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St William Homes LLP

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FORMER GASWORKS, MARSHGATE DRIVE, HERTFORD
FLOOD CONSTRAINTS APPRAISAL

RAMBOLL ENVIRON

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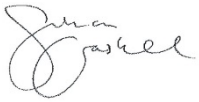

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APPENDICES

1. INTRODUCTION

1.1 Background

Ramboll Environ was commissioned by St William Homes LLP to provide a Flood Constraints Appraisal in connection with the Client's proposed redevelopment of National Grid Gas (NGG) land on Marshgate Drive, Hertford, Hertfordshire SG13 7JY (the "Site"). The Site is centred at grid reference 533260, 213210. It is understood that the Site is intended to be redeveloped for a mixed commercial and residential scheme.

1.2 Site Location

The Site is located in a mixed commercial and industrial setting to the north-east of the centre of Hertford as shown in Figure 1 (Appendix 1). As shown in Figure 2, the Site is irregular in shape and split into two plots which occupy a total area of approximately 3.57 hectares (ha). The Northern Plot extends to approximately 2.64 ha in area and the Southern Plot extends to 0.93 ha.

A summary of surrounding land use is as follows:

- North – a tributary of the River Lee known as the River Lee Navigation is immediately adjacent, beyond which is a scout hut and a series of industrial/commercial units. Beyond this is an unnamed tributary of the River Lee;
- East – industrial units;
- Southeast – Mead Business Park which comprises industrial units. Beyond this is Mead Lane;
- South - Mead Lane beyond which is a railway line and residential dwellings; and
- West – Marshgate Drive (identified on mapping as formerly being Gashouse Lane) beyond this is industrial activity and residential dwellings. Google imagery also shows Evron Wharf to have been constructing a block of flats in 2015.

1.3 Objectives

The Site is currently owned by National Grid (NG) and St William Homes LLP require this preliminary appraisal to assist with internal feasibility assessments associated with their intention to develop the Site for a development comprising primarily residential properties with some commercial premises.

The objectives of the review were to consider existing publically available flood risk information and review against national and local planning policy with regard to redevelopment. The flood risk information is used to inform an appraisal of the potential constraints to the proposed redevelopment of the Site.

1.4 Consultation

In preparing this flood risk appraisal, consultation has been undertaken with the Environment Agency (EA) regarding the extent of available information on flood risk. Data received form the EA is presented in Appendix 2.

2. POLICY REVIEW

2.1 National Policy

2.1.1 National Planning Policy Framework

In England, flood risk is largely regulated through planning policy. Key requirements with respect to flooding are outlined in the National Planning Policy Framework (NPPF)[1] which was published in March 2012 replacing and building on the requirements of Planning Policy Statement 25: Development and Flood Risk (PPS25)[2].

The NPPF requires that an FRA should be submitted with planning applications for all development sites within Flood Zones 2 and 3; and all development sites over one ha in area to determine the risks of flooding at a site from all sources including rivers, the sea, sewers and groundwater. An FRA would, therefore, be an essential element in the overall acceptability of proposed development in planning terms.

Guidance on the content of FRAs is contained in Technical Guidance[3] to the NPPF and within the Planning Practice Guidance[4]. The NPPF sets out which land uses would be appropriate within Flood Zones 1, 2 and 3 as shown below.

Table 2.1: Flood Risk Vulnerability and Flood Zone Compatibility[5]

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	✗	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	✗	✗	✗

[1] Department for Communities and Local Government National Planning Policy Framework, March 2012
[2] Department for Communities and Local Government Planning Policy Statement 25: Development and Flood Risk, March 2010
[3] Department for Communities and Local Government, Technical Guidance to the National Planning Policy Framework, March 2012
[4] Department for Communities and Local Government, Planning Practise Guidance. Available online at: http://planningguidance.planningportal.gov.uk/
[5] Table 3 of the NPPF Technical Guide

Table 2.2: NPPF Flood Risk Vulnerability Classification[6]

Flood risk vulnerability classification	Land Uses
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood.

[6] Table 2 of the NPPF Technical Guide

Flood risk vulnerability classification	Land Uses
	• Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

2.1.2 Planning Practice Guidance

Planning Practice Guidance (PPG), as updated in April 2015, provides further information on the requirements for Sustainable Drainage Systems (SuDS). It is set out that surface water drainage for a proposed development should aim to discharge as high up the following hierarchy of drainage options as reasonably practicable:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain, or another drainage system;
4. to a combined sewer.

The PPG also sets out that clear arrangements should be put in place for ongoing maintenance of any SuDS and drainage measures. It is, however, acknowledged in the PPG that it is unlikely to be reasonably practical to expect compliance with the technical standards if these are more expensive than complying with building regulations.

2.1.3 The Town and Country Planning (Development Management Procedure) Order 2015

The Government has strengthened planning policy on the provision of sustainable drainage for 'major' planning applications as from 6 April 2015. Decisions about the suitability of sustainable drainage provision are made by the local planning authority. However, under The Town and Country Planning (Development Management Procedure) Order 2015[7], which came into force from 15 April 2015, Lead Local Flood Authorities (LLFA) are now statutory consultees for all major applications.

[7] Statutory Instruments 2015, No. 596, Town and Country Planning, England, The Town and Country Planning (General Permitted Development) (England) Order 2015

2.2 Local Policy

2.2.1 East Herts Local Plan Second Review

The current local planning policies that are relevant to the site are set out in the East Herts Local Plan Second Review (April 2007).

Policy ENV19 (Development in Areas Liable to Flood) sets out that:

- *Proposals for development, including raising of land, in the flood plains and washlands will not be permitted if they would:*
  - *materially impede the flow of flood water;*
  - *increase the risk of flooding elsewhere;*
  - *reduce the capacity of floodplains/washlands; or*
  - *increase the risk to people or property from flooding.*
- *Applicants will be required to submit a Flood Risk Assessment in conjunction with their planning application where the Council deems this necessary.*

Policy ENV20 (Groundwater Protection) sets out that "*Development which may cause the contamination of, or otherwise prejudice, groundwater will not be permitted. Development proposals in areas of known groundwater importance will be required to submit a detailed assessment of the impact the development proposals will have on groundwater resource, including measures to mitigate any potential threat to the groundwater*".

Policy ENV21 (Surface Water Drainage) sets out that:

- *Where appropriate and relevant, all development proposals will be expected to take into consideration Best Management Practices to surface water drainage, as advocated by the Environment Agency. Where applicable, planning obligations (or as subsequently revised) may be sought to ensure the on-going maintenance of such practices, including off-site provision.*
- *Proposals that do not take sufficient account of such techniques and/or are detrimental to the effectiveness of existing schemes based on such techniques, will be refused.*

2.2.2 Hertford Mead Lane Urban Design Framework

This Urban Design Framework (UDF) document was adopted as a Supplementary Planning Document to the Local Plan in December 2014. It is confirmed that the Mead Lane area, situated to the east of the town centre, provides one of the town's largest and most valuable employment resources. However, within this location lie some of the town's largest undeveloped brownfield sites, including the Marshgate Drive former gasworks.

It is confirmed in the UDF that Policies ENV18, ENV19 and ENV20 (listed above) are relevant to redevelopment proposals in this area.

It is stated in the UDF that "*the Environment Agency would object to any residential development in Flood Zone 3b*" (the functional floodplain).

In addition, "*following the sequential approach, residential development should primarily be located in Flood Zone 1 with its vulnerability taken into account if development is proposed in Flood Zone 2 or 3*".

2.2.3 Strategic Flood Risk Assessment

The East Hertfordshire Level 1 Strategic Flood Risk Assessment (SFRA) was published in November 2008. The principle objective of the SFRA is to be sufficiently detailed to facilitate the application of the Sequential Test and Exception Test as set out in the NPPF.

2.2.4 SuDS Guidance

Hertfordshire County Council has published a SuDS Design Guidance for Hertfordshire[8]. This document "*promotes an integrated approach to SuDS and landscape design, and establishes a set of local design criteria to help shape the development of SuDS"*.

It is confirmed that on previously developed land where runoff rates have been increased due to previous development, such as the Site, reduction of surface water discharge to a Greenfield rate must still be achieved. Where Greenfield rates cannot be achieved, a "Betterment Rate" should be achieved. The betterment rate is a reduction factor in the peak runoff rate of the existing site. The Guidance sets out the allowable greenfield rates for Hertfordshire. This is discussed further in Section 4 of this report.

[8] Hertfordshire County Council, SuDS Design Guidance for Hertfordshire V2. – Publication date 1st April 2015

3. BASELINE CONDITIONS

3.1 Topography and Land Use

The Site is currently vacant. The Hertford Gas Works formerly occupied the Northern Plot. The Southern Plot was former used as a Scientific Services site although the former buildings on this plot are understood to have now largely been demolished and the land remains vacant.

Light Detection and Ranging (LiDAR) aerially-flown topographic survey data has been acquired for the Site. This shows ground elevations on-site to vary significantly. The Northern Plot slopes in an easterly direction from a peak of approximately 39.2 metres Above Ordnance Datum (mAOD) on the western boundary to a minimum of approximately 34.9 mAOD in the eastern corner. The Southern Plot also slopes in an easterly direction from a peak of approximately 39.8 mAOD on the western boundary to a minimum of approximately 36.5 mAOD in the eastern corner.

3.2 Hydrology

3.2.1 Surface Water Features

The closest watercourse to the Site is the River Lee Navigation which forms the north-western boundary of the Site. Further channels of the River Lee are located 75 m and 225 m north-west of the Site.

3.2.2 Flood Zone Classification

The online Flood Map for Planning designates flood risk according to the following zones:

- Flood Zone 1 (Low Probability)
  - land assessed as having less than a 1 in 1,000 (0.1%) annual probability of flooding from rivers
- Flood Zone 2 (Medium Probability)
  - land assessed as between a 1 in 100 and a 1 in 1,000 (1% - 0.1%) annual probability of flooding from rivers
- Flood Zone 3 (High Probability)
  - land assessed as having greater than a 1 in 100 (1%) annual probability of flooding from rivers.

The majority of the Southern Plot is shown to be located in Flood Zone 1. A small area on the southern boundary of this plot (less than 5% of the plot area or less than 1% of the total Site area) is located within Flood Zones 2 and 3.

Approximately 35% of the Northern Plot (25% of the total Site area) in the centre and east is located within Flood Zone 2 and an additional 12% of the plot (9% of the total Site area) in the eastern corner is located within Flood Zone 3.

However, the extent of Flood Zones 2 and 3 represents the ‘natural floodplain’ and specifically does not take account of flood defences or structures in the floodplain. This is because flood defences reduce, but do not completely remove, the potential for flooding as defences can be overtopped or fail. The River Lee Navigation is subject to flow control via a number of structures including a lock gate approximately 170 m to the north-east of the Site. Therefore, after consideration of such control measures, flood risks at the Site may be less than as presented in the EA Flood Map for Planning.

3.2.3 EA Flood Map for Surface Water

The EA Flood Map for Surface Water delineates risk into the four following categories:-

- Very Low - each year, this area has a chance of flooding of less than 1 in 1,000 (<0.1%).
- Low - each year, this area has a chance of flooding of between 1 in 1,000 (0.1%) and 1 in 100 (1%).
- Medium - each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
- High - each year, this area has a chance of flooding of greater than 1 in 30 (3.3%).

Land in the centre and east of the Northern Plot (broadly equivalent to the land within Flood Zone 2) is shown to have a Low or Medium chance of flooding from surface water in any year. Land in the eastern corner of the plot (broadly equivalent to the land within Flood Zone 3) is shown to have a High chance of flooding from surface water in any year. The remainder of this plot in the west is shown to have a Very Low chance of flooding from surface water in any year.

The majority of the Southern Plot is shown to have a Very Low chance of flooding from surface water in any year. There is some isolated land on the eastern boundary with a High and some land in the south with a Low chance of flooding from surface water in any year.

The mapping of surface water flood risk is undertaken using a digital terrain model and does not take account of any specific surface water drainage assets. The designation of areas at risk of surface water flooding is, therefore, representative of the Site topography with water likely to follow the slope to the east.

It must be noted that surface water drainage networks are typically only designed to accommodate a 1 in 30 (3.33%) annual probability rainfall event. Older drainage networks may have a lower capacity, especially if they have not been maintained adequately. Therefore, surface water ponding would be expected at many locations during storm events which exceed such a return period. Although not true of every situation, surface water flooding is typically relatively shallow and would be expected to subside following the storm event assuming drainage assets are maintained in an appropriate condition. It is expected that future surface water drainage issues would be addressed through the drainage strategy of any proposed development as described in Section 5 of this report.

3.2.4 Historic Flooding

The EA has provided mapping of historic flood incidents recorded in the vicinity of the Site. This shows flooding to have occurred in the vicinity in 1947, 1968, 1978, 1987, 2000, 2009 and 2014. The Site itself is not shown to have been affected during any of these events.

3.2.5 Flood Defence

The EA has confirmed that there are a number of flood defence assets and flow management structures on the River Lee Navigation. However, the EA is not able to provide a specific Standard of Protection (SoP) for these assets, e.g. whether the assets protect against a 1 in 100 (1%) or 1 in 50 (2%) annual probability event.

There is a flood defence shown on the opposite bank of the River Lee Navigation from the Site. This is described as a vegetated earth embankment retained by granite and steel sheet piling. However, no asset is shown on the south bank, directly adjacent to the Site.

The lock gate 170 m north-east of the Site is described as having block stone capping to lock walls with brick chamber walls which appear to be in good condition for age.

3.2.6 Hydraulic Modelling

The EA has provided peak flood level data and extent mapping, extracted from the River Lee 2D Flood Mapping Study (CH2M Hill, 2014). This was a catchment-scale mapping study which was not created to produce flood levels for specific development sites within the catchment. The modelling is described as having taken account of catchment-wide defences.

However, there are significant inconsistencies within the EA data. The flood extent mapping and the 2-dimensional (2D) flood height mapping provided by the EA are not consistent with each other, despite being generated from the same modelling exercise. This issue has been raised with the EA and a response is awaited.

Flood Extent Mapping

The EA has provided mapping of the predicted extent of flooding during a range of return period events. This suggests that no flooding of the Site would occur during events with up to a 1 in 20 (5%) annual probability.

However, the extent mapping predicts flooding to occur on the south-eastern corner of the Southern plot during a 1 in 50 (2%) annual probability event. The remainder of the Site (both plots) is shown to be unaffected by flood waters during this event. Flooding is also predicted to occur in the eastern corner of the Northern Plot during a 1 in 75 (1.3%) annual probability event.

During a 1 in 100 (1%) annual probability event the extent of flooding on the southern boundary of the Southern Plot is not predicted to increase. However, a greater area of land in the south-eastern corner of the Northern Plot is shown to be affected. This is congruous with the designation of this land within Flood Zone 3.

In the climate change adjusted 1 in 100 (1%+CC) and the 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability events, the extent of flooding is predicted to increase to affect land shown to be located within Flood Zone 2, the extent of which is presented in the Flood Map for Planning contained within Appendix 2.

2D Flood Depth Mapping

The 2D flood height mapping predicts that the entire Site would be unaffected by flood waters during an event with a 1 in 5 (20%) annual probability.

However, during a 1 in 10 (10%) annual probability event, flood waters are predicted to affect the eastern corner of the Northern Plot with peak flood levels of 35.66 mAOD predicted on-site. Given that LiDAR data shows the ground elevation to be approximately 34.9 mAOD in this area, peak flood depths of approximately 0.75 m could be expected in this area. The area shown to be affected extends to approximately 20% of this plot. The area shown to be affected by such flooding is significantly larger than the extent of Flood Zone 3 in this area and is significantly different from the situation presented in the flood extent mapping.

On-site flood levels and are shown in the 2D flood height mapping are shown below. Potential flood depths have been derived from comparison against a minimum site elevation of 34.9 mAOD in the east of the Site.

Table 3.1: EA Modelled Peak 2D Flood Height Levels

Return Period	Peak Flood Level (mAOD)	Potential Flood Depth (m)
1 in 10 (10%)	35.66	0.76
1 in 20 (5%)	35.75	0.85
1 in 50 (2%)	35.95	1.05

Return Period	Peak Flood Level (mAOD)	Potential Flood Depth (m)
1 in 75 (1.3%)	36.00	1.1
1 in 100 (1%)	36.04	1.14
1 in 100 plus climate change (1%+CC)	36.11	1.21
1 in 200 (0.5%)	36.10	1.2
1 in 1,000 (0.1%)	36.22	1.32

3.3 Groundwater Flood Risk

The Site is directly underlain by superficial deposits of the Kempton Park Gravel Formation; a sand and gravel with a recorded average thickness of 6m, being much thicker where infilling deep hollows. The bedrock geology comprises the Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated).

The Kempton Park Gravel Formation has been designated by the EA as a Secondary A Aquifer (Permeable formations with potential to support localised abstractions) whilst the Lewes Nodular Chalk Formation and Seaford Chalk Formation has been designated as a Principal Aquifer (Highly permeable, with significant water storage. Able to support large abstractions).

The British Geological Survey (BGS) online mapping shows there to have been a borehole sampled in the west of the Site in April 1997 encountered groundwater at a depth of 4.7 metres below ground level. Groundwater at such a depth would not be expected to present a significant risk of flood risks associated with emergence at ground level. However, is any extensive excavations or basement areas were proposed as part of construction then consideration could need to be given to dewatering activities. It is noted that groundwater levels in 1997 may not remain representative of current conditions.

4. IMPLICATIONS TO DEVELOPMENT

4.1 Developable Areas

Within the areas of Flood Zone 1 on-site (in the west), all land use vulnerability classes would be considered appropriate.

However, within areas of Flood Zone 2, only More or Less Vulnerable land uses would be considered appropriate as set out in Tables 2.1 and 2.2 of this report classes.

Development within these areas would be subject to demonstration that the development would remain safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. Given the discrepancies in the EA data, it is not possible to confirm potential flood depths across the Site. Significant flood depths could be experienced in the east of the Northern Plot such that the feasibility of development could be restricted. Further clarification has been requested from the EA and this is awaited.

4.2 Access/Egress

Consideration would need to be given to emergency access/egress to/from any proposed development. Marshgate Drive is currently shown to be located within Flood Zone 1 and it is anticipated that safe access would be available via this route to wider land in Flood Zone 1 to the south-west.

4.3 Finished Floor Levels

Due to the discrepancies noted in the EA data, it is recommended that Finished Floor Levels for any proposed development are set, where possible, above the height of the climate change adjusted 1 in 100 annual probability event as derived from the 2D flood height mapping (36.11 mAOD).

Consideration would also need to be made to ensuring that the development remains safe during flood depths associated with the 1 in 1,000 annual probability event (36.22 mAOD).

4.4 Floodplain Compensation

Were any ground to be raised within the floodplain, this would result in a net loss of floodplain storage and could increase flood risks downstream. The EA would require that any loss of flood storage be compensated for by the reduction in level of nearby ground, such that the same volume is available at every flood level before and after the works and it can freely fill and drain. This would need to ensure that in terms of floodplain volume, the existing situation for a particular flood is matched with the same storage at each stage (or level). Any cut and fill activities must equate on a level for level basis, i.e. at each level (say at 0.2 metre vertical intervals for example) the excavated and filled volumes are equal.

Such requirement are typically applied to all land within the extent of flooding associated with the climate change adjusted 1 in 100 annual probability event.

5. SURFACE WATER MANAGEMENT

5.1 Post Development Site Runoff Volumes

The Hertfordshire County Council SuDS Design Guidance sets out that developers will be expected to clearly demonstrate that all opportunities to minimise final Site runoff have been taken, such that discharge is as close to greenfield rate as practical.

The SuDS Design Guidance sets out allowable greenfield discharge rates within Hertfordshire according to a site's Soil Type and SAAR value as set out below.

Table 4.1: Hertfordshire Allowable Greenfield Discharge Rates

Soil Type	**1**	**1**	**2**	**3**	**3**	**4**	**4**	**4**
SAAR (mm)	700	800	700	600	650	600	650	700
QBAR (l/s/ha)	0.6	0.7	2.8	4.4	4.8	5.6	6.2	6.8
Q1yr (l/s/ha)	0.5	0.6	2.4	3.7	4.1	4.8	5.3	5.7
Q30yr (l/s/ha)	1.4	1.6	6.4	9.9	10.9	12.8	14.0	15.3
Q100yr (l/s/ha)	2.0	2.3	8.9	13.9	15.3	18.0	19.8	21.6
Q100yr+CC (l/s/ha)	2.6	3.0	11.6	18.1	19.9	23.4	25.7	28.1

Note:
Soil Type is defined according to the Hydrology of Soil Type classifications.
SAAR is the Standard Annual Average Rainfall as defined by the Flood Estimation Handbook for the catchment.

The Site is located with an area with a Soil Type of 2 and the SAAR value for this location is 649. Therefore, the acceptable QBAR value would be 2.8 L/s/ha. The Hertfordshire SuDS Design Guidance sets out that acceptable flow rates from a site would depend on whether a variable or fixed flow control is used, which relates to the approach to storage. Where long-term storage is provided, a variable flow rate (between the 1 in 1 year and the 1 in 100 year greenfield runoff rate) would be allowed. Where long term storage is not provided the peak flow rate will be restricted to the QBAR rate. The 1 in 1 year greenfield rate equates to 8.6 L/s given the Site area of 3.57 ha. A 1 in 100 year greenfield rate equates to 41.4 L/s.

In order to estimate the potential scale of attenuation required on-site as part of a proposed redevelopment, Ramboll Environ has undertaken calculations of the likely attenuation volumes required to ensure that total discharge of surface water to sewer from the Site does not exceed either 8.6 or 41.4 L/s. It must be noted that it may be possible to negotiate a higher rate of discharge if it can be demonstrated that it would not be feasible to provide the required volume of attenuation on-site.

Results were obtained using:

- the FEH method to establish rainfall depths for a range of return periods;
- FEH to determine catchment descriptors such as annual average rainfall;
- the Wallingford Procedure to determine values for soil index (SOIL) and urban catchment wetness index (UCWI); a soil index value of 0.3 and a UCWI value of 58 have been determined for the Site; and

- the Modified Rational Method to calculate storm runoff volumes for each return period. In order to provide a estimates of potential attenuation volume requirement, a range of post-development percentage of impermeable surface area has been estimated, from 100% to 50% which, using the Wallingford Procedure, equates to percentage runoff (PR) values of 74 to 33.

The following Modified Rational Method formula was applied:

$$Q = 2.78 \times C \times i \times A$$

Where, Q_p = Peak flow rate (l/s);

C = Run-off coefficient (dimensionless);

i = Rainfall intensity (mm/hr); and

A = Site area (ha).

Rainfall rates and peak runoff rates and total surface water volumes for the proposed development have been derived for a range of return periods and storm durations as presented in Tables 4.2 to 4.4 below. The 100 year rainfall rates have also been increased by 30% to account for the potential impact of climate change over the lifetime of a development into the future (100 years).

Table 4.2: Rainfall Depths (mm) Derived from FEH

Storm Duration	Return Period (Years)		
	2	30	100+CC
30 mins	13.1	32.1	62.0
40 mins	14.1	33.9	65.0
50 mins	14.9	35.3	67.3
1hr	15.6	36.6	69.4
2hr	18.6	41.7	77.6
3hr	20.6	45.0	82.9
4hr	22.2	47.6	86.8
6hr	24.5	51.4	92.7
10hr	27.9	56.6	100.8
15hr	30.8	60.8	107.1
20hr	32.9	63.9	111.5

Table 4.3: Proposed Development Peak Runoff Rates (L/s) (Pre-Mitigation)

Storm Duration	Return Period (Years)								
	100% Impermeable			75% Impermeable			50% Impermeable		
	2	30	100+CC	2	30	100+CC	2	30	100+CC
30 mins	251	615	1188	181	443	856	111	271	524
40 mins	203	487	934	146	351	673	89	215	412
50 mins	171	406	774	123	292	558	76	179	342
1hr	149	350	665	108	253	479	66	155	294

Storm Duration	Return Period (Years)								
	100% Impermeable			75% Impermeable			50% Impermeable		
	2	30	100+CC	2	30	100+CC	2	30	100+CC
2hr	89	200	372	64	144	268	39	88	164
3hr	66	144	265	47	104	191	29	63	117
4hr	53	114	208	38	82	150	23	50	92
6hr	39	82	148	28	59	107	17	36	65
10hr	27	54	96	19	39	70	12	24	43
15hr	20	39	68	14	28	49	9	17	30
20hr	16	31	53	11	22	38	7	14	24

Table 4.4: Proposed Development Storm Volume (m^3) Pre Mitigation

Storm Duration	Return Period (Years)								
	100% Impermeable			75% Impermeable			50% Impermeable		
	2	30	100+CC	2	30	100+CC	2	30	100+CC
30 mins	451	1106	2136	325	797	1540	199	488	943
40 mins	486	1168	2239	350	842	1614	214	516	989
50 mins	513	1216	2320	370	876	1672	227	537	1024
1hr	537	1261	2391	387	909	1724	237	557	1056
2hr	641	1436	2673	462	1035	1927	283	634	1180
3hr	710	1550	2857	511	1117	2059	313	684	1262
4hr	765	1640	2991	551	1182	2156	338	724	1321
6hr	844	1771	3193	608	1276	2301	373	782	1410
10hr	961	1950	3471	693	1405	2502	424	861	1532
15hr	1061	2094	3690	765	1510	2660	468	925	1629
20hr	1133	2201	3542	817	1587	2769	500	972	1697

The total volume of surface water which would discharge from the Site, given the allowable discharge rates of 8.6 L/s and 41.4 L/s, over a range of storm durations is presented in Table 4.5 below.

Table 4.5: Allowable Discharge (m^3) - Based on Discharge at 18.99 L/s

Storm Duration	Volume	
	8.6 L/s	41.4 L/s
30 mins	15.5	74.5
40 mins	20.6	99.4
50 mins	25.8	124.2
1hr	31.0	149.0
2hr	61.9	298.1
3hr	92.9	447.1
4hr	123.8	596.2
6hr	185.8	894.2
10hr	309.6	1490.4
15hr	464.4	2235.6
20hr	619.2	2980.8

Tables 4.6 and 4.7 below presents the volume of attenuation required by subtracting the allowable discharge volumes in Table 4.5 (above) from the post-development storm volumes in Table 4.4 (above).

Table 4.6: Required Attenuation Volumes (m^3) Based on Discharge at 8.6 L/s

Storm Duration	Return Period (Years)								
	100% Impermeable			75% Impermeable			50% Impermeable		
	2	30	100+CC	2	30	100+CC	2	30	100+CC
30 mins	436	1090	2121	310	782	1524	184	473	928
40 mins	465	1147	2218	329	821	1593	194	495	968
50 mins	487	1190	2294	344	851	1646	201	511	998
1hr	506	1230	2360	356	878	1693	206	526	1025
2hr	579	1375	2612	400	973	1865	221	572	1119
3hr	617	1457	2764	419	1024	1966	220	592	1169
4hr	641	1516	2868	427	1058	2032	214	600	1197
6hr	658	1585	3007	423	1090	2116	187	596	1224
10hr	651	1640	3161	383	1096	2192	115	551	1223
15hr	597	1630	3226	300	1045	2195	4	460	1165
20hr	514	1582	3223	198	967	2150	0	353	1077

Table 4.7: Required Attenuation Volumes (m^3) Based on Discharge at 41.4 L/s

Storm Duration	Return Period (Years)								
	100% Impermeable			75% Impermeable			50% Impermeable		
	2	30	100+CC	2	30	100+CC	2	30	100+CC
30 mins	377	1031	2062	251	722	1465	125	414	869
40 mins	386	1068	2140	251	742	1515	115	416	889
50 mins	389	1092	2195	246	752	1548	102	413	900
1hr	388	1112	2242	238	760	1575	88	408	907
2hr	343	1138	2375	164	737	1629	0	336	882
3hr	262	1103	2410	64	670	1612	0	237	814
4hr	169	1044	2395	0	586	1560	0	128	725
6hr	0	876	2299	0	382	1407	0	0	516
10hr	0	459	1980	0	0	1011	0	0	42
15hr	0	0	1454	0	0	424	0	0	0
20hr	0	0	861	0	0	0	0	0	0

5.2 Sustainable Drainage Systems

To reduce storm runoff on impermeable drainage areas, a range of techniques known as SuDS can be utilised. These can be adopted to reduce peak flows and storm volumes and also to improve water quality.

SuDS are often physical structures and fall into the following broad groups:

- Rainwater harvesting systems - components that capture rainwater and facilitate its use within the building or local environment.
- Pervious surfacing systems – structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system, e.g. green roofs, pervious paving. Many of these systems also include some subsurface storage and treatment.
- Infiltration systems -components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.
- Conveyance systems - components that convey flows to downstream storage systems. Where possible, these systems also provide flow and volume control and treatment, e.g. swales.
- Storage systems - components that control the flows and, where possible, volumes of runoff being discharged from the Site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff, e.g. ponds, wetlands and detention basins.
- Treatment systems - components that remove or facilitate the degradation of contaminants present in the runoff.

The use of SuDS provides a significant contribution towards more sustainable development since they:

- address environmental impacts at source, rather than downstream;
- attenuate surface run-off rates, reducing the impact of urbanisation on flooding;
- protect or enhance water quality;

- can be engineered to be sympathetic to the environmental setting and the needs of the local community;
- provide opportunities for ecological habitat creation; and
- can encourage natural groundwater recharge.

Table 4.8 provides an overview of the feasibility of a range of SuDS techniques in order to identify which may be suitable for redevelopment.

Table 4.8: SuDS Feasibility Matrix

Technique	Physical Constraints	Feasibility
Living roofs	Requires flat or minimal slope roofs. Limited value for runoff attenuation in comparison with other techniques. Requires specialist maintenance.	**Feasible**
Infiltration Devices • Soakaways • Infiltration trenches and basins	Require infiltration rates of 1 x 10-6 m/s or greater. Shallow soakaways or infiltration trenches would be required where groundwater is shallow (i.e. less than 2.0 mbgl).	**Not Feasible** The underlying geology is reported to comprise sand and gravel. Whilst this would suggest that infiltration would be feasible, the presence of residual contamination would be likely to prevent the use of infiltration-led drainage.
Basins and Ponds • Constructed Wetlands • Balancing Ponds • Detention Basins • Retention Ponds	Comprises permanent ponds that provide storage above the resting water level in the pond or dry basins with a controlled outflow. Appropriate for most sites but require suitable space. Require impermeable soils, or can be lined.	**Feasible** There would appear to be sufficient space within the Site to construct a wetlands or pond system, subject to proposed development layouts. Due to underlying geology and residual contaminants, such features may need to be lined to prevent infiltration.
Filter Strips and Swales	Widely applicable for attenuation and treatment of surface run-off by infiltration into the ground. Require slope of no more than 4-10% and can act as a substitute for soakaways where groundwater is shallow.	**Feasible** There is sufficient space on-site for swales and / or filter strips. Due to underlying geology and residual contaminants, such features may need to be lined to prevent infiltration.
Permeable surfaces and filter drains • Gravelled areas • Solid paving blocks • Porous paviors	Ideally requires a level site and favourable underlying ground conditions. Pervious material could be used for hard-surfaced areas in the proposed development. Filter drains are normally used adjacent to areas of car parking or roads and convey runoff via flow through an engineered substrate.	**Feasible** Subject to detailed design, load bearing capacities of access roads and car parks and long-term maintenance issues. If infiltration proves unfeasible, storage in void spaces beneath the permeable surfaces would need to be provided before

Technique	Physical Constraints	Feasibility
		discharge to sewer at a reduced rate.
Tanked systems • Over-sized pipes/tanks • Storm cells	On-line storage within the drainage network or off-line storage in a tank with outflow control.	**Feasible** However, these are the least sustainable and therefore the least preferred option under EA guidance.

5.2.1 Rainwater Harvesting

It is recommended that rainwater harvesting techniques be considered as part of proposals for redevelopment. Such measures could be used for irrigation of landscaped areas and green roofing or could be used within domestic areas for non-potable uses.

5.2.2 Green Roofs

Any proposed green roofing would provide a significant benefit in terms of management of frequent rainfall events during which the majority of rainfall would be absorbed. However, the benefit is reduced when considering extreme rainfall events. As set out in the 2015 CIRIA SuDS Manual, a study by Fassman-Beck and Simcock[9] in 2013 suggested that a rainfall depth of approximately 20 mm would be intercepted without any runoff for a substrate depth of 100 mm to 150 mm. Therefore, while green roofing would provide some storage of rain water, the volumes would not be significant in terms of the total required attenuation volumes. For example, a green roof area of 2,500 m^2 would only provide an attenuation volume of 50 m^3.

5.2.3 Balancing Pond/Detention Basin

If a pond were constructed with an additional freeboard height of 1 m to allow for storm water attenuation, a total area of 2,195 m^2 would be required to accommodate the climate change adjusted 1 in 100 (1%) annual probability event, assuming discharge from the Site at a rate of 8.6 L/s and a 75% impermeable surface cover.

5.2.4 Retention Basin

Some landscaping within the Site could be designed such that it was allowed to flood to a shallow depth during an extreme pluvial event to provide surface water attenuation.

5.2.5 Swales

It is likely that there would be space within the Site to provide swales which are typically shallow, flat bottomed and vegetated open channels which are designed to convey, treat and attenuate surface water. Swales can typically be used to replace conventional pipe drainage as a method of collecting and conveying surface water runoff.

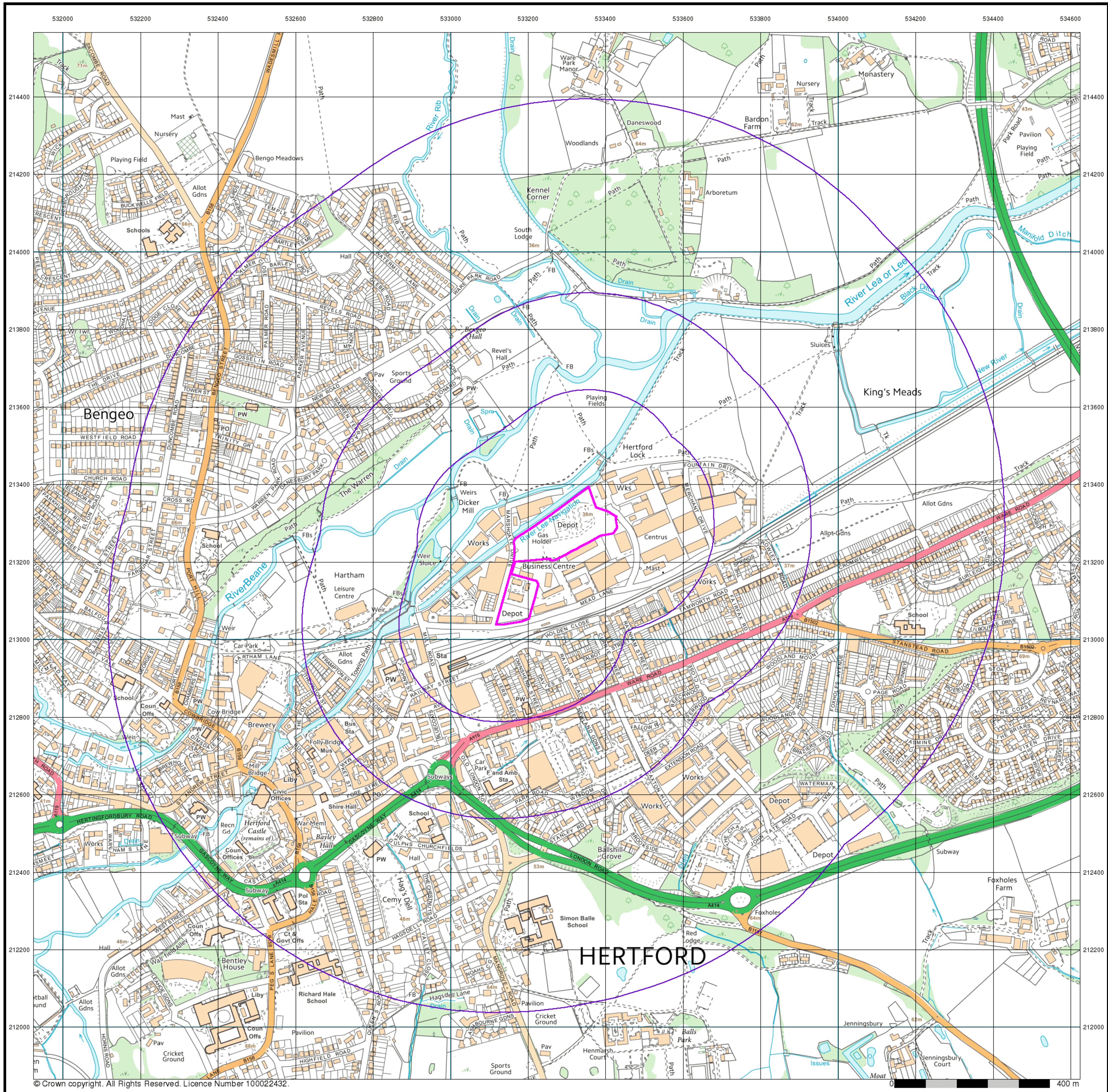
5.2.6 Tank Storage

Whilst underground storage would also be feasible, in the form of tank systems or geo-cellular crate systems, these are considered the least sustainable options and other SuDS options should first be considered in accordance with drainage hierarchy guidance.

[9] Fassman-Beck, E and Simcock, R, University of Auckland and Landcare Research Ltd, Hydrology and water quality of living roofs in Auckland, 2013.

APPENDIX 1
FIGURES

Figure 1: Site Location



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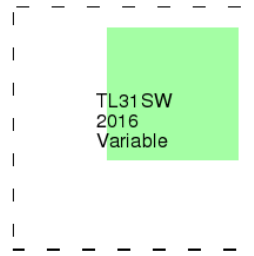
RAMBOLL ENVIRON

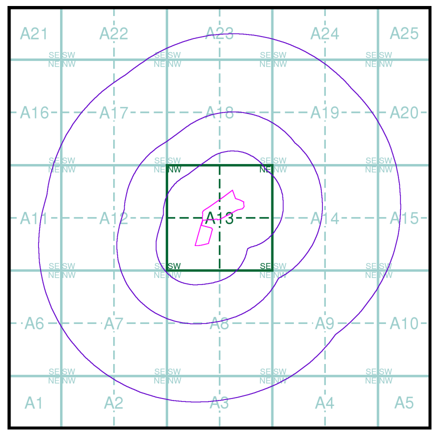
VectorMap Local
Published 2016
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	84401574_1_1
Customer Ref:	UK11-22988_Hertford
National Grid Reference:	533260, 213210
Slice:	A
Site Area (Ha):	3.58
Search Buffer (m):	1000

Site Details

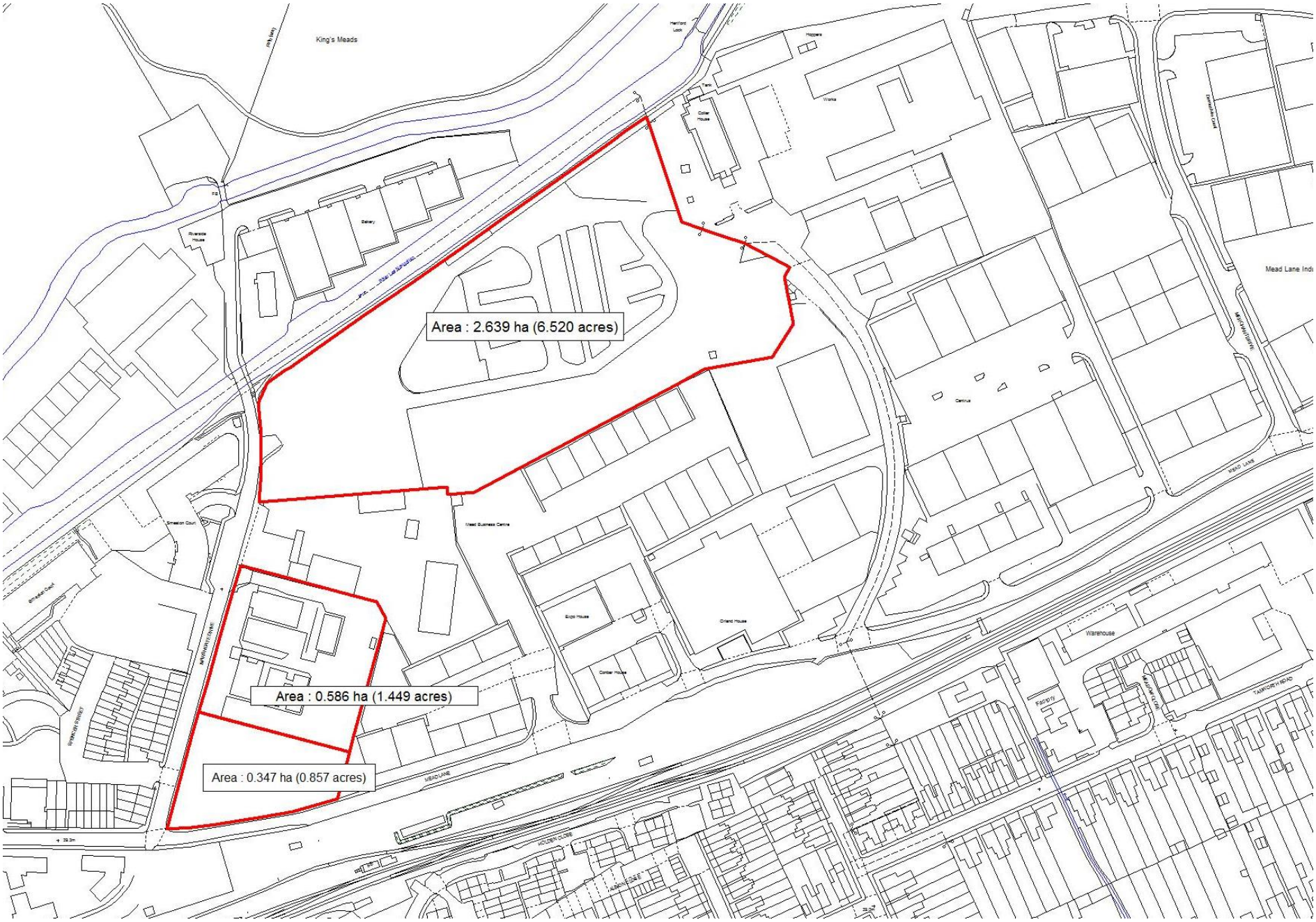
Marshgate Drive, Hertford, Hertfordshire, SG13 7JY

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Figure 2: Site Layout

HERTFORD, MARSHGATE DRIVE
OS MAP



APPENDIX 2
ENVIRONMENT AGENCY DATA

Mr. Chris Day
Ramboll Environ
Via email
CDay@ramboll.com

Our ref: HNL 8384 BC

Your ref:

Date: 8 April 2016

Dear Mr. Day

Enquiry regarding site at Mead Lane, Hertford, Herts

Thank you for your enquiry which was received on 24 March 2016 and payment received 5 April 2016. We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Please find attached Product 4 data from our Partnerships & Strategic Overview Team including a copy of the Flood Map for Planning (Rivers and Sea) for the area relating to your site.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:
https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments
https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

I have attached our Standard Notice or licence which explains the permitted use of this information. Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

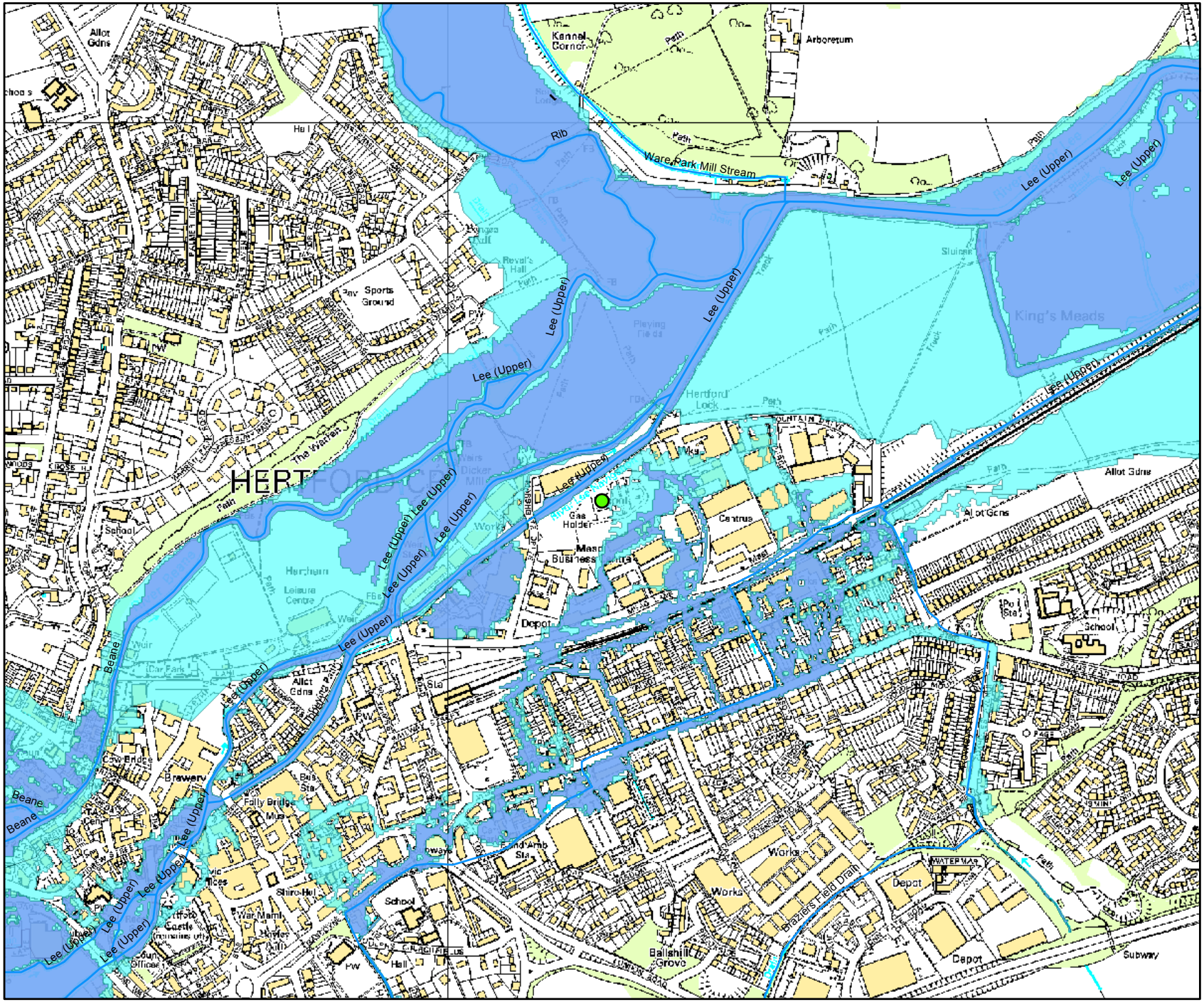
We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:
http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/?a=HNL

Yours sincerely

Becki Clark
Customers and Engagement Officer
Direct dial 01707 632302 / 0203 025 9141
Direct fax 01707 632610
Direct email HNLenquiries@environment-agency.gov.uk

FLOODS DESTROY BE PREPARED

Flood Map for Planning centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



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

0 130 260 520

Metres

Legend

Main Rivers

Flood Map for Planning

- Flood Storage Area
- Areas Benefiting from Flood Defences
- Flood Zone 3
- Flood Zone 2

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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Hertfordshire & North London

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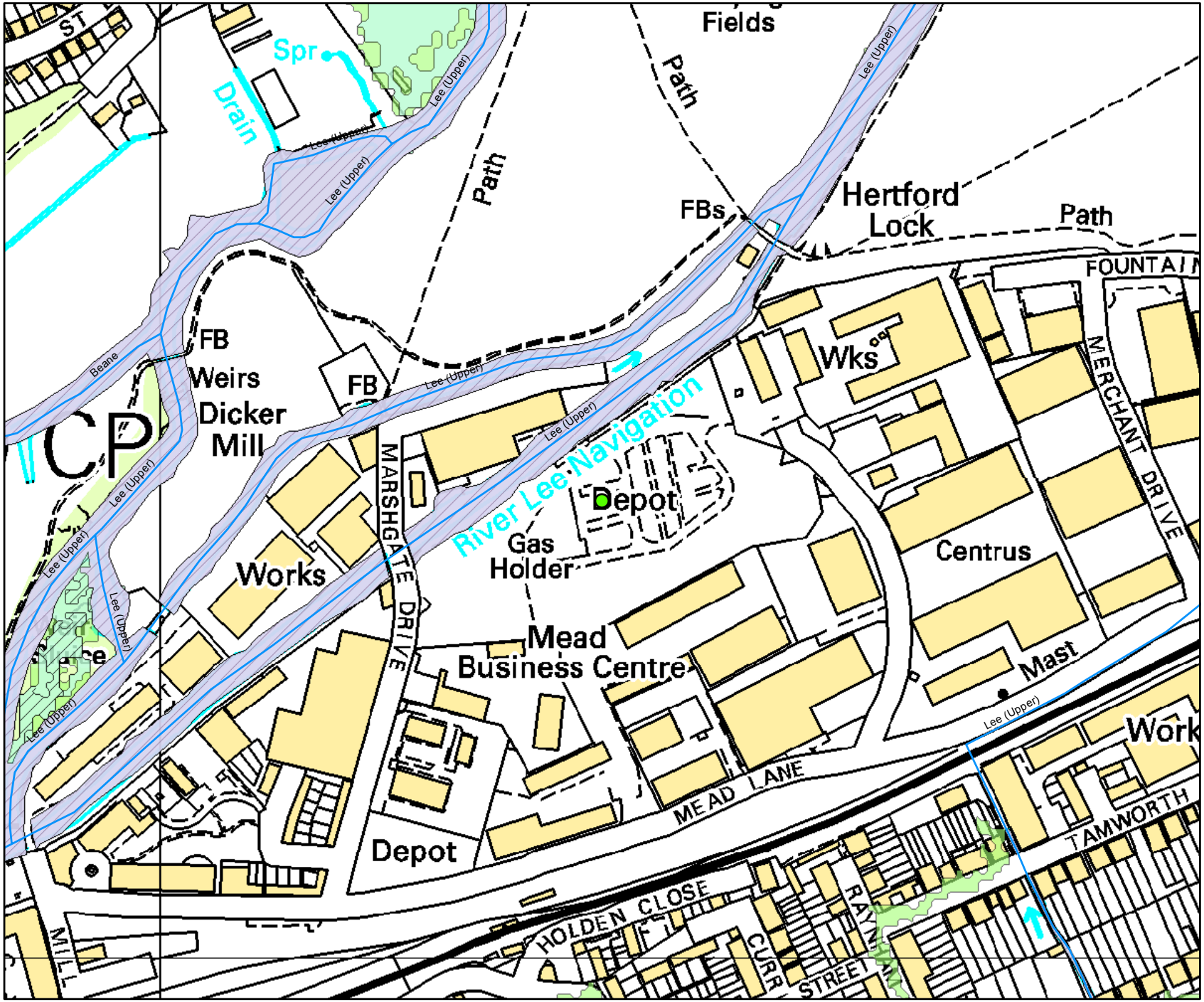

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

Legend

Main Rivers

Defended Flood Outlines

- 1 in 2 (50%) Defended
- 1 in 5 (20%) Defended
- 1 in 10 (10%) Defended
- 1 in 20 (5%) 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).

Flood risk data requests including an allowance for climate change will be based on the 1 in 100 flood plus 20% allowance for climate change, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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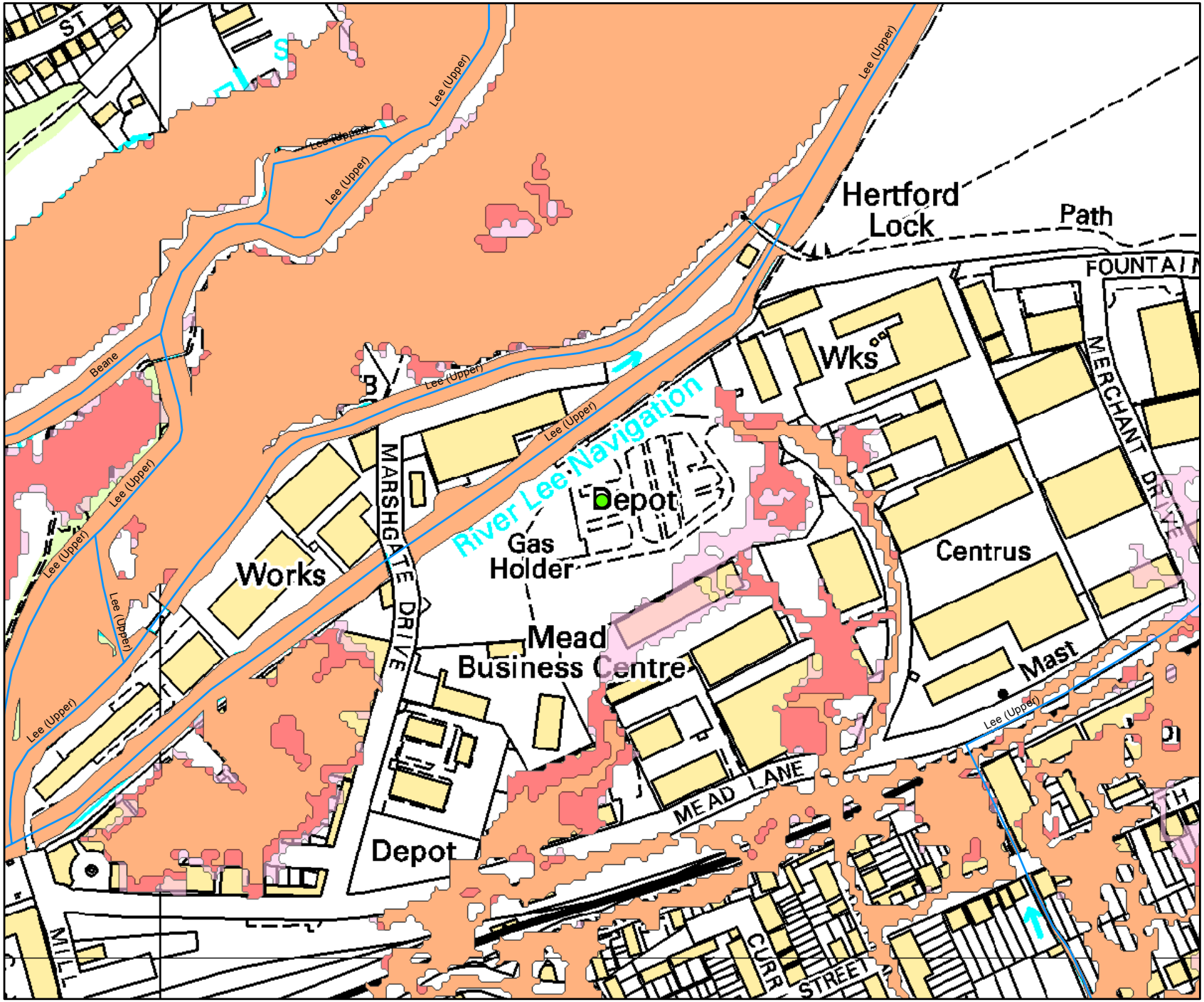

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

Legend

Main Rivers

Defended Flood Outlines

- 1 in 50 (2%) Defended
- 1 in 75 (1.3%) Defended
- 1 in 100 (1%) Defended

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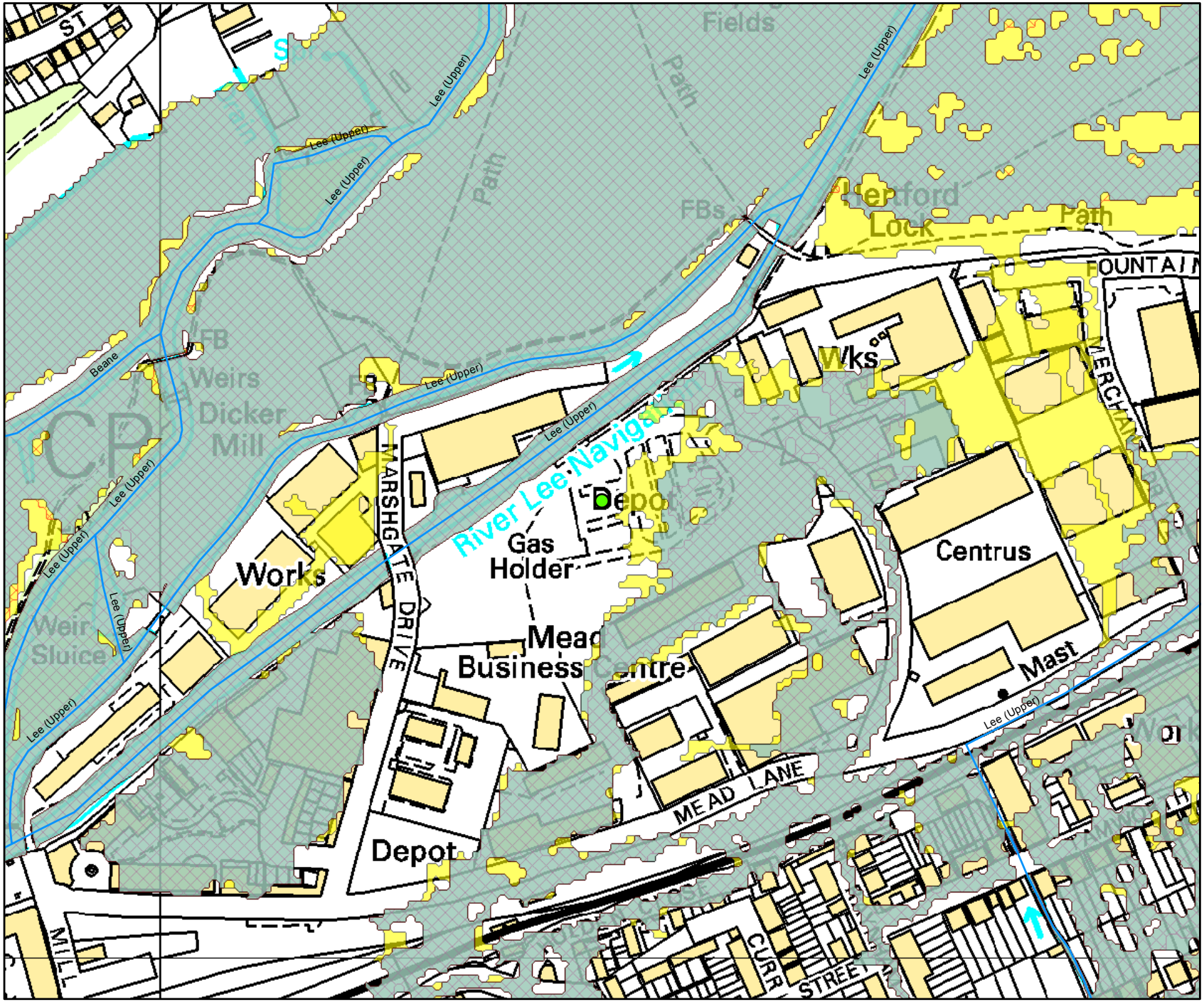

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180

Metres

Legend

Main Rivers

Defended Flood Outlines

- 1 in 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.
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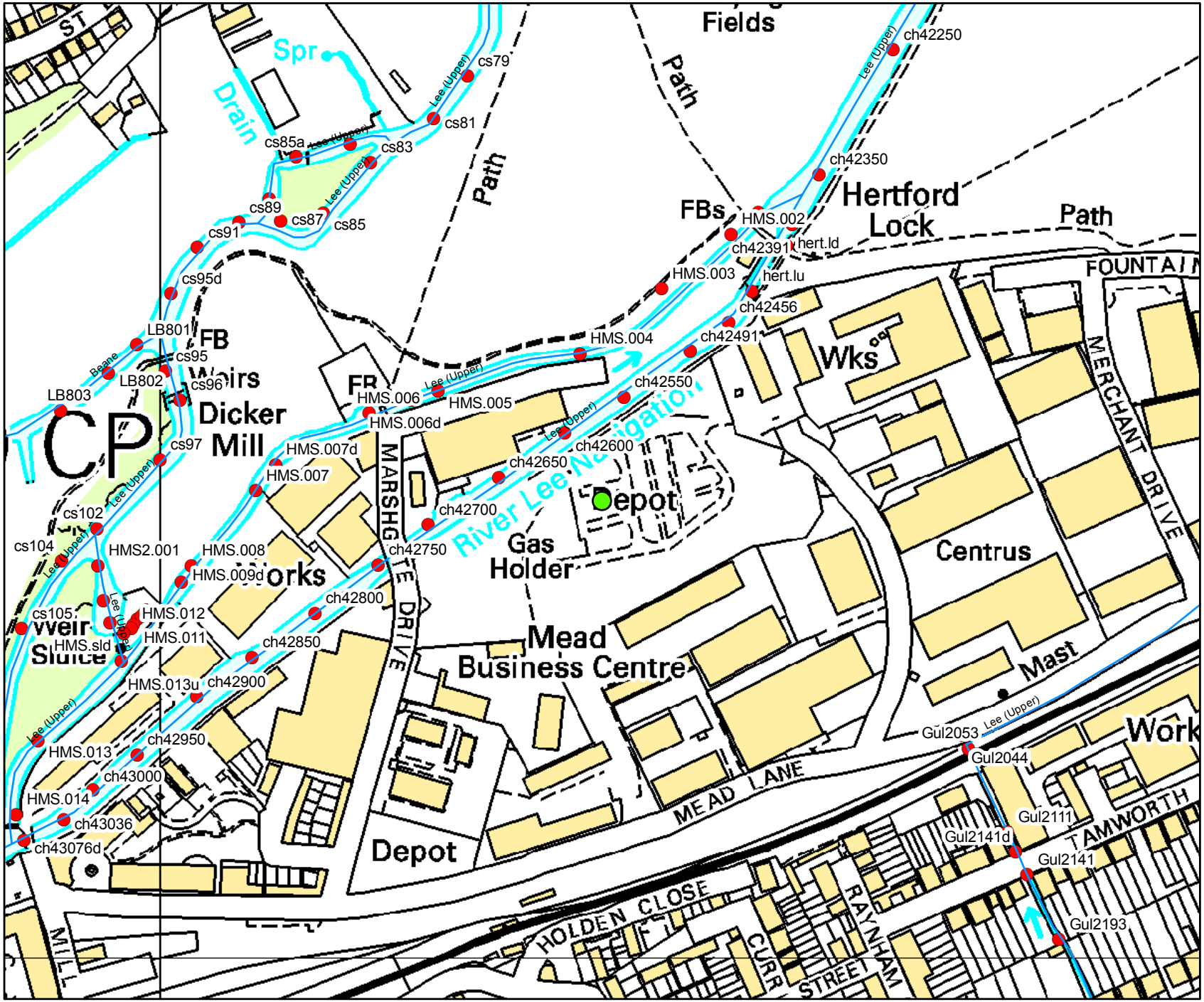

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

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).

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

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)

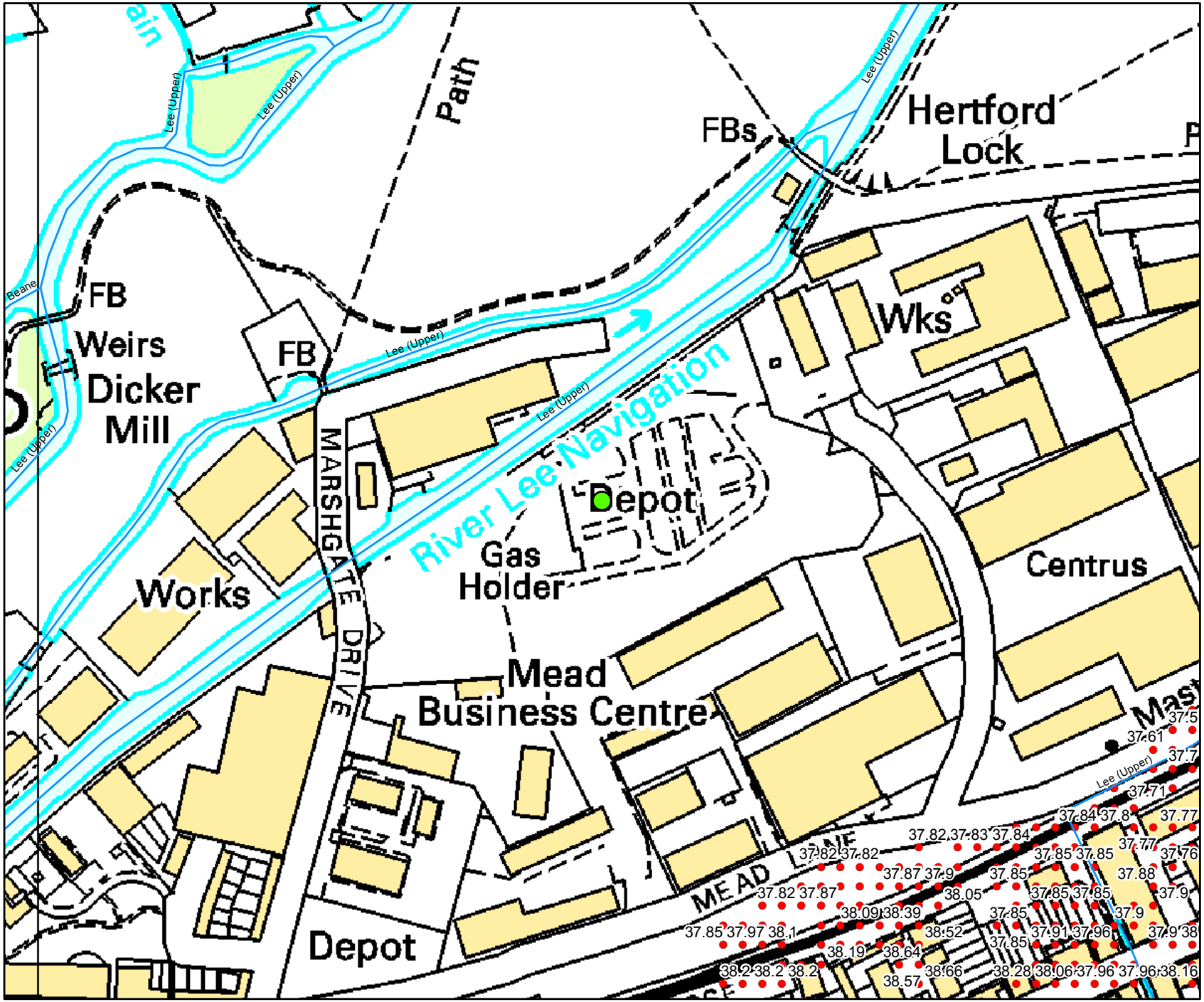
MODELLED FLOOD LEVEL

			Return Period								
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20 yr**	**50 yr**	**100 yr**	**100 yr + 20%**	**200 yr**	**1000 yr**
ch42350	533429.3	213508.5	34.84	35.13	35.31	35.43	35.62	35.72	35.85	35.85	35.97
ch42391	533412.0	213475.7	34.84	35.13	35.31	35.43	35.62	35.72	35.85	35.85	35.97
ch42456	533370.4	213412.2	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42491	533345.4	213393.2	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42550	533302.3	213363.7	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42600	533263.9	213340.3	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42650	533220.8	213311.2	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42700	533174.9	213280.3	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42750	533142.3	213254.3	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42800	533101.1	213223.0	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42850	533060.1	213194.0	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
ch42900	533024.1	213168.7	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
cs81	533178.5	213544.6	35.02	35.42	35.64	35.79	35.99	36.08	36.17	36.17	36.26
cs83	533137.2	213516.3	35.02	35.42	35.64	35.79	35.99	36.08	36.17	36.17	36.26
cs83a	533124.1	213528.1	35.02	35.42	35.64	35.79	35.99	36.08	36.17	36.17	36.26
cs85	533106.5	213483.3	35.04	35.44	35.67	35.82	36.02	36.13	36.21	36.22	36.31
cs85a	533088.8	213519.6	35.04	35.45	35.67	35.82	36.03	36.13	36.21	36.22	36.31
cs87	533078.9	213477.9	35.06	35.47	35.70	35.84	36.06	36.16	36.24	36.25	36.35
cs87a	533071.4	213492.6	35.06	35.47	35.70	35.84	36.06	36.16	36.24	36.25	36.35
cs89	533051.6	213477.0	35.06	35.47	35.70	35.84	36.06	36.16	36.24	36.25	36.35
cs91	533024.5	213460.8	35.10	35.52	35.75	35.91	36.13	36.24	36.33	36.35	36.46
cs95	533003.8	213380.5	35.14	35.56	35.80	35.95	36.19	36.30	36.40	36.41	36.53
cs95d	533007.3	213430.9	35.14	35.56	35.80	35.95	36.19	36.30	36.40	36.41	36.53
cs96	533013.3	213361.6	35.15	35.56	35.80	35.96	36.19	36.31	36.40	36.42	36.53
cs97	533000.2	213322.9	35.74	35.89	36.03	36.17	36.36	36.42	36.47	36.48	36.56
Gul2044	533521.5	213143.6	37.08	37.21	37.27	37.29	37.41	37.49	37.55	37.53	37.66
Gul2053	533526.7	213135.0	37.10	37.23	37.29	37.31	37.43	37.50	37.56	37.54	37.67
Gul2111	533552.0	213080.7	37.22	37.37	37.45	37.48	37.63	37.71	37.78	37.76	37.90
Gul2141	533564.8	213052.8	37.49	37.60	37.66	37.68	37.79	37.86	37.92	37.91	38.04
Gul2141d	533557.3	213067.8	37.41	37.50	37.56	37.57	37.68	37.74	37.80	37.79	37.92
hert.ld	533408.4	213461.9	34.84	35.13	35.31	35.43	35.62	35.72	35.85	35.85	35.97
hert.lu	533385.8	213432.5	37.14	37.19	37.23	37.25	37.30	37.33	37.35	37.34	37.44
HMS.001	533389.9	213484.0	34.84	35.13	35.31	35.43	35.62	35.72	35.85	35.85	35.97
HMS.002	533372.0	213469.7	34.84	35.13	35.31	35.43	35.62	35.72	35.85	35.85	35.96
HMS.003	533326.8	213434.0	34.85	35.14	35.32	35.44	35.63	35.73	35.87	35.87	36.01
HMS.004	533273.6	213391.6	34.88	35.16	35.33	35.45	35.63	35.75	35.88	35.88	36.02
HMS.005	533181.4	213367.4	34.96	35.18	35.35	35.46	35.64	35.78	35.92	35.92	36.09
HMS.006	533136.4	213353.2	34.97	35.19	35.35	35.46	35.64	35.78	35.91	35.92	36.12
HMS.006d	533163.6	213361.7	34.97	35.19	35.35	35.46	35.64	35.78	35.91	35.92	36.07
HMS.007	533062.5	213302.8	35.02	35.21	35.37	35.47	35.66	35.83	35.99	36.00	36.27
HMS.007d	533075.5	213319.5	35.02	35.21	35.37	35.47	35.66	35.83	35.99	36.00	36.27
HMS.008	533020.7	213253.8	35.04	35.22	35.38	35.48	35.67	35.85	36.02	36.02	36.32
HMS.009	532991.0	213225.0	35.04	35.22	35.37	35.48	35.67	35.85	36.02	36.02	36.33
HMS.009d	533014.2	213243.3	35.04	35.22	35.37	35.48	35.67	35.85	36.02	36.02	36.32
HMS.010d	532990.1	213223.1	35.04	35.22	35.38	35.48	35.67	35.85	36.02	36.03	36.33

MODELLED FLOWS

			Return Period								
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20 yr**	**50 yr**	**100 yr**	**100 yr + 20%**	**200 yr**	**1000 yr**
ch42350	533429.32	213508.51	1.27	1.59	1.85	1.96	2.85	4.71	5.59	5.50	7.12
ch42391	533412	213475.65	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.04
ch42456	533370.39	213412.16	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
ch42491	533345.43	213393.24	0.01	0.02	0.04	0.04	0.03	0.03	0.04	0.02	0.02
ch42550	533302.25	213363.7	0.01	0.04	0.08	0.08	0.04	0.06	0.07	0.03	0.05
ch42600	533263.87	213340.28	0.02	0.05	0.11	0.11	0.05	0.08	0.07	0.05	0.08
ch42650	533220.8	213311.24	0.02	0.05	0.12	0.12	0.06	0.11	0.09	0.06	0.10
ch42700	533174.93	213280.33	0.02	0.07	0.12	0.13	0.07	0.14	0.11	0.07	0.11
ch42750	533142.27	213254.26	0.02	0.08	0.14	0.15	0.09	0.16	0.12	0.08	0.13
ch42800	533101.09	213222.97	0.03	0.09	0.15	0.15	0.10	0.18	0.13	0.10	0.14
ch42850	533060.11	213194	0.03	0.10	0.15	0.14	0.12	0.17	0.13	0.11	0.19
ch42900	533024.08	213168.7	0.03	0.12	0.15	0.15	0.21	0.67	1.17	1.01	2.21
cs81	533178.47	213544.64	14.15	22.38	28.59	33.22	41.95	46.87	50.56	52.26	58.91
cs83	533137.18	213516.27	9.71	15.03	19.01	21.95	27.02	29.82	32.01	33.06	37.17
cs83a	533124.14	213528.14	4.44	7.36	9.60	11.28	14.93	17.05	18.55	19.19	21.74
cs85	533106.54	213483.25	9.72	15.03	19.01	21.95	26.59	29.06	31.17	32.19	36.32
cs85a	533088.76	213519.64	4.44	7.36	9.59	11.28	15.39	17.82	19.39	20.07	22.58
cs87	533078.88	213477.91	9.72	15.03	19.01	21.95	25.78	28.00	30.11	31.08	35.29
cs87a	533071.37	213492.55	4.44	7.37	9.59	11.28	16.22	18.88	20.46	21.18	23.62
cs89	533051.6	213477.02	14.16	22.39	28.60	33.23	41.95	46.88	50.56	52.26	58.90
cs91	533024.51	213460.83	14.16	22.39	28.60	33.24	41.96	46.88	50.56	52.26	58.90
cs95	533003.78	213380.46	10.87	14.77	18.23	19.97	23.35	23.88	24.84	24.16	25.91
cs95d	533007.27	213430.91	14.16	22.39	28.61	33.24	41.96	46.89	50.74	52.52	61.72
cs96	533013.28	213361.56	10.87	14.77	18.24	19.98	23.37	23.89	24.85	24.18	25.94
cs97	533000.18	213322.87	10.87	14.77	18.24	19.98	23.37	23.89	24.85	24.18	25.94
Gul2044	533521.48	213143.59	0.82	1.07	1.18	1.20	1.23	1.25	1.27	1.26	1.30
Gul2053	533526.69	213134.99	0.82	1.07	1.18	1.20	1.23	1.25	1.27	1.26	1.30
Gul2111	533551.96	213080.69	0.82	1.07	1.18	1.20	1.23	1.25	1.27	1.26	1.30
Gul2141	533564.83	213052.77	0.82	1.07	1.18	1.20	1.23	1.25	1.27	1.26	1.31
Gul2141d	533557.34	213067.78	0.82	1.07	1.18	1.20	1.23	1.25	1.27	1.26	1.31
hert.ld	533408.42	213461.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
hert.lu	533385.76	213432.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HMS.001	533389.91	213484.02	1.26	1.59	1.85	1.96	2.85	4.71	5.59	5.50	7.12
HMS.002	533371.99	213469.67	1.26	1.60	1.85	1.96	2.85	4.72	5.59	5.50	6.93
HMS.003	533326.77	213434	1.26	1.58	1.86	1.97	2.85	4.72	5.60	5.51	6.91
HMS.004	533273.63	213391.59	1.26	1.59	1.86	1.98	2.86	4.78	6.35	6.21	9.71
HMS.005	533181.42	213367.41	1.27	1.59	1.87	1.99	2.87	4.79	7.17	7.19	12.44
HMS.006	533136.43	213353.22	1.27	1.59	1.87	1.99	2.87	4.79	7.17	7.18	12.44
HMS.006d	533163.57	213361.66	1.27	1.59	1.87	1.99	2.87	4.79	7.17	7.18	12.44
HMS.007	533062.47	213302.77	1.27	1.60	1.87	2.00	2.87	4.63	6.52	6.49	11.41
HMS.007d	533075.46	213319.54	1.27	1.60	1.87	2.00	2.87	4.63	6.52	6.49	11.41
HMS.008	533020.71	213253.82	1.27	1.60	1.87	2.00	2.29	2.45	2.60	2.53	3.19
HMS.009	532991.03	213225	1.27	1.60	1.87	2.00	2.29	2.45	2.59	2.52	3.02
HMS.009d	533014.22	213243.31	1.27	1.60	1.87	2.00	2.29	2.45	2.59	2.52	3.02
HMS.010d	532990.08	213223.1	1.27	1.60	1.87	2.00	2.29	2.45	2.59	2.52	3.02

Detailed FRA centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



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

0 35 70 140
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).

Flood risk data requests including an allowance for climate change will be based on the 1 in 100 flood plus 20% allowance for climate change, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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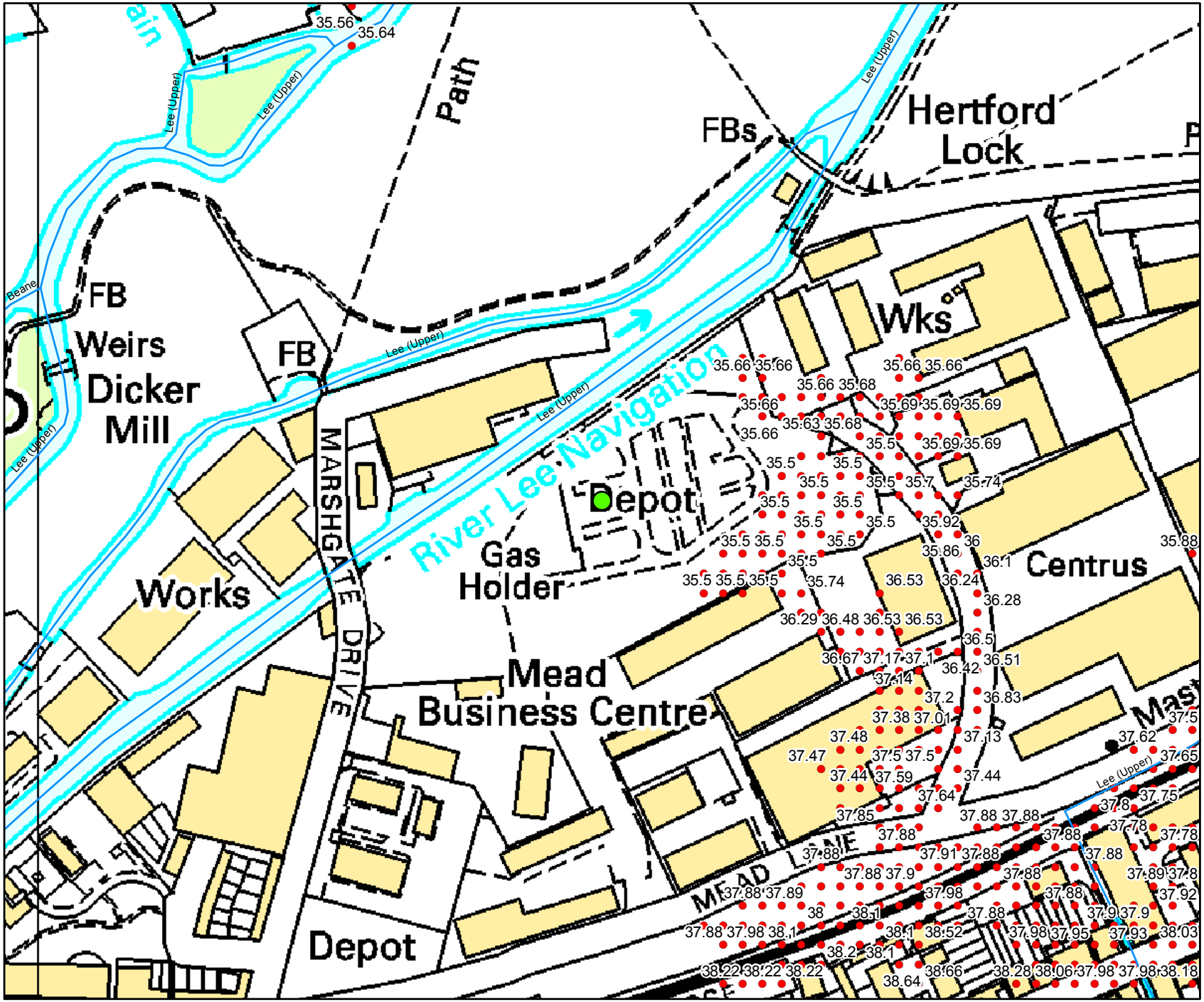

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 10 (10%) Defended M01

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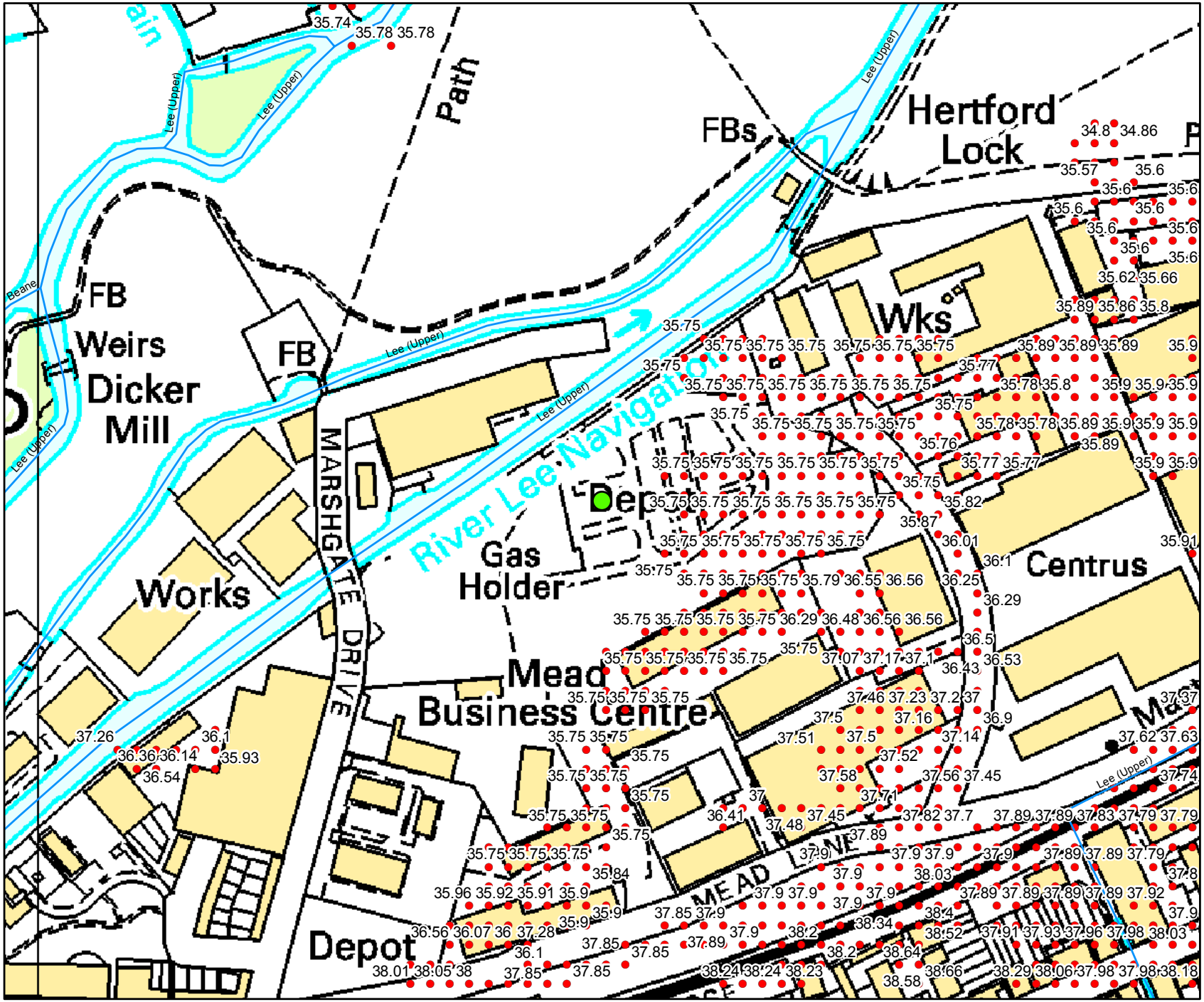

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2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 20 (5%) Defended M01

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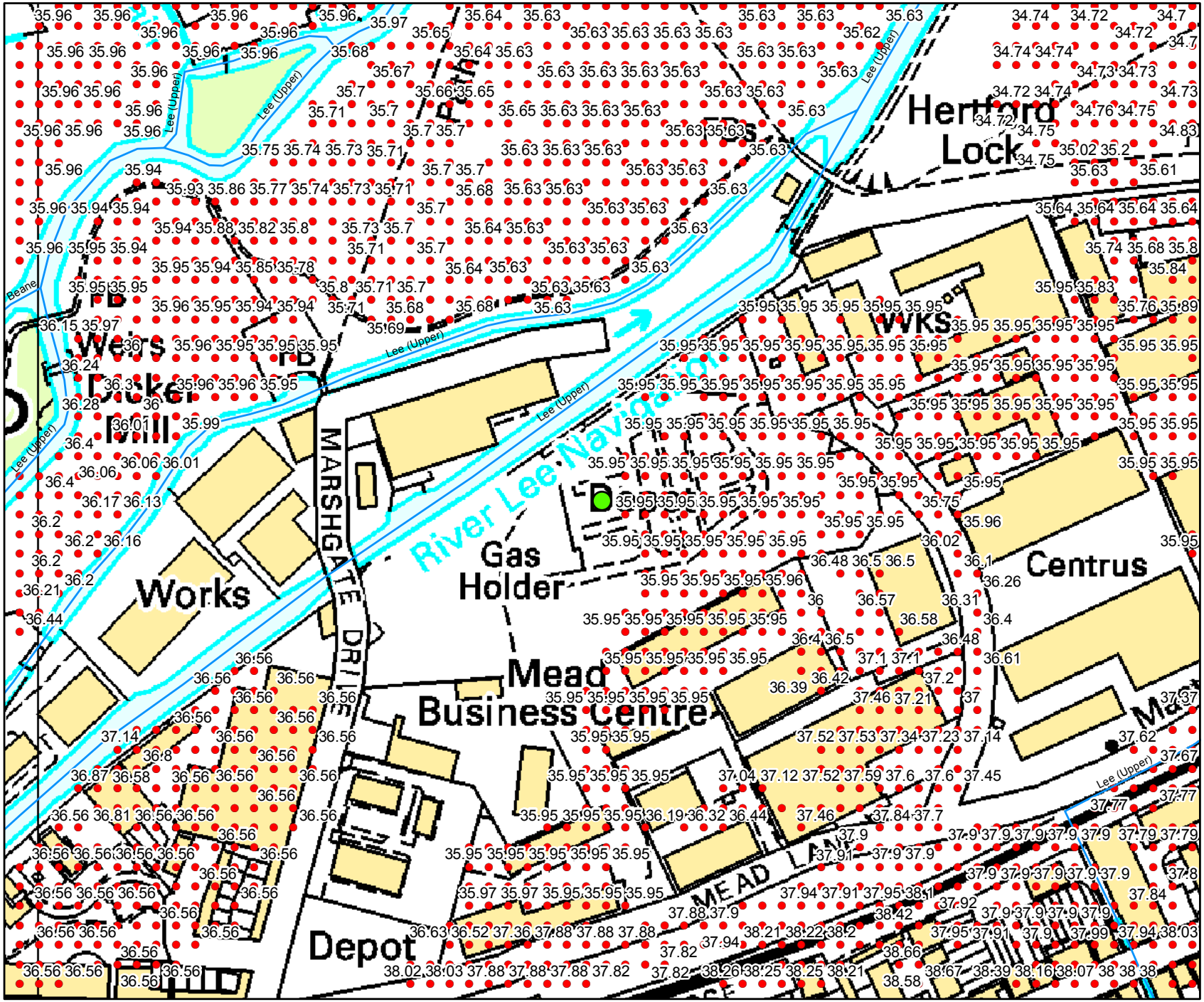

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Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 50 (2%) Defended M01

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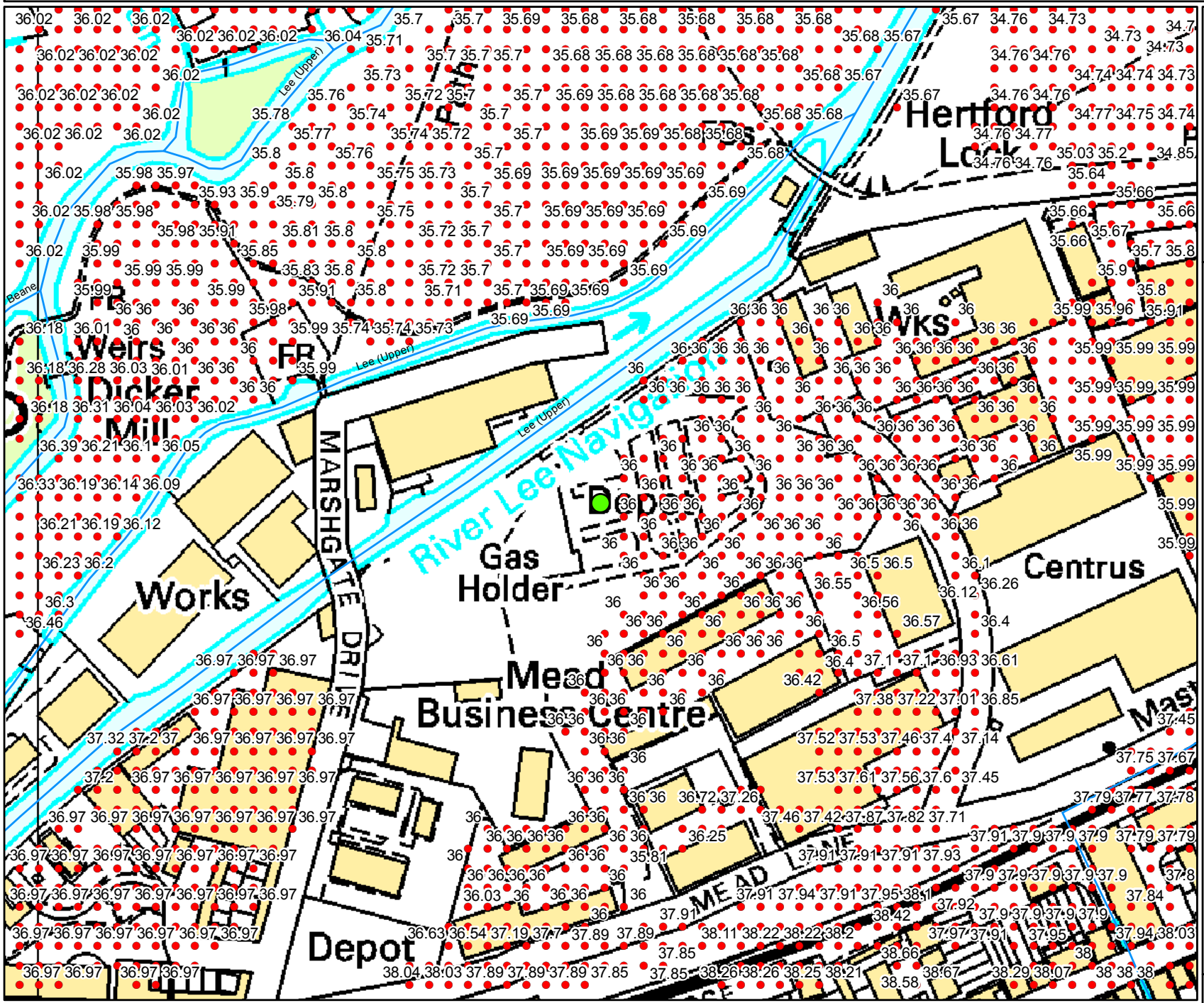

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Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 75 (1.33%) Defended M01

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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).

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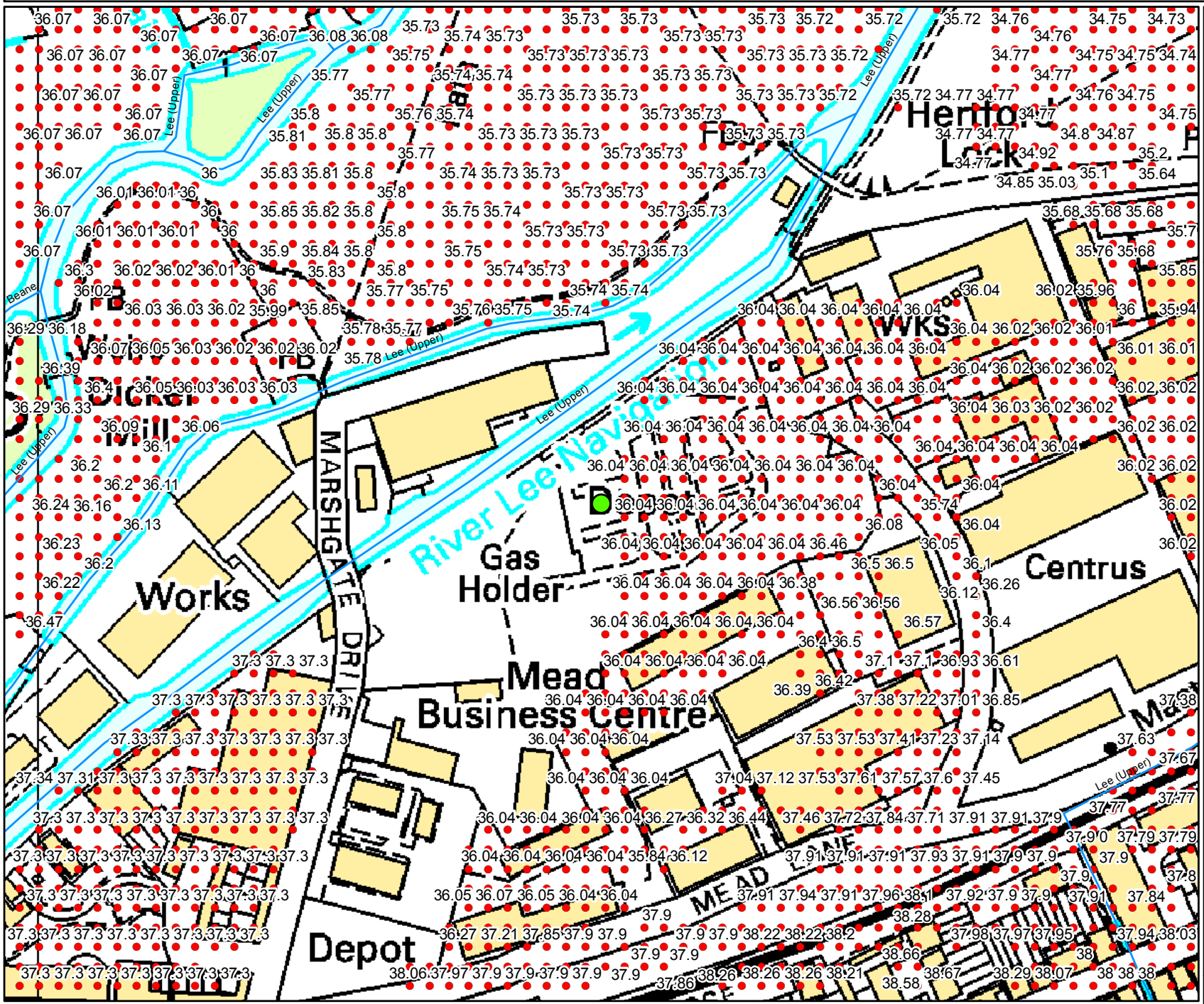

Environment Agency

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

0 35 70 140
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).

Flood risk data requests including an allowance for climate change will be based on the 1 in 100 flood plus 20% allowance for climate change, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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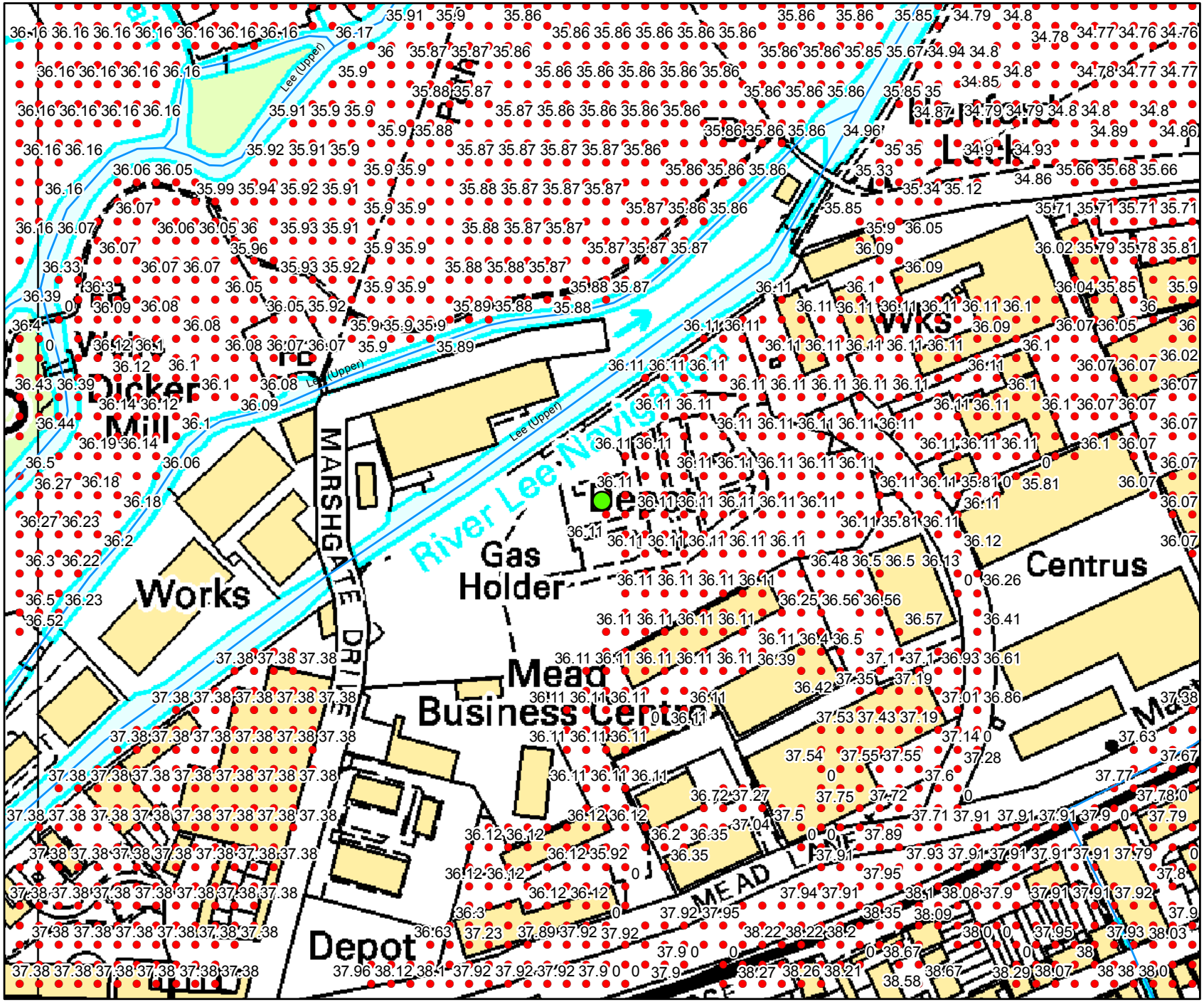

Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
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).

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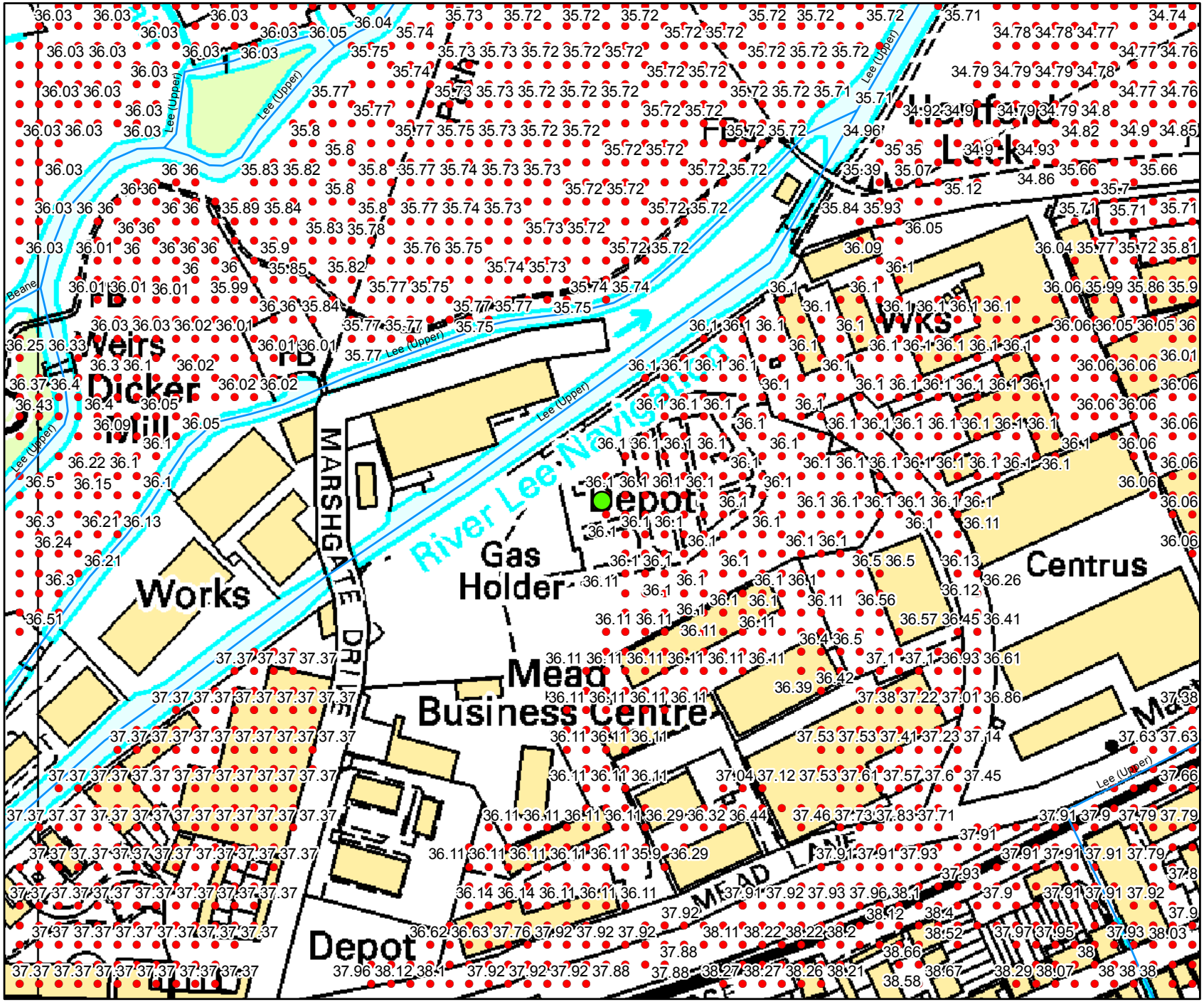
Detailed FRA centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



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

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 200 (0.5%) Defended M01

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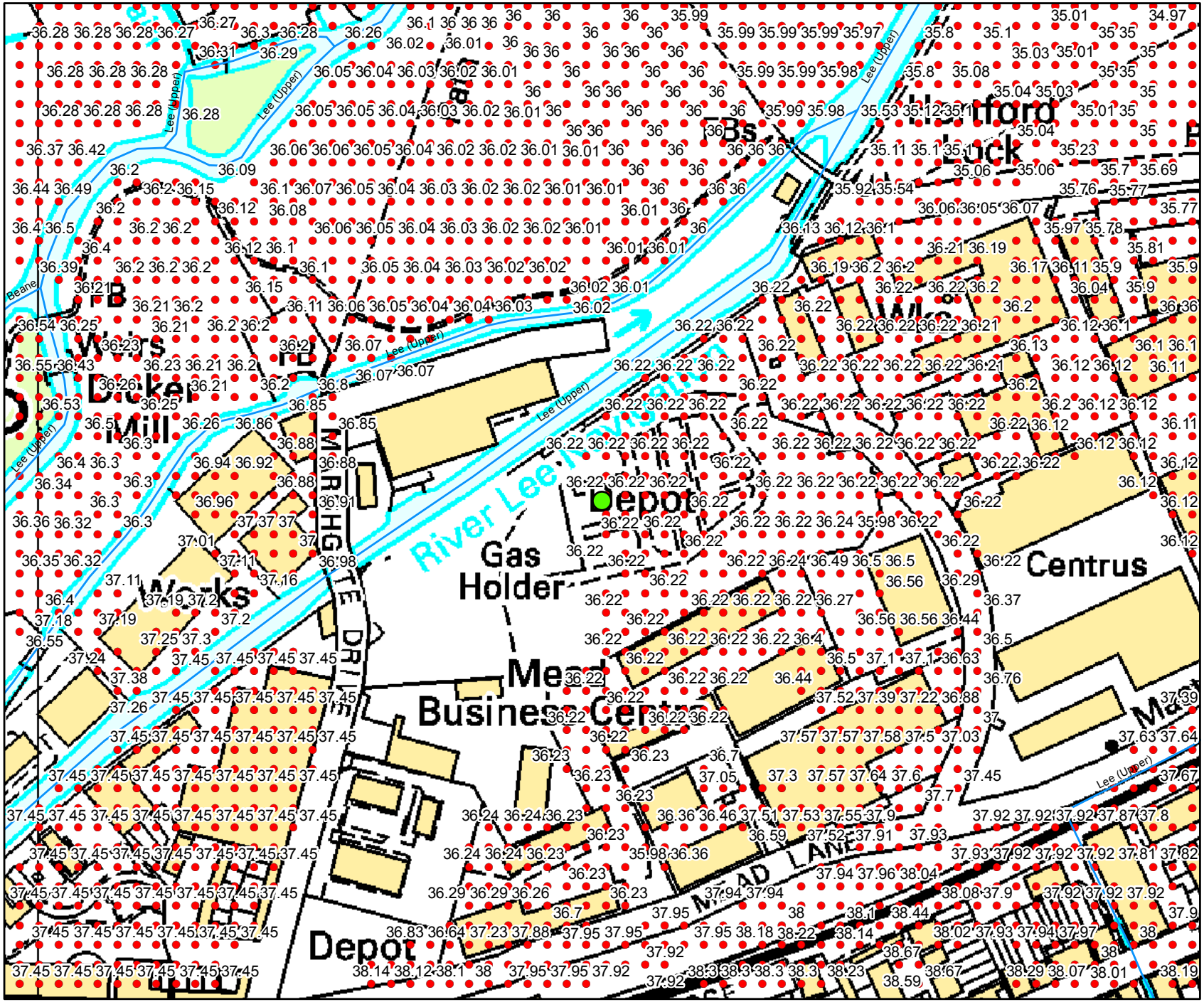
Detailed FRA centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



Environment Agency

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Hatfield
Hertfordshire
AL10 9EX

0 35 70 140
Metres

Legend

Main Rivers

2D Node Results: Heights

1 in 1000 (0.1%) Defended M01

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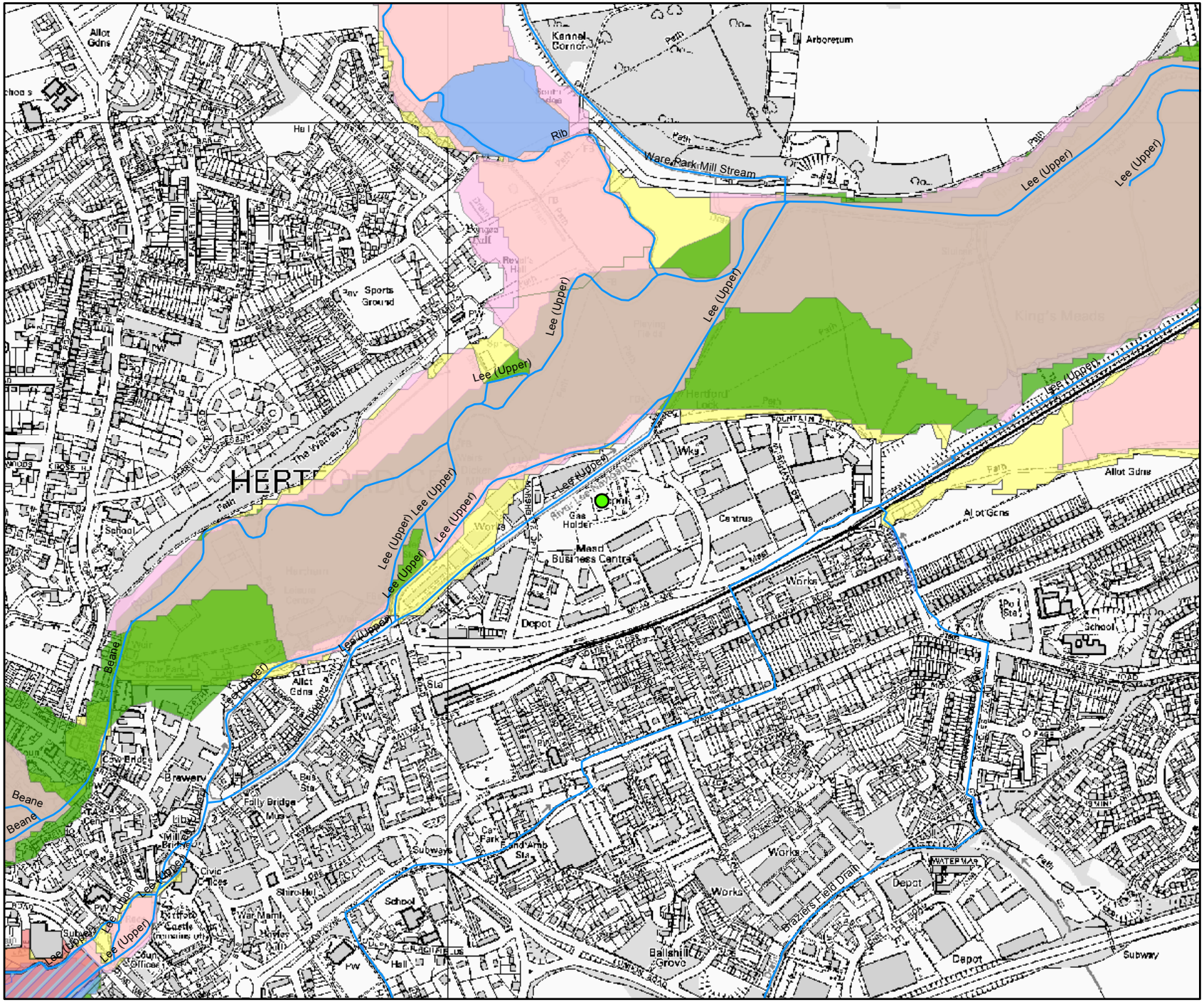
Historic Flood Map centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



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Hatfield
Hertfordshire
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0 130 260 520
Metres

Legend

Main Rivers

Flood Event Outlines

- 2014
- 2009
- 2000
- 1987
- 1978
- 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.

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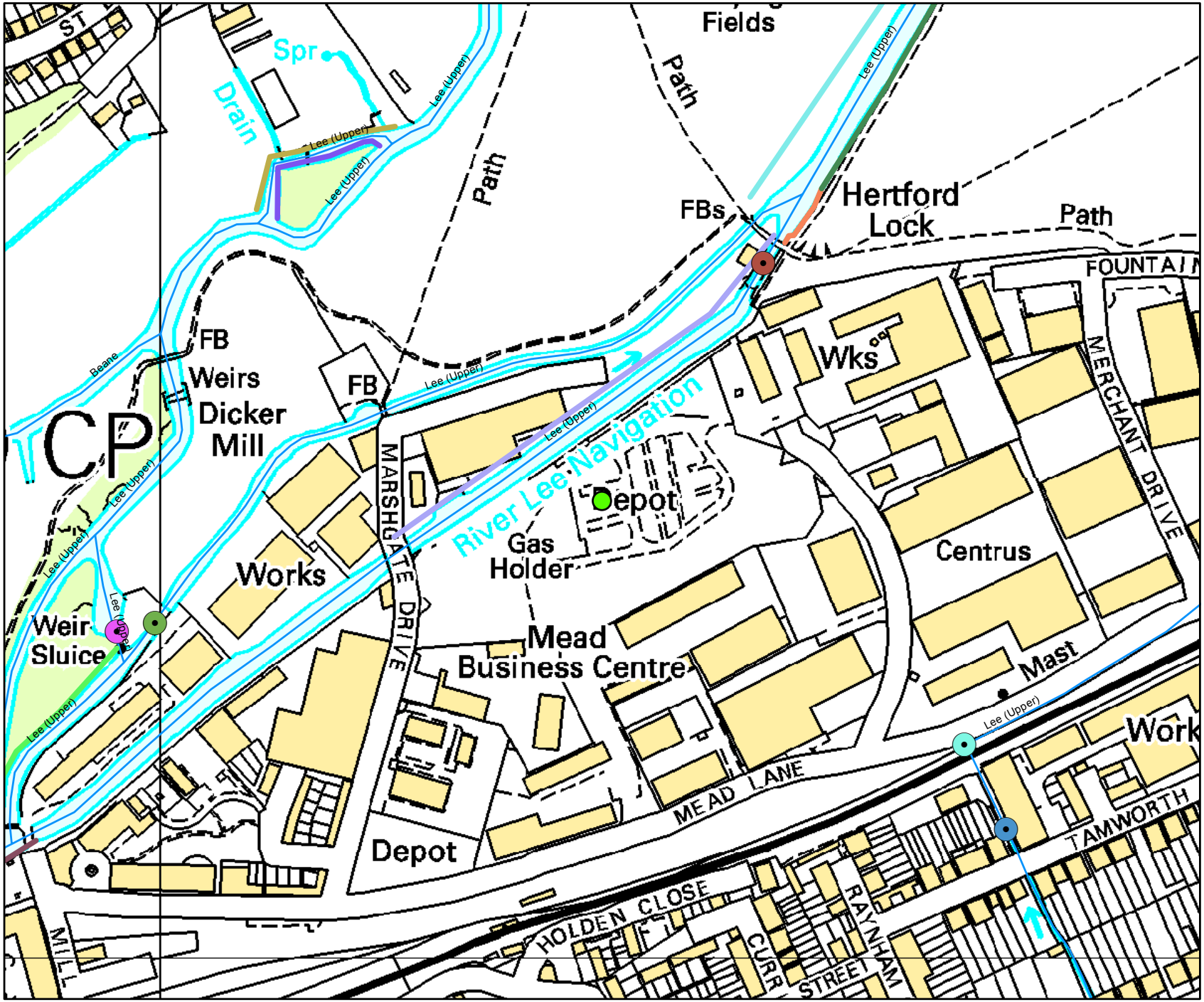
Defences and Structures centred on Mead Lane, Hertford - 07/04/2016 - HNL 8384 BC



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St Albans Road West
Hatfield
Hertfordshire
AL10 9EX

0 45 90 180
Metres

Legend

Main Rivers

STRUCTURE ASSET_ID	DEFENCE ASSET_ID
201400	11333
201405	42180
321020	42256
412963	42370
413015	112635
	112636
	129723
	151736

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

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Environment Agency ref: HNL 8384 BC

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

Defences

Asset ID	Asset Type	Asset Protection	Asset Comment	Asset Description	Design Standard of protection (years)	Upstream Crest Level	Downstream Crest Level	Condition of Defences (1=Good, 5 = Poor)
11333	defence	fluvial	Dicker Mill Island South Embankment.	Natural embankment. Heavily vegetated with mature trees and shrubs to crest. Low section upstream of side sluice.	No infromation available	37.4	37.25	4
42370	defence	fluvial	Kingsmead West Embankment.	Earth embankment. with formaltowpath surface along crest. Busy footpath.	No infromation available	36.29	35.52	2
42256	defence	fluvial	Meads at Hertford Embankment.	Well vegetated and maintained embankment adjacent to channel	No infromation available	35.68	35.73	3
129723	defence	fluvial	Lined channel, concrete, timber and stone form complex wall along length	Channel lined with timber concrete and masonary sections.	No infromation available	37.46	37.71	3
42180	defence	fluvial	Hertford Lock Embankment	Vegetated earth embankment with lock keepers cottage to crest retained by granite to start and then steel sheet piling. Majority is natural bank.	No infromation available	38.51	37.56	3
112636	defence	fluvial	Veggatated channel sides	No infromation available	10	No infromation available	No infromation available	3
112635	defence	fluvial	Natural channel through park land	No infromation available	10	No infromation available	No infromation available	3
151736	defence	fluvial	Lined Channel.	Masonry and steel sheet piled defence.	10	37.58	35.16	2

Structures

Asset ID	Asset Type	Asset Protection	Asset Comment	Asset Description	Condition of Structures (1=Good, 5 = Poor)
201400	control_gate	fluvial	SLUICE GATE Dicker Mill Sluices (Old Mill).	Cast iron sluice and penstock forming part of old Dicker Mill. Masonry channel walls with concrete footbridge. Penstock appears unmaintained. Length along watercourse 1m.	3
201405	control_gate	fluvial	SLUICE GATE Sluice (Dicker Mill). Simple Ransomes Vertical lift sluice	Disused sluice forming part of old Mill complex, with insitu concrete access bridge & steel handrail. Winding gear in place but not operational, wire bonds have been removed, sluice in shut position. Length along watercourse 9m.	3
321020	control_gate	fluvial	SLUICE GATE Hertford Lock	Metal lock gates. good condition. block stone capping to lock walls. brick chamber walls which appear to be in good condition for age. lock length 40m. width 5m. Remedial work done to walls. rails and invert. Condition improved.	3
412963	screen	fluvial	ExCow screen	No infromation available	No infromation available
413015	screen	fluvial	ExCow site	No infromation available	No infromation available