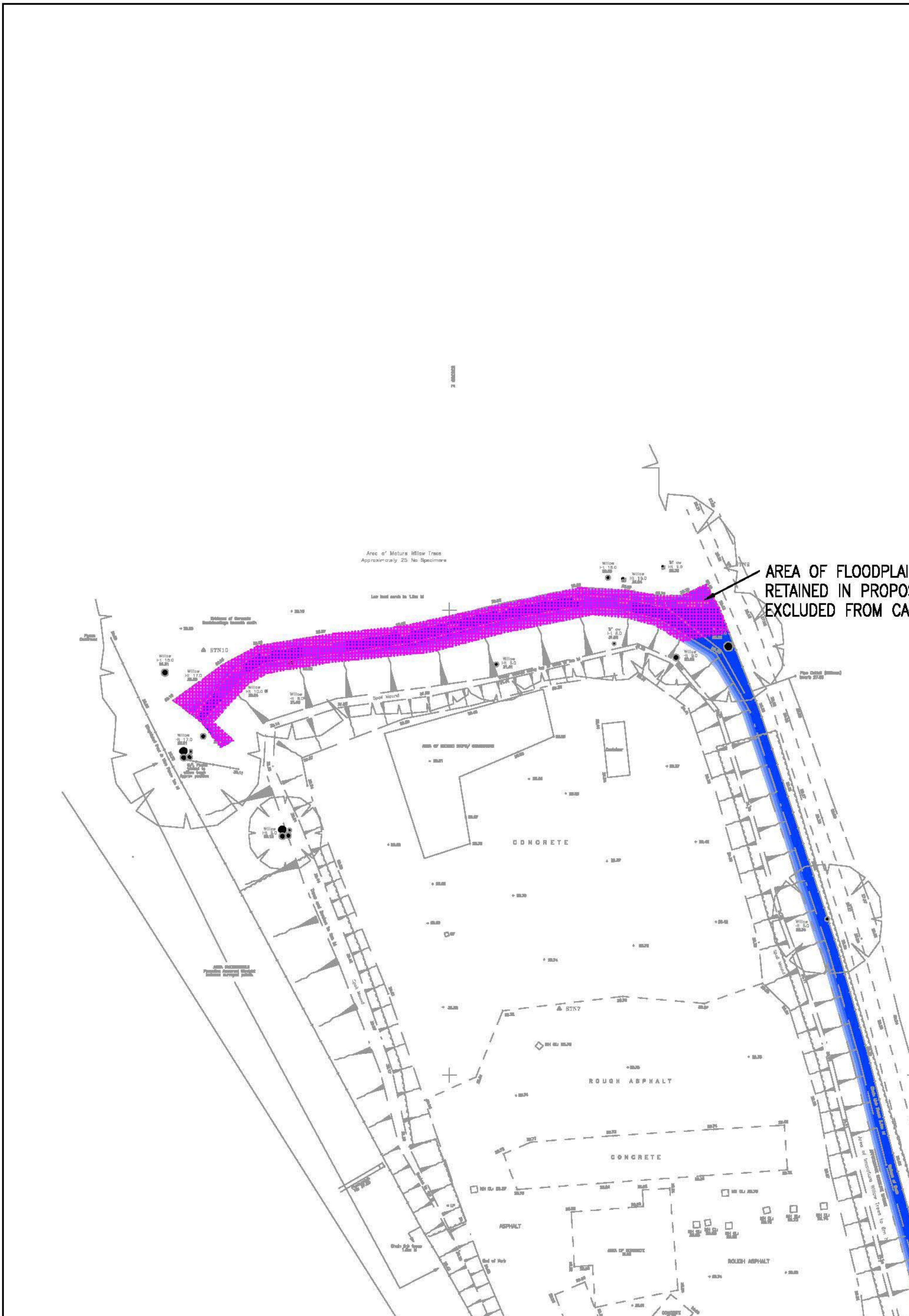
If you've any further questions, please contact me on 0203 577 9811

Yours sincerely

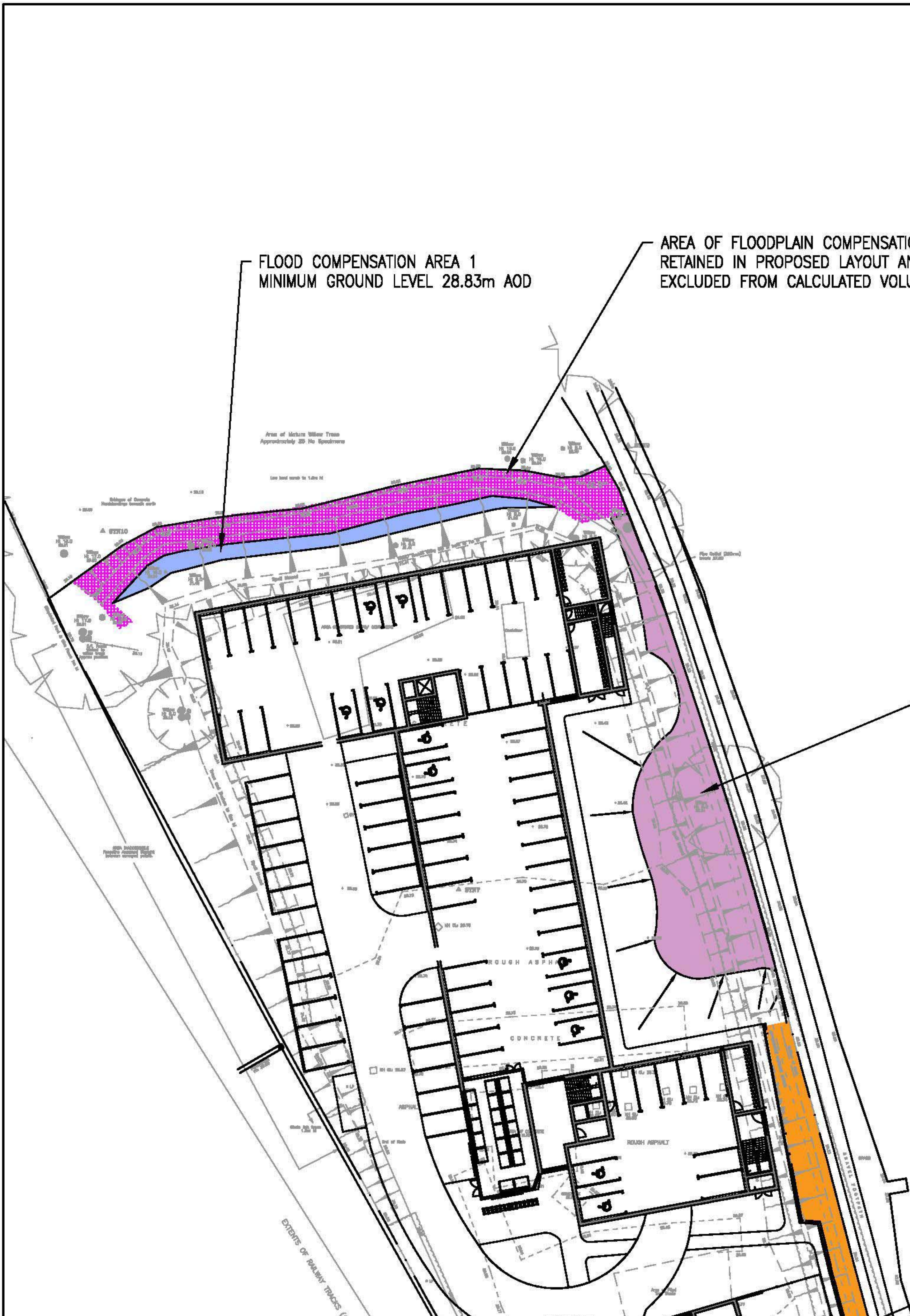
Siva Rajaratnam – Adoptions Engineer

Thames Water

# Appendix: F – Existing Flood Extents and Volumes


AREA OF FLOODPLAI
RETAINED IN PROPOS
EXCLUDED FROM CA
STN10
STN7
CONCRETE
ROUGH ASPHALT
CONCRETE
ASPHALT
ROUGH ASPHALT

# Appendix: G – Floodplain Compensation Modelling for 1 in 100 year + 35% Climate Change Event



FLOOD COMPENSATION AREA 1
MINIMUM GROUND LEVEL 28.83m AOD
AREA OF FLOODPLAIN COMPENSATIO
RETAINED IN PROPOSED LAYOUT AN
EXCLUDED FROM CALCULATED VOLU
ROUGH ASPHALT
CONCRETE
EXTENTS OF RAILWAY TRACKS

EAS

# Appendix: H – Existing Runoff Rate Calculations



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS

Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

**Run-off from Existing Site (1 in 100 yr event allowance)**

**Methodology**

Using the Modified Rational Method, the surface water run-off rate, has been calculated for the existing impermeable part of the developed site that are understood to be formally drained, but excluding the gravelled areas and unsurfaced driveway.

Ref: Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed, SPON.

Q = CiA

where

$C = \frac{PIMP}{PR}$

PIMP = Percentage of impervious area to total area
PR = Percentage Runoff

| | **Surface Area ($m^2$)** |
|---|---|
| **Existing Impervious Areas** | 12000 |
| **Total Area** | 12000 |

i (Rainfall intensity, mm/hr) = 50.00
i (Rainfall intensity, m/hr) = 0.050
i (Rainfall intensity, m/s) = $1.38 \times 10^{-5}$

**Percentage run-off (PR)**
Existing Impervious Area = 100%

**Percentage of impervious area to total area (PIMP)**
PIMP = 12000/12000 = 100%

Therefore $C = \frac{PIMP}{PR} = 1$

**Runoff from existing site:**
Q = CiA
$Q = 1 \times 1.38 \times 10^{-5} \times 12000 m^2$
$Q = 0.166 m^3 s^{-1}$
$Q = 166.67 ls^{-1}$

**Total Q for the existing site = 166.67 $ls^{-1}$**

## Appendix: I – MicroDrainage Greenfield Runoff Rates


TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG **Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk**

ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 1.000 | Urban | 0.000 |
| SAAR (mm) | 600 | Region Number | Region 6 |

| **Results** | **l/s** |
|---|---|
| QBAR Rural | 3.7 |
| QBAR Urban | 3.7 |
| | |
| Q100 years | 11.7 |
| | |
| Q1 year | 3.1 |
| Q30 years | 8.3 |
| Q100 years | 11.7 |

EAS

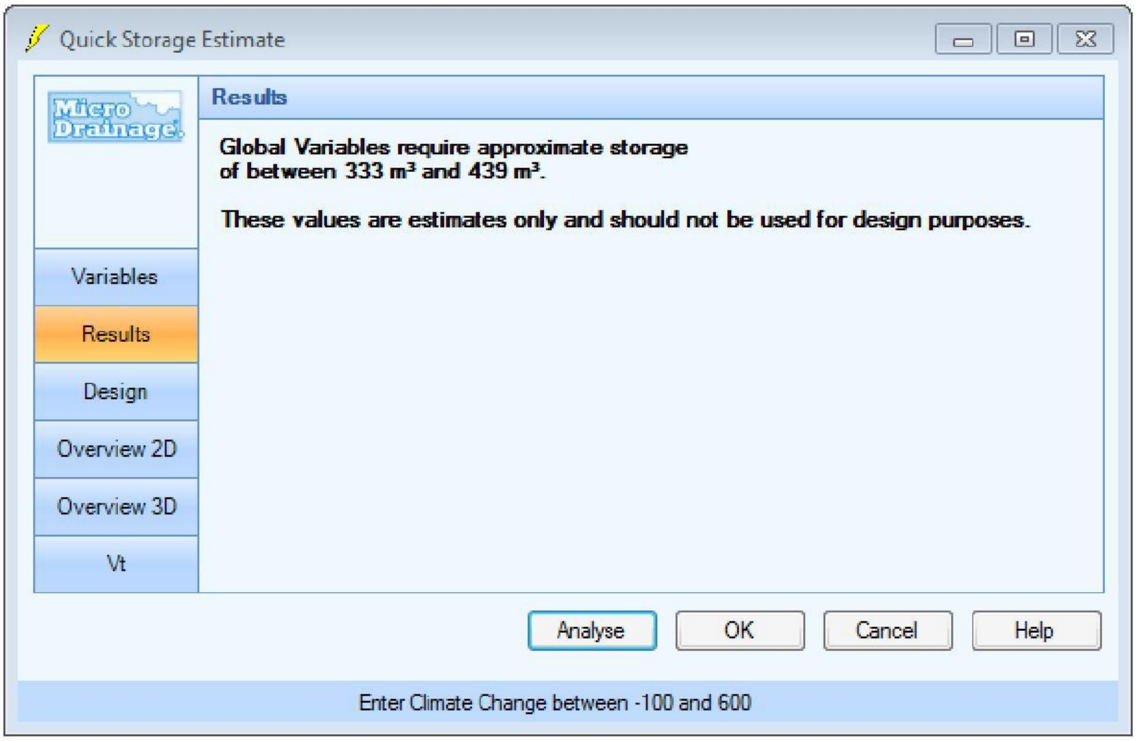
# Appendix: J - MicroDrainage Quick Storage Estimate



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

# Quick Storage Estimate

Quick Storage Estimate based on 1 in 100 year + 40% climate change event.



EAS

# Appendix: K – MicroDrainage Outputs

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

Half Drain Time : 434 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 29.270 | 0.180 | 0.0 | 1.9 | 1.9 | 57.1 | O K |
| 30 min Summer | 29.323 | 0.233 | 0.0 | 2.2 | 2.2 | 74.2 | O K |
| 60 min Summer | 29.373 | 0.283 | 0.0 | 2.4 | 2.4 | 90.0 | O K |
| 120 min Summer | 29.414 | 0.324 | 0.0 | 2.6 | 2.6 | 102.9 | Flood Risk |
| 180 min Summer | 29.429 | 0.339 | 0.0 | 2.7 | 2.7 | 107.9 | Flood Risk |
| 240 min Summer | 29.435 | 0.345 | 0.0 | 2.7 | 2.7 | 109.6 | Flood Risk |
| 360 min Summer | 29.434 | 0.344 | 0.0 | 2.7 | 2.7 | 109.3 | Flood Risk |
| 480 min Summer | 29.432 | 0.342 | 0.0 | 2.7 | 2.7 | 108.6 | Flood Risk |
| 600 min Summer | 29.428 | 0.338 | 0.0 | 2.7 | 2.7 | 107.6 | Flood Risk |
| 720 min Summer | 29.424 | 0.334 | 0.0 | 2.7 | 2.7 | 106.3 | Flood Risk |
| 960 min Summer | 29.414 | 0.324 | 0.0 | 2.6 | 2.6 | 103.2 | Flood Risk |
| 1440 min Summer | 29.392 | 0.302 | 0.0 | 2.5 | 2.5 | 95.9 | O K |
| 2160 min Summer | 29.358 | 0.268 | 0.0 | 2.4 | 2.4 | 85.2 | O K |
| 2880 min Summer | 29.329 | 0.239 | 0.0 | 2.2 | 2.2 | 75.9 | O K |
| 4320 min Summer | 29.283 | 0.193 | 0.0 | 2.0 | 2.0 | 61.4 | O K |
| 5760 min Summer | 29.250 | 0.160 | 0.0 | 1.8 | 1.8 | 51.0 | O K |
| 7200 min Summer | 29.226 | 0.136 | 0.0 | 1.6 | 1.6 | 43.4 | O K |
| 8640 min Summer | 29.208 | 0.118 | 0.0 | 1.5 | 1.5 | 37.6 | O K |
| 10080 min Summer | 29.194 | 0.104 | 0.0 | 1.4 | 1.4 | 33.1 | O K |
| 15 min Winter | 29.293 | 0.203 | 0.0 | 2.0 | 2.0 | 64.7 | O K |
| 30 min Winter | 29.354 | 0.264 | 0.0 | 2.4 | 2.4 | 83.9 | O K |
| 60 min Winter | 29.410 | 0.320 | 0.0 | 2.6 | 2.6 | 101.7 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 143.954 | 0.0 | 54.2 | 26 |
| 30 min Summer | 92.629 | 0.0 | 71.9 | 40 |
| 60 min Summer | 56.713 | 0.0 | 93.2 | 68 |
| 120 min Summer | 33.583 | 0.0 | 111.5 | 126 |
| 180 min Summer | 24.424 | 0.0 | 122.1 | 184 |
| 240 min Summer | 19.389 | 0.0 | 129.5 | 242 |
| 360 min Summer | 13.924 | 0.0 | 139.7 | 314 |
| 480 min Summer | 11.018 | 0.0 | 147.5 | 374 |
| 600 min Summer | 9.182 | 0.0 | 153.6 | 436 |
| 720 min Summer | 7.908 | 0.0 | 158.6 | 504 |
| 960 min Summer | 6.245 | 0.0 | 166.7 | 642 |
| 1440 min Summer | 4.471 | 0.0 | 177.9 | 914 |
| 2160 min Summer | 3.197 | 0.0 | 193.2 | 1308 |
| 2880 min Summer | 2.518 | 0.0 | 201.6 | 1704 |
| 4320 min Summer | 1.796 | 0.0 | 212.4 | 2460 |
| 5760 min Summer | 1.413 | 0.0 | 222.3 | 3176 |
| 7200 min Summer | 1.172 | 0.0 | 227.9 | 3896 |
| 8640 min Summer | 1.006 | 0.0 | 231.8 | 4592 |
| 10080 min Summer | 0.884 | 0.0 | 234.1 | 5344 |
| 15 min Winter | 143.954 | 0.0 | 61.7 | 26 |
| 30 min Winter | 92.629 | 0.0 | 81.4 | 40 |
| 60 min Winter | 56.713 | 0.0 | 105.2 | 68 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 120 min Winter | 29.457 | 0.367 | 0.0 | 2.8 | 2.8 | 116.6 | Flood Risk |
| 180 min Winter | 29.475 | 0.385 | 0.0 | 2.9 | 2.9 | 122.6 | Flood Risk |
| 240 min Winter | 29.483 | 0.393 | 0.0 | 2.9 | 2.9 | 124.9 | Flood Risk |
| 360 min Winter | 29.482 | 0.392 | 0.0 | 2.9 | 2.9 | 124.7 | Flood Risk |
| 480 min Winter | 29.476 | 0.386 | 0.0 | 2.9 | 2.9 | 122.9 | Flood Risk |
| 600 min Winter | 29.471 | 0.381 | 0.0 | 2.9 | 2.9 | 121.3 | Flood Risk |
| 720 min Winter | 29.465 | 0.375 | 0.0 | 2.8 | 2.8 | 119.1 | Flood Risk |
| 960 min Winter | 29.449 | 0.359 | 0.0 | 2.8 | 2.8 | 114.0 | Flood Risk |
| 1440 min Winter | 29.414 | 0.324 | 0.0 | 2.6 | 2.6 | 102.9 | Flood Risk |
| 2160 min Winter | 29.365 | 0.275 | 0.0 | 2.4 | 2.4 | 87.6 | O K |
| 2880 min Winter | 29.325 | 0.235 | 0.0 | 2.2 | 2.2 | 74.8 | O K |
| 4320 min Winter | 29.267 | 0.177 | 0.0 | 1.9 | 1.9 | 56.2 | O K |
| 5760 min Winter | 29.228 | 0.138 | 0.0 | 1.6 | 1.6 | 43.8 | O K |
| 7200 min Winter | 29.201 | 0.111 | 0.0 | 1.4 | 1.4 | 35.4 | O K |
| 8640 min Winter | 29.183 | 0.093 | 0.0 | 1.3 | 1.3 | 29.6 | O K |
| 10080 min Winter | 29.170 | 0.080 | 0.0 | 1.1 | 1.1 | 25.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 120 min Winter | 33.583 | 0.0 | 125.7 | 124 |
| 180 min Winter | 24.424 | 0.0 | 137.6 | 180 |
| 240 min Winter | 19.389 | 0.0 | 145.9 | 236 |
| 360 min Winter | 13.924 | 0.0 | 157.4 | 344 |
| 480 min Winter | 11.018 | 0.0 | 166.1 | 390 |
| 600 min Winter | 9.182 | 0.0 | 173.0 | 464 |
| 720 min Winter | 7.908 | 0.0 | 178.7 | 542 |
| 960 min Winter | 6.245 | 0.0 | 187.8 | 692 |
| 1440 min Winter | 4.471 | 0.0 | 200.4 | 984 |
| 2160 min Winter | 3.197 | 0.0 | 217.7 | 1404 |
| 2880 min Winter | 2.518 | 0.0 | 227.3 | 1792 |
| 4320 min Winter | 1.796 | 0.0 | 240.1 | 2556 |
| 5760 min Winter | 1.413 | 0.0 | 251.3 | 3288 |
| 7200 min Winter | 1.172 | 0.0 | 258.0 | 3976 |
| 8640 min Winter | 1.006 | 0.0 | 262.9 | 4680 |
| 10080 min Winter | 0.884 | 0.0 | 266.2 | 5352 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.450 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.237

| **Time From:** | **(mins) To:** | **Area (ha)** | **Time From:** | **(mins) To:** | **Area (ha)** | **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 0.079 | 4 | 8 | 0.079 | 8 | 12 | 0.079 |

## Model Details

Storage is Online Cover Level (m) 29.700

## Porous Car Park Structure

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 106.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 10.0 |
| Max Percolation (l/s) | 294.4 | Slope (1:X) | 0.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 29.090 | Cap Volume Depth (m) | 0.400 |

## Orifice Outflow Control

Diameter (m) 0.048 Discharge Coefficient 0.600 Invert Level (m) 29.090

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

Half Drain Time : 571 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 29.091 | 0.301 | 0.0 | 2.5 | 2.5 | 100.2 | O K |
| 30 min Summer | 29.179 | 0.389 | 0.0 | 2.9 | 2.9 | 129.4 | O K |
| 60 min Summer | 29.261 | 0.471 | 0.0 | 3.2 | 3.2 | 157.0 | O K |
| 120 min Summer | 29.332 | 0.542 | 0.0 | 3.5 | 3.5 | 180.5 | O K |
| 180 min Summer | 29.363 | 0.573 | 0.0 | 3.6 | 3.6 | 190.8 | O K |
| 240 min Summer | 29.377 | 0.587 | 0.0 | 3.6 | 3.6 | 195.5 | O K |
| 360 min Summer | 29.382 | 0.592 | 0.0 | 3.6 | 3.6 | 197.2 | O K |
| 480 min Summer | 29.379 | 0.589 | 0.0 | 3.6 | 3.6 | 196.0 | O K |
| 600 min Summer | 29.374 | 0.584 | 0.0 | 3.6 | 3.6 | 194.6 | O K |
| 720 min Summer | 29.369 | 0.579 | 0.0 | 3.6 | 3.6 | 192.8 | O K |
| 960 min Summer | 29.356 | 0.566 | 0.0 | 3.5 | 3.5 | 188.6 | O K |
| 1440 min Summer | 29.325 | 0.535 | 0.0 | 3.4 | 3.4 | 178.3 | O K |
| 2160 min Summer | 29.277 | 0.487 | 0.0 | 3.3 | 3.3 | 162.3 | O K |
| 2880 min Summer | 29.233 | 0.443 | 0.0 | 3.1 | 3.1 | 147.5 | O K |
| 4320 min Summer | 29.160 | 0.370 | 0.0 | 2.8 | 2.8 | 123.1 | O K |
| 5760 min Summer | 29.104 | 0.314 | 0.0 | 2.6 | 2.6 | 104.5 | O K |
| 7200 min Summer | 29.061 | 0.271 | 0.0 | 2.4 | 2.4 | 90.1 | O K |
| 8640 min Summer | 29.026 | 0.236 | 0.0 | 2.2 | 2.2 | 78.7 | O K |
| 10080 min Summer | 28.999 | 0.209 | 0.0 | 2.1 | 2.1 | 69.6 | O K |
| 15 min Winter | 29.129 | 0.339 | 0.0 | 2.7 | 2.7 | 113.0 | O K |
| 30 min Winter | 29.228 | 0.438 | 0.0 | 3.1 | 3.1 | 145.9 | O K |
| 60 min Winter | 29.321 | 0.531 | 0.0 | 3.4 | 3.4 | 176.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 143.954 | 0.0 | 95.8 | 26 |
| 30 min Summer | 92.629 | 0.0 | 124.9 | 41 |
| 60 min Summer | 56.713 | 0.0 | 161.5 | 70 |
| 120 min Summer | 33.583 | 0.0 | 192.4 | 128 |
| 180 min Summer | 24.424 | 0.0 | 210.4 | 186 |
| 240 min Summer | 19.389 | 0.0 | 222.9 | 244 |
| 360 min Summer | 13.924 | 0.0 | 240.3 | 360 |
| 480 min Summer | 11.018 | 0.0 | 253.5 | 418 |
| 600 min Summer | 9.182 | 0.0 | 263.9 | 478 |
| 720 min Summer | 7.908 | 0.0 | 272.5 | 540 |
| 960 min Summer | 6.245 | 0.0 | 286.2 | 672 |
| 1440 min Summer | 4.471 | 0.0 | 304.8 | 944 |
| 2160 min Summer | 3.197 | 0.0 | 333.0 | 1352 |
| 2880 min Summer | 2.518 | 0.0 | 348.3 | 1756 |
| 4320 min Summer | 1.796 | 0.0 | 369.2 | 2516 |
| 5760 min Summer | 1.413 | 0.0 | 387.2 | 3288 |
| 7200 min Summer | 1.172 | 0.0 | 398.7 | 4032 |
| 8640 min Summer | 1.006 | 0.0 | 407.5 | 4752 |
| 10080 min Summer | 0.884 | 0.0 | 413.9 | 5448 |
| 15 min Winter | 143.954 | 0.0 | 108.1 | 26 |
| 30 min Winter | 92.629 | 0.0 | 140.2 | 40 |
| 60 min Winter | 56.713 | 0.0 | 181.8 | 68 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 120 min Winter | 29.402 | 0.612 | 0.0 | 3.7 | 3.7 | 203.9 | Flood Risk |
| 180 min Winter | 29.439 | 0.649 | 0.0 | 3.8 | 3.8 | 216.0 | Flood Risk |
| 240 min Winter | 29.456 | 0.666 | 0.0 | 3.9 | 3.9 | 221.9 | Flood Risk |
| 360 min Winter | 29.466 | 0.676 | 0.0 | 3.9 | 3.9 | 225.1 | Flood Risk |
| 480 min Winter | 29.462 | 0.672 | 0.0 | 3.9 | 3.9 | 223.9 | Flood Risk |
| 600 min Winter | 29.453 | 0.663 | 0.0 | 3.8 | 3.8 | 220.6 | Flood Risk |
| 720 min Winter | 29.445 | 0.655 | 0.0 | 3.8 | 3.8 | 218.2 | Flood Risk |
| 960 min Winter | 29.426 | 0.636 | 0.0 | 3.8 | 3.8 | 211.9 | Flood Risk |
| 1440 min Winter | 29.381 | 0.591 | 0.0 | 3.6 | 3.6 | 196.7 | O K |
| 2160 min Winter | 29.311 | 0.521 | 0.0 | 3.4 | 3.4 | 173.4 | O K |
| 2880 min Winter | 29.248 | 0.458 | 0.0 | 3.2 | 3.2 | 152.7 | O K |
| 4320 min Winter | 29.150 | 0.360 | 0.0 | 2.8 | 2.8 | 119.8 | O K |
| 5760 min Winter | 29.078 | 0.288 | 0.0 | 2.5 | 2.5 | 96.0 | O K |
| 7200 min Winter | 29.026 | 0.236 | 0.0 | 2.2 | 2.2 | 78.6 | O K |
| 8640 min Winter | 28.987 | 0.197 | 0.0 | 2.0 | 2.0 | 65.6 | O K |
| 10080 min Winter | 28.957 | 0.167 | 0.0 | 1.8 | 1.8 | 55.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 120 min Winter | 33.583 | 0.0 | 216.4 | 126 |
| 180 min Winter | 24.424 | 0.0 | 236.5 | 182 |
| 240 min Winter | 19.389 | 0.0 | 250.6 | 240 |
| 360 min Winter | 13.924 | 0.0 | 270.0 | 350 |
| 480 min Winter | 11.018 | 0.0 | 284.8 | 456 |
| 600 min Winter | 9.182 | 0.0 | 296.5 | 500 |
| 720 min Winter | 7.908 | 0.0 | 306.1 | 568 |
| 960 min Winter | 6.245 | 0.0 | 321.3 | 720 |
| 1440 min Winter | 4.471 | 0.0 | 341.6 | 1022 |
| 2160 min Winter | 3.197 | 0.0 | 374.3 | 1456 |
| 2880 min Winter | 2.518 | 0.0 | 391.7 | 1876 |
| 4320 min Winter | 1.796 | 0.0 | 415.6 | 2648 |
| 5760 min Winter | 1.413 | 0.0 | 436.0 | 3408 |
| 7200 min Winter | 1.172 | 0.0 | 449.4 | 4176 |
| 8640 min Winter | 1.006 | 0.0 | 459.8 | 4848 |
| 10080 min Winter | 0.884 | 0.0 | 467.7 | 5560 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.450 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.400

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 0.134 | 4 | 8 | 0.133 | 8 | 12 | 0.133 |

## Model Details

Storage is Online Cover Level (m) 29.700

## Porous Car Park Structure

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Width (m) | 111.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 10.0 |
| Max Percolation (l/s) | 308.3 | Slope (1:X) | 0.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 28.790 | Cap Volume Depth (m) | 0.700 |

## Orifice Outflow Control

Diameter (m) 0.048 Discharge Coefficient 0.600 Invert Level (m) 28.790

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

Half Drain Time : 355 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Σ Max Outflow (l/s) | Max Volume (m³) | Status |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 15 min Summer | 28.990 | 0.390 | 0.0 | 0.7 | 0.7 | 18.5 | O K |
| 30 min Summer | 29.093 | 0.493 | 0.0 | 0.8 | 0.8 | 23.4 | O K |
| 60 min Summer | 29.184 | 0.584 | 0.0 | 0.9 | 0.9 | 27.7 | O K |
| 120 min Summer | 29.247 | 0.647 | 0.0 | 0.9 | 0.9 | 30.8 | O K |
| 180 min Summer | 29.263 | 0.663 | 0.0 | 0.9 | 0.9 | 31.5 | O K |
| 240 min Summer | 29.259 | 0.659 | 0.0 | 0.9 | 0.9 | 31.3 | O K |
| 360 min Summer | 29.236 | 0.636 | 0.0 | 0.9 | 0.9 | 30.2 | O K |
| 480 min Summer | 29.212 | 0.612 | 0.0 | 0.9 | 0.9 | 29.1 | O K |
| 600 min Summer | 29.186 | 0.586 | 0.0 | 0.9 | 0.9 | 27.8 | O K |
| 720 min Summer | 29.164 | 0.564 | 0.0 | 0.9 | 0.9 | 26.8 | O K |
| 960 min Summer | 29.126 | 0.526 | 0.0 | 0.8 | 0.8 | 25.0 | O K |
| 1440 min Summer | 29.063 | 0.463 | 0.0 | 0.8 | 0.8 | 22.0 | O K |
| 2160 min Summer | 28.986 | 0.386 | 0.0 | 0.7 | 0.7 | 18.3 | O K |
| 2880 min Summer | 28.922 | 0.322 | 0.0 | 0.7 | 0.7 | 15.3 | O K |
| 4320 min Summer | 28.824 | 0.224 | 0.0 | 0.6 | 0.6 | 10.7 | O K |
| 5760 min Summer | 28.754 | 0.154 | 0.0 | 0.5 | 0.5 | 7.3 | O K |
| 7200 min Summer | 28.700 | 0.100 | 0.0 | 0.5 | 0.5 | 4.8 | O K |
| 8640 min Summer | 28.654 | 0.054 | 0.0 | 0.5 | 0.5 | 2.6 | O K |
| 10080 min Summer | 28.610 | 0.010 | 0.0 | 0.5 | 0.5 | 0.5 | O K |
| 15 min Winter | 29.038 | 0.438 | 0.0 | 0.8 | 0.8 | 20.8 | O K |
| 30 min Winter | 29.155 | 0.555 | 0.0 | 0.9 | 0.9 | 26.3 | O K |
| 60 min Winter | 29.258 | 0.658 | 0.0 | 0.9 | 0.9 | 31.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
| --- | --- | --- | --- | --- |
| 15 min Summer | 143.954 | 0.0 | 19.1 | 19 |
| 30 min Summer | 92.629 | 0.0 | 24.6 | 33 |
| 60 min Summer | 56.713 | 0.0 | 30.2 | 62 |
| 120 min Summer | 33.583 | 0.0 | 35.7 | 122 |
| 180 min Summer | 24.424 | 0.0 | 39.0 | 180 |
| 240 min Summer | 19.389 | 0.0 | 41.3 | 240 |
| 360 min Summer | 13.924 | 0.0 | 44.5 | 294 |
| 480 min Summer | 11.018 | 0.0 | 46.9 | 356 |
| 600 min Summer | 9.182 | 0.0 | 48.9 | 422 |
| 720 min Summer | 7.908 | 0.0 | 50.5 | 492 |
| 960 min Summer | 6.245 | 0.0 | 53.2 | 628 |
| 1440 min Summer | 4.471 | 0.0 | 57.1 | 908 |
| 2160 min Summer | 3.197 | 0.0 | 61.2 | 1300 |
| 2880 min Summer | 2.518 | 0.0 | 64.3 | 1700 |
| 4320 min Summer | 1.796 | 0.0 | 68.9 | 2424 |
| 5760 min Summer | 1.413 | 0.0 | 72.2 | 3176 |
| 7200 min Summer | 1.172 | 0.0 | 74.9 | 3896 |
| 8640 min Summer | 1.006 | 0.0 | 77.1 | 4664 |
| 10080 min Summer | 0.884 | 0.0 | 79.0 | 5240 |
| 15 min Winter | 143.954 | 0.0 | 21.4 | 18 |
| 30 min Winter | 92.629 | 0.0 | 27.6 | 33 |
| 60 min Winter | 56.713 | 0.0 | 33.8 | 62 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Σ Max Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 120 min Winter | 29.336 | 0.736 | 0.0 | 1.0 | 1.0 | 35.0 | O K |
| 180 min Winter | 29.359 | 0.759 | 0.0 | 1.0 | 1.0 | 36.1 | O K |
| 240 min Winter | 29.360 | 0.760 | 0.0 | 1.0 | 1.0 | 36.1 | O K |
| 360 min Winter | 29.335 | 0.735 | 0.0 | 1.0 | 1.0 | 34.9 | O K |
| 480 min Winter | 29.310 | 0.710 | 0.0 | 1.0 | 1.0 | 33.7 | O K |
| 600 min Winter | 29.283 | 0.683 | 0.0 | 0.9 | 0.9 | 32.4 | O K |
| 720 min Winter | 29.254 | 0.654 | 0.0 | 0.9 | 0.9 | 31.1 | O K |
| 960 min Winter | 29.196 | 0.596 | 0.0 | 0.9 | 0.9 | 28.3 | O K |
| 1440 min Winter | 29.107 | 0.507 | 0.0 | 0.8 | 0.8 | 24.1 | O K |
| 2160 min Winter | 28.997 | 0.397 | 0.0 | 0.8 | 0.8 | 18.8 | O K |
| 2880 min Winter | 28.910 | 0.310 | 0.0 | 0.7 | 0.7 | 14.7 | O K |
| 4320 min Winter | 28.786 | 0.186 | 0.0 | 0.6 | 0.6 | 8.8 | O K |
| 5760 min Winter | 28.699 | 0.099 | 0.0 | 0.5 | 0.5 | 4.7 | O K |
| 7200 min Winter | 28.602 | 0.002 | 0.0 | 0.5 | 0.5 | 0.1 | O K |
| 8640 min Winter | 28.600 | 0.000 | 0.0 | 0.4 | 0.4 | 0.0 | O K |
| 10080 min Winter | 28.600 | 0.000 | 0.0 | 0.4 | 0.4 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 120 min Winter | 33.583 | 0.0 | 40.0 | 120 |
| 180 min Winter | 24.424 | 0.0 | 43.7 | 176 |
| 240 min Winter | 19.389 | 0.0 | 46.2 | 232 |
| 360 min Winter | 13.924 | 0.0 | 49.8 | 332 |
| 480 min Winter | 11.018 | 0.0 | 52.5 | 376 |
| 600 min Winter | 9.182 | 0.0 | 54.8 | 452 |
| 720 min Winter | 7.908 | 0.0 | 56.6 | 530 |
| 960 min Winter | 6.245 | 0.0 | 59.6 | 682 |
| 1440 min Winter | 4.471 | 0.0 | 64.0 | 970 |
| 2160 min Winter | 3.197 | 0.0 | 68.7 | 1384 |
| 2880 min Winter | 2.518 | 0.0 | 72.0 | 1788 |
| 4320 min Winter | 1.796 | 0.0 | 77.1 | 2552 |
| 5760 min Winter | 1.413 | 0.0 | 80.8 | 3344 |
| 7200 min Winter | 1.172 | 0.0 | 83.9 | 3744 |
| 8640 min Winter | 1.006 | 0.0 | 86.4 | 0 |
| 10080 min Winter | 0.884 | 0.0 | 88.5 | 0 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 20.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.450 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.071

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.071 |

## Model Details

Storage is Online Cover Level (m) 29.700

## Cellular Storage Structure

Invert Level (m) 28.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 50.0 | 50.0 | 0.900 | 0.0 | 131.6 |
| 0.800 | 50.0 | 131.6 | | | |

## Hydro-Brake® Outflow Control

Design Head (m) 0.800 Hydro-Brake® Type Md4 Invert Level (m) 28.500
Design Flow (l/s) 1.0 Diameter (mm) 37

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 0.5 | 1.200 | 1.2 | 3.000 | 1.8 | 7.000 | 2.8 |
| 0.200 | 0.5 | 1.400 | 1.3 | 3.500 | 2.0 | 7.500 | 2.9 |
| 0.300 | 0.6 | 1.600 | 1.3 | 4.000 | 2.1 | 8.000 | 3.0 |
| 0.400 | 0.7 | 1.800 | 1.4 | 4.500 | 2.3 | 8.500 | 3.1 |
| 0.500 | 0.8 | 2.000 | 1.5 | 5.000 | 2.4 | 9.000 | 3.2 |
| 0.600 | 0.8 | 2.200 | 1.6 | 5.500 | 2.5 | 9.500 | 3.3 |
| 0.800 | 1.0 | 2.400 | 1.7 | 6.000 | 2.6 | | |
| 1.000 | 1.1 | 2.600 | 1.7 | 6.500 | 2.7 | | |

## Appendix: L - Drainage Catchment Areas


TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG **Tel 01920 871 777** **e: contact@eastp.co.uk** **www.eastp.co.uk**

EAS

## Appendix: M – SuDS Layout

## Appendix: N – Exceedance Route



TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk