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Client: Hyde Park Construction Ltd

Flood Risk Assessment for the Proposed Development at Haydon House, 296 Joel Street, Pinner, London

December 2022

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Project Reference: 3450

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Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date
1	0	Draft report issued by email	13 May 2022
2	1	Final report issued by email	20 May 2022
3	2	Report updated to include latest scheme drawings. Revised report issued by email	25 May 2022
4	3	Report updated for new build scheme. Revised report issued by email.	01 September 2022
5	4	Report updated to include the latest scheme drawings. Revised report issued by email.	16 December 2022

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Document Verification

Issue	Revision	Date:	13 May 2022	
1	0	Author(s):	LS	
		First Check By:	TV	
		Amendments Agreed:	LS	
		Second Check By:	TV	
Issue	**Revision**	**Date:**	**20 May 2022**	
2	1	Author(s):	LS	
		Checked By:	TV	
Issue	**Revision**	**Date:**	**25 May 2022**	
3	2	Author(s):	LS	
		Checked By:	TV	
Issue	**Revision**	**Date:**	**01 September 2022**	
4	3	Author(s):	LS	SH
		First Check By:	TV	
		Director Sign Off:	SMB	
Issue	**Revision**	**Date:**	**16 December 2022**	
5	4	Author(s):	LS	
		Checked By:	TV	

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1 Background and Scope of Appraisal

Flooding is a major issue in the United Kingdom. The impacts can be devastating in terms of the cost of repairs, replacement of damaged property and loss of business. The objectives of the Flood Risk Assessment (FRA) are therefore to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source.
- whether the development will increase flood risk elsewhere within the floodplain.
- whether the measures proposed to address these effects and risks are appropriate.
- whether the site will pass Part B of the Exception Test (where applicable).

Herrington Consulting has been commissioned by Hyde Park Construction Ltd to prepare a Flood Risk Assessment (FRA) for the proposed development at **Haydon House 296 Joel Street, Pinner, London, HA5 2PY.**

A Flood Risk Assessment (FRA) appraises the risk of flooding to development at a site specific scale, and recommends appropriate mitigation measures to reduce the impact of flooding to both the site and the surrounding area. New development has the potential to increase the risk of flooding to neighbouring sites and properties through increased surface water runoff and as such, an assessment of the proposed site drainage can help to accurately quantify the runoff rates, flow pathways and the potential for infiltration at the site. This assessment considers the practicality of incorporating Sustainable Drainage Systems (SuDS) into the scheme design, with the aim of reducing the risk of flooding by actively managing surface water runoff.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (2021) and the National Planning Practice Guidance Suite (August 2022) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs. In addition, reference has also been made to Local Planning Policy.

To ensure that due account is taken of industry best practice, this FRA has been carried out in line with the CIRIA Report C624 ‘Development and flood risk - guidance for the construction industry’.

2 Development Description and Planning Context

2.1 Site Location Development

The site is located at OS coordinates 510447, 188870 off Joel Street in Pinner. The site covers an area of approximately 740m^2 and currently comprises of a single building with associated parking facilities. The location of the site in relation to the surrounding area and the River Pinn is shown in Figure 2.1.

Figure 2.1 – Location map (contains Ordnance Survey data © Crown copyright and database right 2022). River Pinn shown in blue, site boundary delineated in red.

The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

2.2 Proposed Development

The proposals for development comprise the demolition of the existing building and the construction of a block of flats containing 13no. residential flats/studios (Figure 2.2).

Figure 2.2 – Proposed site layout plan

Drawings of the proposed scheme are included in Appendix A.1 of this report.

2.3 The Sequential Test

The National Planning Policy Framework (NPPF) requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the Environment Agency's (EA) 'Flood Map for Planning' (Figure 2.3). These maps and the associated information are intended for guidance and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site-based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The Flood Zones are classified as follows:

Zone 1 – *Low probability of flooding* – This zone is assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any one year.

Zone 2 – *Medium probability of flooding* – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – *High probability of flooding* - This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

Zone 3b – *The Functional Floodplain* – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 30 or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

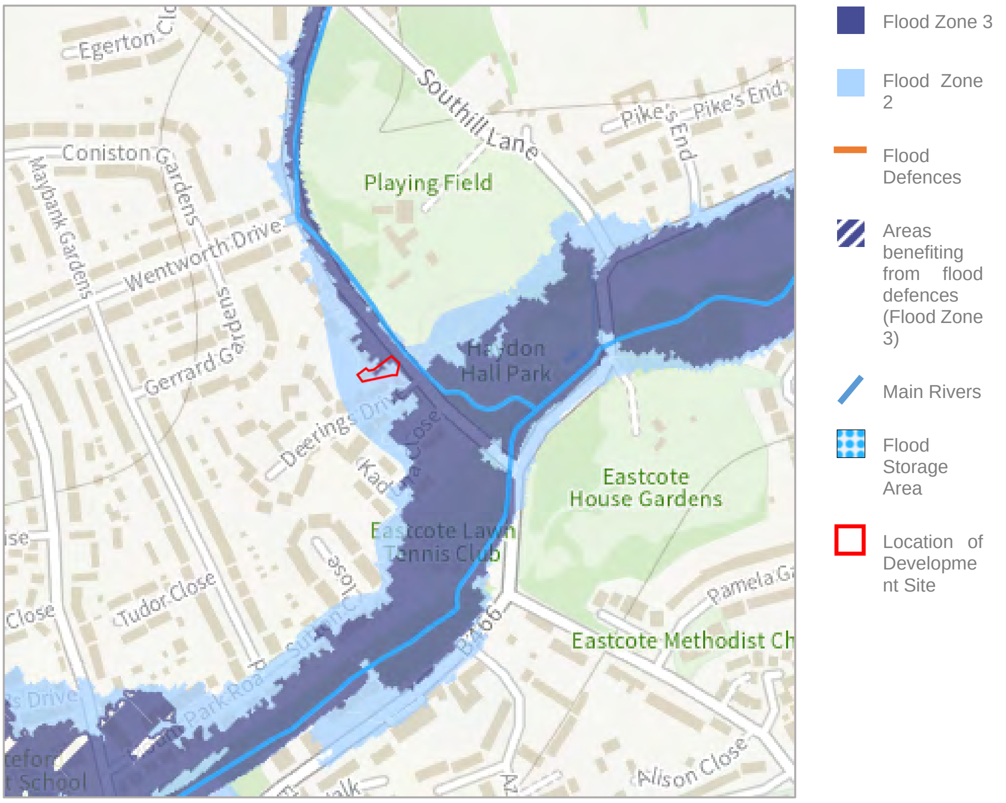


Figure 2.3 – EA's 'Flood Map for Planning' (© Environment Agency).

Figure 2.3 shows the development site is located within Flood Zone 3 and identifies that the site does not benefit from existing flood defences. This mapping does not distinguish between high risk areas and the functional floodplain, i.e., Zones 3a and 3b. This is an important differentiation that needs to be made by the FRA because the NPPF states that no development, other than essential transport and utilities infrastructure, should be located within the functional floodplain.

The NPPG states that the Functional Floodplain is land where water has to flow or be stored in times of flood. The NPPG provides the following definition:

This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:

- *land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or*
- *land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).*

Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Based on information provided by the EA and that derived as part of this appraisal, the following Functional Floodplain test is applied:

Do predicted flood levels show that the site will be affected by an event having a return period of 1 in 30 years or less?	**X**
Is the site defended by flood defence infrastructure that prevents flooding for events having a return period of 1 in 30 years or greater?	**X**
Does the site provide a flood storage or floodwater conveyance function?	**X**
Does the site contain areas that are 'intended' to provide transmission and storage of water from other sources?	**X**
Is site within the functional floodplain (Zone 3b)?	**No**

Table 2.1 – Functional floodplain test.

The flood zone mapping and associated information has been summarised in Table 2.2 below.

Flood Zone (Percentage of site within zone)		**Source of Flooding**	**Benefiting from existing flood defences**
Zone 1	**0%**		
Zone 2	**80%**	River (Fluvial)	No
Zone 3a	**20%**	River (Fluvial)	No
Zone 3b	**0%**		

Table 2.2 – Flood zone classification.

The NPPF states that the Local Planning Authority (LPA) should apply the sequential approach as part of the identification of land for development in areas at risk from flooding. The overarching objective of the Sequential Test is to ensure that lower risk sites are developed before sites in higher risk areas. When applying the Sequential Test, it is also necessary to ensure that the subject site is compared to only those sites that are available for development and are similar in size.

This requires a comprehensive knowledge of development sites within the district and is generally applied as part of the Local Plan process. However, when applying the Sequential Test to sites that have not been assessed as part of the Local Plan it is necessary to apply a bespoke test, and the Flood Risk Assessment can help to provide additional evidence to better quantify the true risk of flooding, enabling an informed judgement to be made.

In this case a Sequential Test assessment has not been undertaken in support of this FRA. However, from the work that has been undertaken as part of this site-specific appraisal it is possible to provide evidence that can help in the application of the Sequential Test.

The second level of appraisal is through the application of the more detailed and refined flood risk information contained within the Strategic Flood Risk Assessments (SFRA). Such a document has been prepared for the London Borough of Hillingdon and this has been referenced as part of this site-specific FRA.

The most detailed stage at which the sequential approach can be applied is at a site-based level. Careful consideration of the topography of the site and development uses can provide opportunities to locate more vulnerable buildings on the higher parts of the site and placing less vulnerable elements such as car parking or recreational use in the areas exposed to higher risk. This approach is examined later on in this FRA.

2.4 The Exception Test

According to the NPPF, if it is not possible, consistent with wider sustainability objectives, for the development to be located in areas at lower risk, the Exception Test may have to be applied. The application of the Exception Test will depend on the type and nature of the development, in line with the Flood Risk vulnerability classification set out in the NPPG. This has been summarised in Table 2.3 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential Infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations.	✓	✓	e	e
High Vulnerability – Emergency services, basement dwellings, caravans and mobile homes intended for permanent residential use.	✓	e	×	×
More Vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education.	✓	✓	e	×
Less Vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants.	✓	✓	✓	×
Water Compatible Development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓

Key:
✓ Development is appropriate
× Development should not be permitted
e Exception Test required
Shaded cell represents the classification of this development

Table 2.3 - Flood risk vulnerability and flood zone compatibility.

Table 2.3 above it can be seen that the development falls into a classification that requires the Exception Test to be applied. For the Exception Test to be passed it should be demonstrated that:

A. *the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*

B. *the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

Both parts of the test will have to be passed for development to be allocated or permitted.

Demonstrating that the development provides wider sustainability benefits to the community that outweigh flood risk is outside the scope of this report. Nevertheless, reference is made to the SFRA to establish the key risks associated with flooding and to help demonstrate that this objective can be achieved. The key focus of this FRA is therefore to establish whether the site is likely to pass Part B of the Exception Test.

3 Definition of Flood Hazard

3.1 Site Specific Information

Information from a wide range of sources has been referenced to appraise the true risk of flooding at this location. This section summarises the additional information collected as part of this FRA.

Site specific flood level data provided by the EA – The EA has been contacted to request modelled flood level information and a copy of their response is included in Appendix A.2 of this report. The EA has also provided the model results of the River Pinn Modelling and Mapping Study carried out in 2016 (by others), which have been referenced as part of this appraisal.

Information contained within the SFRA – The West London SFRA (2018) contains detailed mapping showing historic flood records for a wide range of sources. This document has been referenced as part of this site-specific FRA.

Information on localised flooding contained within the SWMP – A Surface Water Management Plan (SWMP) is a study to understand the risk of flooding that arises from local surface water flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater, and ordinary watercourses. Such a document has been prepared for London Borough of Hillingdon (2014) and has therefore been referenced as part of this site-specific FRA.

Information provided by Thames Water –Thames Water has provided the results of an asset location search for the site. The response is included in Appendix A.3.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From the survey, it can be seen that the level of the site varies between 44.10m and 45.34m Above Ordnance Datum Newlyn (AODN).

Geology – Reference to the British Geological Survey (BGS) map shows that the underlying solid geology in the location of the subject site is Lambeth Group (clay, silt and sand). There are no overlying superficial deposits.

Historic flooding – The EA 'Recorded Flood Outlines' GIS layer indicates that the site is located within the extent of a flood event that took place in 1977.

3.2 Potential Sources of Flooding

The main sources of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this development are discussed below. Table 3.1 at the end of this section summarises the risks associated with each of the sources of flooding.

Flooding from Rivers,* Ordinary or Man-Made Watercourses *(Fluvial) – The site lies within Flood Zone 3 of the River Pinn (main river) as shown on the EA's 'Flood Map for Planning' (Figure 2.3). These maps are used as a consultation tool by planners to highlight areas where more detailed investigation into the risk of flooding is required. Consequently, the risk of flooding from this source has been examined in more detail in Section 5 of this FRA.

Flooding from the Sea – The site is located a significant distance inland and is elevated well above predicted extreme tide levels. Consequently, the risk of flooding from this source is considered to be *low*.

Flooding from Surface Water – Surface Water, or overland, flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This mechanism of flooding can occur almost anywhere but is likely to be of particular concern in any topographical low spot, or where the pathway for runoff is restricted by terrain or man-made obstructions.

The EA's 'Flood Risk from Surface Water' map (Figure 3.1) shows the development site is located in an area classified as having a 'very low' to 'high' risk of surface water flooding.

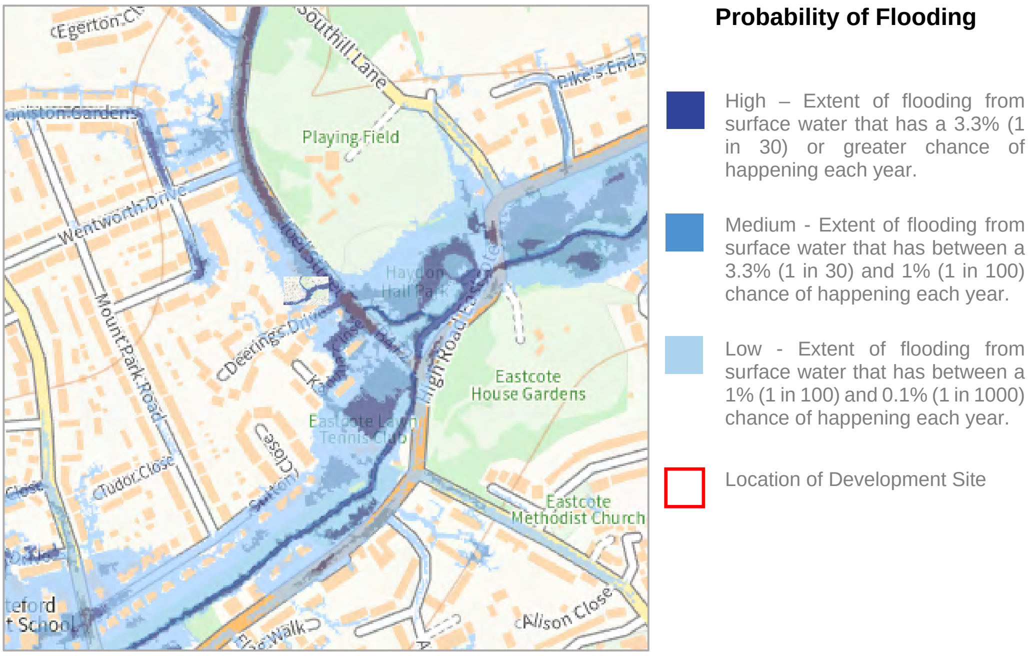


Figure 3.1 – EA's 'Flood Risk from Surface Water' map (© Environment Agency).

However, the EA mapping does not consider the influence of the adjacent River Pinn, which would act to drain surface water away from the site. Therefore, the EA mapping is considered to be an overestimate of the risk of flooding from surface water.

If the watercourse was full to capacity following an extreme rainfall event, the lower lying areas surrounding the watercourse could be subject to flooding, however, this would be attributed to flooding from fluvial sources. The risk of flooding from fluvial sources is therefore discussed above and is assessed further in Section 5.

Overall, given that there are no known records of surface water flooding on site within the SFRA and there are no topographical low points within the site boundary, it is concluded that the risk from surface water flooding is *low*.

Flooding from Groundwater – Water levels below the ground rise during wet winter months and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year).

Groundwater flooding is most likely to occur in low-lying areas that are underlain by permeable rock (aquifers). The underlying geology in this area is Lambeth Group (clay, silt, and sand), which is typically impermeable and not usually associated with groundwater flooding. This is supported by BGS groundwater flood risk mapping data which shows that the general area in which the development site lies is identified as being at low risk from groundwater flooding and by mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004) which shows that the site itself is not located within an area where groundwater emergence is predicted.

Furthermore, no groundwater flooding events were recorded during the very wet periods of 2000/01 or 2002/03 and the SFRA also identifies that there are no historic records of groundwater flooding onsite in the past. Consequently, the risk of groundwater flooding is considered to be *low.*

Flooding from Sewers – In urban areas, rainwater is typically drained into surface water sewers or sewers containing both surface and wastewater known as "combined sewers". Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or has inadequate capacity; this will continue until the water drains away.

Inspection of the asset location mapping provided by Thames Water (Figure 3.2) identifies that the sewers in this area are separate foul and surface water. The historic records set out in the London Borough of Hillingdon SWMP identify that the site falls within a large region which has experienced greater than 5 incidents of flooding from sewers prior to 2010. However, the sewer flooding data used in the SWMP (provided by Thames Water) is relatively coarse and is limited to postcode data. Consequently, the area shown by the SFRA to have been affected by sewer flooding in the past is comparatively large, when in reality these recorded flood events are likely to be smaller isolated incidents. This is supported by the fact that there are no known records of the site being affected by sewer flooding within the SFRA.

Furthermore, the topography of the land within the site and the surrounding area suggests that any above ground flooding that might occur as a result of a surcharged sewer would not pond at the site but would rather flow southeast along Joel Street. The risk of flooding from this source is therefore considered to be *low*.

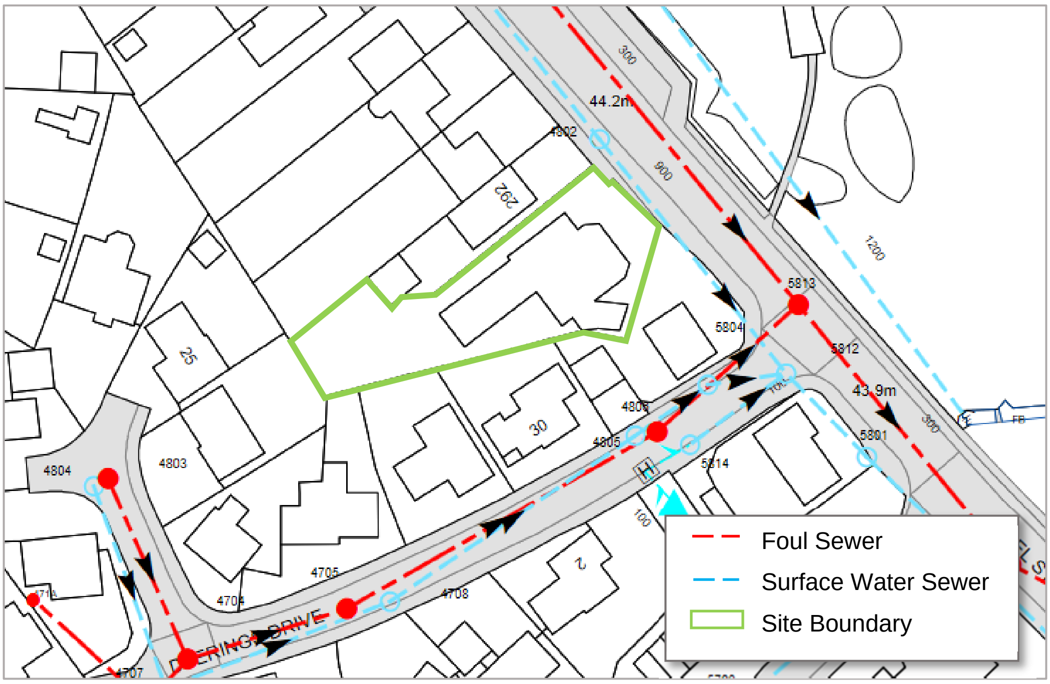


Figure 3.2 - Asset location mapping provided by Thames Water (a full-scale copy can be found in Appendix A.3).

***Flooding from Reservoirs, Canals, and Other Artificial Sources* –** Non-natural or artificial sources of flooding can include reservoirs, canals, and lakes, where water is retained above natural ground level. In addition, operational and redundant industrial processes including mining, quarrying, sand, and gravel extraction, may also increase the depth of floodwater in areas adjacent to these features.

The potential effects of flood risk management infrastructure and other structures also needs to be considered. For example, reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the Ordnance Survey mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. However, the EA's 'Flood Risk from Reservoirs' map (Figure 3.3) shows that the site is located within an area considered to be at risk of flooding from the failure of the King George Reservoir when there is also flooding from rivers, which is located approximately 27km from the site.

When considering the risk of flooding from this source it is necessary to consider the fact that these reservoirs are located a significant distance from the site and are owned and operated by the relevant water companies, who have a duty under the Reservoirs Act to ensure that they are maintained in a good working order and are inspected regularly. Consequently, due to the high standard of protection the risk of flooding from these man-made water bodies is considered to be *low*.

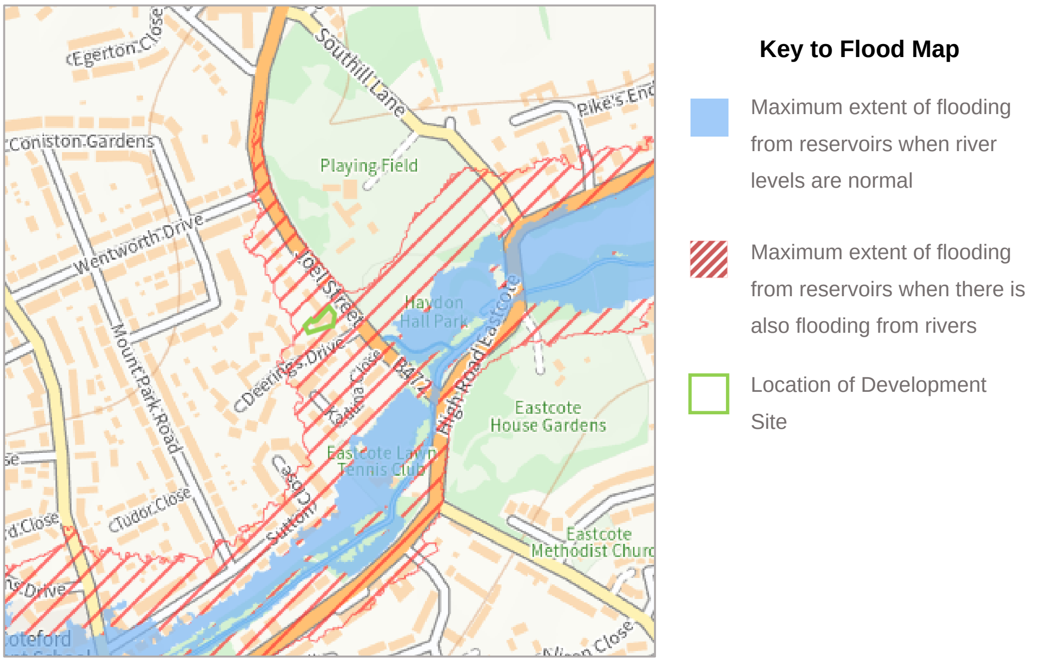


Figure 3.3 – EA's 'Risk of Flooding from Reservoirs' map (© Environment Agency).

A summary of the overall risk of flooding from each source is provided in Table 3.1 below.

Source of Flooding	Initial Level of Risk	Appraisal method applied at the initial flood risk assessment stage
Rivers, Ordinary or Man-Made watercourses	Appraised further in Section 5	OS mapping, aerial height data and the EA's 'Flood Map for Planning'
Sea	Low	OS mapping and aerial height data
Surface Water	Low	EA's 'Flood Risk from Surface Water' map, and historic records contained within the London Borough of Hillingdon SWMP, aerial height data, OS mapping and site-specific topographic survey
Groundwater	Low	BGS groundwater flood hazard maps, Defra Groundwater Flood Scoping Study, aerial height data, OS mapping, and site-specific topographic survey
Sewers	Low	Aerial height data, OS mapping, site-specific topographic survey, asset location data provided by Thames Water and historic sewer records contained within the SWMP
Artificial Sources	Low	OS mapping and EA's 'Flood Risk from Reservoirs' map

Table 3.1 – Summary of flood sources and risks.

3.3 Existing Flood Risk Management Measures

The EA's 'Spatial Flood Defence' GIS layer indicates that the site benefits from an area of high ground alongside the river Pinn, which acts as a flood defence for the property.

4 Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present, and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall, and more frequent periods of long-duration rainfall could be expected.

These effects will tend to increase the size of Flood Zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high-water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

4.1 Planning Horizon

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development, such as the proposed development, should be considered for a minimum of 100 years.

4.2 Potential Changes in Climate

Peak River Flow

Recognising that the impact of climate change will vary across the UK, the allowances show the anticipated changes to peak flow by management catchment. Management catchments are sub-catchments of river basin districts. The proposed development site is covered by the **Thames River Basin District**, as defined by the EA 'River Basin District' maps, and is located in the **London Management Catchment**, as defined on the EA's 'Peak River Flow' map.

For each Management Catchment, a range of climate change allowances are provided for three different time epochs. For each epoch there are three climate change allowances defined. These represent different levels of statistical confidence in the possible emissions scenarios on which they are calculated. The three levels of allowance are as follows:

- Central: based on the 50th percentile
- Higher Central: based on the 70th percentile
- Upper End: based on the 95th percentile

The EA has provided guidance regarding the application of the climate change allowances and how they should be applied in the planning process. The range of allowance for the Management Catchment in which the development site is located are shown in Table 4.1 below.

Management Catchment Name (River Basin District)	Allowance Category	2020s	2050s	2080s
London (Thames)	Upper End	26%	30%	54%
	Higher Central	14%	14%	27%
	Central	10%	7%	**17%**

Table 4.1 – Recommended peak river flow allowances for each epoch for the London Management Catchment (1981 to 2000 baseline).

For 'more vulnerable' development with a design life of 100 years in Flood Zone 3a, a **Central** climate change allowance is recommended. From Table 4.1 above, it can be seen that the recommended climate change allowance for this site is a **17%** increase for all peak river flows.

Peak Rainfall Intensity

Recognising that the impact of climate change will vary across the UK, the allowances were updated in May 2022 to show the anticipated changes to peak rainfall across a series of management catchments. The proposed development site is located in the **London Management Catchment**, as defined by the 'Peak Rainfall Allowance' maps, hosted by the Department for Environment, Food and Rural Affairs. Guidance provided by the EA states that this mapping should be used in small catchments (less than 5km^2), or urbanised drainage catchments. For large rural catchments, the peak river flow allowances should be used.

The development site lies within an urbanised drainage catchment and therefore, the Peak Rainfall Allowances for the London Management Catchment should be applied.

For each Management Catchment, a range of climate change allowances are provided for two time epochs and for each epoch, there are two climate change allowances defined. These represent different levels of statistical confidence in the possible scenarios on which they are calculated. The two levels are as follows:

- Central: based on the 50th percentile
- Upper End: based on the 90th percentile

The EA has provided guidance regarding the application of the climate change allowances and how they should be applied in the planning process. The range of allowances for the Management Catchment in which the development site is located are shown in Table 4.2 below.

Management Catchment Name	Annual exceedance probability	Allowance Category	2050s	2070s
London	3.3 %	Central	20%	20%
		Upper End	35%	35%
	1 %	Central	20%	25%
		Upper End	40%	40%

Table 4.2 – Recommended peak rainfall intensity allowances for each epoch for the London Management Catchment.

For a development with a design life of 100 years the Upper End climate change allowance is recommended to assesses whether:

- there is no increase in flood risk elsewhere, and;
- the development will be safe from surface water flooding.

From Table 4.2 above, it can be seen that the recommended climate change allowance for this site is a 40% increase in peak rainfall. Therefore, this increase has been applied to the hydraulic drainage model constructed to inform the surface water management strategy. Where this allowance has been applied the abbreviation "+40%cc" has been used.

All of the above recommended allowances for climate change should be used as a guideline and can be superseded if local evidence supports the use of other data or allowances. Additionally, in the instance where flood mitigation measures are not considered necessary at present but will be required in the future to account for changes in the climate, a "managed adaptive approach" can be adopted. This approach allows appropriate mitigation measures to be incorporated into the development in the future to combat the impacts of climate change.

5 Probability and Consequence of Flooding

5.1 The Likelihood of Flooding

When appraising the risk of flooding to new development it is necessary to assess the impact of the 'design flood event'. Flood conditions can be predicted for a range of return periods, and these are expressed in either years or as a probability, i.e., the probability that the event will occur in any given year, or Annual Exceedance Probability (AEP). The design flood event is taken as the 1 in 100 year (1% AEP) event for fluvial flooding, including an appropriate allowance for climate change (refer to Section 4.2).

The EA has previously provided the modelling outputs from the River Pinn Modelling Study (2015) which has been referenced as part of this appraisal. A summary of the maximum predicted flood level at the site for the key return period events is provided in Table 5.1 below.

Return Period in Years (% AEP)	Modelled Flood Levels (m AODN)
1 in 30 year (3.3%)	-
1 in 100 year (1%)	44.31
1 in 100 year + 25% allowances for climate change (1% +25CC)	44.41

Table 5.1 – – Modelled flood levels provided by the EA. A value of "- "indicates the site is not subject to flooding during this event.

The 1 in 30 year Flood Event – Functional Floodplain

The functional floodplain is defined by the NPPF as land where water has to flow or be stored in times of flood during events that have a probability of occurrence of 1 in 30 (3.3%) or greater in any one year. From Table 5.1 it is evident that the development is not located within the functional floodplain.

The Design Flood Event

When appraising the risk of flooding to new development it is necessary to assess the impact of the 'design flood event'. The design flood event is taken as the 1 in 100 year (1% AEP) event for fluvial flooding, including an appropriate allowance for climate change (refer to Section 4.2).

Section 4.2 has identified that for a more vulnerable development situated within Flood Zone 3, a 17% increase in peak river flow has to be applied to the 1 in 100 year flood event to account for climate change throughout the lifetime of the development (i.e. design flood event). As the guidance on climate change allowances has recently been updated, this scenario has not been modelled as part of the River Pinn Modelling Study. In absence of an event with the recommended allowance, a conservative approach has been adopted, by applying the 1 in 100 year return period event including a 25% allowance for climate change (i.e. the closest available modelled climate change scenario to the recommended allowance) as the design flood event.

This scenario has been modelled by the EA and reference to Table 5.1 above shows that the design flood level for the development site is **44.41m AODN**. When this level is compared to the topographic survey it can be seen that the maximum predicted depth of flooding on the site is 0.31m AODN, which is at the lowest point on the site at the front of the property (Figure 5.1).

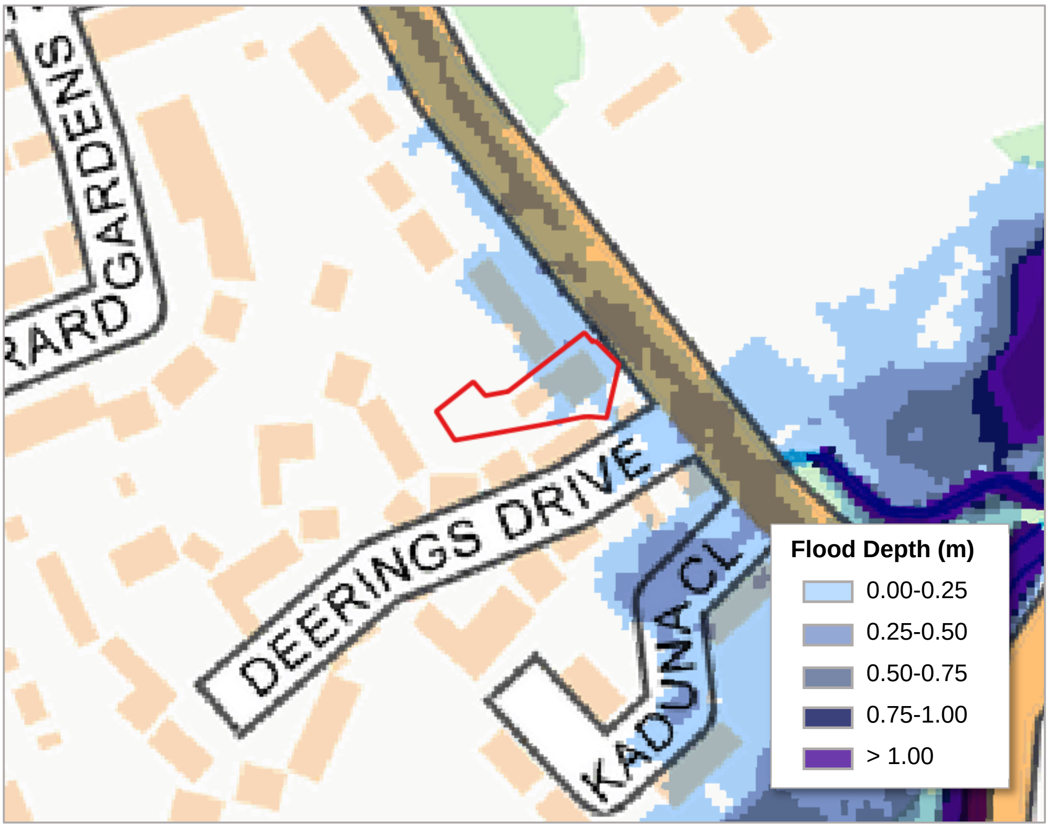


Figure 5.1 – Maximum predicted extent and depth of flooding during the design flood event. (© Environment Agency - contains Ordnance Survey data © Crown copyright and database right 2022).

5.2 Time to Inundation

Inspection of the model files identifies that it takes 2 hours for floodwater to reach the site from the point at which floodwater first exits the channel near to the site. It takes a further 30 minutes before the maximum flood level on site is reached.

6 Offsite Impacts and Other Considerations

6.1 Displacement of Floodwater

The construction of a new building within the floodplain has the potential to displace water and to increase the risk elsewhere by raising flood levels. A compensatory flood storage scheme can be used to mitigate this impact, ensuring the volume of water displaced is minimised.

The proposals comprise the demolition of the existing building onsite and the construction of a larger building which increases the built footprint onsite by 55m2. The proposals also include the construction of a raised ramp access on the northwest boundary of the building.

Due to the confined nature of the site, it is not possible to provide compensatory storage onsite outside the extent of flooding. It should also be acknowledged that lowering land levels to the rear of the site to accommodate any compensatory storage would result in the drainage system requiring the use of a pump to discharge surface water captured in the rear (southwest) of the site to the public sewer network.

As compensatory storage is not possible, it is proposed that the new building will be elevated above ground level with a floodable void beneath the structure to provide storage for floodwater. The voids will be designed in accordance with the EA typical requirements as follows:

- The ground floor of the building will be elevated 600mm above the design flood level (refer to Section 7.1) and the underside of the void will be located at least 300mm above the design flood level;
- Openings in the side of the void should be at least 1m wide;
- There should be at least one opening in every 5 metre length of wall;
- Vertical steel bars should be fitted at 0.1m spacing to precent unsafe access and the void being used for storage;
- A maintenance plan should be produced, including information on how the voids can be cleared following a flood event.

The proposed ramp access to the building will also be designed to be an open structure allowing for the flow and storage of water beneath the ramp.

With these measures included it is considered that the proposed development will provide a significant betterment when compared to the existing situation whereby the entire building footprint is situated at ground level and would displace floodwater during an extreme event.

6.2 Public Safety and Access

The NPPF states that safe access and escape should be available to/from new developments located within areas at risk of flooding. The Practice Guide goes on to state that access routes should enable occupants to safely access and exit their dwellings during design flood conditions and that vehicular access should be available to allow the emergency services to safely reach the development.

It has been identified that part of the site and the access road (Joel Street) could be subject to flooding under the design event. Inspection of the hazard mapping outputs provided by the EA show that the site is located in an area classified as having a 'low' hazard rating and therefore residents would be able to move about the site (Figure 6.1). However, Joel Street is classified as having a 'low' to 'significant' hazard rating and therefore safe access to the wider area may not be available at the peak of the design event.

It is therefore recommended that residents sign up to the EA's Flood Warning Service to ensure they are aware of conditions which could result in flooding onsite and in the surrounding area (refer to section 7.2). Residents will have safe refuge above the flood level within the building for the duration of the design flood event.

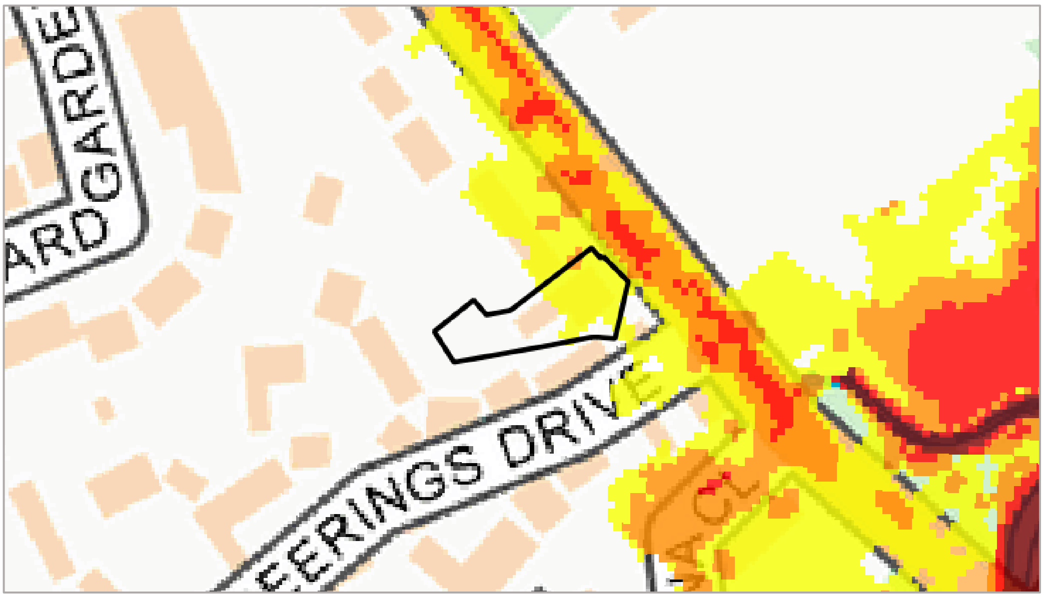


Figure 6.1 - Flood Hazard Rating mapping extracted from the River Pinn Modelling Study. Site boundary shown in black. Refer to Table 6.1 for the key.

Hazard Rating (HR)	Degree of Flood Hazard	Description
< 0.75	Low	Caution – shallow flowing water or deep standing water
0.75 to 1.25	Moderate	Dangerous for some, i.e., children – deep or fast flowing water
1.25 to 2.0	Significant	Dangerous for most people – deep fast flowing water
> 2.0	Extreme	Dangerous for all – extreme danger with deep and fast flowing water

Table 6.1 – Classification of Hazard Rating Thresholds.

6.3 Proximity to Watercourse

Under the Water Resources Act 1991 and Land Drainage Byelaws, any proposals for development in close proximity to a 'main river' would need to consider the EA's requirement for an 8m buffer zone between the riverbank and any permanent construction such as buildings or car parking etc.

The development site is located more than 8m from the River Pinn, therefore will not compromise any of the EA's maintenance or access requirements.

7 Flood Mitigation Measures

The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded.
- to ensure continued operation and safety during flood events.
- to ensure that the flood risk downstream of the site is not increased by increased runoff.
- to ensure that the development does not have an adverse impact on flood risk elsewhere.

The following section of this report examines ways in which the risk of flooding at the development site can be mitigated.

Mitigation Measure	Appropriate	Comment
Careful location of development within site boundaries (i.e., Sequential Approach)	x	There is limited opportunity to apply this approach.
Land raising	x	It is not considered necessary to include these measures in this instance.
Alterations/ improvements to channels and hydraulic structures	x	
Flood defences	x	
Compensatory floodplain storage	x	Not required - Refer to section 6.1
Raising floor levels	✓	Refer to section 7.1
Flood resistance & resilience	✓	Refer to Section 7.2
Flood warning	✓	Refer to Section 7.3
Surface water management	✓	Refer to Section 8

Table 7.1 – Appropriateness of mitigation measures.

7.1 Raising Floor Levels

The EA recommends that the minimum floor level of buildings at risk of flooding should be 300mm above the design flood level, which is the 1 in 100-year extreme water level plus the appropriate allowance for climate change. The EA's guidance also requires that all sleeping accommodation be raised a minimum of 600mm above the design flood level.

The design flood level for this development is 44.41m AODN and therefore based on the above guidance, the minimum floor levels are as follows:

Living Accommodation = 44.71m AODN

Sleeping Accommodation = 45.01m AODN

The applicant has confirmed, and the scheme drawings show, that the ground floor of the building will be elevated 600mm above the design flood level at a level of 45.01m AODN. Consequently, the development meets the EAs requirements for finished floor levels.

7.2 Flood Resistance and Resilience

During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood Resistance or 'dry proofing', where flood water is prevented from entering the building. For example, using flood barriers across doorways and airbricks, or raising floor levels. These measures are considered appropriate for 'more vulnerable' development where recovery from internal flooding is not considered to be practical.

Flood Resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood.

Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

Whilst the ground floor of the proposed development is elevated above the design flood level, it is recommended that the ground floor of the dwelling and the under-croft voids be designed using flood resilient construction techniques to reduce the impact of floodwater on the structure.

Details of flood resilience and flood resistance construction techniques can be found in the document '*Improving the Flood Performance of New Buildings; Flood Resilient Construction'*, which can be downloaded from www.gov.uk.

A Code of Practice (CoP) for Property Flood Resilience (PFR) has been put in place to provide a standardised approach for the delivery and management of PFR. Further information on the CoP and guidance on how to make a property more flood resilient can be accessed, and downloaded, from the Construction Industry Research and Information Association (CIRIA) Website:

https://www.ciria.org/Resources/Free_publications/CoP_for_PFR_resource.aspx

7.3 Flood Warning

The EA operate 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.

It has been demonstrated that the ground floor of the building will be elevated above the design flood level and therefore internal flooding is not predicted. Notwithstanding this, as part of the site is subject to flooding and safe access may not be available via Joel Street at the peak of an extreme rainfall event it is recommended that the residents of the site sign up to the EA's Flood Warning Service either by calling 0345 988 1188, or by visiting.

www.gov.uk/sign-up-for-flood-warnings

8 Surface Water Management Strategy

8.1 Background and Policy

The general requirement for all new development is to ensure that the runoff from the development is managed sustainably and that the drainage solution does not increase the risk of flooding at the site, or within the surrounding area. In the case of brownfield sites, drainage proposals are typically measured against the existing performance of the site, although it is preferable (where practicable) to provide runoff characteristics that are similar to greenfield behaviour.

The Non-statutory Technical Standards for SuDS (NTSS) specify criteria to ensure sustainable drainage is included within development classified as 'major development' as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2015. It is, however, recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is for the construction of 13 no. residential units and the proposals are classified as 'major' development. Therefore, the NTSS will apply. Reference to the NTSS has therefore been made throughout the following sections of this report to ensure the principles of sustainable drainage are considered.

Policy SI 13 of the London Plan states developments should incorporate SuDS wherever possible within schemes unless there is a practicable reason for not doing so.

Policy SI 13 of the London Plan also states that developers should also follow the drainage hierarchy by prioritising the discharge of surface water runoff as close to source as possible. The London Plan Drainage Hierarchy is outlined below:

1. Rainwater use as a resource (for example: rainwater harvesting, blue roofs for irrigation).
2. Rainwater infiltration to ground at or close to source.
3. Rainwater attenuation in green infrastructure features for gradual release (for example: green roofs, rain gardens).
4. Rainwater discharge direct to a watercourse (unless not appropriate).
5. Controlled rainwater discharge to a surface water sewer or drain.
6. Controlled rainwater discharge to a combined sewer.

The proposed development must therefore attempt, where possible, to incorporate SuDS features in accordance with the requirements of the London Plan and any other adopted local planning policies pertaining to drainage. Consequently, the potential options for incorporating SuDS and their viability within the proposed scheme are discussed further in the following sections of this report.

8.2 Surface Water Management Overview

The main characteristics of the site that have the potential to influence surface water drainage are summarised in Table 8.1 below.

Site Characteristic	Value
Total area of site	~ 0.074 ha
Impermeable area (existing)	**420 m^2**
Impermeable area (proposed)	Roof Area = 310 m^2 Hardstanding = 330 m^2 **Total = 640 m^2**
Current site condition	Brownfield Site
Infiltration coefficient	0.001-1.0 m/hr (assumed based on underlying geology and typical soil conditions)
Current surface water discharge method	Assumed to drain to private sewer network with onward connectivity to public sewer system.
Is there a watercourse within close proximity to site?	Yes (River Pinn)

Table 8.1 – Site characteristics affecting rainfall runoff.

Reference to the tables above show the proposed development will increase the percentage of impermeable area within the boundaries of the site. Consequently, this will increase the rate and volume of surface water runoff discharged from the site. It will therefore be necessary to provide mitigation measures to ensure the rate of runoff discharged from the site is not increased as a result of the proposed development.

Furthermore, the potential use of SuDS within the proposed development will be considered to assess the practicality of better replicating greenfield behaviour, in accordance with Local Planning Policy, and S3 and S5 of the NTSS.

8.3 Existing Drainage

The existing site drainage has not been surveyed and it is currently unknown how the existing buildings at the site currently drain. However, it is considered likely that the runoff from the roof of the existing building, as well as the adjacent parking and hardstanding, is drained to a network of private drainage pipes located beneath the building. This drainage system is assumed to drain into the large surface water sewer (public sewer) underneath the adjacent road, as seen in Figure 3.2 (above).

Runoff rates for the existing site have been calculated for a range of annual return probabilities including the 100 year return period event. These values are summarised in Table 8.2 alongside greenfield runoff rates for the site calculated using the FEH Statistical methodology.

Return Period (years)	Peak Runoff		
	Brownfield Runoff Rate (l/s)	Greenfield Runoff Rate (l/s/ha)	Greenfield Runoff Rate (l/s)
2	9.1	4.7	0.3
Qbar	NA	5.3	0.3
10	19.6	8.6	0.6
30	26.3	12.8	0.8
100	**34.5**	17.0	1.1

Table 8.2 – Summary of peak runoff rates.

Further investigation may be required as part of the detailed design to confirm the exact layout of the existing underground drainage network and the potential to utilise any pre-existing connections to the public sewer system.

8.4 Opportunities to Discharge Surface Water Runoff

Part H of the Building Regulations summarises a hierarchy of options for discharging surface water runoff from developments. The preferred option is to **infiltrate** water into the ground, as this deals with the water at source and serves to replenish groundwater. If this option is not viable, the next option of preference is for the runoff to be discharged into a **watercourse**. Only if neither of these options are possible, the water should be discharged into the **public sewer** system.

The following opportunities for managing the surface water runoff discharged from the development site are listed in order of preference:

Water Re-Use - Water re-use systems can rarely manage 100% of the surface water runoff discharged from a development, as this requires the yield from the building and hardstanding area to balance perfectly with the demand from the proposed development. Consequently, whilst rainwater recycling systems could be considered for inclusion within the scheme, an alternative solution for attenuating storm water would still be required.

Infiltration – Whilst infiltration rates into the underlying Lambeth group sands silt and clay can potentially be sufficient to support the use of infiltration SuDS, there is insufficient space onsite to provide the required 5m easement between infiltration SuDS and neighbouring buildings. Furthermore, given the close proximity to the river Pinn, it is considered likely that groundwater levels will be elevated, which could restrict the viability of using infiltration SuDS at this location. On this basis, the use of infiltration SuDS is not considered a suitable solution for managing surface water runoff discharged from the proposed development and an alternative solution is therefore required.

Discharge to Watercourses – The site is located in close proximity to the River Pinn which lies to the east of the adjacent road. Whilst the river is fairly close to the site, there are no known existing drainage connections between the site and this watercourse. Furthermore, for part of its course the watercourse is culverted and access can only be obtained by crossing third party land. In conclusion, it is therefore considered unlikely that a new connection to this watercourse would be feasible.

Surveys of the existing drainage network at the site and surrounding area should be undertaken at the detailed design stage to confirm that there are no existing connections which could be reused. Notwithstanding this, at this stage in the development design process it is assumed that a new direct connection to the River Pinn will not be possible.

Discharge to Public Sewer System – As an alternative preferred solution is not available, it is assumed that the existing connection to the large public surface water sewer beneath Joel Street will present the most viable solution for managing the surface water runoff discharged from the development.

8.5 Constraints and Further Considerations

The key constraints that are relevant to this development are listed below:

- There is limited open space to incorporate SuDS that require significant areas of land such as wetland areas.

- If additional surface water runoff is to be discharged into the public sewer system, or if a new connection is required, it will be necessary to gain consent for this connection from the sewerage undertaker (Thames Water).

- Ideally post development runoff rates should be restricted to greenfield runoff rates. However, on small sites where discharge rates are exceptionally low (less than 2.0l/s) higher rates are generally considered acceptable, due to the technical limitations of flow control devices. In this case a limiting discharge rate of 2.0l/s is likely to be acceptable by the LPA, LLFA, and Thames Water.

- The depth of the public surface water sewer network in this area appears to be very shallow and as a result, the proposed drainage will need to be kept as shallow as possible to avoid the need to use pumps, as gravity drainage is typically preferred by LLFA's and LPA, where possible.

- During high return period events the site has been shown to flood (Section 5.1), and therefore, it will be necessary to ensure the proposed drainage system has additional storage capacity to mitigate some (or all) of the impacts this flooding may have on the performance of the drainage system.

8.6 Proposed Surface Water Management Strategy (SWMS)

The drainage strategy set out below discusses each of the different elements of the proposed scheme, along with the results of a hydraulic drainage model that has been constructed to demonstrate how the overall objectives can be achieved. This does not represent a detailed surface water drainage design; it is simply an assessment to demonstrate that the objectives and requirements of the NPPF and NTSS can be met at the planning stage.

Water Butts

To reduce the developments reliance on potable water supplies for external use there is the potential to incorporate water butts within the communal garden area. Typical sizes and dimensions of water butts are outlined in Table 8.3 below.

Typical house water butt options	Dimensions of a typical house water butt	Volume of storage provided (litres)
Type 1 (wall mounted – small)	1.22m high x 0.46m x 0.23m	100
Type 2 (standard house water butt)	0.9m high x 0.68m diameter	210
Type 3 (large house water butt)	1.26m high x 1.24m x 0.8m	510
Type 4 (column tank – very large)	2.23m high x 1.28m diameter	2000

Table 8.3 – Estimated storage capacity of available water butts.

In this case the demand for potable water is likely to be relatively small and as a result, a standard (Type 2 - 210 litre) unit is likely to be the most appropriate size for inclusion within the scheme.

It is recognised that each of the water butts will need to overflow into the main drainage system for the site, to ensure that in the event the water butt is full prior to the onset of the design rainfall event, water can be discharged away from the properties without increasing the risk of flooding.

Green Roof

Rain landing on the roof of the proposed building will be intercepted by a combined blue/green roof located across the flat part of the proposed roof. This feature will allow rainwater to be stored on the roof before draining via downpipes into permeable paving adjacent to the building (discussed further below). Flows from the blue/green roof will be attenuated using a flow control device, specific to the design of the blue/green roof system. For the purposes of the calculations used in this report, this system has been simulated using a vortex flow control device designed to limit discharge rates to no greater than 2.0l/s. A summary of the blue/green roof is shown in Table 8.4 below.

Parameter	Value (1:100yr+40%cc event)
SuDS	Blue/Green roof
Area of roof draining to Blue/Green Roof	220m^2
Area of Blue / Green Roof	220m^2
Sub-base depth	0.200m
Infiltration	0.95
Flow control device	Hydro-Brake
Limiting discharge rate	2l/s
1 in 100yr+cc	~1.5l/s

Table 8.4 – Summary of the proposed blue/green roof calculations.

Permeable Surfacing

Rain landing on the proposed hardstanding will be intercepted by permeable. This permeable surfacing can be laid atop a layer of geo-cellular storage crates, which will provide storage for stormwater beneath the permeable surface. The permeable surfacing will be split into two sperate areas to allow for access and services to pass beside the property. These two systems have been modelled as a single area of permeable surfacing and are assumed to be connected via piped underdrains. Flows out of the permeable surfacing system can be attenuated using a vortex flow control device (Hydro-Brake or similar). A summary of the Causeway Flow+ analysis for the permeable surfacing system is shown in Table 8.5 below.

Parameter	**Value (1:100yr+40%cc event)**
SuDS	Geo-cellular sub-base
Total area draining directly to permeable surfacing	420 m^2
Peak inflow from blue / green roof	1.5 l/s
Infiltration	Not permitted
Depth of subbase	0.400 m
Area of Geo-cellular sub-base	~329 m^2
Porosity of sub-base	95 %
Flow control device	Vortex flow control device (Hydro-Brake or similar)
Limiting discharge rate	2.0 l/s
Critical storm duration	360 minutes
Overflow device	Pipe *Connects directly to the public combined sewer system*

Table 8.5 – Summary of permeable surfacing system.

8.7 Hydraulic Drainage Model

A Hydraulic Drainage model for the proposed drainage system and SuDS has been constructed in Causeway Flow +, which has been used to confirm that the proposed drainage system will provide sufficient storage and attenuation for runoff draining into the public sewer system. Table 8.6 below provides a summary of the pre- and post-development discharge rates, based on the results of this drainage model.

Return Period (years)	**Existing Runoff Rates l/s**	**Proposed Discharge Rate (including SuDS) l/s**	**Percentage Difference**
2	9.1	0.5	95% (reduction)
10	19.6	1.0	95% (reduction)
30	26.3	1.3	95% (reduction)
100	**34.5**	1.7	95% (reduction)
100 + 40%	N/A	**2.0**	94*% (reduction)

*Table 8.6 – Summary of peak runoff. *compared with the 1:100 pre-existing discharge rate.*

In addition to the design rainfall event, the proposed drainage model has been sensitivity tested to account for the potential surcharging of the sewer system or the outlet (e.g. due to flooding). Whilst the FRA concludes that the flood depths are relatively low, the outlet from the site is shown to surcharge during design flood conditions. The results of the surcharge calculations show that if this event was to occur, it is unlikely that any floodwater would overflow the drainage system (i.e. the drainage system has been sized to account for a 100% blockage event).

8.8 Indicative Drainage Layout Plan

Figure 8.1 below is an indicative drainage layout plan delineating how the proposed SuDS can be incorporated into the scheme proposals.

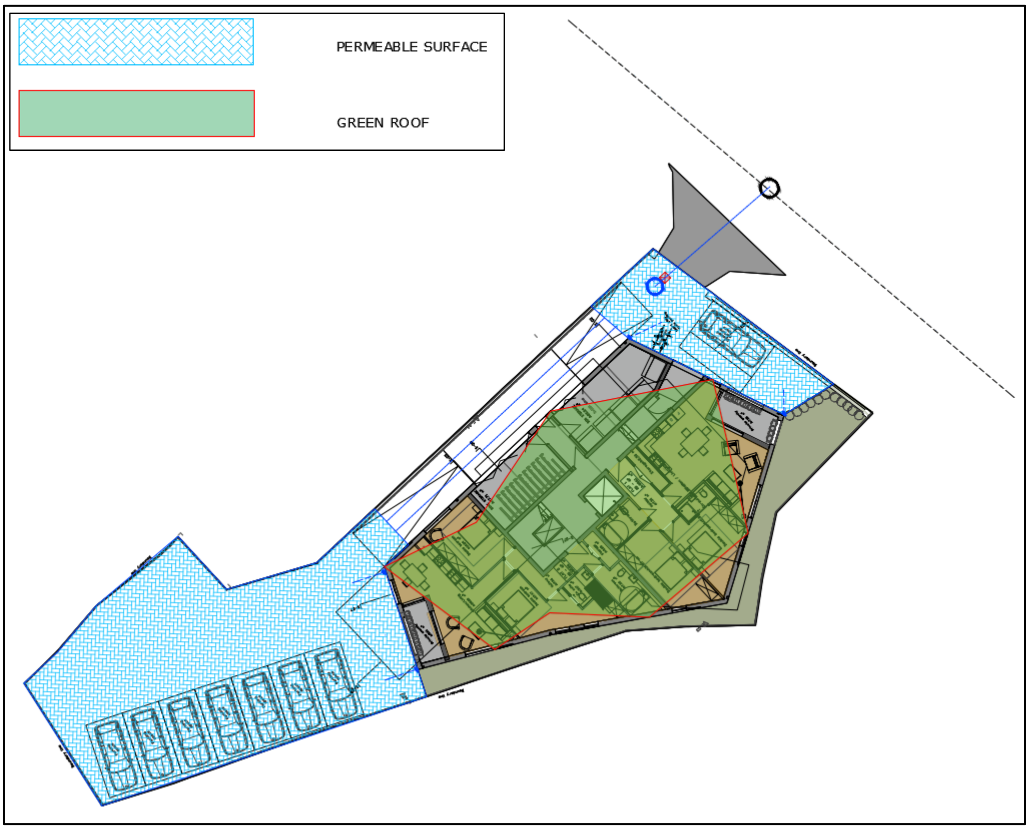


Figure 8.1 - Indicative drainage layout plan showing the proposed location of SuDS.

A full-scale copy of this layout is located in Appendix A.4 of this report.

8.9 Management and Maintenance

For any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime.

The key requirements of any management regime are routine inspection and maintenance. When the development is taken forward to the detailed design stage, an ‘owner’s manual’ will need to be prepared. This should include:

- A description of the drainage scheme.
- A location plan showing all of the SuDS and equipment, such as flow control devices etc.
- Maintenance requirements for each element, including any manufacturer specific requirements.
- An explanation of the consequences of not carrying out the specified maintenance.
- Details of who will be responsible for the ongoing maintenance of the drainage system.

For developments such as this that rely to some extent on the ongoing inspection and maintenance of SuDS, it will be necessary to ensure that measures are in place to maintain the system for the lifetime of the development. One option would be to task the management company responsible for maintaining the rest of the site with the inspection and maintenance of the SuDS elements.

For the SuDS recommended by this assessment, the most obvious maintenance tasks will be cleaning, inspection and monitoring of the blue/green roof and waterproofing system, as well as the removal of litter and debris from the permeable surfacing and underground storage. For the latter, it is important to ensure that the design must recognise the need for this operation and thus incorporate silt traps and easy access for emptying. Typical maintenance schedules for the proposed SuDS have been included in Appendix A.5. Below.

One potential maintenance task that is specific to this site is the need to inspect and potentially replace parts of the permeable surfacing and underlying geo-cellular storage sub-base following a flood event. This may be necessary if silt debris or contaminated materials become washed into the paving system if flooding was to reach the site. The additional costs associated with this activity will need to be incorporated into the detailed maintenance plan for the site / drainage system.

8.10 Sensitivity Testing and Residual Risk

It is necessary to ensure that the drainage proposals will not increase the risk of flooding if the drainage system becomes blocked, or if a rainfall event which exceeds the design rainfall event occurs.

Typically the design of blue/green roofs includes two principal outfalls and include two additional overflows should the primary flow controls become blocked or overwhelmed. It is assumed that this will be the case in this instance, and as a result, should a blockage or failure occur in the blue/green roof drainage system it is likely that water will simply overflow into the downpipes, or run freely off the roof and into the permeable surfacing that surrounds parts of the building.

Inspection of the topography across the site suggests that if the permeable surfacing system was to block, or become overwhelmed following an extreme rainfall event, water would exit the system and would flow overland. The lowest point onsite is most likely the point where water will begin to overflow the permeable surfacing system first. Figure 8.2 delineates the most likely path water would take as it flows across the site in such an event.

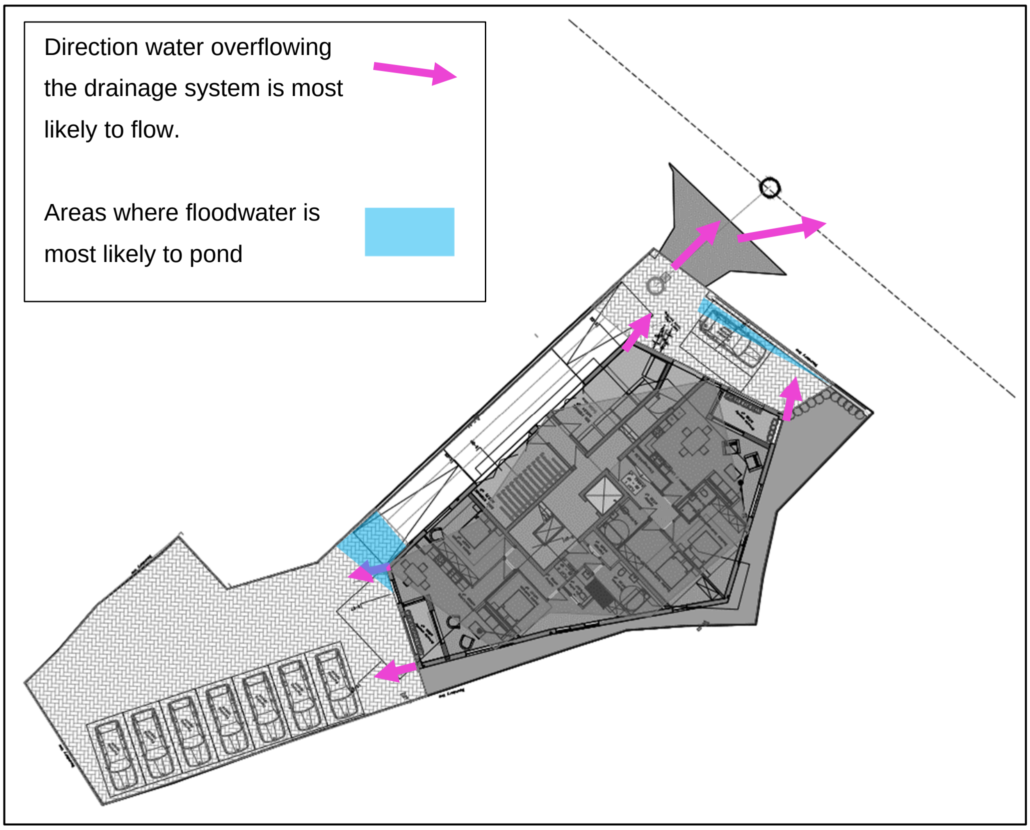


Figure 8.2 – Anticipated flow routes during an exceedance or blockage event.

From Figure 8.2, above it is evident that the majority of water would be discharged safely into the adjacent road, where it will be intercepted by local highway drains, or will drain overland into the neighbouring River Pinn.

In all cases, the inclusion of SuDS onsite should help to reduce the volume of water discharged offsite during a failure of the drainage system. As a result, with the inclusion of the proposed SuDS discussed within this strategy, it is considered that the development will not increase the risk of flooding off-site.

9 Conclusions and Recommendations

The aim of this report is to determine whether the proposed development at Haydon House, 296 Joel Street, Pinner, London**,** is sustainable in terms of flood risk and how mitigation measures can be incorporated into the building to ensure the development is safe for its lifetime. In addition, the NPPF also requires the risk of flooding offsite to be managed, to prevent any increase in flood risk as a result of the development proposals. This report has therefore been prepared to appraise the risk of flooding from all sources and to provide a sustainable solution for managing the surface water runoff discharged from the development site, in accordance with the NPPF and local planning policy.

The site is located in Flood Zones 2 and 3 and therefore, the Sequential Test and Exception Test should be applied. The Sequential Test and Exception Test Part A are outside the scope of the FRA, but evidence within the report can be used to assist the application of the tests. The main aim of the report is to demonstrate whether Part B of the Exception Test can be passed.

The risk of flooding has therefore been considered across a wide range of sources and it has been identified that the site is located in an area at risk of fluvial flooding from the River Pinn. As a result, the following flood risk mitigation measures are recommended:

- **The ground floor of the building should be elevated 600mm above the design flood level, as sleeping accommodation is included at ground floor level.** The applicant has confirmed that the ground floor of the building will be elevated 600mm above the flood level (refer to planning drawings). Therefore, the building is in accordance with the EA's guidance on finished floor levels.

- **A floodable void space should be included below the building and access ramp to allow floodwater to flow beneath the building.** The applicant has confirmed that a void will be included below the ground floor slab. With the inclusion of the void space, the development will provide a significant betterment when compared to the existing building which is located at ground level and could displace floodwater.

- **Flood resistance and resilience measures should be used where possible**. Whilst the ground floor level will be elevated above the flood level, it is recommended that the ground floor be constructed using flood resilient construction techniques to reduce the impact of floodwater on structure.

- **The residents should sign up to receive the EAs Flood Warnings**. The EA's flood warnings will provide forewarning of extreme weather conditions which may result in flooding occurring. Forewarning will enable the residents to evacuate to an area located outside the predicted extent of flooding. If it is not possible to evacuate before floodwater reaches the site, safe refuge will be available within the building, which is located above the design flood level.

In addition, the development proposals will need to incorporate sustainable drainage systems to manage surface water runoff discharged from the proposed buildings. The opportunities for draining the site have been explored and it has been concluded that a connection to the existing surface water sewer network will be the preferred solution for draining the site.

The proposed drainage strategy that has been developed relies upon a combination of permeable surfacing with a geocellular sub-base and a blue/green roof atop the proposed building. These SuDS can be used in conjunction with flow control devices, including a vortex flow control device, to limit the total flow to 2.0l/s on the outlet of the permeable surfacing system (i.e. before runoff is discharged into the existing sewer network).

A hydraulic drainage model has been constructed to simulate the proposed drainage and SuDS and the results of this model confirm that sufficient storage can be provided onsite to minimise the offsite discharge to 2.0l/s. This should result in a significant betterment when compared to the existing situation at the site.

With the above mitigation measures incorporated into the design of the development, the proposals will meet the requirements of the NTSS, NPPF and its Planning Practice Guidance and will therefore be acceptable and sustainable in terms of flood risk.

10 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Environment Agency Flood Report

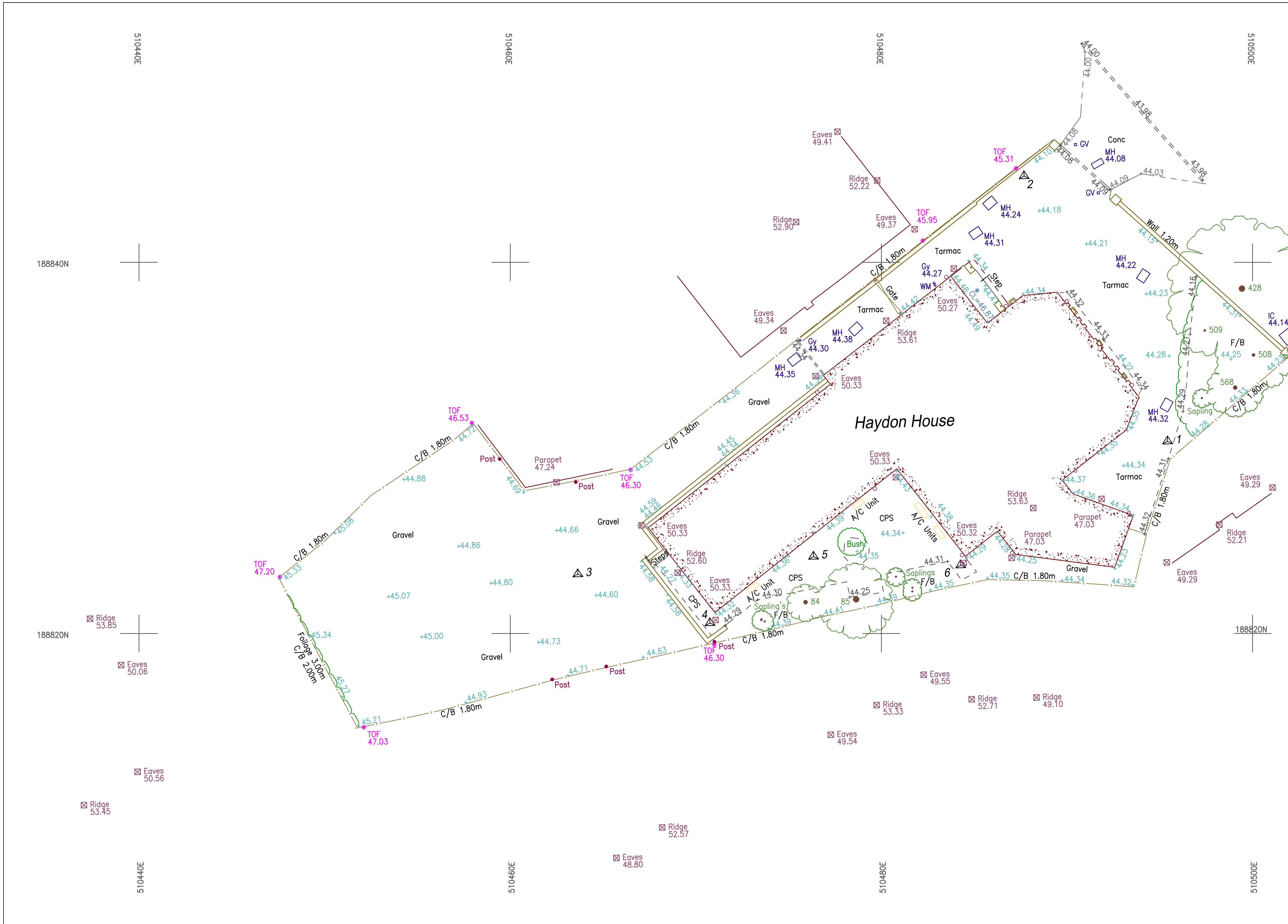
Appendix A.3 – Thames Water Asset Location Data

Appendix A.4 – Indicative Drainage Layout

Appendix A.5 – Maintenance Schedules

Appendix A.6 – Surface Water Management Calculations

Appendix A.1 – Drawings



Survey Legend

FENCES

BARBED WIRE FENCE	B/W	Trees	
CORRUGATED IRON FENCE	C/I		
CLOSE BOARD FENCE	C/B		
CHESTNUT PALING FENCE	C/P	Hedges	Privet 1.2
IRON RAILING FENCE	I/R		
POST AND CHAIN FENCE	P/C		
POST AND RAIL FENCE	P/R	Walls	Wall 2.0m (Width to Scale)
POST AND WIRE FENCE	P/W		
CHAIN LINK FENCE	C/L		
LARCH LAP FENCE	L/L	Fences	C/B 1.8m
INTERWOVEN FENCE	I/W		
WIRE MESH FENCE	W/M		

ABBREVIATIONS

BOLLARD	Bo	MARKER	Mk
BRITISH TELECOM IC	BT	NOTICE BOARD	NB
CONCRETE PAVING SLABS	CPS	PARKING METER	PM
COVER LEVEL	CL	ROAD NAME PLATE	RNP
DROP KERB	DK	ROAD SIGN	RS
ELECTRIC INSPECTION COVER	EC	RODDING EYE	RE
ELECTRICITY POLE	EP	RETAINING WALL	Rtw
FIRE HYDRANT	FH	RAINWATER PIPE	RWP
FLOWER BED	FB	STOP VALVE	SV
FOOTPATH	FP	TELEGRAPH POLE	TP
GAS VALVE	GV	TELEPHONE CALL BOX	TCB
GULLY	Gy	TRAFFIC LIGHT	TL
INSPECTION COVER	IC	UNABLE TO LIFT	UTL
PIPE INVERT LEVEL	IL	UNKNOWN	Unk
KERB OUTLET	KO	VENT PIPE	VP
MAN HOLE	MH	WATER METER	WM
THRESHOLD	TH	DIAMETER	Ø

Tree Schedule

Pt No	Spread	Bole	Height	Feature
84	2.0	0.20	5.0	HOLLY
85	4.0	0.30	4.0	TREEUNK
428	8.0	0.30	8.0	TREEUNK
508	4.0	0.15	4.0	TREEUNK
509	1.0	0.10	4.0	PALM
568	3.0	0.20	3.0	TREEUNK

JOB NO: CM21738 | SCALE: 1:200m @ A3 | DRAWN: BP | DATE: May 2022 | SHEET: 1 of 1

NOTES:

All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction.

NORTH:

indicative

CLIENT:

Westgold Developments

REVISION:

LEVELLING: OS GPS

PROJECT TITLE: Topographical Survey

SITE ADDRESS: Haydon House, 296 Joel Street, HA5 2PY

Cadmap Ltd
Unit 131 Dunsfold Park
Cranleigh
Surrey, GU6 8TB
T: 01483 429385
E: info@cadmap.co.uk
W: www.cadmap.co.uk

PROPOSED SITE PLAN
Scale 1:200

0 2.0 4.0 10.0 20.0

Notes
1. All dimensions to be checked on site.
2. All dimensions are to masonry unless otherwise stated (ie not plaster finishes)
3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
4. Discrepancies or omissions to be brought to the attention of **CIAO** prior to construction.
5. This drawing has been drawn to scale,as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD	**Stage:** Planning	**Date:** 14/12/2022	
Project: Haydon House, 296 Joel Street, HA5 2PY	**Project Ref. No:** 166	**Scale:** 1:200@A3	
Drawing title: Proposed site plan	**Drawing number:** 166-3GA-01	**Drawn By:** LP	**Checked By:** AP

203-213 Mare Street
London, E8 3JS

+ 44 (0)20 34751385
email : info@ciao.archi
www.ciao.archi

CIAO
Creative Ideas & Architecture Office

PROPOSED GROUND FLOOR PLAN
Scale 1:100

PROPOSED FIRST FLOOR PLAN
Scale 1:100

KEY

- 2 bedroom 4 people flat
- 2 bedroom 3 people flat
- 1 bedroom 2 people flat
- 1 person studio flat

0 1.0 2.0 5.0 10.0

Notes

1. All dimensions to be checked on site.
2. All dimensions are to masonry unless otherwise stated (ie not plaster finishes)
3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
4. Discrepancies or omissions to be brought to the attention of **CIAO** prior to construction.
5. This drawing has been drawn to scale, as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD	**Stage:** Planning	**Date:** 14/12/2022
Project: Haydon House, 296 Joel Street, HA5 2PY	**Project Ref. No:** 166	**Scale:** 1:100@A2
Drawing title: Proposed Ground Floor & First Floor plans	**Drawing number:** 166-3GA-02	**Drawn By:** LP / **Checked By:** AP

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London, E8 3JS
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info@ciao.archi
www.ciao.archi

CIAO
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PROPOSED SECOND FLOOR PLAN
Scale 1:100

PROPOSED SECOND FLOOR PLAN
Scale 1:100

KEY

- 2 bedroom 4 people flat
- 2 bedroom 3 people flat
- 1 bedroom 2 people flat
- 1 person studio flat

0 1.0 2.0 5.0 10.0

Notes

1. All dimensions to be checked on site.
2. All dimensions are to masonry unless otherwise stated (ie not plaster finishes)
3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
4. Discrepancies or omissions to be brought to the attention of **CIAO** prior to construction.
5. This drawing has been drawn to scale, as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD
Stage: Planning
Date: 14/12/2022
Project: Haydon House, 296 Joel Street, HA5 2PY
Project Ref. No: 166
Scale: 1:100@A2
Drawing title: Proposed Second & Third Floor plans
Drawing number: 166-3GA-03
Drawn By: LP
Checked By: AP

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London, E8 3JS
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CIAO
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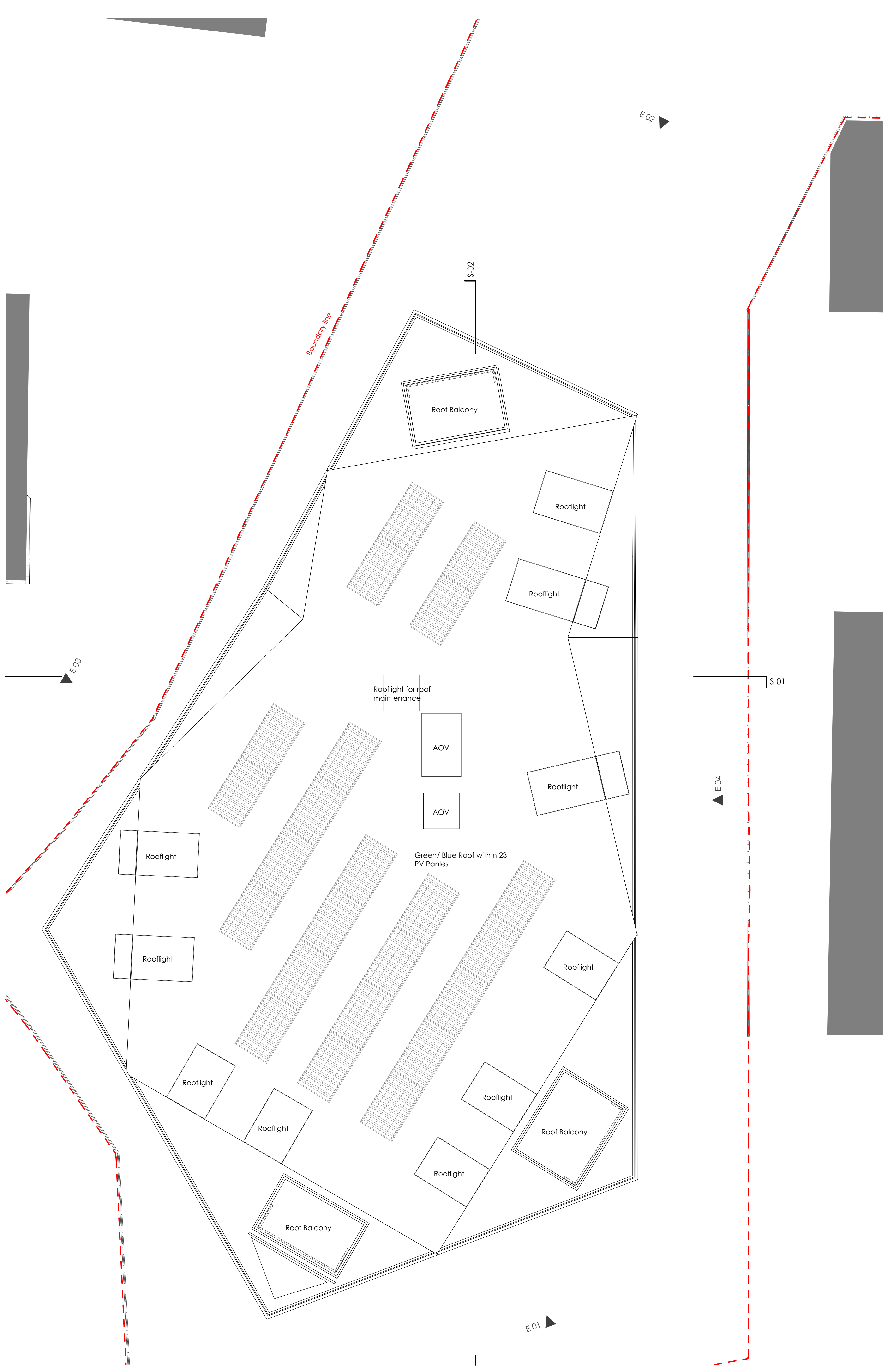

PROPOSED ROOF PLAN
Scale 1:100

0 1.0 2.0 5.0 10.0

Notes

1. All dimensions to be checked on site.
2. All dimensions are to masonry unless otherwise stated (ie not plaster finishes)
3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
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5. This drawing has been drawn to scale, as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD
Stage: Planning
Date: 14/12/2022

Project: Haydon House, 296 Joel Street, HA5 2PY
Project Ref. No: 166
Scale: 1:100@A2

Drawing title: Proposed roof plan
Drawing number: 166-3GA-04
Drawn By: LP
Checked By: AP

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London, E8 3JS

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PROPOSED REAR ELEVATION
Scale 1:100

PROPOSED WEST ELEVATION
Scale 1:100

0 1.0 2.0 5.0 10.0

Notes

1. All dimensions to be checked on site.
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3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
4. Discrepancies or omissions to be brought to the attention of **CIAO** prior to construction.
5. This drawing has been drawn to scale, as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD	**Stage:** Planning	**Date:** 14/12/2022
Project: Haydon House, 296 Joel Street, HA5 2PY	**Project Ref. No:** 166	**Scale:** 1:100@A2
Drawing title: Proposed Elevations	**Drawing number:** 166-3GA-06	**Drawn By:** LP
		Checked By: AP

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+ 44 (0)20 34751385
info@ciao.archi
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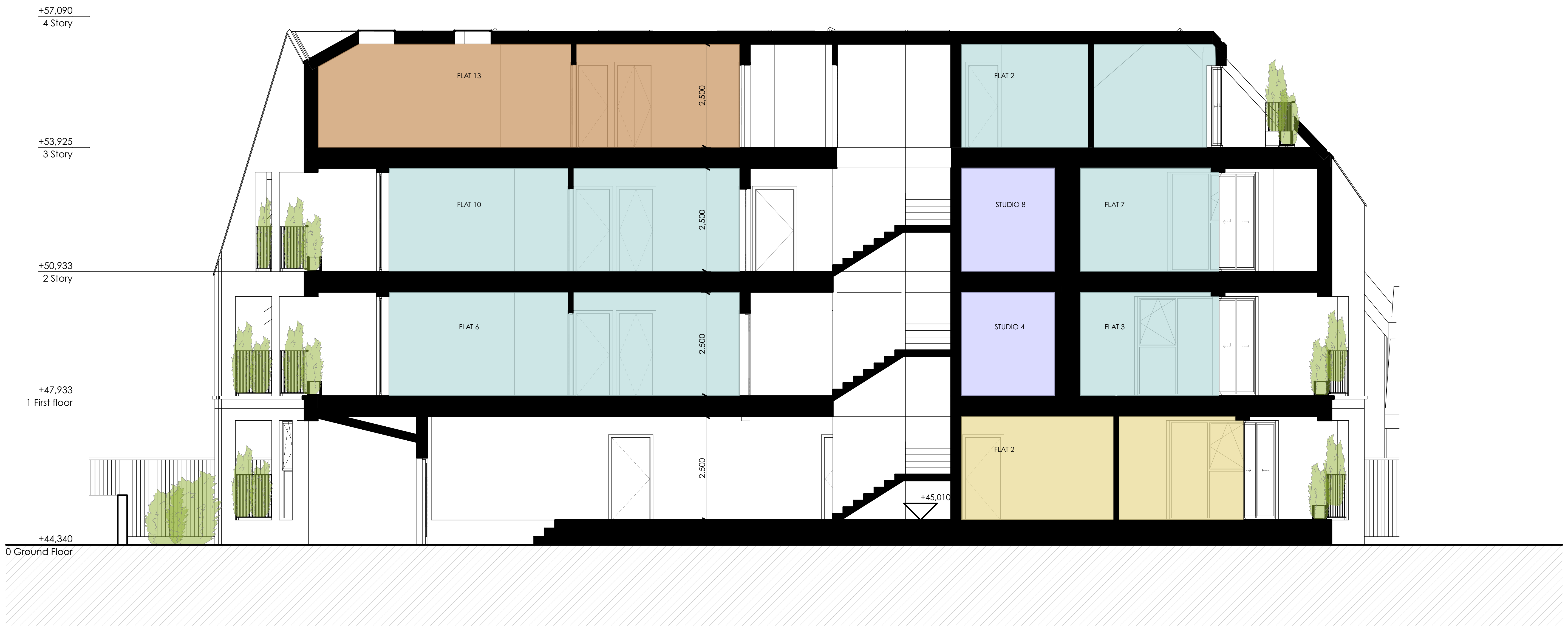
PROPOSED SECTION 01
Scale 1:100



PROPOSED SECTION 02
Scale 1:100

KEY

- 2 bedroom 4 people flat
- 2 bedroom 3 people flat
- 1 bedroom 2 people flat
- 1 person studio flat

0 1.0 2.0 5.0 10.0

Notes

1. All dimensions to be checked on site.
2. All dimensions are to masonry unless otherwise stated (ie not plaster finishes)
3. All information is to be checked and verified by the contractors and sub-contractors for accuracy and fit.
4. Discrepancies or omissions to be brought to the attention of **CIAO** prior to construction.
5. This drawing has been drawn to scale, as shown, for the purpose of obtaining local authority approval
6. For General Notes refer to Drawing No. 4GN-01

Rev	Date	Notes

Client: Westgold Holdings LTD
Project: Haydon House, 296 Joel Street, HA5 2PY
Drawing title: Proposed Sections

Stage: Planning
Date: 14/12/2022
Project Ref. No: 166
Scale: 1:100@A2
Drawing number: 166-3GA-07
Drawn By: LP
Checked By: AP

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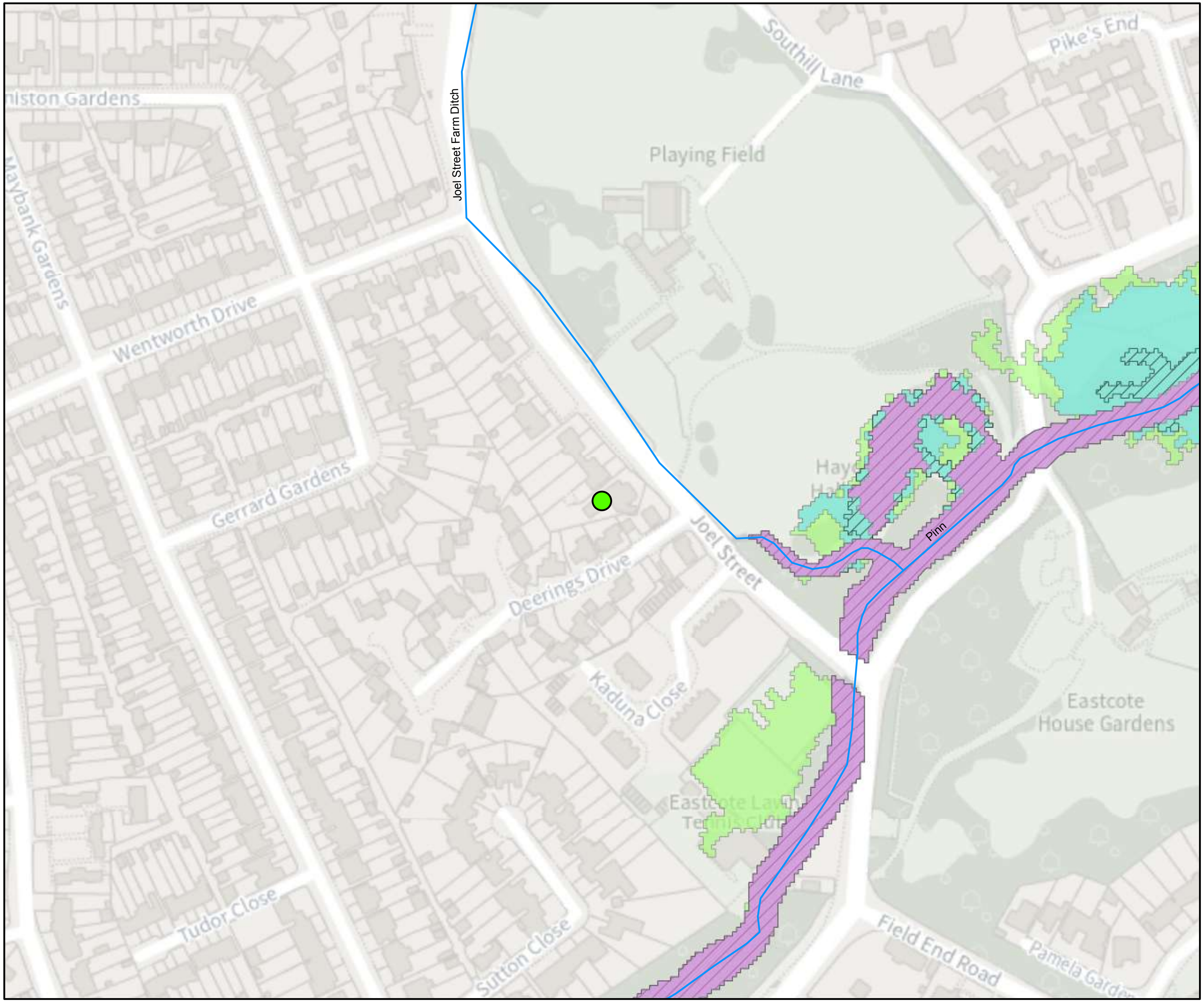
Appendix A.2 – Environment Agency Flood Report

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 37.5 75 150
Metres

Legend

Main Rivers

Site location

Defended Flood Outlines

1 in 2 year (50%) Defended

1 in 5 year (20%) Defended

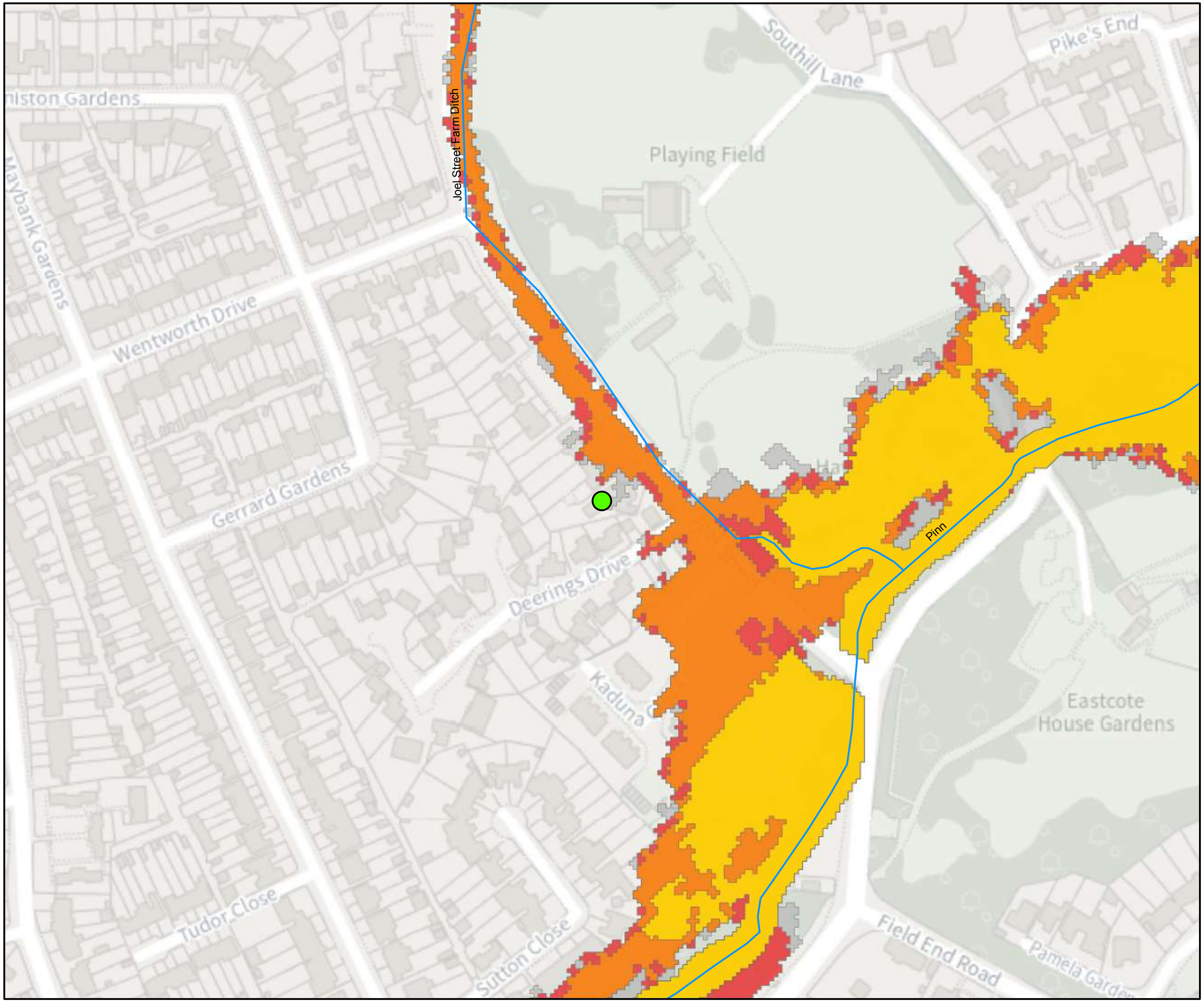
1 in 10 year (10%) Defended

1 in 20 year (5%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. 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.
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

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

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 37.5 75 150
Metres

Legend

- Main Rivers
- Site location

Defended Flood Outlines

- 1 in 30 year (3.33%) Defended
- 1 in 50 year (2%) Defended
- 1 in 75 year (1.33%) Defended
- 1 in 100 year (1%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. 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.
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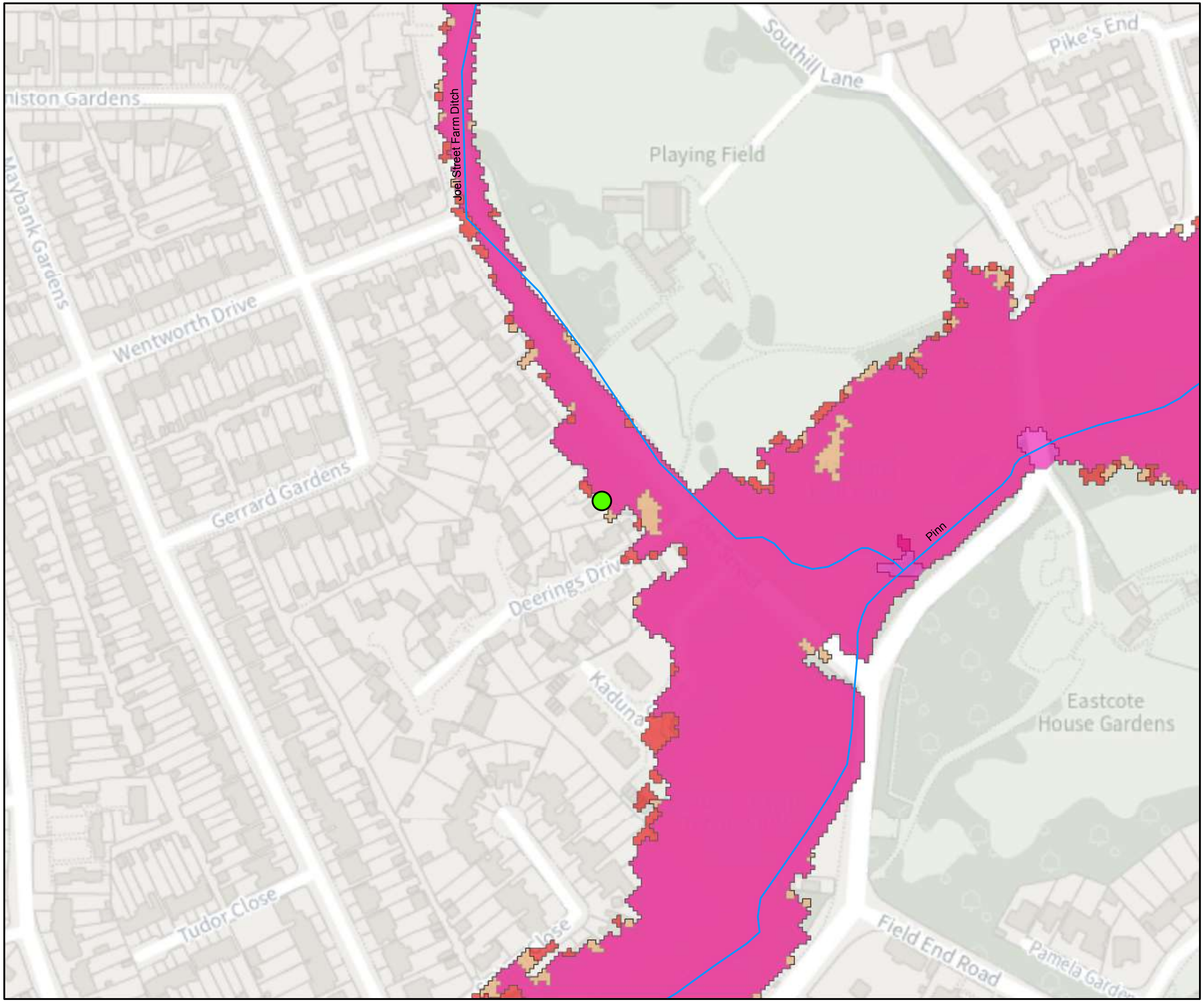
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 37.5 75 150
Metres

Legend

Main Rivers

Site location

Defended Flood Outlines

1 in 100 year + 20% (*CC) Defended

1 in 100 year + 25% (*CC) Defended

1 in 100 year + 35% (*CC) Defended

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

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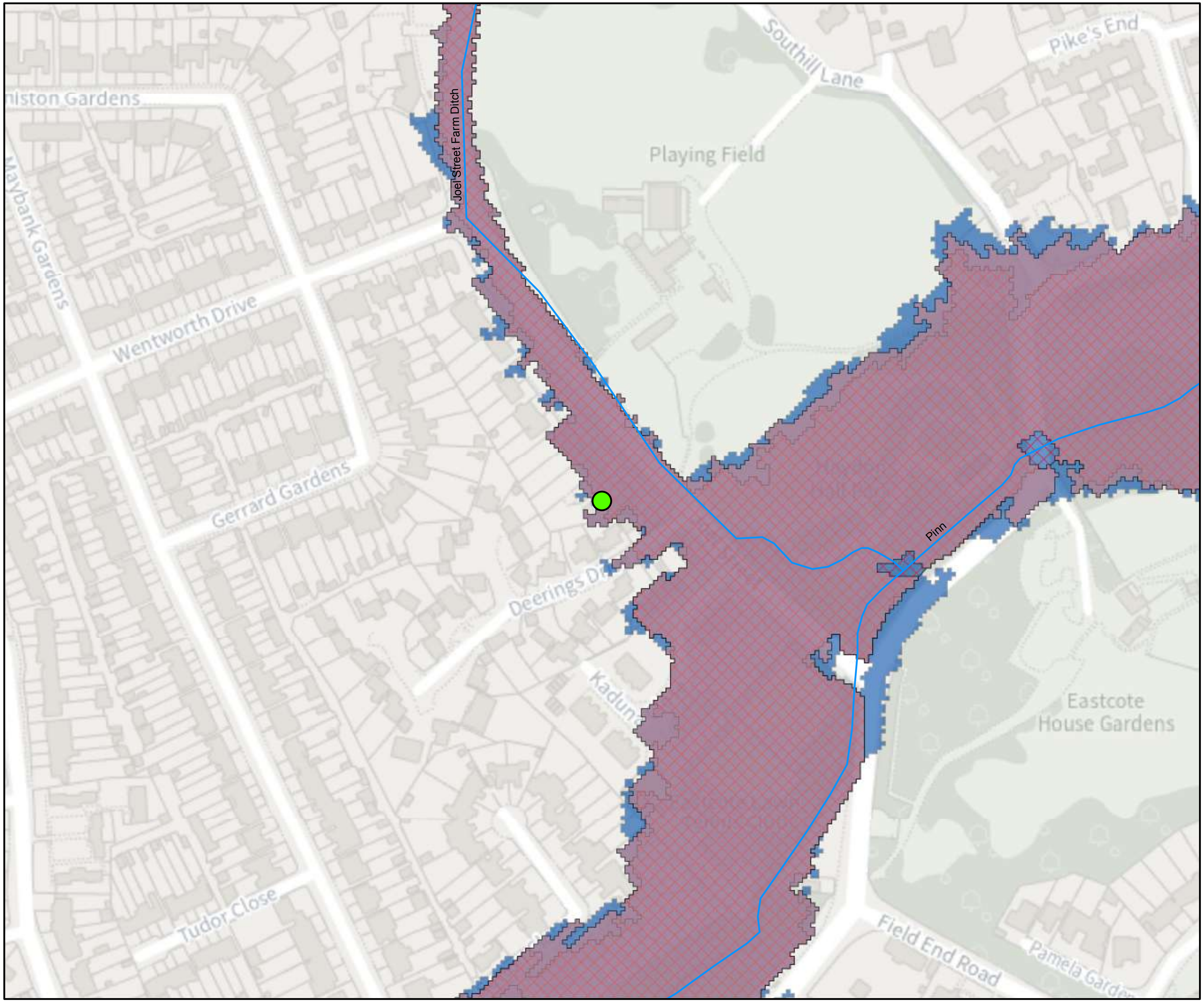
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

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Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 37.5 75 150
Metres

Legend

- Main Rivers
- Site location

Defended Flood Outlines

- 1 in 100 year + 70% (*CC) Defended
- 1 in 250 year (0.4%) Defended
- 1 in 1000 year (0.1%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
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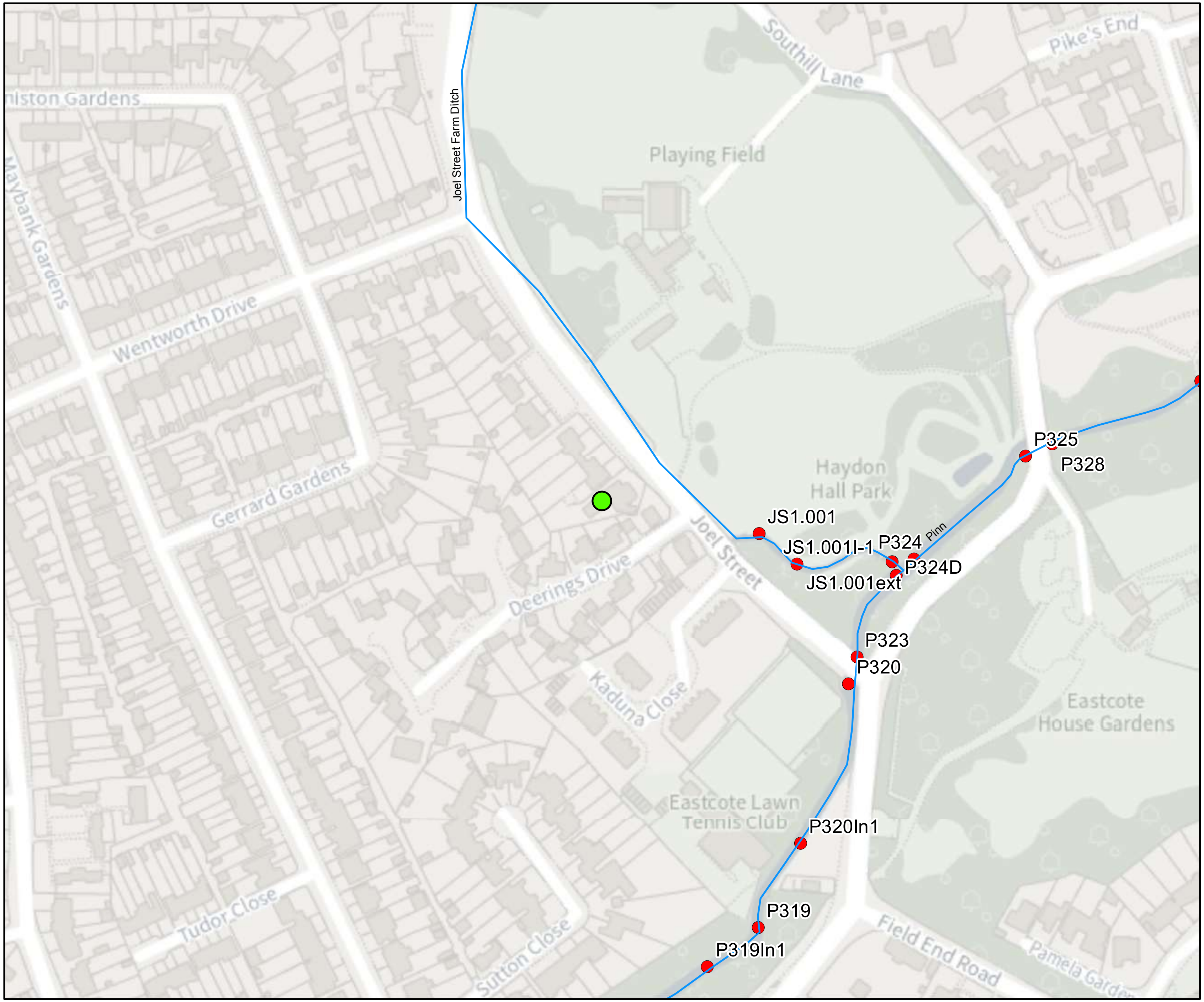
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 37.5 75 150
Metres

Legend

Main Rivers

Site location

1D Node Results

Nodes

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. 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.
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

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

Environment Agency ref: HNL 258175 HH

The following information has been extracted from the River Pinn Mapping Study (JBA, 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

Caution:
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites across the entire catchment.

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

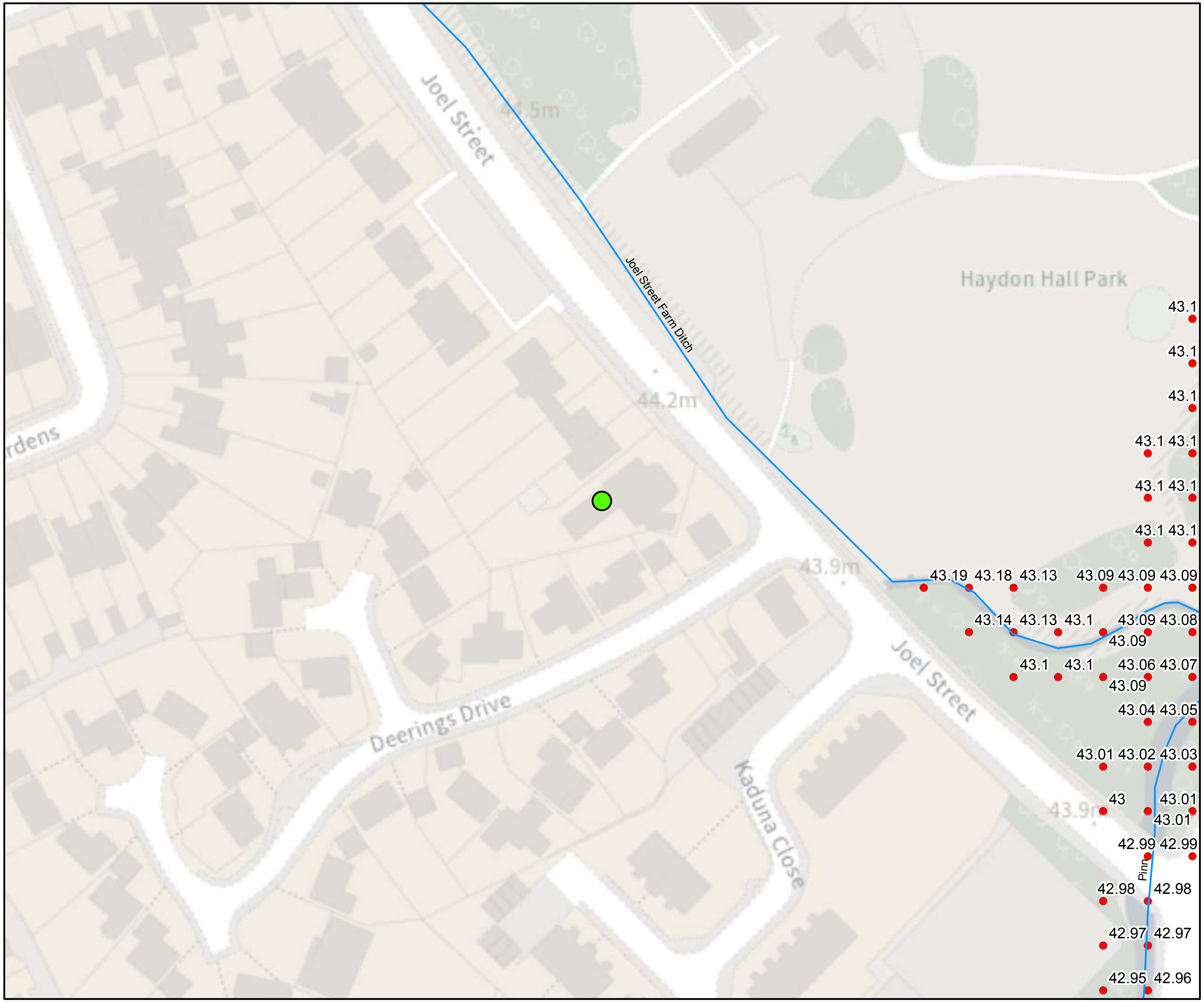
MODELLED FLOOD LEVEL

				Return Period												
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20 yr**	**30 yr**	**50 yr**	**75 yr**	**100 yr**	**100yr + 20%**	**100yr + 25%**	**100yr + 35%**	**100yr + 70%**	**250 yr**	**1000yr**
P328	510695	188858	43.13	43.38	43.50	43.62	43.72	43.83	43.92	43.98	44.08	44.10	44.15	44.29	44.14	44.41
P325	510682	188852	43.11	43.36	43.47	43.58	43.67	43.78	43.86	43.91	44.01	44.03	44.08	44.23	44.07	44.35
P324	510628	188802	43.07	43.32	43.44	43.55	43.65	43.76	43.84	43.89	43.98	44.00	44.05	44.20	44.04	44.33
P324D	510619	188794	43.07	43.32	43.44	43.55	43.65	43.76	43.84	43.89	43.98	44.00	44.05	44.20	44.04	44.33
P323	510600	188755	42.98	43.24	43.35	43.47	43.57	43.68	43.76	43.81	43.89	43.90	43.94	44.07	43.93	44.21
P320	510596	188742	42.98	43.23	43.34	43.46	43.56	43.66	43.74	43.78	43.85	43.87	43.90	44.01	43.89	44.13
P320In1	510573	188665	42.86	43.10	43.22	43.34	43.43	43.54	43.63	43.68	43.76	43.78	43.81	43.92	43.80	44.03
P319	510553	188624	42.76	43.00	43.12	43.24	43.33	43.43	43.51	43.58	43.68	43.70	43.75	43.87	43.74	43.98
P319In1	510528	188605	42.68	42.94	43.05	43.16	43.26	43.36	43.44	43.51	43.64	43.66	43.71	43.85	43.70	43.95
JS1.001	510553	188814	43.19	43.38	43.48	43.60	43.68	43.79	43.86	43.91	44.00	44.02	44.07	44.21	44.06	44.34
JS1.001I-1	510571	188800	43.10	43.34	43.46	43.58	43.67	43.78	43.86	43.91	44.01	44.03	44.07	44.22	44.07	44.34
JS1.001ext	510617	188801	43.07	43.32	43.44	43.55	43.65	43.76	43.84	43.89	43.98	44.00	44.05	44.20	44.04	44.33

MODELLED FLOWS

				Return Period												
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20 yr**	**30 yr**	**50 yr**	**75 yr**	**100 yr**	**100yr + 20%**	**100yr + 25%**	**100yr + 35%**	**100yr + 70%**	**250 yr**	**1000yr**
P328	510695	188858	3.94	5.18	5.86	6.61	7.22	7.88	8.15	8.31	8.53	8.54	8.55	8.67	8.54	8.68
P325	510682	188852	3.94	5.18	5.86	6.61	7.22	7.88	8.15	8.31	8.53	8.54	8.55	8.67	8.54	8.68
P324	510628	188802	3.96	5.04	5.53	6.02	6.48	7.04	7.52	7.98	8.89	9.11	9.42	9.86	9.38	9.96
P324D	510619	188794	4.89	6.53	7.36	8.32	8.94	9.96	10.69	11.50	13.06	13.35	13.82	14.24	13.76	14.16
P323	510600	188755	4.89	6.53	7.36	8.32	8.94	9.96	10.70	11.55	13.43	13.86	14.78	17.36	14.63	18.57
P320	510596	188742	4.89	6.53	7.36	8.32	8.94	9.96	10.70	11.55	13.43	13.86	14.78	17.36	14.63	18.57
P320In1	510573	188665	4.89	6.53	7.36	8.21	8.89	9.65	9.84	10.22	11.24	11.46	12.00	13.93	11.91	15.98
P319	510553	188624	4.89	6.53	7.36	8.21	8.93	9.80	10.07	10.40	10.78	10.81	10.99	12.03	10.95	14.01
P319In1	510528	188605	4.89	6.52	7.36	8.21	8.93	9.80	9.99	10.12	10.25	10.28	10.36	10.89	10.32	12.88
JS1.001	510553	188814	1.28	1.74	2.12	2.52	2.74	2.83	2.86	2.88	2.93	2.94	2.96	3.02	2.95	3.05
JS1.001I-1	510571	188800	1.27	1.74	2.11	2.50	2.74	2.85	2.96	3.08	3.35	3.41	3.54	3.85	3.46	3.98
JS1.001ext	510617	188801	1.27	1.72	2.13	2.62	2.91	3.22	3.47	3.71	4.22	4.28	4.42	4.72	4.39	4.87

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 2 year (50%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
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https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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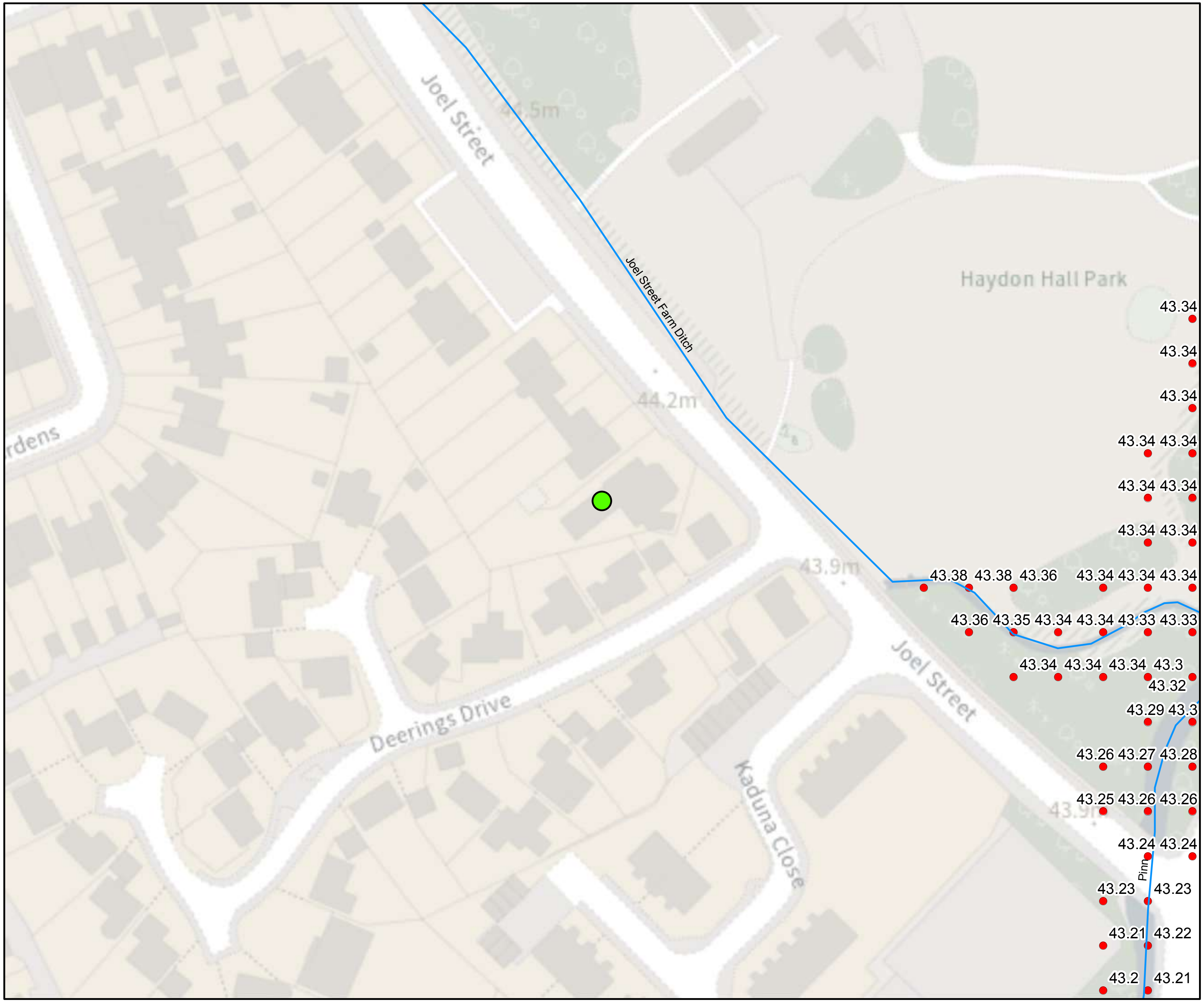
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
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Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 5 year (20%) Defended

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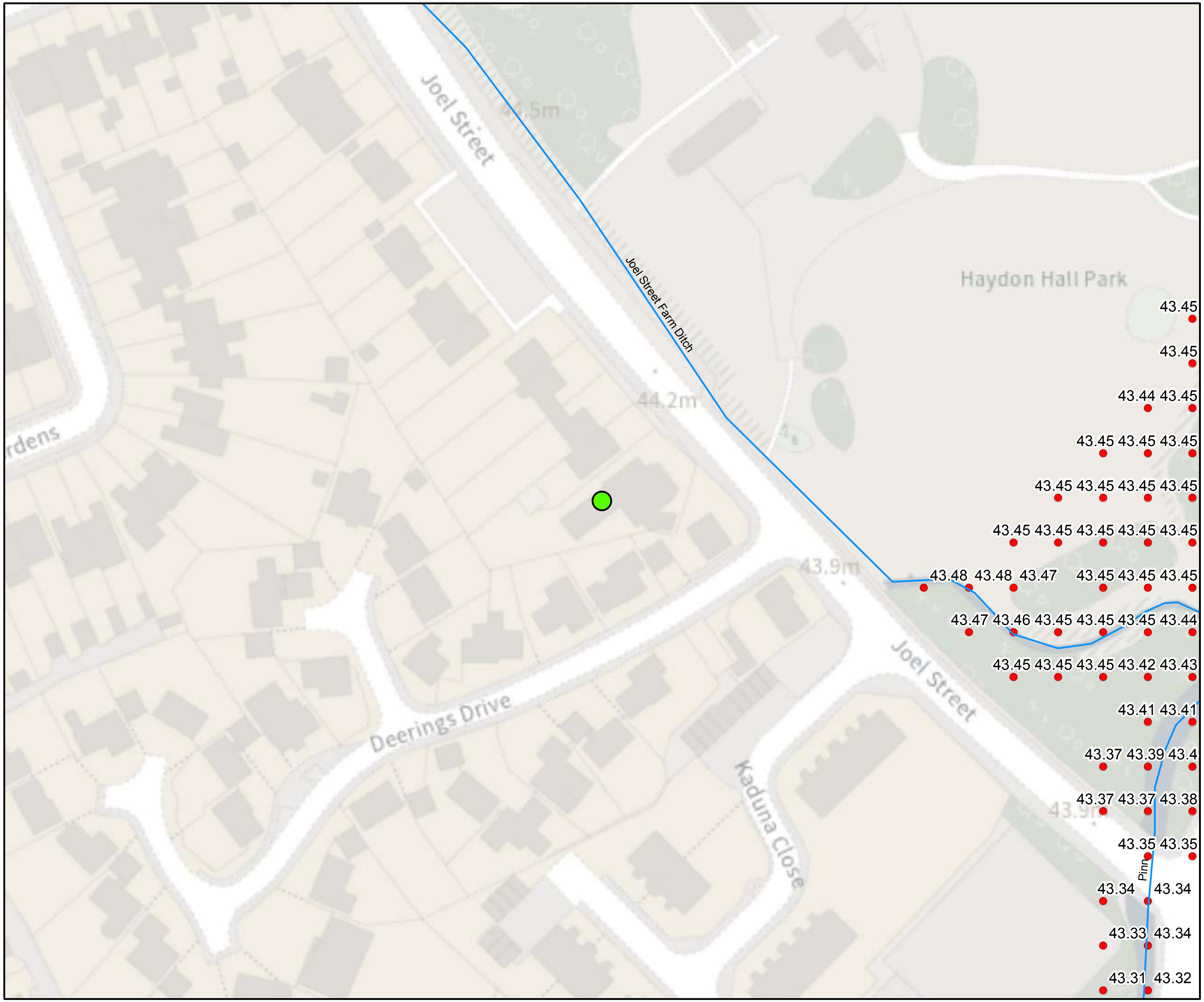
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 10 year (10%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
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Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

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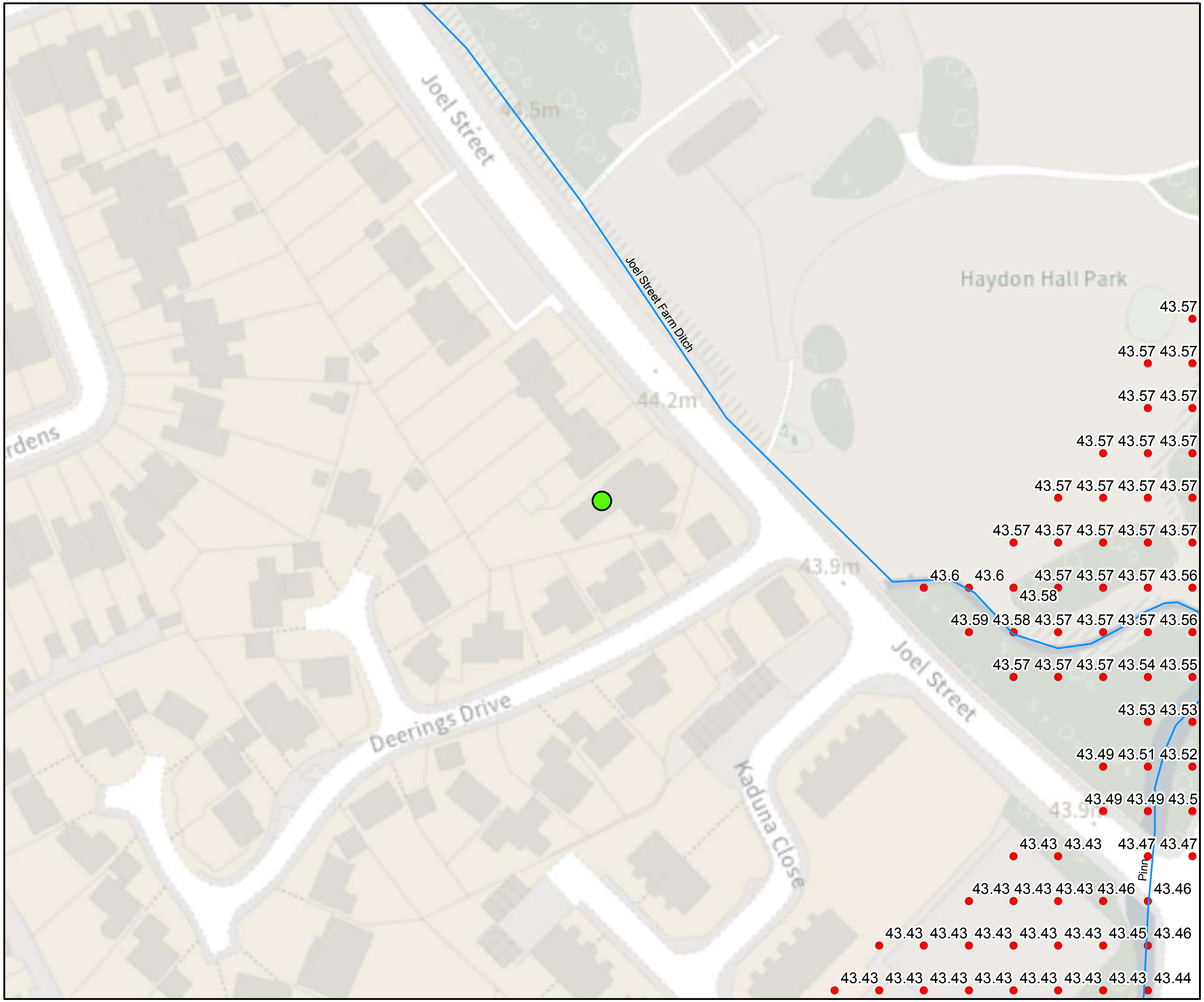

Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 20 year (5%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
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Produced by:
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Hertfordshire & North London

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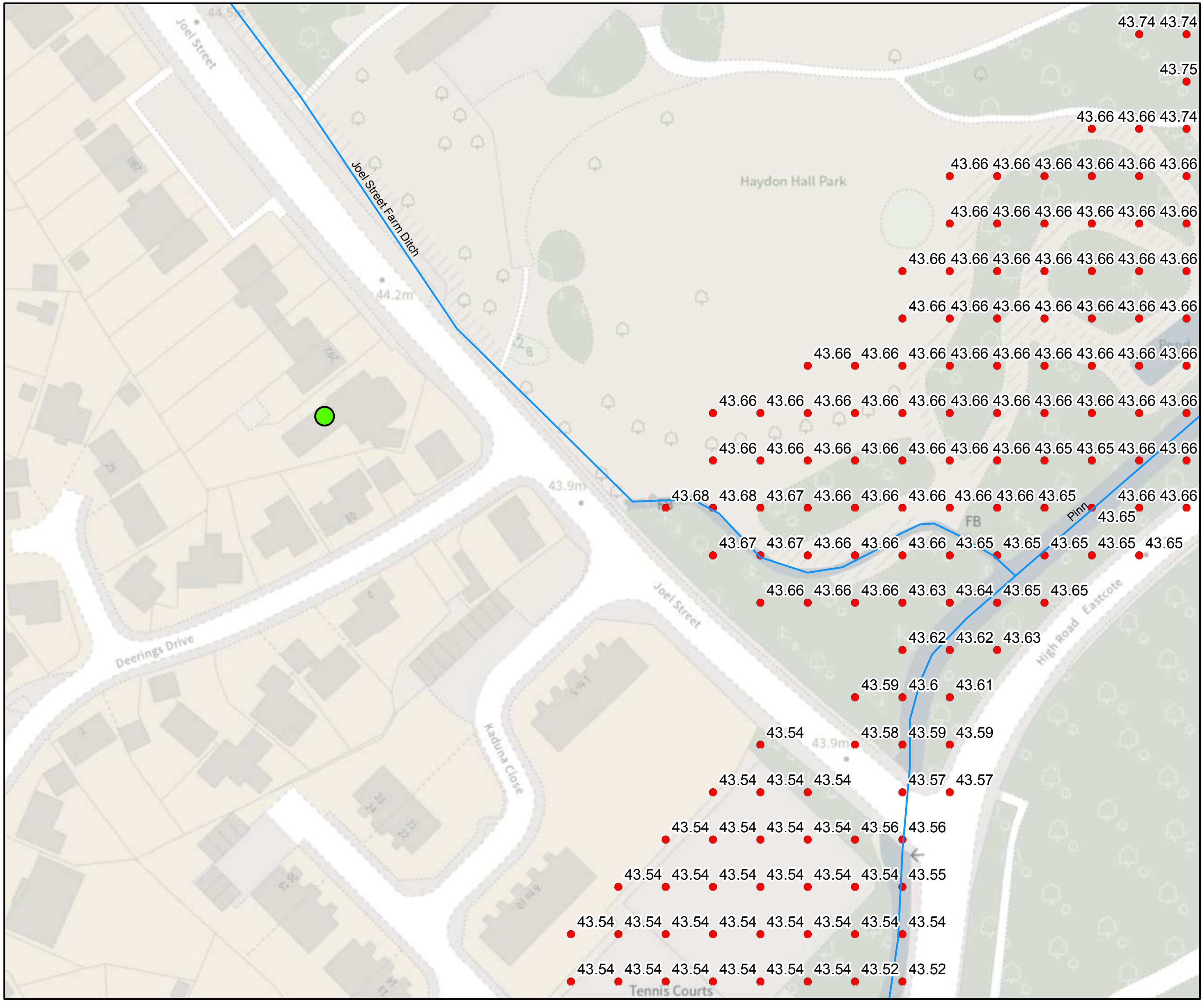

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60

Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 30 year (3.33%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. 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.

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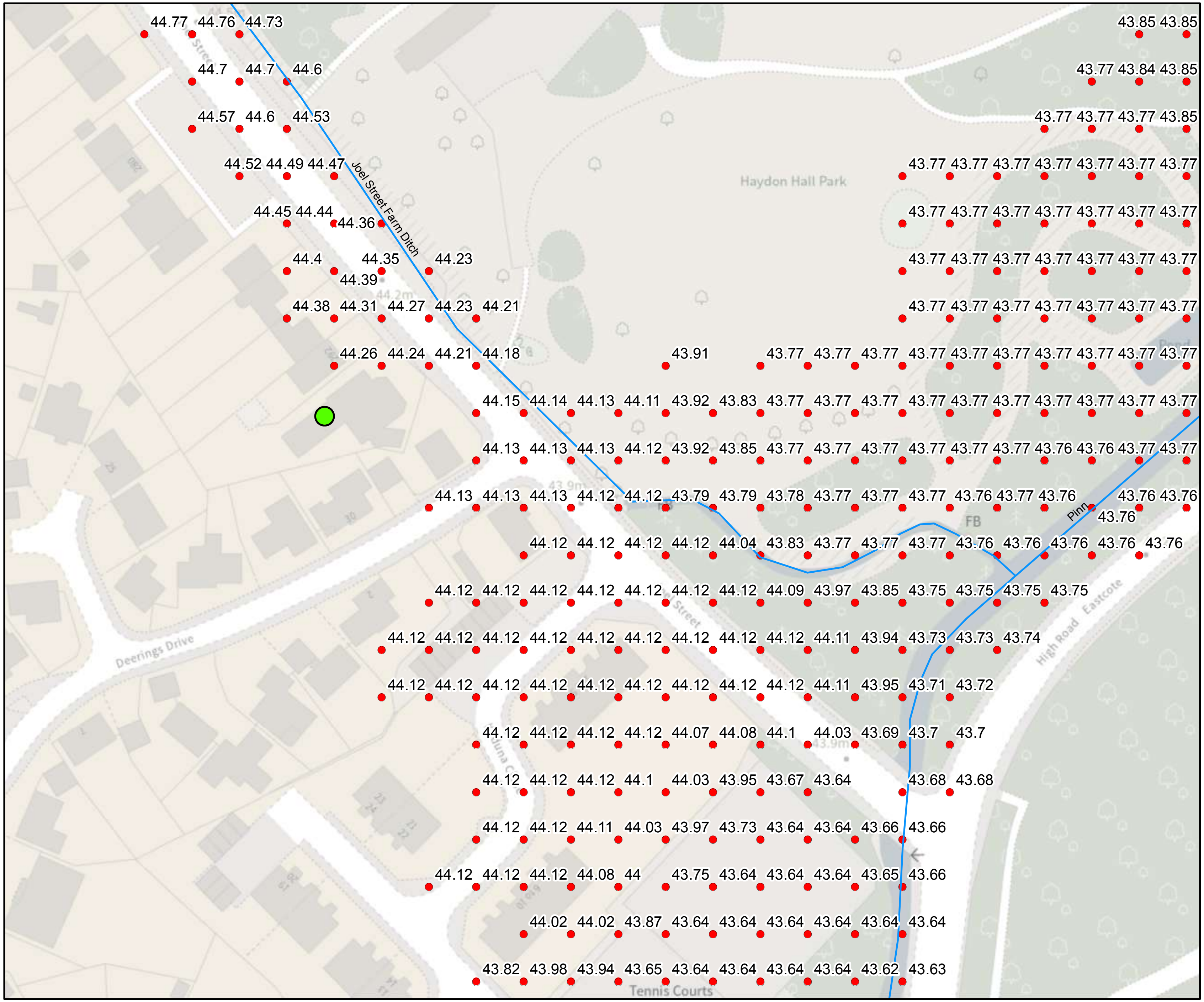
Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 50 year (2%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
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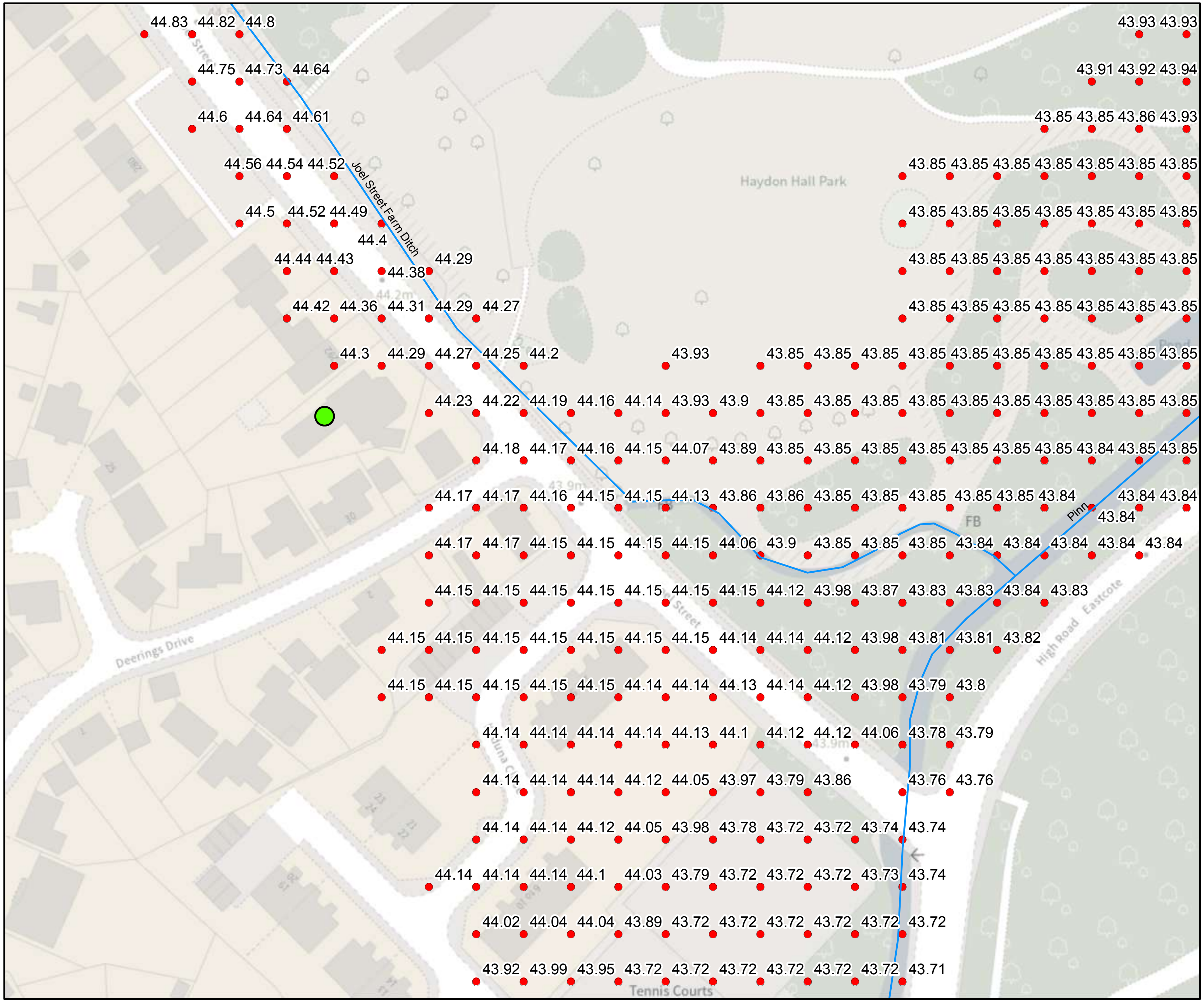
Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 75 year (1.33%) Defended

The data in this map has been extracted from the River Pinn Mapping Study (JBA, 2015).
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.
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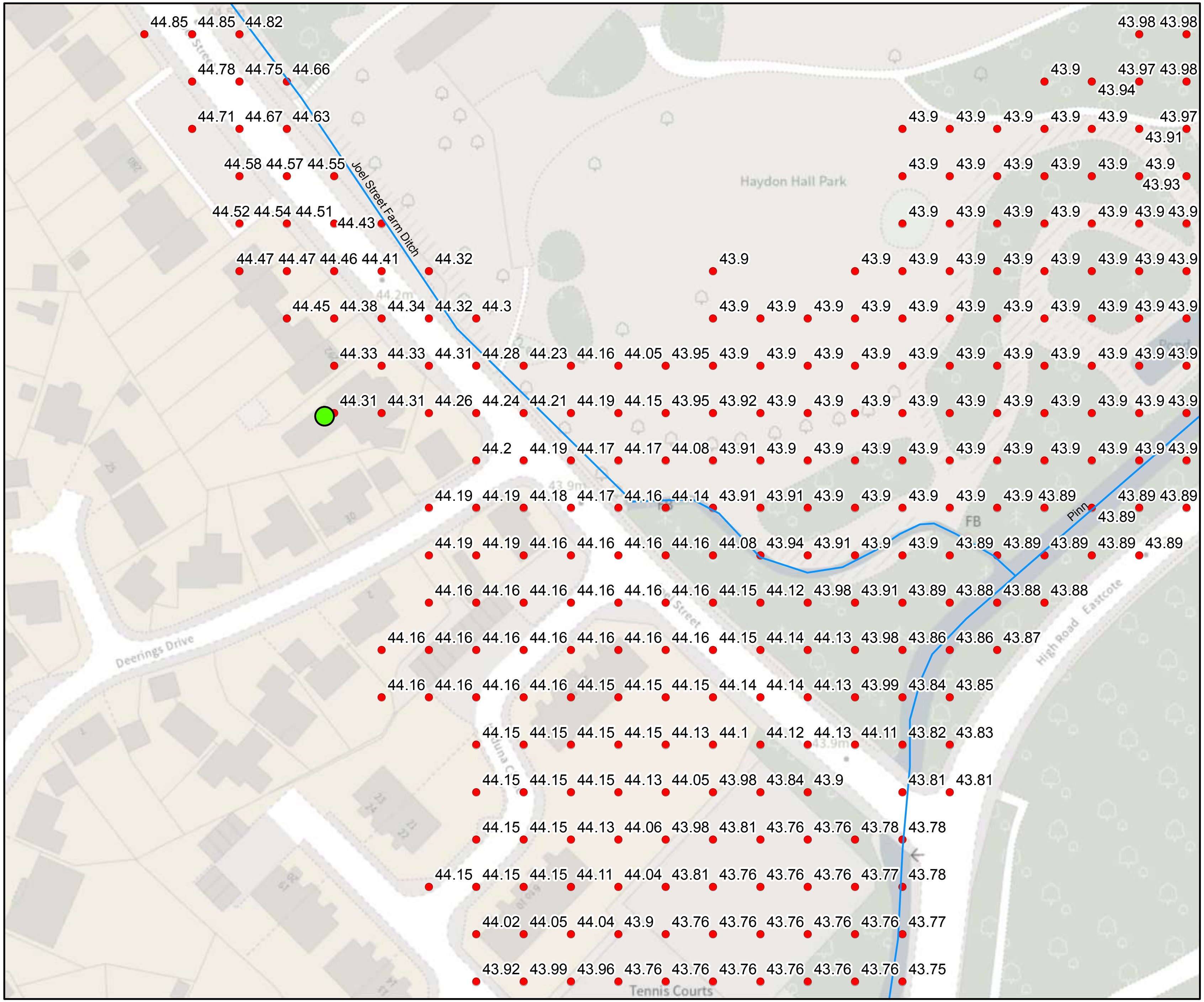
Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 100 year (1%) Defended

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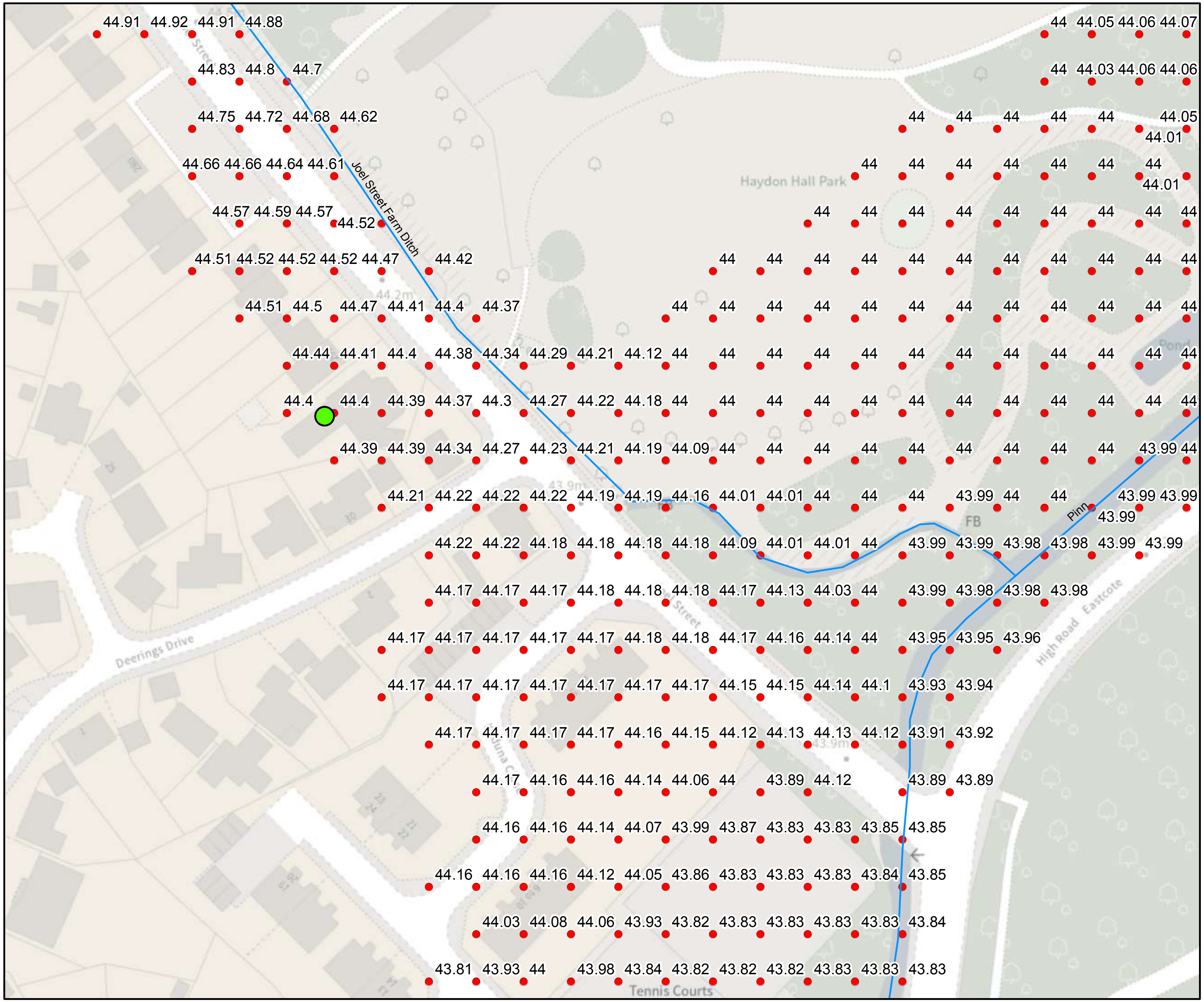

Environment Agency

Environment Agency,
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 100 year + 20% (*CC) Defended

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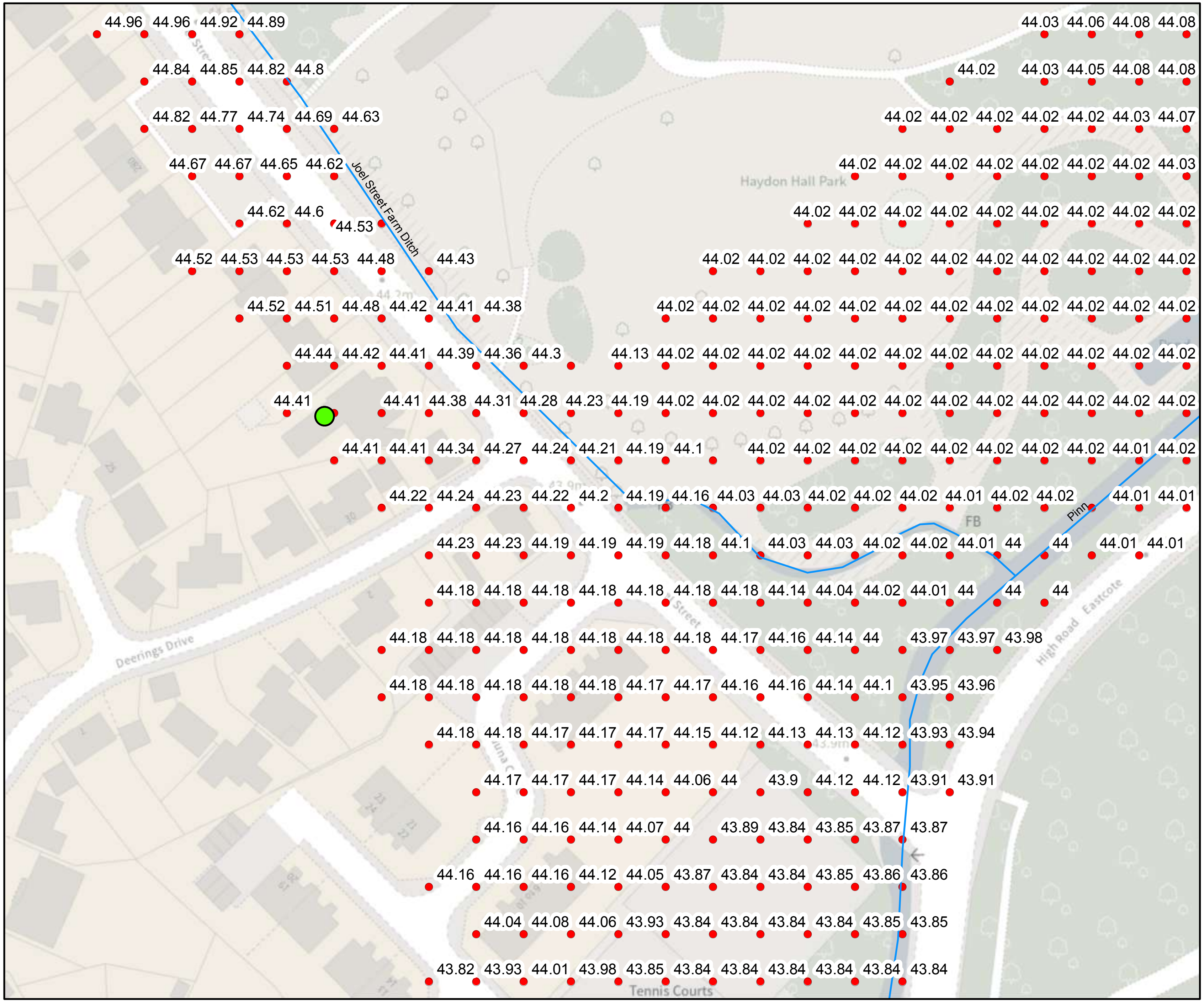
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 100 year + 25% (*CC) Defended

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Hertfordshire & North London

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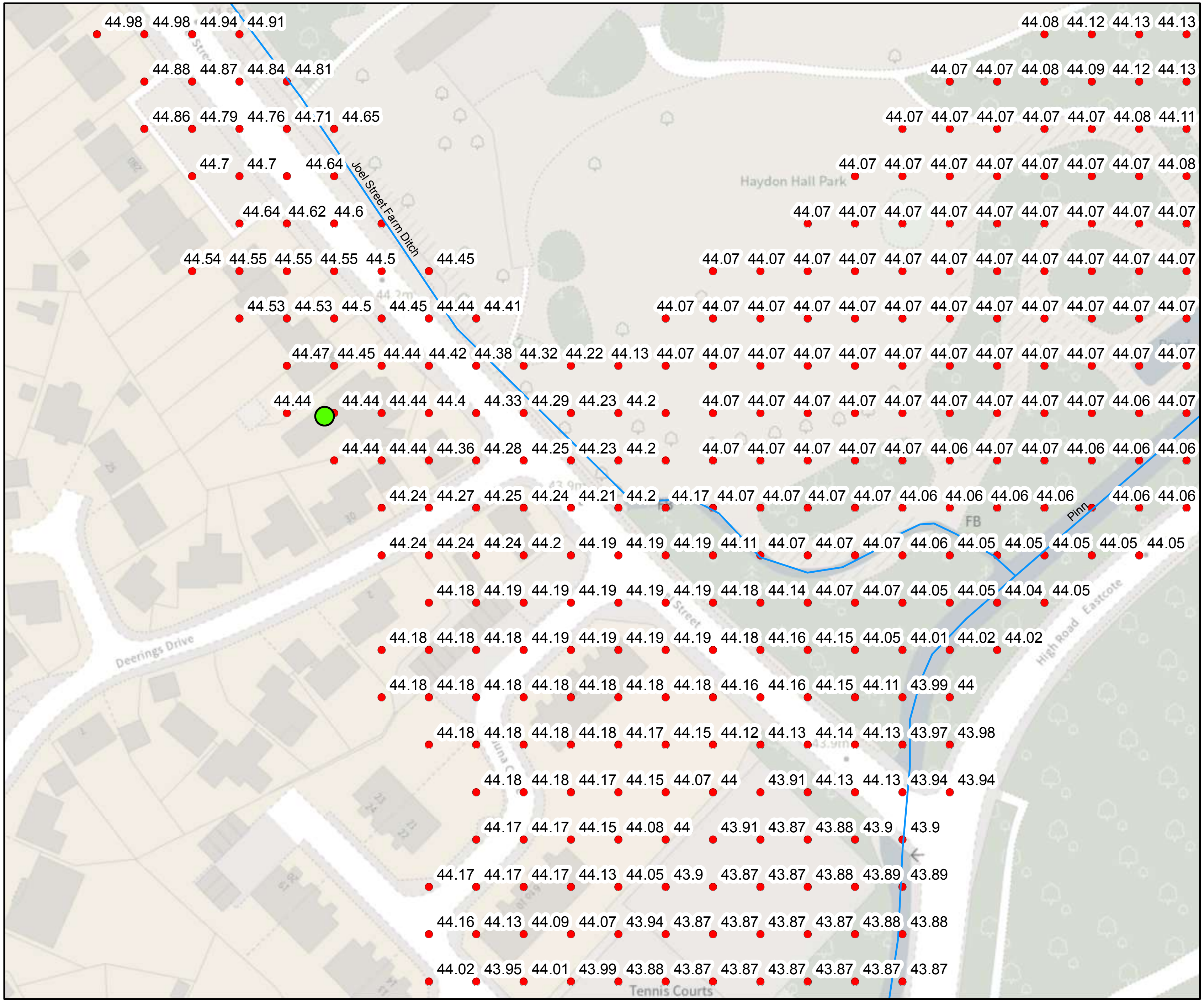

Environment Agency

Environment Agency,
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 100 year + 35% (*CC) Defended

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Hertfordshire & North London

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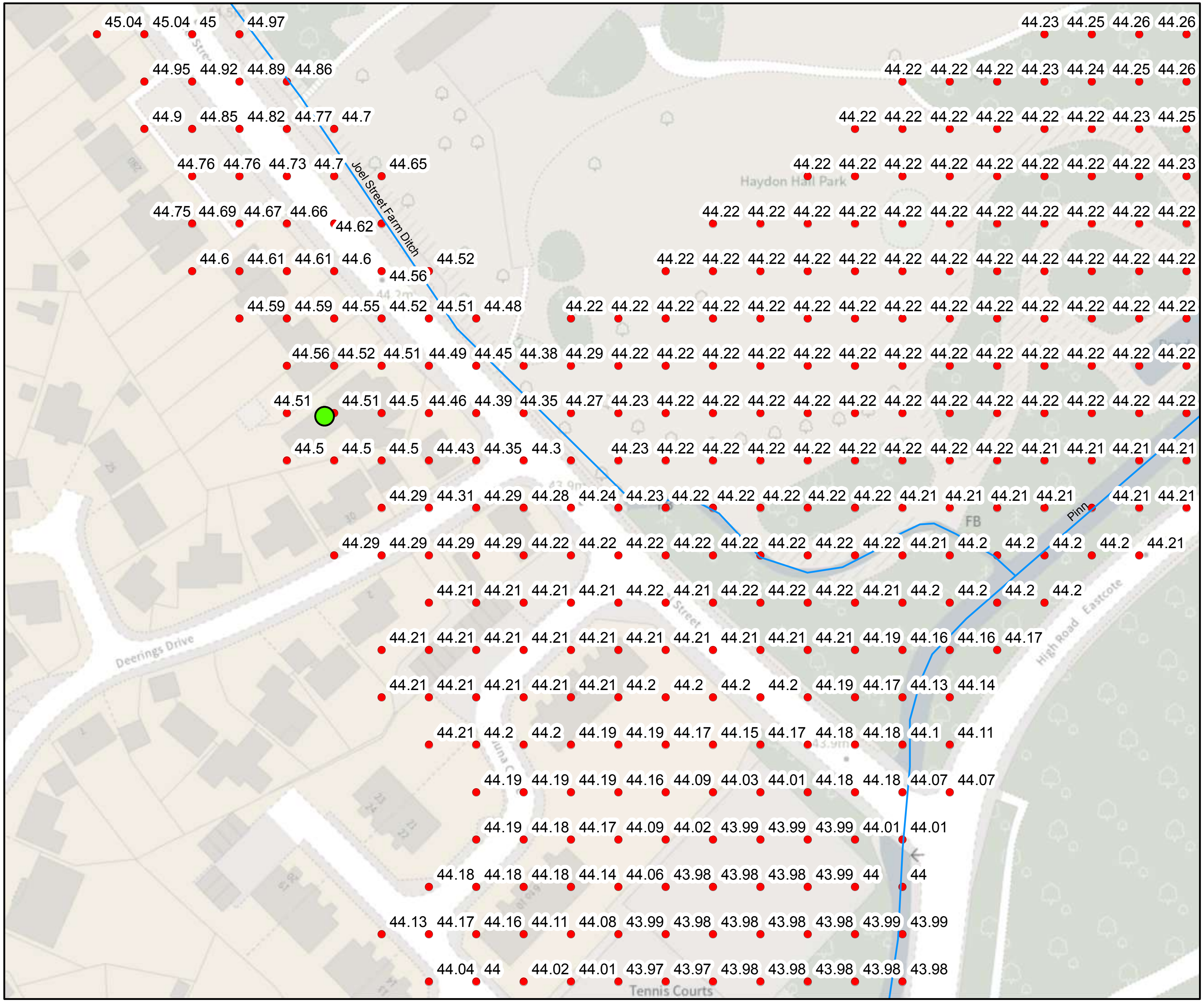

Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 100 year + 70% (*CC) Defended

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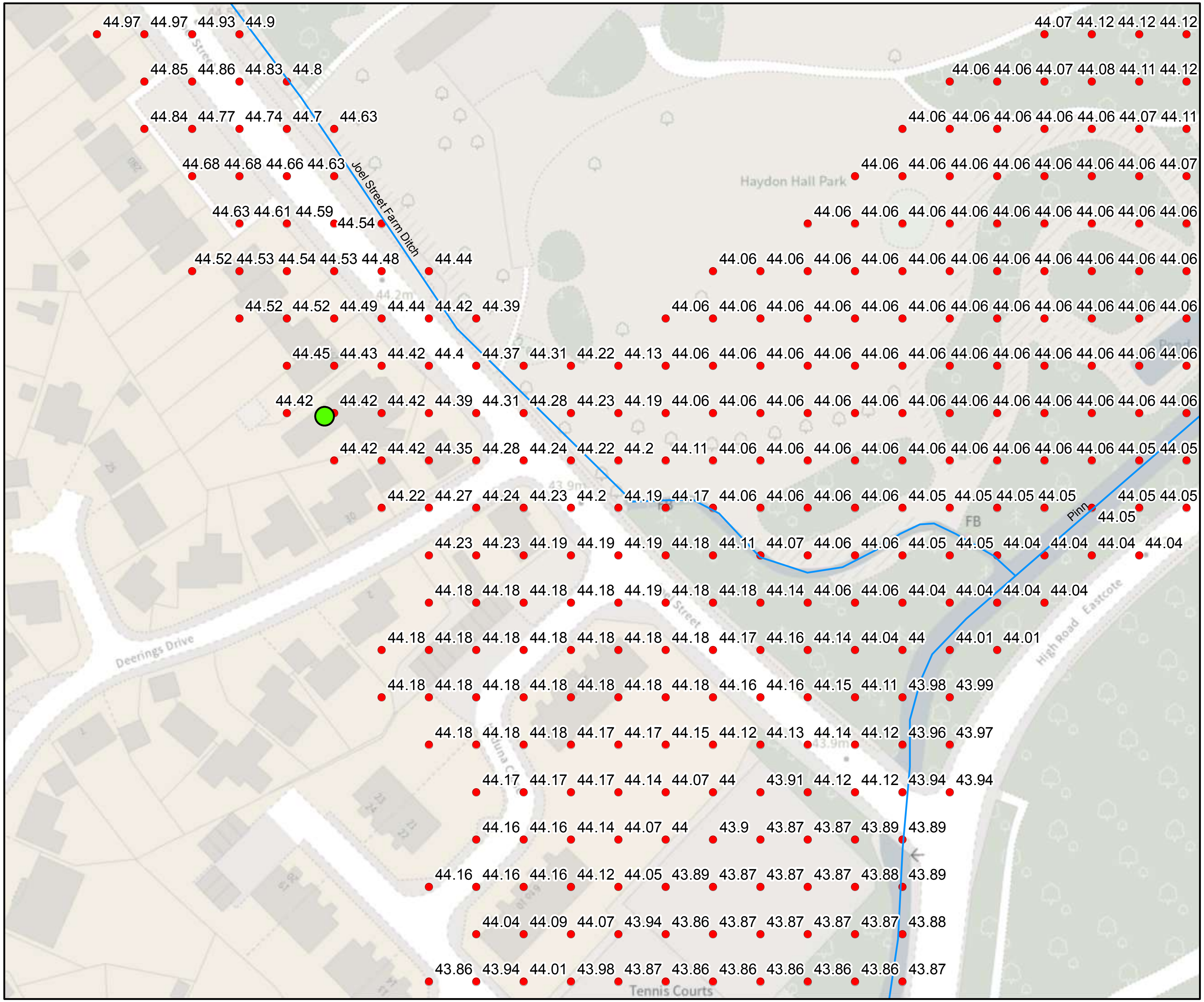

Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 250 year (0.4%) Defended

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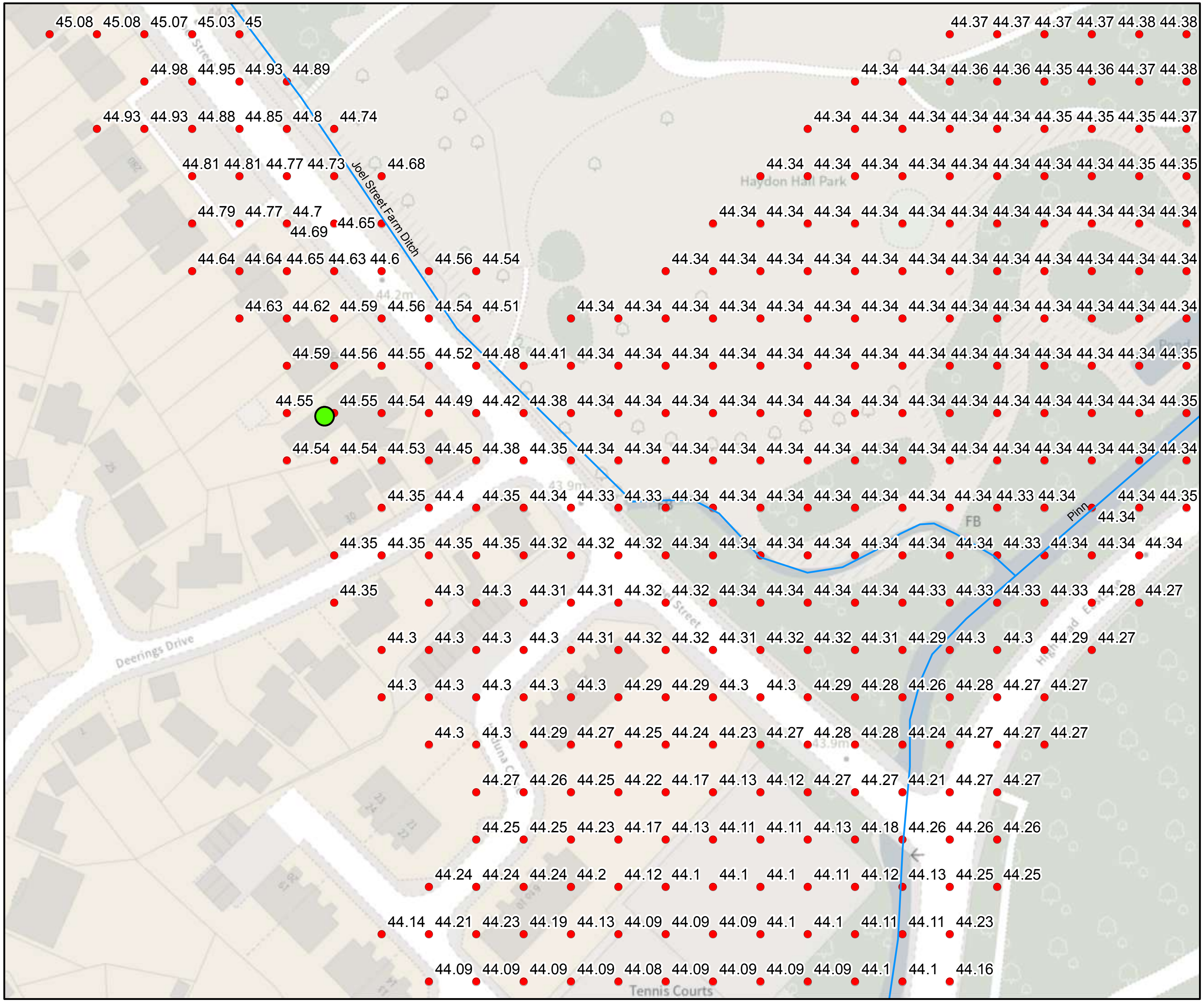
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

Main Rivers

Site location

2D Node Results: Heights

1 in 1000 year (0.1%) Defended

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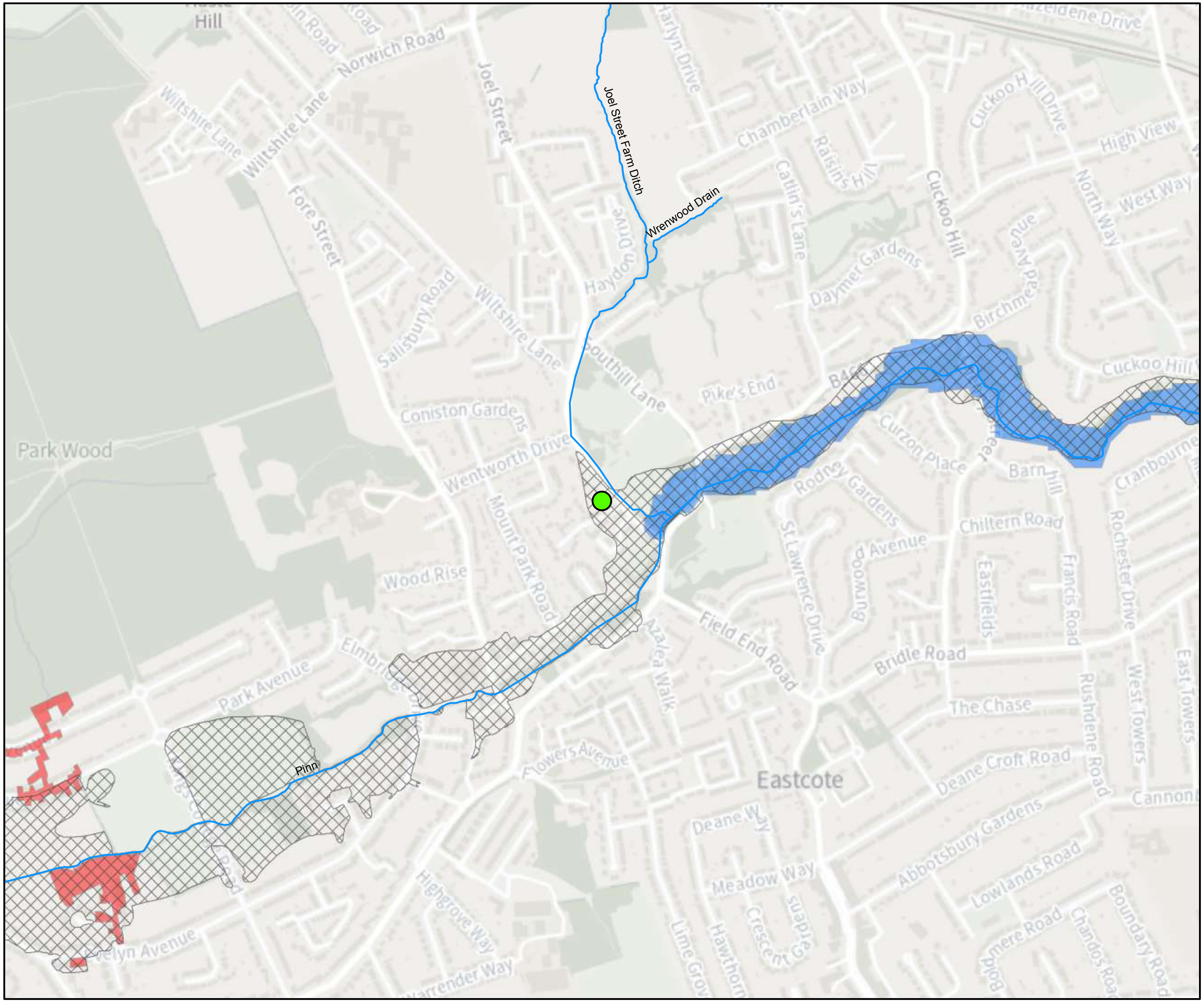
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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

Historic Flood Map centred on: Haydon House, 296 Joel Street, HA5 2PY - 14/04/2022 - HNL 258175 HH



![Environment Agency]

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 170 340 680
Metres

Legend

Main Rivers

Site location

Flood Event Outlines

1977

1988

2016

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

Appendix A.3 – Thames Water Asset Location Data

Asset location search

Thames Water Property Searches

Herrington Consulting Limited
Barham Business Park,Unit 6 Barham Business Park

CANTERBURY
CT4 6DQ

Search address supplied	Splendid Hospitality Group Llp Haydon House 296 Joel Street Pinner HA5 2PY
Your reference	EG/3450
Our reference	ALS/ALS Standard/2022_4628874
Search date	20 April 2022

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Asset location search

Thames Water Property Searches

Search address supplied: Splendid Hospitality Group Llp, Haydon House, 296, Joel Street, Pinner, HA5 2PY

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

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

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

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

Affinity Water Ltd
Tamblin Way
Hatfield

AL10 9EZ
Tel: 0345 3572401

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

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

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

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

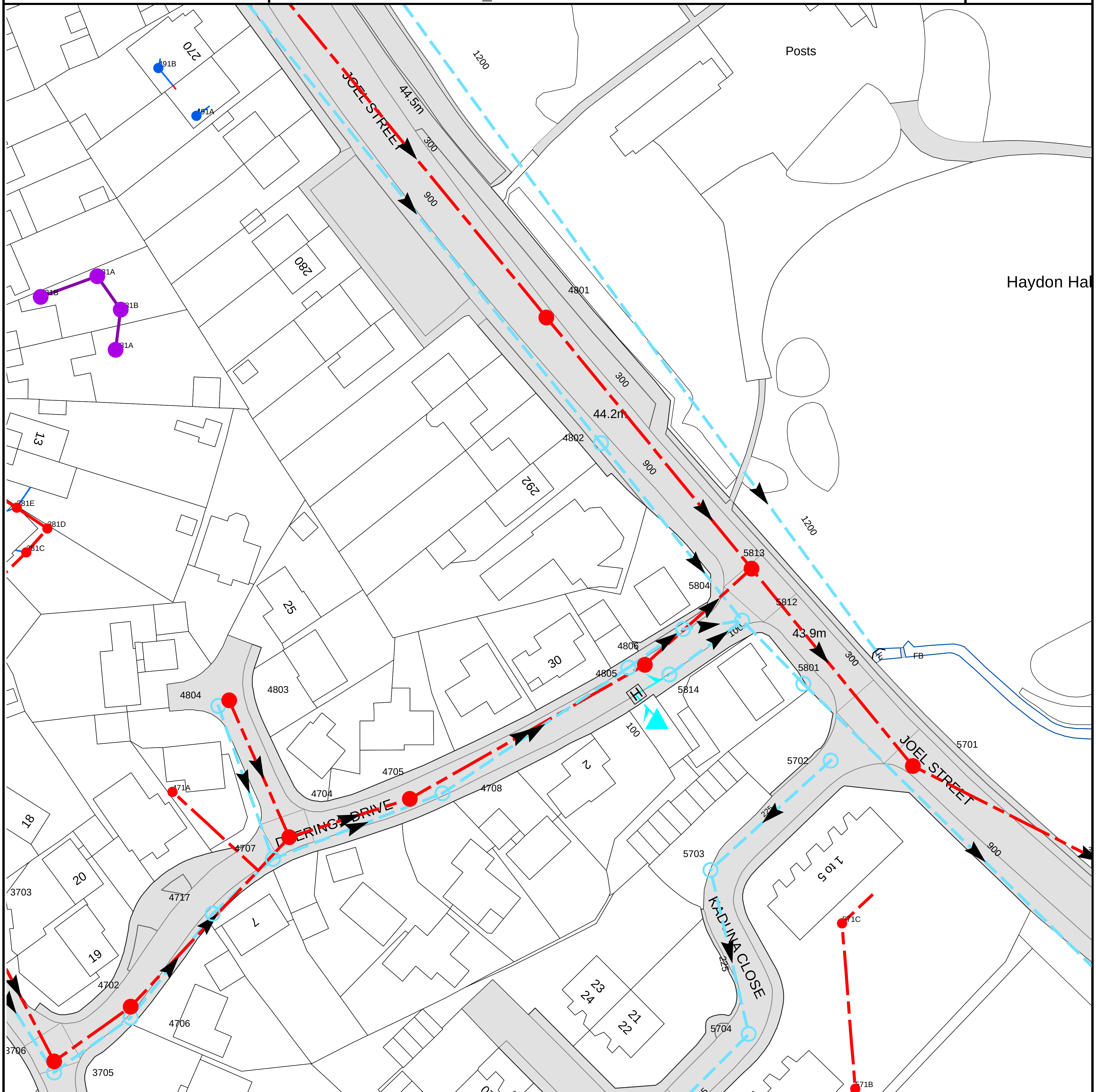
Clean Water queries

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

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

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4628874



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 510481,188831

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
381A	n/a	n/a
481A	n/a	n/a
481B	n/a	n/a
491B	n/a	n/a
491A	n/a	n/a
4801	44.2	41.3
4802	44.14	42.66
381B	n/a	n/a
571B	n/a	n/a
5704	43.83	42.84
571C	n/a	n/a
4717	n/a	n/a
5703	43.92	42.96
4707	n/a	n/a
4704	n/a	n/a
4705	n/a	n/a
4708	n/a	n/a
471A	n/a	n/a
5701	43.85	40.48
5702	43.84	43.08
4804	n/a	n/a
4803	n/a	n/a
5801	43.92	42.56
5814	n/a	n/a
4805	n/a	n/a
4806	n/a	n/a
5804	n/a	n/a
5812	n/a	n/a
5813	n/a	n/a
381C	n/a	n/a
381D	n/a	n/a
381E	n/a	n/a
3705	n/a	n/a
3706	n/a	n/a
4706	n/a	n/a
4702	n/a	n/a

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

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

- Storm Sewer
- Sludge Sewer
- Foul Trunk Sewer
- Surface Trunk Sewer
- Combined Trunk Sewer
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Vacuum
- Thames Water Proposed
- Vent Pipe
- Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

- Sewer
- Culverted Watercourse
- Proposed
- Decommissioned Sewer
- Content of this drainage network is currently unknown
- Ownership of this drainage network is currently unknown

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
- Meter
- Dam Chase
- Vent
- Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- 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.

- Inlet
- Outfall
- Undefined End

Other Symbols

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

- Change of Characteristic Indicator
- Public / Private Pumping Station
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

- Casement
- Conduit Bridge
- Subway
- Tunnel

Ducts may contain high voltage cables. Please check with Thames Water.

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the 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 indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. 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, please contact Property Searches on 0800 009 4540.

Terms and Conditions

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

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

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

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

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

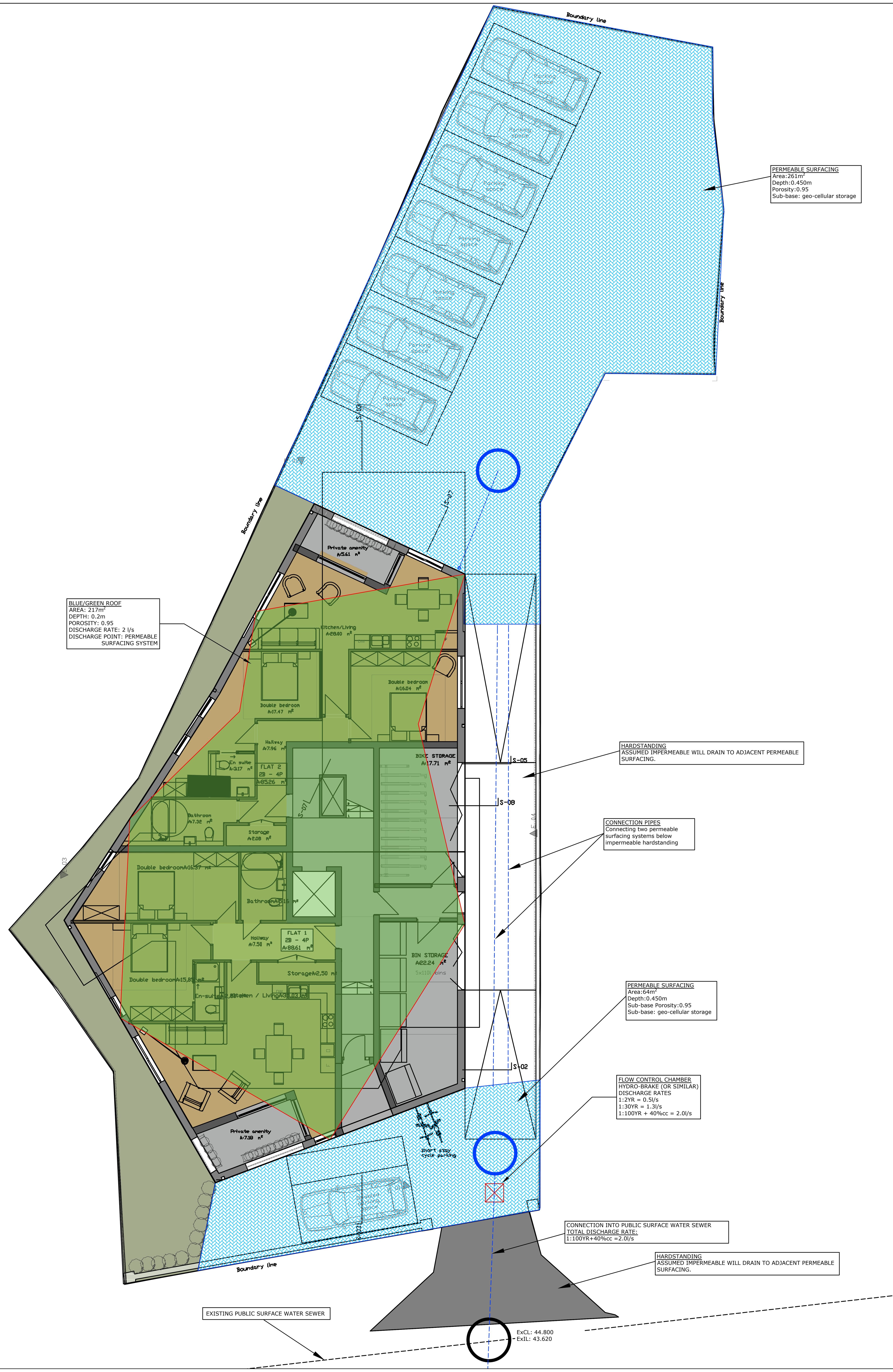
If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria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

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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

Appendix A.4 – Indicative Drainage Layout



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GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
2. ALL WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE RELEVANT BRITISH STANDARDS, EUROPEAN NORMS, CODES OF PRACTICE AND BUILDING PRACTICE.
3. ALL DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR PRIOR TO STARTING THE WORKS ON SITE. ANY DISCREPANCIES ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
4. INFILTRATION FEATURES WILL BE SUBJECT TO SITE SPECIFIC INFILTRATION TESTING AND TRIAL HOLES.
5. ALL DRAINAGE SYSTEMS WILL NEED TO BE INSTALLED AND DESIGNED FOR SUITABLE LOADING REQUIREMENTS.
6. THE CONTRACTOR SHALL OBTAIN PRIOR APPROVAL AND ALL NECESSARY LICENCES FROM THE THE HIGHWAY AUTHORITY AND/OR SEWERAGE UNDERTAKER BEFORE CARRYING OUT ANY WORKS.

KEY:

- SURFACE WATER DRAIN
- SURFACE WATER MANHOLE
- EXISTING SURFACE WATER SEWER
- FLOW CONTROL DEVICE
- EXISTING SURFACE WATER CHAMBER
- RAINWATER PIPE
- PERMEABLE SURFACE
- BLUE/GREEN ROOF

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Rev	Description	Author	Checked	Date
P1	First issue	RM	SMB	01/09/22

CLIENT
HYDE PARK CONSTRUCTION LTD

PROJECT
HAYDEN HOUSE, JOEL STREET, PINNER, LONDON

SCALE	PROJ REF	ORIGINATOR	CHECKED BY
1:100	3450	RM	SMB

SCALE 1 : 100 @ A1
1 m 0 10 m

DWG REF.
INDICATIVE SURFACE WATER DRAINAGE LAYOUT

DWG No.
HC-3450-501

Appendix A.5 – Maintenance Schedules

Operation and Maintenance Schedule – Water Butts		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Inspections and Maintenance	Inspection and cleaning of debris and sedimentation at the base of the tank.	At least once per year and following any noticeable deterioration in performance (e.g. observation of sediment entrained within water).
	Cleaning out of house guttering	As frequently as advised by maintenance plan for the property. Must be cleaned as soon as possible if blockage of guttering occurs.
	Inspection and repair of areas receiving overflow from the tank in the event of erosion	Inspected at least once every 3 months for the first year following installation, reduced inspection frequencies thereafter, at least once per year.
	inspection and repair of the inlet, outlet and overflows.	Inspected at least once every 3 months for the first year following installation, reduced inspection frequencies thereafter, at least once per year.
	cleaning of the tank, inlets, outlets, filters (if present) and removal of debris.	Inspected at least once every 3 months for the first year following installation, reduced inspection frequencies thereafter, at least once per year.
Remedial Maintenance	Repairing of any erosive damage or damage to the tank	As required, whenever damage leaks or erosion is detected.
	Inspection of the tank for debris, leaks or other damage and repair where necessary.	
	Inspection of area receiving overflow from the tank in the event of erosion	
Occasional maintenance	Replacement of any filters	When Required, due to clogging, or manufacturer specific instructions.

Typical Maintenance Requirements for Water Butts.

Operation and Maintenance Schedule – Green Roofs		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Routine Inspection	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Routine maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e. year one), replace all dead plants as required	Monthly (usually the responsibility of the manufacturer)
	Post establishment replace dead plants as required (where >5% of coverage)	Annually (in Autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow gasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

General Operation and Maintenance Table for Green Roofs.

Operation and Maintenance Schedule – Pervious paving / surfacing		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Brushing and vacuuming (for driveways this can be a standard cosmetic sweep over whole surface).	At minimum once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – particular attention must be payed to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using a suitable weed killer which will not adversely affect water quality. Weed killer should be applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving / surfacing.	As required when damage or erosion is detected following inspection. For block paving systems jointing material to be replaced shortly after installation and subsequently when required.
	Remedial work to any depressions. Rutting and cracked or broken blocks and replace lost jointing material (where block paving is used).	
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

General Maintenance Requirements for Permeable Surfacing (additional requirements may apply depending on type of surfacing material used).

Appendix A.6 – Surface Water Management Calculations

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	200.0	Include Intermediate Ground	✓
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Green-roof	0.022	4.00	55.000		-162.514	-8.986	0.200
Outlet			44.800	900	-148.513	-22.827	1.180
Remaining roof area	0.009	4.00	45.000	1200	-173.384	-16.657	0.460
Permeable Surfacing	0.033	4.00	45.000		-162.525	-22.919	0.550
Existing	0.042	4.00	10.000	1900			1.000
Existing 1	0.000		10.000	1900			2.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Proposed Discharge	Permeable Surfacing	Outlet	14.012	0.600	44.450	43.620	0.830	16.9	225	4.32	196.0
1.000	Green-roof	Permeable Surfacing	13.933	0.600	54.800	44.450	10.350	1.3	100	4.03	196.0
2.000	Remaining roof area	Permeable Surfacing	12.535	0.600	44.540	44.450	0.090	139.3	150	4.25	196.0
Existing Runoff	Existing	Existing 1	10.000	0.600	9.000	8.000	1.000	10.0	1000	4.02	196.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Proposed Discharge	3.200	127.2	63.5	0.325	0.955	0.064	0.0	112	3.195
1.000	6.722	52.8	21.8	0.100	0.450	0.022	0.0	45	6.414
2.000	0.849	15.0	8.9	0.310	0.400	0.009	0.0	83	0.886
Existing Runoff	10.602	8327.0	41.7	0.000	1.000	0.042	0.0	49	2.897

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Proposed Discharge	14.012	16.9	225	Circular	45.000	44.450	0.325	44.800	43.620	0.955
1.000	13.933	1.3	100	Circular	55.000	54.800	0.100	45.000	44.450	0.450
2.000	12.535	139.3	150	Circular	45.000	44.540	0.310	45.000	44.450	0.400

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Proposed Discharge	Permeable Surfacing		Junction		Outlet	900	Manhole	Adoptable
1.000	Green-roof		Junction		Permeable Surfacing		Junction	
2.000	Remaining roof area	1200	Manhole	Adoptable	Permeable Surfacing		Junction	

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Existing Runoff	10.000	10.0	1000	Circular	10.000	9.000	0.000	10.000	8.000	1.000

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Existing Runoff	Existing	1900	Manhole	Adoptable	Existing 1	1900	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Green-roof	-162.514	-8.986	55.000	0.200		0	1.000	54.800	100
Outlet	-148.513	-22.827	44.800	1.180	900	1	Proposed Discharge	43.620	225
Remaining roof area	-173.384	-16.657	45.000	0.460	1200	0	2.000	44.540	150
Permeable Surfacing	-162.525	-22.919	45.000	0.550		1	2.000	44.450	150
						2	1.000	44.450	100
						0	Proposed Discharge	44.450	225
Existing			10.000	1.000	1900	0	Existing Runoff	9.000	1000

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing 1			10.000	2.000	1900	1	Existing Runoff	8.000	1000

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Detailed	Additional Storage (m³/ha)	0.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	10	0	30	0	10	0
2	40	10	0	30	40	10	0
10	0	10	0	100	0	10	0
10	40	10	0	100	40	10	0

Node Green-roof Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.000	Sump Available	x
Replaces Downstream Link	✓	Product Number	CTL-CHE-0075-2000-0400-2000
Invert Level (m)	54.800	Min Outlet Diameter (m)	0.100
Design Depth (m)	0.400	Min Node Diameter (mm)	1200
Design Flow (l/s)	2.0		

Node Permeable Surfacing Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	Proposed Discharge	Sump Available	x
Replaces Downstream Link	✓	Product Number	CTL-CHE-0074-2000-0450-2000
Invert Level (m)	44.450	Min Outlet Diameter (m)	0.100
Design Depth (m)	0.450	Min Node Diameter (mm)	1200
Design Flow (l/s)	2.0		

Node Permeable Surfacing Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Width (m)	18.000	Depth (m)	0.400
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	44.450	Length (m)	18.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	1000.0		

Node Green-roof Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Width (m)	14.700	Depth (m)	0.200
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	54.800	Length (m)	14.700	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	172	Slope (1:X)	1000.0		

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +10% A 15 minute summer	109.092	30.869	2 year +10% A 240 minute winter	14.552	5.789
2 year +10% A 15 minute winter	76.556	30.869	2 year +10% A 360 minute summer	16.874	4.342
2 year +10% A 30 minute summer	69.389	19.635	2 year +10% A 360 minute winter	10.969	4.342
2 year +10% A 30 minute winter	48.694	19.635	2 year +10% A 480 minute summer	13.205	3.490
2 year +10% A 60 minute summer	45.852	12.117	2 year +10% A 480 minute winter	8.773	3.490
2 year +10% A 60 minute winter	30.463	12.117	2 year +10% A 600 minute summer	10.711	2.930
2 year +10% A 120 minute summer	33.402	8.827	2 year +10% A 600 minute winter	7.318	2.930
2 year +10% A 120 minute winter	22.191	8.827	2 year +10% A 720 minute summer	9.450	2.533
2 year +10% A 180 minute summer	27.097	6.973	2 year +10% A 720 minute winter	6.351	2.533
2 year +10% A 180 minute winter	17.614	6.973	2 year +10% A 960 minute summer	7.615	2.005
2 year +10% A 240 minute summer	21.904	5.789	2 year +10% A 960 minute winter	5.044	2.005

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +10% A 1440 minute summer	5.391	1.445	2 year +40% CC +10% A 600 minute summer	14.995	4.101
2 year +10% A 1440 minute winter	3.623	1.445	2 year +40% CC +10% A 600 minute winter	10.246	4.101
2 year +10% A 2160 minute summer	3.795	1.049	2 year +40% CC +10% A 720 minute summer	13.229	3.546
2 year +10% A 2160 minute winter	2.615	1.049	2 year +40% CC +10% A 720 minute winter	8.891	3.546
2 year +10% A 2880 minute summer	3.144	0.843	2 year +40% CC +10% A 960 minute summer	10.661	2.807
2 year +10% A 2880 minute winter	2.113	0.843	2 year +40% CC +10% A 960 minute winter	7.062	2.807
2 year +10% A 4320 minute summer	2.415	0.631	2 year +40% CC +10% A 1440 minute summer	7.547	2.023
2 year +10% A 4320 minute winter	1.590	0.631	2 year +40% CC +10% A 1440 minute winter	5.072	2.023
2 year +10% A 5760 minute summer	2.041	0.522	2 year +40% CC +10% A 2160 minute summer	5.313	1.468
2 year +10% A 5760 minute winter	1.321	0.522	2 year +40% CC +10% A 2160 minute winter	3.661	1.468
2 year +10% A 7200 minute summer	1.788	0.456	2 year +40% CC +10% A 2880 minute summer	4.401	1.180
2 year +10% A 7200 minute winter	1.154	0.456	2 year +40% CC +10% A 2880 minute winter	2.958	1.180
2 year +10% A 8640 minute summer	1.612	0.411	2 year +40% CC +10% A 4320 minute summer	3.381	0.884
2 year +10% A 8640 minute winter	1.040	0.411	2 year +40% CC +10% A 4320 minute winter	2.226	0.884
2 year +10% A 10080 minute summer	1.485	0.379	2 year +40% CC +10% A 5760 minute summer	2.857	0.731
2 year +10% A 10080 minute winter	0.959	0.379	2 year +40% CC +10% A 5760 minute winter	1.849	0.731
2 year +40% CC +10% A 15 minute summer	152.729	43.217	2 year +40% CC +10% A 7200 minute summer	2.503	0.638
2 year +40% CC +10% A 15 minute winter	107.178	43.217	2 year +40% CC +10% A 7200 minute winter	1.615	0.638
2 year +40% CC +10% A 30 minute summer	97.144	27.489	2 year +40% CC +10% A 8640 minute summer	2.256	0.576
2 year +40% CC +10% A 30 minute winter	68.172	27.489	2 year +40% CC +10% A 8640 minute winter	1.456	0.576
2 year +40% CC +10% A 60 minute summer	64.193	16.964	2 year +40% CC +10% A 10080 minute summer	2.079	0.530
2 year +40% CC +10% A 60 minute winter	42.648	16.964	2 year +40% CC +10% A 10080 minute winter	1.342	0.530
2 year +40% CC +10% A 120 minute summer	46.762	12.358	10 year +10% A 15 minute summer	234.241	66.282
2 year +40% CC +10% A 120 minute winter	31.068	12.358	10 year +10% A 15 minute winter	164.379	66.282
2 year +40% CC +10% A 180 minute summer	37.936	9.762	10 year +10% A 30 minute summer	149.049	42.176
2 year +40% CC +10% A 180 minute winter	24.660	9.762	10 year +10% A 30 minute winter	104.596	42.176
2 year +40% CC +10% A 240 minute summer	30.665	8.104	10 year +10% A 60 minute summer	97.960	25.888
2 year +40% CC +10% A 240 minute winter	20.373	8.104	10 year +10% A 60 minute winter	65.082	25.888
2 year +40% CC +10% A 360 minute summer	23.624	6.079	10 year +10% A 120 minute summer	63.548	16.794
2 year +40% CC +10% A 360 minute winter	15.356	6.079	10 year +10% A 120 minute winter	42.220	16.794
2 year +40% CC +10% A 480 minute summer	18.487	4.886	10 year +10% A 180 minute summer	49.251	12.674
2 year +40% CC +10% A 480 minute winter	12.282	4.886	10 year +10% A 180 minute winter	32.014	12.674

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
10 year +10% A 240 minute summer	38.791	10.251	10 year +40% CC +10% A 60 minute summer	137.143	36.243
10 year +10% A 240 minute winter	25.772	10.251	10 year +40% CC +10% A 60 minute winter	91.115	36.243
10 year +10% A 360 minute summer	29.019	7.468	10 year +40% CC +10% A 120 minute summer	88.967	23.511
10 year +10% A 360 minute winter	18.863	7.468	10 year +40% CC +10% A 120 minute winter	59.108	23.511
10 year +10% A 480 minute summer	22.324	5.900	10 year +40% CC +10% A 180 minute summer	68.951	17.743
10 year +10% A 480 minute winter	14.831	5.900	10 year +40% CC +10% A 180 minute winter	44.820	17.743
10 year +10% A 600 minute summer	17.893	4.894	10 year +40% CC +10% A 240 minute summer	54.307	14.352
10 year +10% A 600 minute winter	12.225	4.894	10 year +40% CC +10% A 240 minute winter	36.080	14.352
10 year +10% A 720 minute summer	15.644	4.193	10 year +40% CC +10% A 360 minute summer	40.626	10.455
10 year +10% A 720 minute winter	10.514	4.193	10 year +40% CC +10% A 360 minute winter	26.408	10.455
10 year +10% A 960 minute summer	12.438	3.275	10 year +40% CC +10% A 480 minute summer	31.253	8.259
10 year +10% A 960 minute winter	8.239	3.275	10 year +40% CC +10% A 480 minute winter	20.764	8.259
10 year +10% A 1440 minute summer	8.651	2.319	10 year +40% CC +10% A 600 minute summer	25.050	6.852
10 year +10% A 1440 minute winter	5.814	2.319	10 year +40% CC +10% A 600 minute winter	17.116	6.852
10 year +10% A 2160 minute summer	5.969	1.650	10 year +40% CC +10% A 720 minute summer	21.901	5.870
10 year +10% A 2160 minute winter	4.113	1.650	10 year +40% CC +10% A 720 minute winter	14.719	5.870
10 year +10% A 2880 minute summer	4.863	1.303	10 year +40% CC +10% A 960 minute summer	17.413	4.585
10 year +10% A 2880 minute winter	3.269	1.303	10 year +40% CC +10% A 960 minute winter	11.535	4.585
10 year +10% A 4320 minute summer	3.636	0.951	10 year +40% CC +10% A 1440 minute summer	12.111	3.246
10 year +10% A 4320 minute winter	2.395	0.951	10 year +40% CC +10% A 1440 minute winter	8.140	3.246
10 year +10% A 5760 minute summer	3.007	0.770	10 year +40% CC +10% A 2160 minute summer	8.356	2.309
10 year +10% A 5760 minute winter	1.946	0.770	10 year +40% CC +10% A 2160 minute winter	5.758	2.309
10 year +10% A 7200 minute summer	2.586	0.660	10 year +40% CC +10% A 2880 minute summer	6.809	1.825
10 year +10% A 7200 minute winter	1.669	0.660	10 year +40% CC +10% A 2880 minute winter	4.576	1.825
10 year +10% A 8640 minute summer	2.295	0.585	10 year +40% CC +10% A 4320 minute summer	5.091	1.331
10 year +10% A 8640 minute winter	1.481	0.585	10 year +40% CC +10% A 4320 minute winter	3.353	1.331
10 year +10% A 10080 minute summer	2.085	0.532	10 year +40% CC +10% A 5760 minute summer	4.210	1.078
10 year +10% A 10080 minute winter	1.346	0.532	10 year +40% CC +10% A 5760 minute winter	2.725	1.078
10 year +40% CC +10% A 15 minute summer	327.937	92.795	10 year +40% CC +10% A 7200 minute summer	3.620	0.923
10 year +40% CC +10% A 15 minute winter	230.131	92.795	10 year +40% CC +10% A 7200 minute winter	2.336	0.923
10 year +40% CC +10% A 30 minute summer	208.668	59.046	10 year +40% CC +10% A 8640 minute summer	3.212	0.820
10 year +40% CC +10% A 30 minute winter	146.434	59.046	10 year +40% CC +10% A 8640 minute winter	2.073	0.820

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
10 year +40% CC +10% A 10080 minute summer	2.919	0.745	30 year +10% A 5760 minute summer	3.625	0.928
10 year +40% CC +10% A 10080 minute winter	1.884	0.745	30 year +10% A 5760 minute winter	2.346	0.928
30 year +10% A 15 minute summer	313.429	88.690	30 year +10% A 7200 minute summer	3.084	0.787
30 year +10% A 15 minute winter	219.950	88.690	30 year +10% A 7200 minute winter	1.990	0.787
30 year +10% A 30 minute summer	202.051	57.173	30 year +10% A 8640 minute summer	2.711	0.692
30 year +10% A 30 minute winter	141.790	57.173	30 year +10% A 8640 minute winter	1.750	0.692
30 year +10% A 60 minute summer	133.311	35.230	30 year +10% A 10080 minute summer	2.444	0.624
30 year +10% A 60 minute winter	88.569	35.230	30 year +10% A 10080 minute winter	1.578	0.624
30 year +10% A 120 minute summer	84.199	22.251	30 year +40% CC +10% A 15 minute summer	438.801	124.166
30 year +10% A 120 minute winter	55.940	22.251	30 year +40% CC +10% A 15 minute winter	307.931	124.166
30 year +10% A 180 minute summer	64.632	16.632	30 year +40% CC +10% A 30 minute summer	282.871	80.043
30 year +10% A 180 minute winter	42.012	16.632	30 year +40% CC +10% A 30 minute winter	198.506	80.043
30 year +10% A 240 minute summer	50.637	13.382	30 year +40% CC +10% A 60 minute summer	186.635	49.322
30 year +10% A 240 minute winter	33.642	13.382	30 year +40% CC +10% A 60 minute winter	123.996	49.322
30 year +10% A 360 minute summer	37.648	9.688	30 year +40% CC +10% A 120 minute summer	117.879	31.152
30 year +10% A 360 minute winter	24.472	9.688	30 year +40% CC +10% A 120 minute winter	78.316	31.152
30 year +10% A 480 minute summer	28.839	7.621	30 year +40% CC +10% A 180 minute summer	90.485	23.285
30 year +10% A 480 minute winter	19.160	7.621	30 year +40% CC +10% A 180 minute winter	58.817	23.285
30 year +10% A 600 minute summer	23.037	6.301	30 year +40% CC +10% A 240 minute summer	70.892	18.735
30 year +10% A 600 minute winter	15.740	6.301	30 year +40% CC +10% A 240 minute winter	47.099	18.735
30 year +10% A 720 minute summer	20.083	5.382	30 year +40% CC +10% A 360 minute summer	52.707	13.563
30 year +10% A 720 minute winter	13.497	5.382	30 year +40% CC +10% A 360 minute winter	34.261	13.563
30 year +10% A 960 minute summer	15.890	4.184	30 year +40% CC +10% A 480 minute summer	40.375	10.670
30 year +10% A 960 minute winter	10.526	4.184	30 year +40% CC +10% A 480 minute winter	26.824	10.670
30 year +10% A 1440 minute summer	10.951	2.935	30 year +40% CC +10% A 600 minute summer	32.251	8.821
30 year +10% A 1440 minute winter	7.360	2.935	30 year +40% CC +10% A 600 minute winter	22.036	8.821
30 year +10% A 2160 minute summer	7.478	2.067	30 year +40% CC +10% A 720 minute summer	28.116	7.535
30 year +10% A 2160 minute winter	5.153	2.067	30 year +40% CC +10% A 720 minute winter	18.896	7.535
30 year +10% A 2880 minute summer	6.041	1.619	30 year +40% CC +10% A 960 minute summer	22.246	5.858
30 year +10% A 2880 minute winter	4.060	1.619	30 year +40% CC +10% A 960 minute winter	14.736	5.858
30 year +10% A 4320 minute summer	4.444	1.162	30 year +40% CC +10% A 1440 minute summer	15.331	4.109
30 year +10% A 4320 minute winter	2.927	1.162	30 year +40% CC +10% A 1440 minute winter	10.304	4.109

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +40% CC +10% A 2160 minute summer	10.469	2.893	100 year +10% A 720 minute summer	27.142	7.274
30 year +40% CC +10% A 2160 minute winter	7.214	2.893	100 year +10% A 720 minute winter	18.241	7.274
30 year +40% CC +10% A 2880 minute summer	8.458	2.267	100 year +10% A 960 minute summer	21.419	5.640
30 year +40% CC +10% A 2880 minute winter	5.684	2.267	100 year +10% A 960 minute winter	14.189	5.640
30 year +40% CC +10% A 4320 minute summer	6.222	1.627	100 year +10% A 1440 minute summer	14.620	3.918
30 year +40% CC +10% A 4320 minute winter	4.098	1.627	100 year +10% A 1440 minute winter	9.826	3.918
30 year +40% CC +10% A 5760 minute summer	5.075	1.299	100 year +10% A 2160 minute summer	9.818	2.713
30 year +40% CC +10% A 5760 minute winter	3.285	1.299	100 year +10% A 2160 minute winter	6.765	2.713
30 year +40% CC +10% A 7200 minute summer	4.317	1.101	100 year +10% A 2880 minute summer	7.814	2.094
30 year +40% CC +10% A 7200 minute winter	2.786	1.101	100 year +10% A 2880 minute winter	5.251	2.094
30 year +40% CC +10% A 8640 minute summer	3.796	0.968	100 year +10% A 4320 minute summer	5.602	1.465
30 year +40% CC +10% A 8640 minute winter	2.450	0.968	100 year +10% A 4320 minute winter	3.689	1.465
30 year +40% CC +10% A 10080 minute summer	3.422	0.873	100 year +10% A 5760 minute summer	4.473	1.145
30 year +40% CC +10% A 10080 minute winter	2.209	0.873	100 year +10% A 5760 minute winter	2.895	1.145
100 year +10% A 15 minute summer	410.896	116.269	100 year +10% A 7200 minute summer	3.739	0.954
100 year +10% A 15 minute winter	288.348	116.269	100 year +10% A 7200 minute winter	2.413	0.954
100 year +10% A 30 minute summer	267.647	75.735	100 year +10% A 8640 minute summer	3.240	0.826
100 year +10% A 30 minute winter	187.822	75.735	100 year +10% A 8640 minute winter	2.091	0.826
100 year +10% A 60 minute summer	177.095	46.801	100 year +10% A 10080 minute summer	2.885	0.736
100 year +10% A 60 minute winter	117.658	46.801	100 year +10% A 10080 minute winter	1.862	0.736
100 year +10% A 120 minute summer	111.686	29.515	100 year +40% CC +10% A 15 minute summer	575.255	162.777
100 year +10% A 120 minute winter	74.201	29.515	100 year +40% CC +10% A 15 minute winter	403.688	162.777
100 year +10% A 180 minute summer	86.213	22.186	100 year +40% CC +10% A 30 minute summer	374.705	106.029
100 year +10% A 180 minute winter	56.041	22.186	100 year +40% CC +10% A 30 minute winter	262.951	106.029
100 year +10% A 240 minute summer	67.873	17.937	100 year +40% CC +10% A 60 minute summer	247.933	65.521
100 year +10% A 240 minute winter	45.093	17.937	100 year +40% CC +10% A 60 minute winter	164.721	65.521
100 year +10% A 360 minute summer	50.762	13.063	100 year +40% CC +10% A 120 minute summer	156.360	41.321
100 year +10% A 360 minute winter	32.996	13.063	100 year +40% CC +10% A 120 minute winter	103.882	41.321
100 year +10% A 480 minute summer	38.980	10.301	100 year +40% CC +10% A 180 minute summer	120.698	31.060
100 year +10% A 480 minute winter	25.898	10.301	100 year +40% CC +10% A 180 minute winter	78.457	31.060
100 year +10% A 600 minute summer	31.151	8.520	100 year +40% CC +10% A 240 minute summer	95.022	25.111
100 year +10% A 600 minute winter	21.284	8.520	100 year +40% CC +10% A 240 minute winter	63.130	25.111

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC +10% A 360 minute summer	71.066	18.288	100 year +40% CC +10% A 2160 minute winter	9.471	3.799
100 year +40% CC +10% A 360 minute winter	46.195	18.288	100 year +40% CC +10% A 2880 minute summer	10.939	2.932
100 year +40% CC +10% A 480 minute summer	54.572	14.422	100 year +40% CC +10% A 2880 minute winter	7.352	2.932
100 year +40% CC +10% A 480 minute winter	36.257	14.422	100 year +40% CC +10% A 4320 minute summer	7.843	2.051
100 year +40% CC +10% A 600 minute summer	43.611	11.929	100 year +40% CC +10% A 4320 minute winter	5.165	2.051
100 year +40% CC +10% A 600 minute winter	29.798	11.929	100 year +40% CC +10% A 5760 minute summer	6.262	1.603
100 year +40% CC +10% A 720 minute summer	37.999	10.184	100 year +40% CC +10% A 5760 minute winter	4.053	1.603
100 year +40% CC +10% A 720 minute winter	25.538	10.184	100 year +40% CC +10% A 7200 minute summer	5.235	1.335
100 year +40% CC +10% A 960 minute summer	29.987	7.896	100 year +40% CC +10% A 7200 minute winter	3.378	1.335
100 year +40% CC +10% A 960 minute winter	19.864	7.896	100 year +40% CC +10% A 8640 minute summer	4.535	1.157
100 year +40% CC +10% A 1440 minute summer	20.468	5.486	100 year +40% CC +10% A 8640 minute winter	2.927	1.157
100 year +40% CC +10% A 1440 minute winter	13.756	5.486	100 year +40% CC +10% A 10080 minute summer	4.038	1.030
100 year +40% CC +10% A 2160 minute summer	13.745	3.799	100 year +40% CC +10% A 10080 minute winter	2.606	1.030

Results for 2 year +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute summer	Green-roof	375	54.827	0.027	0.7	3.9494	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.2	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.580	0.040	2.0	0.0453	0.0000	OK
360 minute winter	Permeable Surfacing	312	44.490	0.040	1.6	9.4566	0.0000	OK
15 minute summer	Existing	10	9.026	0.026	9.1	0.0739	0.0000	OK
15 minute summer	Existing 1	10	8.025	0.025	9.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
600 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.3				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	2.0	0.917	0.134	0.0294	
360 minute winter	Permeable Surfacing	Hydro-Brake®	Outlet	0.5				11.5
15 minute summer	Existing	Existing Runoff	Existing 1	9.1	1.803	0.001	0.0505	3.6

Results for 2 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	Green-roof	240	54.834	0.034	1.6	5.4435	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.2	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.586	0.046	2.7	0.0523	0.0000	OK
360 minute summer	Permeable Surfacing	272	44.502	0.052	3.2	13.1094	0.0000	OK
15 minute summer	Existing	10	9.030	0.030	12.8	0.0863	0.0000	OK
15 minute summer	Existing 1	10	8.029	0.029	12.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.4				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	2.7	1.009	0.181	0.0363	
360 minute summer	Permeable Surfacing	Hydro-Brake®	Outlet	0.8				17.1
15 minute summer	Existing	Existing Runoff	Existing 1	12.8	1.999	0.002	0.0641	5.0

Results for 10 year +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	Green-roof	140	54.840	0.040	2.2	6.6714	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.4	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.597	0.057	4.2	0.0650	0.0000	OK
360 minute summer	Permeable Surfacing	264	44.511	0.061	4.0	15.8917	0.0000	OK
15 minute summer	Existing	10	9.037	0.037	19.6	0.1053	0.0000	OK
15 minute summer	Existing 1	10	8.035	0.035	19.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	Green-roof	Hydro-Brake®	Permeable Surfacing	0.5				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	4.2	1.153	0.281	0.0495	
360 minute summer	Permeable Surfacing	Hydro-Brake®	Outlet	1.0				21.5
15 minute summer	Existing	Existing Runoff	Existing 1	19.6	2.260	0.002	0.0868	7.6

Results for 10 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	164	54.852	0.052	3.7	9.1791	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.6	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.608	0.068	5.9	0.0770	0.0000	OK
360 minute winter	Permeable Surfacing	288	44.532	0.082	3.9	22.3418	0.0000	OK
15 minute summer	Existing	10	9.044	0.044	27.5	0.1238	0.0000	OK
15 minute summer	Existing 1	10	8.041	0.041	27.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.8				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	5.9	1.267	0.394	0.0633	
360 minute winter	Permeable Surfacing	Hydro-Brake®	Outlet	1.4				30.7
15 minute summer	Existing	Existing Runoff	Existing 1	27.5	2.476	0.003	0.1111	10.7

Results for 30 year +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.849	0.049	3.4	8.5896	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.6	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.606	0.066	5.6	0.0750	0.0000	OK
240 minute winter	Permeable Surfacing	228	44.526	0.076	4.8	20.7299	0.0000	OK
15 minute summer	Existing	10	9.043	0.043	26.3	0.1211	0.0000	OK
15 minute summer	Existing 1	10	8.041	0.041	26.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.8				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	5.6	1.250	0.374	0.0610	
240 minute winter	Permeable Surfacing	Hydro-Brake®	Outlet	1.3				24.1
15 minute summer	Existing	Existing Runoff	Existing 1	26.3	2.447	0.003	0.1075	10.2

Results for 30 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.864	0.064	4.8	11.6998	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.9	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.619	0.079	7.9	0.0897	0.0000	OK
240 minute winter	Permeable Surfacing	232	44.555	0.105	6.7	29.5755	0.0000	OK
15 minute summer	Existing	10	9.050	0.050	36.8	0.1416	0.0000	OK
15 minute summer	Existing 1	10	8.047	0.047	36.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.1				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	7.9	1.359	0.528	0.0789	
240 minute winter	Permeable Surfacing	Hydro-Brake®	Outlet	1.7				33.5
15 minute summer	Existing	Existing Runoff	Existing 1	36.8	2.666	0.004	0.1381	14.3

Results for 100 year +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.863	0.063	4.6	11.2922	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.8	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.617	0.077	7.4	0.0866	0.0000	OK
360 minute summer	Permeable Surfacing	288	44.551	0.101	7.2	28.3407	0.0000	OK
15 minute summer	Existing	10	9.048	0.048	34.5	0.1374	0.0000	OK
15 minute summer	Existing 1	10	8.046	0.046	34.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.1				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	7.4	1.338	0.494	0.0751	
360 minute summer	Permeable Surfacing	Hydro-Brake®	Outlet	1.7				38.1
15 minute summer	Existing	Existing Runoff	Existing 1	34.5	2.621	0.004	0.1316	13.4

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.884	0.084	6.4	15.6986	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	1.2	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.632	0.092	10.3	0.1039	0.0000	OK
360 minute winter	Permeable Surfacing	344	44.595	0.145	7.0	41.8929	0.0000	OK
15 minute summer	Existing	10	9.057	0.057	48.2	0.1618	0.0000	OK
15 minute summer	Existing 1	10	8.054	0.054	48.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.5				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	10.3	1.433	0.687	0.0972	
360 minute winter	Permeable Surfacing	Hydro-Brake®	Outlet	2.0				50.7
15 minute summer	Existing	Existing Runoff	Existing 1	48.2	2.867	0.006	0.1681	18.8

Design Settings

Rainfall Methodology	FEH-13	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	100	Maximum Rainfall (mm/hr)	200.0	Include Intermediate Ground	✓
Additional Flow (%)	40	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	x
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	4.00	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Green-roof	0.022	4.00	55.000		-162.514	-8.986	0.200
Outlet			44.800	900	-148.513	-22.827	1.180
Remaining roof area	0.009	4.00	45.000	1200	-173.384	-16.657	0.460
Permeable Surfacing	0.033	4.00	45.000		-162.638	-22.834	0.550
Existing	0.042	4.00	10.000	1900			1.000
Existing 1	0.000		10.000	1900			2.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
Proposed Discharge	Permeable Surfacing	Outlet	14.125	0.600	44.450	43.620	0.830	17.0	225	4.32	196.0
1.000	Green-roof	Permeable Surfacing	13.849	0.600	54.800	44.450	10.350	1.3	100	4.03	196.0
2.000	Remaining roof area	Permeable Surfacing	12.395	0.600	44.540	44.450	0.090	137.7	150	4.24	196.0
Existing Runoff	Existing	Existing 1	10.000	0.600	9.000	8.000	1.000	10.0	1000	4.02	196.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
Proposed Discharge	3.187	126.7	63.5	0.325	0.955	0.064	0.0	113	3.192
1.000	6.742	53.0	21.8	0.100	0.450	0.022	0.0	45	6.434
2.000	0.854	15.1	8.9	0.310	0.400	0.009	0.0	83	0.889
Existing Runoff	10.602	8327.0	41.7	0.000	1.000	0.042	0.0	49	2.897

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Proposed Discharge	14.125	17.0	225	Circular	45.000	44.450	0.325	44.800	43.620	0.955
1.000	13.849	1.3	100	Circular	55.000	54.800	0.100	45.000	44.450	0.450
2.000	12.395	137.7	150	Circular	45.000	44.540	0.310	45.000	44.450	0.400

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Proposed Discharge	Permeable Surfacing		Junction		Outlet	900	Manhole	Adoptable
1.000	Green-roof		Junction		Permeable Surfacing		Junction	
2.000	Remaining roof area	1200	Manhole	Adoptable	Permeable Surfacing		Junction	

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
Existing Runoff	10.000	10.0	1000	Circular	10.000	9.000	0.000	10.000	8.000	1.000

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
Existing Runoff	Existing	1900	Manhole	Adoptable	Existing 1	1900	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Green-roof	-162.514	-8.986	55.000	0.200		0	1.000	54.800	100
Outlet	-148.513	-22.827	44.800	1.180	900	1	Proposed Discharge	43.620	225
Remaining roof area	-173.384	-16.657	45.000	0.460	1200	0	2.000	44.540	150
Permeable Surfacing	-162.638	-22.834	45.000	0.550		1	2.000	44.450	150
						2	1.000	44.450	100
						0	Proposed Discharge	44.450	225
Existing			10.000	1.000	1900	0	Existing Runoff	9.000	1000

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
Existing 1			10.000	2.000	1900	1	Existing Runoff	8.000	1000

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Detailed	Additional Storage (m³/ha)	0.0
Summer CV	1.000	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	10	0	30	0	10	0
2	40	10	0	30	40	10	0
10	0	10	0	100	0	10	0
10	40	10	0	100	40	10	0

Node Green-roof Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.000	Sump Available	x
Replaces Downstream Link	✓	Product Number	CTL-CHE-0075-2000-0400-2000
Invert Level (m)	54.800	Min Outlet Diameter (m)	0.100
Design Depth (m)	0.400	Min Node Diameter (mm)	1200
Design Flow (l/s)	2.0		

Node Permeable Surfacing Online Weir Control

Flap Valve	x	Replaces Downstream Link	x	Width (m)	1.000
Downstream Link	Proposed Discharge	Invert Level (m)	44.990	Discharge Coefficient	0.590

Node Permeable Surfacing Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Width (m)	18.000	Depth (m)	0.400
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	44.450	Length (m)	18.000	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)		Slope (1:X)	1000.0		

Node Green-roof Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Width (m)	14.700	Depth (m)	0.200
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	54.800	Length (m)	14.700	Inf Depth (m)	
Safety Factor	2.0	Time to half empty (mins)	172	Slope (1:X)	1000.0		

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +10% A 15 minute summer	109.092	30.869	2 year +10% A 480 minute winter	8.773	3.490
2 year +10% A 15 minute winter	76.556	30.869	2 year +10% A 600 minute summer	10.711	2.930
2 year +10% A 30 minute summer	69.389	19.635	2 year +10% A 600 minute winter	7.318	2.930
2 year +10% A 30 minute winter	48.694	19.635	2 year +10% A 720 minute summer	9.450	2.533
2 year +10% A 60 minute summer	45.852	12.117	2 year +10% A 720 minute winter	6.351	2.533
2 year +10% A 60 minute winter	30.463	12.117	2 year +10% A 960 minute summer	7.615	2.005
2 year +10% A 120 minute summer	33.402	8.827	2 year +10% A 960 minute winter	5.044	2.005
2 year +10% A 120 minute winter	22.191	8.827	2 year +10% A 1440 minute summer	5.391	1.445
2 year +10% A 180 minute summer	27.097	6.973	2 year +10% A 1440 minute winter	3.623	1.445
2 year +10% A 180 minute winter	17.614	6.973	2 year +10% A 2160 minute summer	3.795	1.049
2 year +10% A 240 minute summer	21.904	5.789	2 year +10% A 2160 minute winter	2.615	1.049
2 year +10% A 240 minute winter	14.552	5.789	2 year +10% A 2880 minute summer	3.144	0.843
2 year +10% A 360 minute summer	16.874	4.342	2 year +10% A 2880 minute winter	2.113	0.843
2 year +10% A 360 minute winter	10.969	4.342	2 year +10% A 4320 minute summer	2.415	0.631
2 year +10% A 480 minute summer	13.205	3.490	2 year +10% A 4320 minute winter	1.590	0.631

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +10% A 5760 minute summer	2.041	0.522	2 year +40% CC +10% A 2160 minute summer	5.313	1.468
2 year +10% A 5760 minute winter	1.321	0.522	2 year +40% CC +10% A 2160 minute winter	3.661	1.468
2 year +10% A 7200 minute summer	1.788	0.456	2 year +40% CC +10% A 2880 minute summer	4.401	1.180
2 year +10% A 7200 minute winter	1.154	0.456	2 year +40% CC +10% A 2880 minute winter	2.958	1.180
2 year +10% A 8640 minute summer	1.612	0.411	2 year +40% CC +10% A 4320 minute summer	3.381	0.884
2 year +10% A 8640 minute winter	1.040	0.411	2 year +40% CC +10% A 4320 minute winter	2.226	0.884
2 year +10% A 10080 minute summer	1.485	0.379	2 year +40% CC +10% A 5760 minute summer	2.857	0.731
2 year +10% A 10080 minute winter	0.959	0.379	2 year +40% CC +10% A 5760 minute winter	1.849	0.731
2 year +40% CC +10% A 15 minute summer	152.729	43.217	2 year +40% CC +10% A 7200 minute summer	2.503	0.638
2 year +40% CC +10% A 15 minute winter	107.178	43.217	2 year +40% CC +10% A 7200 minute winter	1.615	0.638
2 year +40% CC +10% A 30 minute summer	97.144	27.489	2 year +40% CC +10% A 8640 minute summer	2.256	0.576
2 year +40% CC +10% A 30 minute winter	68.172	27.489	2 year +40% CC +10% A 8640 minute winter	1.456	0.576
2 year +40% CC +10% A 60 minute summer	64.193	16.964	2 year +40% CC +10% A 10080 minute summer	2.079	0.530
2 year +40% CC +10% A 60 minute winter	42.648	16.964	2 year +40% CC +10% A 10080 minute winter	1.342	0.530
2 year +40% CC +10% A 120 minute summer	46.762	12.358	10 year +10% A 15 minute summer	234.241	66.282
2 year +40% CC +10% A 120 minute winter	31.068	12.358	10 year +10% A 15 minute winter	164.379	66.282
2 year +40% CC +10% A 180 minute summer	37.936	9.762	10 year +10% A 30 minute summer	149.049	42.176
2 year +40% CC +10% A 180 minute winter	24.660	9.762	10 year +10% A 30 minute winter	104.596	42.176
2 year +40% CC +10% A 240 minute summer	30.665	8.104	10 year +10% A 60 minute summer	97.960	25.888
2 year +40% CC +10% A 240 minute winter	20.373	8.104	10 year +10% A 60 minute winter	65.082	25.888
2 year +40% CC +10% A 360 minute summer	23.624	6.079	10 year +10% A 120 minute summer	63.548	16.794
2 year +40% CC +10% A 360 minute winter	15.356	6.079	10 year +10% A 120 minute winter	42.220	16.794
2 year +40% CC +10% A 480 minute summer	18.487	4.886	10 year +10% A 180 minute summer	49.251	12.674
2 year +40% CC +10% A 480 minute winter	12.282	4.886	10 year +10% A 180 minute winter	32.014	12.674
2 year +40% CC +10% A 600 minute summer	14.995	4.101	10 year +10% A 240 minute summer	38.791	10.251
2 year +40% CC +10% A 600 minute winter	10.246	4.101	10 year +10% A 240 minute winter	25.772	10.251
2 year +40% CC +10% A 720 minute summer	13.229	3.546	10 year +10% A 360 minute summer	29.019	7.468
2 year +40% CC +10% A 720 minute winter	8.891	3.546	10 year +10% A 360 minute winter	18.863	7.468
2 year +40% CC +10% A 960 minute summer	10.661	2.807	10 year +10% A 480 minute summer	22.324	5.900
2 year +40% CC +10% A 960 minute winter	7.062	2.807	10 year +10% A 480 minute winter	14.831	5.900
2 year +40% CC +10% A 1440 minute summer	7.547	2.023	10 year +10% A 600 minute summer	17.893	4.894
2 year +40% CC +10% A 1440 minute winter	5.072	2.023	10 year +10% A 600 minute winter	12.225	4.894

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
10 year +10% A 720 minute summer	15.644	4.193	10 year +40% CC +10% A 360 minute summer	40.626	10.455
10 year +10% A 720 minute winter	10.514	4.193	10 year +40% CC +10% A 360 minute winter	26.408	10.455
10 year +10% A 960 minute summer	12.438	3.275	10 year +40% CC +10% A 480 minute summer	31.253	8.259
10 year +10% A 960 minute winter	8.239	3.275	10 year +40% CC +10% A 480 minute winter	20.764	8.259
10 year +10% A 1440 minute summer	8.651	2.319	10 year +40% CC +10% A 600 minute summer	25.050	6.852
10 year +10% A 1440 minute winter	5.814	2.319	10 year +40% CC +10% A 600 minute winter	17.116	6.852
10 year +10% A 2160 minute summer	5.969	1.650	10 year +40% CC +10% A 720 minute summer	21.901	5.870
10 year +10% A 2160 minute winter	4.113	1.650	10 year +40% CC +10% A 720 minute winter	14.719	5.870
10 year +10% A 2880 minute summer	4.863	1.303	10 year +40% CC +10% A 960 minute summer	17.413	4.585
10 year +10% A 2880 minute winter	3.269	1.303	10 year +40% CC +10% A 960 minute winter	11.535	4.585
10 year +10% A 4320 minute summer	3.636	0.951	10 year +40% CC +10% A 1440 minute summer	12.111	3.246
10 year +10% A 4320 minute winter	2.395	0.951	10 year +40% CC +10% A 1440 minute winter	8.140	3.246
10 year +10% A 5760 minute summer	3.007	0.770	10 year +40% CC +10% A 2160 minute summer	8.356	2.309
10 year +10% A 5760 minute winter	1.946	0.770	10 year +40% CC +10% A 2160 minute winter	5.758	2.309
10 year +10% A 7200 minute summer	2.586	0.660	10 year +40% CC +10% A 2880 minute summer	6.809	1.825
10 year +10% A 7200 minute winter	1.669	0.660	10 year +40% CC +10% A 2880 minute winter	4.576	1.825
10 year +10% A 8640 minute summer	2.295	0.585	10 year +40% CC +10% A 4320 minute summer	5.091	1.331
10 year +10% A 8640 minute winter	1.481	0.585	10 year +40% CC +10% A 4320 minute winter	3.353	1.331
10 year +10% A 10080 minute summer	2.085	0.532	10 year +40% CC +10% A 5760 minute summer	4.210	1.078
10 year +10% A 10080 minute winter	1.346	0.532	10 year +40% CC +10% A 5760 minute winter	2.725	1.078
10 year +40% CC +10% A 15 minute summer	327.937	92.795	10 year +40% CC +10% A 7200 minute summer	3.620	0.923
10 year +40% CC +10% A 15 minute winter	230.131	92.795	10 year +40% CC +10% A 7200 minute winter	2.336	0.923
10 year +40% CC +10% A 30 minute summer	208.668	59.046	10 year +40% CC +10% A 8640 minute summer	3.212	0.820
10 year +40% CC +10% A 30 minute winter	146.434	59.046	10 year +40% CC +10% A 8640 minute winter	2.073	0.820
10 year +40% CC +10% A 60 minute summer	137.143	36.243	10 year +40% CC +10% A 10080 minute summer	2.919	0.745
10 year +40% CC +10% A 60 minute winter	91.115	36.243	10 year +40% CC +10% A 10080 minute winter	1.884	0.745
10 year +40% CC +10% A 120 minute summer	88.967	23.511	30 year +10% A 15 minute summer	313.429	88.690
10 year +40% CC +10% A 120 minute winter	59.108	23.511	30 year +10% A 15 minute winter	219.950	88.690
10 year +40% CC +10% A 180 minute summer	68.951	17.743	30 year +10% A 30 minute summer	202.051	57.173
10 year +40% CC +10% A 180 minute winter	44.820	17.743	30 year +10% A 30 minute winter	141.790	57.173
10 year +40% CC +10% A 240 minute summer	54.307	14.352	30 year +10% A 60 minute summer	133.311	35.230
10 year +40% CC +10% A 240 minute winter	36.080	14.352	30 year +10% A 60 minute winter	88.569	35.230

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +10% A 120 minute summer	84.199	22.251	30 year +40% CC +10% A 15 minute summer	438.801	124.166
30 year +10% A 120 minute winter	55.940	22.251	30 year +40% CC +10% A 15 minute winter	307.931	124.166
30 year +10% A 180 minute summer	64.632	16.632	30 year +40% CC +10% A 30 minute summer	282.871	80.043
30 year +10% A 180 minute winter	42.012	16.632	30 year +40% CC +10% A 30 minute winter	198.506	80.043
30 year +10% A 240 minute summer	50.637	13.382	30 year +40% CC +10% A 60 minute summer	186.635	49.322
30 year +10% A 240 minute winter	33.642	13.382	30 year +40% CC +10% A 60 minute winter	123.996	49.322
30 year +10% A 360 minute summer	37.648	9.688	30 year +40% CC +10% A 120 minute summer	117.879	31.152
30 year +10% A 360 minute winter	24.472	9.688	30 year +40% CC +10% A 120 minute winter	78.316	31.152
30 year +10% A 480 minute summer	28.839	7.621	30 year +40% CC +10% A 180 minute summer	90.485	23.285
30 year +10% A 480 minute winter	19.160	7.621	30 year +40% CC +10% A 180 minute winter	58.817	23.285
30 year +10% A 600 minute summer	23.037	6.301	30 year +40% CC +10% A 240 minute summer	70.892	18.735
30 year +10% A 600 minute winter	15.740	6.301	30 year +40% CC +10% A 240 minute winter	47.099	18.735
30 year +10% A 720 minute summer	20.083	5.382	30 year +40% CC +10% A 360 minute summer	52.707	13.563
30 year +10% A 720 minute winter	13.497	5.382	30 year +40% CC +10% A 360 minute winter	34.261	13.563
30 year +10% A 960 minute summer	15.890	4.184	30 year +40% CC +10% A 480 minute summer	40.375	10.670
30 year +10% A 960 minute winter	10.526	4.184	30 year +40% CC +10% A 480 minute winter	26.824	10.670
30 year +10% A 1440 minute summer	10.951	2.935	30 year +40% CC +10% A 600 minute summer	32.251	8.821
30 year +10% A 1440 minute winter	7.360	2.935	30 year +40% CC +10% A 600 minute winter	22.036	8.821
30 year +10% A 2160 minute summer	7.478	2.067	30 year +40% CC +10% A 720 minute summer	28.116	7.535
30 year +10% A 2160 minute winter	5.153	2.067	30 year +40% CC +10% A 720 minute winter	18.896	7.535
30 year +10% A 2880 minute summer	6.041	1.619	30 year +40% CC +10% A 960 minute summer	22.246	5.858
30 year +10% A 2880 minute winter	4.060	1.619	30 year +40% CC +10% A 960 minute winter	14.736	5.858
30 year +10% A 4320 minute summer	4.444	1.162	30 year +40% CC +10% A 1440 minute summer	15.331	4.109
30 year +10% A 4320 minute winter	2.927	1.162	30 year +40% CC +10% A 1440 minute winter	10.304	4.109
30 year +10% A 5760 minute summer	3.625	0.928	30 year +40% CC +10% A 2160 minute summer	10.469	2.893
30 year +10% A 5760 minute winter	2.346	0.928	30 year +40% CC +10% A 2160 minute winter	7.214	2.893
30 year +10% A 7200 minute summer	3.084	0.787	30 year +40% CC +10% A 2880 minute summer	8.458	2.267
30 year +10% A 7200 minute winter	1.990	0.787	30 year +40% CC +10% A 2880 minute winter	5.684	2.267
30 year +10% A 8640 minute summer	2.711	0.692	30 year +40% CC +10% A 4320 minute summer	6.222	1.627
30 year +10% A 8640 minute winter	1.750	0.692	30 year +40% CC +10% A 4320 minute winter	4.098	1.627
30 year +10% A 10080 minute summer	2.444	0.624	30 year +40% CC +10% A 5760 minute summer	5.075	1.299
30 year +10% A 10080 minute winter	1.578	0.624	30 year +40% CC +10% A 5760 minute winter	3.285	1.299

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +40% CC +10% A 7200 minute summer	4.317	1.101	100 year +10% A 2880 minute summer	7.814	2.094
30 year +40% CC +10% A 7200 minute winter	2.786	1.101	100 year +10% A 2880 minute winter	5.251	2.094
30 year +40% CC +10% A 8640 minute summer	3.796	0.968	100 year +10% A 4320 minute summer	5.602	1.465
30 year +40% CC +10% A 8640 minute winter	2.450	0.968	100 year +10% A 4320 minute winter	3.689	1.465
30 year +40% CC +10% A 10080 minute summer	3.422	0.873	100 year +10% A 5760 minute summer	4.473	1.145
30 year +40% CC +10% A 10080 minute winter	2.209	0.873	100 year +10% A 5760 minute winter	2.895	1.145
100 year +10% A 15 minute summer	410.896	116.269	100 year +10% A 7200 minute summer	3.739	0.954
100 year +10% A 15 minute winter	288.348	116.269	100 year +10% A 7200 minute winter	2.413	0.954
100 year +10% A 30 minute summer	267.647	75.735	100 year +10% A 8640 minute summer	3.240	0.826
100 year +10% A 30 minute winter	187.822	75.735	100 year +10% A 8640 minute winter	2.091	0.826
100 year +10% A 60 minute summer	177.095	46.801	100 year +10% A 10080 minute summer	2.885	0.736
100 year +10% A 60 minute winter	117.658	46.801	100 year +10% A 10080 minute winter	1.862	0.736
100 year +10% A 120 minute summer	111.686	29.515	100 year +40% CC +10% A 15 minute summer	575.255	162.777
100 year +10% A 120 minute winter	74.201	29.515	100 year +40% CC +10% A 15 minute winter	403.688	162.777
100 year +10% A 180 minute summer	86.213	22.186	100 year +40% CC +10% A 30 minute summer	374.705	106.029
100 year +10% A 180 minute winter	56.041	22.186	100 year +40% CC +10% A 30 minute winter	262.951	106.029
100 year +10% A 240 minute summer	67.873	17.937	100 year +40% CC +10% A 60 minute summer	247.933	65.521
100 year +10% A 240 minute winter	45.093	17.937	100 year +40% CC +10% A 60 minute winter	164.721	65.521
100 year +10% A 360 minute summer	50.762	13.063	100 year +40% CC +10% A 120 minute summer	156.360	41.321
100 year +10% A 360 minute winter	32.996	13.063	100 year +40% CC +10% A 120 minute winter	103.882	41.321
100 year +10% A 480 minute summer	38.980	10.301	100 year +40% CC +10% A 180 minute summer	120.698	31.060
100 year +10% A 480 minute winter	25.898	10.301	100 year +40% CC +10% A 180 minute winter	78.457	31.060
100 year +10% A 600 minute summer	31.151	8.520	100 year +40% CC +10% A 240 minute summer	95.022	25.111
100 year +10% A 600 minute winter	21.284	8.520	100 year +40% CC +10% A 240 minute winter	63.130	25.111
100 year +10% A 720 minute summer	27.142	7.274	100 year +40% CC +10% A 360 minute summer	71.066	18.288
100 year +10% A 720 minute winter	18.241	7.274	100 year +40% CC +10% A 360 minute winter	46.195	18.288
100 year +10% A 960 minute summer	21.419	5.640	100 year +40% CC +10% A 480 minute summer	54.572	14.422
100 year +10% A 960 minute winter	14.189	5.640	100 year +40% CC +10% A 480 minute winter	36.257	14.422
100 year +10% A 1440 minute summer	14.620	3.918	100 year +40% CC +10% A 600 minute summer	43.611	11.929
100 year +10% A 1440 minute winter	9.826	3.918	100 year +40% CC +10% A 600 minute winter	29.798	11.929
100 year +10% A 2160 minute summer	9.818	2.713	100 year +40% CC +10% A 720 minute summer	37.999	10.184
100 year +10% A 2160 minute winter	6.765	2.713	100 year +40% CC +10% A 720 minute winter	25.538	10.184

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +40% CC +10% A 960 minute summer	29.987	7.896	100 year +40% CC +10% A 4320 minute winter	5.165	2.051
100 year +40% CC +10% A 960 minute winter	19.864	7.896	100 year +40% CC +10% A 5760 minute summer	6.262	1.603
100 year +40% CC +10% A 1440 minute summer	20.468	5.486	100 year +40% CC +10% A 5760 minute winter	4.053	1.603
100 year +40% CC +10% A 1440 minute winter	13.756	5.486	100 year +40% CC +10% A 7200 minute summer	5.235	1.335
100 year +40% CC +10% A 2160 minute summer	13.745	3.799	100 year +40% CC +10% A 7200 minute winter	3.378	1.335
100 year +40% CC +10% A 2160 minute winter	9.471	3.799	100 year +40% CC +10% A 8640 minute summer	4.535	1.157
100 year +40% CC +10% A 2880 minute summer	10.939	2.932	100 year +40% CC +10% A 8640 minute winter	2.927	1.157
100 year +40% CC +10% A 2880 minute winter	7.352	2.932	100 year +40% CC +10% A 10080 minute summer	4.038	1.030
100 year +40% CC +10% A 4320 minute summer	7.843	2.051	100 year +40% CC +10% A 10080 minute winter	2.606	1.030

Results for 2 year +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
600 minute summer	Green-roof	375	54.827	0.027	0.7	3.9494	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.580	0.040	2.0	0.0452	0.0000	OK
10080 minute winter	Permeable Surfacing	7980	44.555	0.105	0.2	29.4199	0.0000	OK
15 minute summer	Existing	10	9.026	0.026	9.1	0.0739	0.0000	OK
15 minute summer	Existing 1	10	8.025	0.025	9.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
600 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.3				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	2.0	0.919	0.133	0.0290	
10080 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	9.1	1.803	0.001	0.0505	3.6

Results for 2 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute summer	Green-roof	240	54.834	0.034	1.6	5.4435	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
10080 minute winter	Remaining roof area	8880	44.592	0.052	0.0	0.0587	0.0000	OK
10080 minute winter	Permeable Surfacing	9660	44.592	0.142	0.2	40.8376	0.0000	OK
15 minute summer	Existing	10	9.030	0.030	12.8	0.0863	0.0000	OK
15 minute summer	Existing 1	10	8.029	0.029	12.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
360 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.4				
10080 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.0	0.002	0.002	0.1402	
10080 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	12.8	1.999	0.002	0.0641	5.0

Results for 10 year +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	Green-roof	140	54.840	0.040	2.2	6.6714	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
15 minute summer	Remaining roof area	10	44.597	0.057	4.2	0.0648	0.0000	OK
2880 minute winter	Permeable Surfacing	3120	44.594	0.144	0.6	41.5508	0.0000	OK
15 minute summer	Existing	10	9.037	0.037	19.6	0.1053	0.0000	OK
15 minute summer	Existing 1	10	8.035	0.035	19.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	Green-roof	Hydro-Brake®	Permeable Surfacing	0.5				
15 minute summer	Remaining roof area	2.000	Permeable Surfacing	4.2	1.155	0.279	0.0488	
2880 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	19.6	2.260	0.002	0.0868	7.6

Results for 10 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	164	54.852	0.052	3.7	9.1791	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
10080 minute winter	Remaining roof area	7860	44.673	0.133	0.1	0.1506	0.0000	OK
10080 minute winter	Permeable Surfacing	9840	44.673	0.223	0.4	65.8596	0.0000	OK
15 minute summer	Existing	10	9.044	0.044	27.5	0.1238	0.0000	OK
15 minute summer	Existing 1	10	8.041	0.041	27.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.8				
10080 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.1	0.019	0.007	0.2115	
10080 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	27.5	2.476	0.003	0.1111	10.7

Results for 30 year +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.849	0.049	3.4	8.5896	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
4320 minute winter	Remaining roof area	4440	44.645	0.105	0.1	0.1190	0.0000	OK
4320 minute winter	Permeable Surfacing	4560	44.645	0.195	0.6	57.2724	0.0000	OK
15 minute summer	Existing	10	9.043	0.043	26.3	0.1211	0.0000	OK
15 minute summer	Existing 1	10	8.041	0.041	26.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	0.8				
4320 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.1	0.047	0.007	0.1909	
4320 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	26.3	2.447	0.003	0.1075	10.2

Results for 30 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.864	0.064	4.8	11.6998	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
5760 minute winter	Remaining roof area	5700	44.733	0.193	0.1	0.2178	0.0000	FLOOD RISK
5760 minute winter	Permeable Surfacing	5820	44.732	0.282	0.6	84.1484	0.0000	FLOOD RISK
15 minute summer	Existing	10	9.050	0.050	36.8	0.1416	0.0000	OK
15 minute summer	Existing 1	10	8.047	0.047	36.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.1				
5760 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.1	0.036	0.007	0.2182	
5760 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	36.8	2.666	0.004	0.1381	14.3

Results for 100 year +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.863	0.063	4.6	11.2922	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
5760 minute winter	Remaining roof area	5340	44.703	0.163	0.1	0.1848	0.0000	FLOOD RISK
5760 minute winter	Permeable Surfacing	5760	44.703	0.253	0.6	75.1813	0.0000	FLOOD RISK
15 minute summer	Existing	10	9.048	0.048	34.5	0.1374	0.0000	OK
15 minute summer	Existing 1	10	8.046	0.046	34.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.1				
5760 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.1	0.035	0.007	0.2182	
5760 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	34.5	2.621	0.004	0.1316	13.4

Results for 100 year +40% CC +10% A Critical Storm Duration. Lowest mass balance: 99.99%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	Green-roof	160	54.884	0.084	6.4	15.6986	0.0000	OK
15 minute summer	Outlet	1	43.620	0.000	0.0	0.0000	0.0000	OK
8640 minute winter	Remaining roof area	8220	44.832	0.292	0.1	0.3299	0.0000	FLOOD RISK
8640 minute winter	Permeable Surfacing	8400	44.831	0.381	0.6	114.6361	0.0000	FLOOD RISK
15 minute summer	Existing	10	9.057	0.057	48.2	0.1618	0.0000	OK
15 minute summer	Existing 1	10	8.054	0.054	48.2	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	Green-roof	Hydro-Brake®	Permeable Surfacing	1.5				
8640 minute winter	Remaining roof area	2.000	Permeable Surfacing	0.1	0.022	0.007	0.2182	
8640 minute winter	Permeable Surfacing	Proposed Discharge	Outlet	0.0	0.000	0.000	0.0000	0.0
15 minute summer	Existing	Existing Runoff	Existing 1	48.2	2.867	0.006	0.1681	18.8