APPENDIX 7.2: BASEMENT IMPACT ASSESSMENT SCOPING, SCREENING AND ASSESSMENT

Ham Close Regeneration

Planning Application:

Basement Impact Assessment Scoping, Screening and Assessment

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1.0 Introduction

1.1. Background

1.1.1. Enzygo Geoenvironmental Limited have been commissioned to undertake a Basement Impact Assessment which will include a detailed desk study and site investigation to establish ground conditions and groundwater levels. The report assesses the impact of the proposed development in relation to the proposed basement to be constructed underneath the central areas of the site (Ham Close, Ham, Richmond Upon Thames, TW10 7PG) as per the basement drawing given in the Appendix A.

1.1.2. The Richmond Basements Assessment User Guide (2021) published by METIS consultants and on behalf of London Borough of Richmond Upon Thames has been utilised.

1.1.3. The initial stage undertaken is a Screening Assessment in order to identify what, if any further assessment is required to support the planning application for the proposed development.

1.2. Objectives

1.2.1. The objectives of this document are:

- Undertake a preliminary review of available information on the site and the proposed development.
- Review the risks posed by the proposed basement construction to the proposed buildings, neighbouring buildings and the environment;
- Screen out those risks which can be dismissed, and
- Identify areas where further assessment should be undertaken (Scoping).

1.3. Sources of Information

1.3.1. Background information was sought from the following sources.

- Previous Desk study information undertaken by Chelmer Consultant Services (11 August 2017) Ref DTS/9324 (Copy is given in Appendix D).
- Available borehole records;
- Ground investigation report by Enzygo Geoenvironmental Ltd (CRM.1027.087 GE.R003C).
- Geological records;
- Historical Maps; and
- Desk Study including Ground Sure Reports

Copies of this information are included in Appendix D.

2.0 Site Setting

2.1 Site Description

2.1.1 The site comprises an existing development of residential properties and flats associated with Ham close.

2.1.3 The site is bordered to the north by Woodville Road, the south eastern corner by Ham Street and Ashburnham Road with the eastern boundary being Wiggins Lane and Ham Street. The western-most extent of the site includes the existing boundary wall with school playing fields and St Richard's CE Primary School beyond. An existing layout plan is given in Appendix A.

2.1.4 The eastern area of the site comprises open space with a small car park.

2.1.5 The remainder of the site comprises residential development comprising three to five storey residential apartments, garages, storage area, car parks and a youth centre.

2.1.6 There is an electricity substation on site and located close to the western boundary of the site.

2.1.7 A school and playing fields are shown to the west of the site. Part of the land associated with the Woodville Centre is shown within the western part of the site.

2.1.8 A selection of terraced shops with associated car parking and a substation are shown to the southeast of the site.

2.1.9 There are no embankments or areas of cut near to the site.

2.1.10 The site level is approximately 6 to 7m AOD.

2.2 Site History

2.2.1 A review of historical maps shows that the site comprised open land up until 1868 when it is referenced as a farm with buildings to the east which were reconfigured by 1896. By 1947 the site appears to be a residential development with some open grass areas. By 1959 a ruin is shown within the eastern part of the site. By 1969 the ruin is no longer shown and no longer appears to be residential within the eastern part of the site, however the western part of the site is now shown as a residential development together with a clinic to the south of the site. The western part of the site appears to now be part of adjacent school grounds. A small car park is shown to the south-eastern part of the site.

2.2.2 There are a number of historical uses surrounding the site and these are listed below in tabular form below:

Date	Historical feature	Distance to the site (m)	Direction
1968-1959	Pit	206	E
1871	Pond	403	SE
1913-1934	Smithy	250	SE
1913-1959	Gravel pit	527	W
1933-1960	Nursery	107	N
1933-1960	Sand and gravel work	542	W
1934-1960	Sand and Ballast works	340	SW
1959-1969	Lake	111	NW
1933-1971	Tanks/disused works	212	S
1959	Plant nursery	296	N
1973	Pumping station	202	S
1973	Tank	195	S

2.2.3 Review of subsequent maps shows that the site has been redeveloped from a green field site to a residential development or school grounds. Given the redevelopment of the site some Made Ground can be expected associated with the existing development of the site.

2.2.4 The historical land uses within 250m of the site are the pit, the pumping station, the nursery and the lake and the tanks.

2.2.5 Apart from the tank 195m south and shown in 1973 all the other historical land uses are either too far to be a risk and/or so old to have been replaced/infilled with development.

2.3 Ground Conditions

2.3.1 The British Geological Survey (BGS) indicates that the site is underlain Kempton Park Gravel over London Clay. Records held by the Environment Agency show the Kempton Park Gravel is shown to be a Secondary A Aquifer comprising very high to high permeability sands and gravels and the London Clay is shown to be an Un-productive Aquifer comprising very low to low permeability clay.

2.3.2 Made Ground is shown below or adjacent to the site.

2.3.3 Borehole records available within 250m of the site indicated Made Ground and Kempton Park Gravels proved to 6-7m depth. This was underlain by firm becoming stiff blue grey London Clay. Groundwater was not encountered.

2.3.4 The ground investigation works are summarised in the table below:

Rational	Exploratory Holes	Notes
Site Coverage.	WS1 to WS18.	Across site.
Car park areas	WS101 to WS106	Car parks
Soakaways	SA1 to SA6	To assess viability of soil infiltration.
Monitoring.	WS5 WS6 WS7 WS9 WS14 WS16 & WS18.	Installations.
Deep foundations.	BH1 to BH6.	Deep boreholes.

2.3.5 The Ground investigation identified ground conditions as per Boreholes records and compromised Made Ground over Firm clay and lose becoming dense sand and gravel. Shallow ground water was not encountered.

2.3.6 Elevated PAH, Lead and arsenic were encountered together with asbestos. Remediation and management procedures were recommended.

2.4 Geotechnical Hazards

2.4.1 BGS information presented within the Groundsure Geoinsight report identifies the following ground conditions:

Hazard	Risk Designation (Groundsure)
Coal Mining	None.
Collapsible Ground	Very low.
Compressible Ground	Very Low
Ground Dissolution	Very Low
Landslide	Very low.
Running Sand	Very low.
Swelling / Shrinking Clay	Very low.

2.4.2 There are no significant geotechnical hazards identified by the BGS.

2.5 Groundwater

2.5.1 The soils below the site are classified as a Secondary A Aquifer over an Unproductive Aquifer and the geological records confirm the presence of Sand and Gravels with a very high to high permeability over London Clay with a very low to low permeability.

2.5.2 Based on this shallow groundwater may be present within the Kempton Park Gravel.

2.5.3 CIRIA Special Publication 69, identifies that the base of the London Clay within this area is approximately 50m below ground level. Groundwater contours indicate water level of approximately 15m below Ordnance Datum. Based on the site level of 7m AOD. The groundwater level will be 22m below ground level. In addition it indicates that with predicted groundwater level rises the groundwater level in the Richmond area will be 30m bgl. Based on this groundwater rise may impact the basement, however consideration will need to be given to the thickness of the London clay below the proposed basement which is based on the contour plots for the base of the London clay and the proposed basement level is 45m thick below the proposed basement. On this basis it is considered that deep groundwater may have an impact on the proposed basement with predicted rises over time and so screening should be undertaken.

2.6 Hydrology

2.6.1 Based on a review of the Environment Agency online flood maps, the site is shown to be located within Flood Zone 1; outside the 1 in 1000 annual probability of fluvial/tidal flooding (<0.1% AEP). Properties located within Flood Zone 1 are considered to be at 'Low' risk of fluvial flooding.

2.6.2 The Environment Agency flood maps are currently the best source of information regarding the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development.

2.6.3 It has been confirmed through review of the Strategic Flood Risk Assessment (SFRA[1]) for the London Borough of Richmond Upon Thames that no 'lost rivers' pass in close proximity to the site. These comprise watercourses which have been culverted or turned into sewers.

<u>Historical Flooding</u>

2.6.4 Historic flood mapping within the London Borough of Richmond on Thames PFRA[2] and SFRA has been reviewed.

2.6.5 Whilst the site is not indicated to have been affected by historic flooding, four major events are recorded between Datchet and Teddington, upstream of the Site, in 1947, 1968, 2003 and 2014.

2.6.6 Strategic Flood Risk Assessment (SFRA) mapping indicates that there have been 0 and 10 recorded incidents of Sewer Flooding within the post code area. This information does not specify the exact number of records or the locations of these incidents within the postcode area.

<u>Fluvial/Tidal Flood Zones and NPPF Vulnerability</u>

2.6.7 The Environment Agency online flood mapping (for planning) indicates the Site to be located entirely within Flood Zone 1 and to be at 'Low' risk from flooding.

[1] London Borough of Richmond Upon Thames (2021) Strategic Flood Risk Assessment (Final) March 2021.
[2] London Borough of Richmond Upon Thames Preliminary Flood Risk Assessment, May 2011.

2.6.8 In PPG ID: 7[3] (Table 2) appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in Table 2 and 3 of the PPG ID: 7, the proposed development is classified as 'More Vulnerable'.

2.6.9 Table 3 of PPG ID: 7-067-20140306 states that 'More Vulnerable' uses are appropriate within Flood Zone 1.

Groundwater Flooding

2.6.10 BGS mapping and the Ground Investigation Report[4] indicate the presence of the Kempton Park Gravel Formation beneath the site, underlain by London Clay. The London Clay is classified as unproductive strata, while the Kempton Park Gravel is indicated as a Secondary A (minor) Aquifer, defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of baseflow to rivers. Groundwater within the on-site borehole records (TQ17SE124, TQ17SE229) is recorded at between 3.2 and 3.8m below ground, likely associated with the interface between the Kempton Park Gravel and underlying London Clay.

2.6.11 The SFRA (Figure 6), indicates a high susceptibility to groundwater flooding in this locale, linked to the underlying Kempton Park Gravel. The groundwater flood risk is given as between 25% and 49.9% in the west of the Site, and 75% or more in the east of the Site.

Pluvial/Surface Water Flooding

2.6.12 Review of the Environment Agency online 'Flood Risk from Surface Water' mapping and the SFRA (2021) flood mapping, indicates the site to be affected by surface water flooding in the southwestern and north-western parts of the Site.

2.6.13 The EA flood mapping has been used in the assessment of surface water / pluvial flood risk since it is considered to be the most up to date source of flood mapping and provides associated flood depths and hazard ratings.

2.6.14 Detailed pluvial flood mapping downloaded from the EA website, assesses three main scenarios, Low Risk (0.1%-1% probability of flooding annually), Medium Risk (1%-3.3%) and High Risk (>3.3%). The findings of this assessment are summarised in the table below and shown graphically at Appendix A.

Flood Risk Scenario Assessed	Flood Depth	Flow Velocity
Low	Unaffected	NA
Medium	Unaffected	NA
High	Unaffected	NA

2.6.15 It is concluded that the flood risk to the property from pluvial sources is Low.

[3] Department for Communities and Local Government (2014) Planning Practice Guidance, ID: 7 – Flood Risk and Coastal Change
[4] Enzygo CRM.1027.087.GE.R003. Desk Study and Ground Investigation Report.

Sustainable Drainage (SuDS)

2.6.16 The Local Plan (Policy LP21), the Ham & Petersham Neighbourhood Plan (Policy E4), LBRuT's Good Practice Guide on Basement Developments SPD (2015) and LBRuT's Surface Water Management Plan (2021) require that wherever possible a degree of improvement to surface water flooding be provided through the incorporation of Sustainable Drainage Systems (SuDS) within new development. This has been duly assessed.

2.6.17 There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations 2010. Rainwater shall discharge to one of the following, listed in order of priority:

- An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- A sewer.

2.7 Conceptual model

2.7.1 Based on the desk study information the following Preliminary Conceptual Model has been prepared:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal site management practices and PPE will address risk.
			Site users.	Negligible.	No source identified.
Asbestos, Hydrocarbon and metals.	Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Very Low.	If present can easily be addressed through development.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No significant off-site sources identified.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No source identified.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified.
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site.	Vertical Migration.	Groundwater.	Dismissed.	No source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site.	Horizontal Migration.	River Network.	Dismissed.	No source or credible receptor.

Environmental Receptors				
On site contaminants	Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
	Direct.	Archaeology.	Dismissed.	None present.
	Direct.	Geology.	Dismissed.	No sensitive receptor present.
	Phytotoxic.	Woodland.	Dismissed.	None present.
	Phytotoxic.	Crops.	Dismissed.	No source identified.
	Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services				
On site contaminants	Direct.	Historic Buildings.	Dismissed.	None present.
	Direct.	Proposed Buildings.	Dismissed.	No source identified.
	Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

2.7.2 There is a very low risk from Made Ground, including former buildings which will be investigated. Should contamination be present this can easily be addressed through development. No other significant risks are identified.

2.8 Proposed Development

2.8.1 The current proposals show the proposed development to comprise a new basement construction up to approximately 5.0m below existing ground levels. The main basement will be situated in the centre of the site and below some of the proposed residential blocks and landscaping areas with access ramps to the north and to the south. An initial assessment of the proposed construction details has been provided. The thicknesses of each construction element are given in the section thicknesses below:

- 1,200mm Landscaping for trees
- 650mm Podium transfer slab,
- 500mm Nominal services zone (Allowing for ventilation ducts/fans)
- 2200mm Headroom for cars
- 450mm Basement slab
- 75mm Blinding

2.8.2 Given the basement extends below the proposed building and proposed landscaping areas to a depth of approximately 5.00m and given the potential ground conditions it is likely that the site will be sealed around the edge using a secant piles design to allow the materials to be dug out within the basement flow slab and a basement slab installed. However, given the required loading of this basement with the proposed residential block covering part of the basement area the foundations will comprise a piled basement slab thereby minimising differential settlements.

3.0 Assessment of Risk

3.1 General

3.1.1 The Basements Assessment User Guide (2021), prepared by Metis Consultants requires an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability. This requires the following:

- Maintain the structural stability of the building and neighbouring properties;
- Avoid adversely affecting drainage and run-off or causing other damage to the water environment;
- Avoid cumulative impacts upon structural stability or the water environment in the local area;
- Avoid harm to the amenity of neighbours;
- Protect important archaeological remains.

3.1.2 This screening assessment will review risks posed to:

- Structural stability of the building and neighbouring property;
- Land stability;
- Groundwater impacts and groundwater flooding; and
- Surface Water risks.

3.1.3 These are discussed in the sections below:

3.2 Structural Stability

3.2.1 As the construction of the basement is located within the centre of the site and will not directly be affected by any surrounding developments it is considered that the stability risk to the adjacent properties is mitigated as the new construction will not affect the surrounding properties. As part of this assessment a foundation assessment will be carried out for the proposed basement and the proposed overlying buildings. The following structural stability risks have been assessed:

3.2.2 Foundation bearing capacity failure (ultimate limit state conditions) are a low risk as the site is underlain by Kempton Park Gravel and London Clay, the properties of which are well known. The depth of the proposed foundations will increase with increasing depth as these become denser and stiffer with depth and also there are greater restoring moments on the foundations from the overlying soils. The proposed basement slab is likely to be piled due to the required loads for the proposed basement and the residential blocks on top. Bearing capacity will be assessed to allow design of the basement floor slab to be included into the foundation loadings of the basement and the proposed buildings and therefore the risk is not screened out.

3.2.3 Differential settlement between the proposed basement in the landscaping areas as compared to the proposed buildings has been considered. As the basement is to be constructed underneath the entire footprint of a number of proposed buildings and landscaping areas it is considered that differing net additional stress will be applied at the foundation formation level and as such differential settlement associated with the proposed loads from the proposed landscaping areas above the basement as compared to the proposed buildings above the basement will be different. Settlement predictions for the proposed basement extension will be assessed for both areas and so is not screened out.

3.2.4 There are no trees being retained close to the proposed basement and given that Kempton Park Gravel underlies the site potential risks from clay heave and desiccation are not considered significant and are screened out.

3.2.5 Consideration has been given to the risk of basement heave due to stress relief. The basement excavation is only 5.0 metres depth and the London Clay is anticipated to be between 5.20mbgl and 5.4mbgl and is likely to be stiff with a corresponding low consolidation/heave potential. As such the risk to the basement floor slab is not considered significant and is screened out.

3.2.6 The proposed basement wall will have lateral earth pressure applied by the adjacent soils, however there are no significant adjacent loading from any adjacent structures as all the structures are located above the basement and therefore will have minimal lateral loads. The basement walls should be reinforced in order to accommodate this lateral load and will be fixed at the top and bottom by the basement slabs and Ground floor thereby preventing rotation. The risk is considered low given normal construction methods employed.

3.2.7 It is considered that the greatest risk to structural stability is during construction. Excavation of the basement areas will be within Kempton Park Gravel and possibly London Clay. As such it is considered that there is a requirement for temporary support or battering back of the excavation sides and will depend on the depth of the excavation works (5.00mbgl) and any groundwater levels. This risk is considered low but cannot be screened out.

3.3 Land Stability

3.3.1 The site and surrounding area are reasonably level and there is no evidence of embankments or cuttings close to the site. Risks from potential landslides identified by the BGS are very low. As such the risk from land instability such as landslides resulting from the proposed works are not considered likely. This risk is screened out.

3.4 Groundwater Impacts

3.4.1 The Kempton Park Gravel is classified as Secondary A Aquifer with a very high to high intergranular permeability and the London Clay is classified as a non-productive aquifer with a low to very low permeability and there are no recorded instances of licensed groundwater abstraction within 1000m of the site with the closest recorded 1587m north east. No surface water courses are present close to the site. Perched groundwater is expected in the Kempton Park Gravel. As such the proposed basement construction may encounter shallow groundwater associated with the Kempton Park Gravel and cannot be screened out.

3.4.2 Given the high permeability Kempton Park Gravel is present across the site the British Geological Survey records indicate that there is moderate risk for groundwater ingress. This risk cannot be screened out.

3.4.3 Risk from deep groundwater is not considered viable resulting from the thickness of London Clay below the proposed basement (45m thick) confining the aquifer (aquiclude) and will isolate the basement from the underlying aquifer. Based on this there is not considered to be any significant risk to the basement from either deep groundwater ingress or potential uplift. This risk is therefore screened out.

3.5 Surface Water Risk

3.5.1 According to Environment Agency online surface water flooding mapping, pluvial or surface water flooding, presents a low risk to the site, and can be screened out. A review of the existing and proposed drainage arrangements will however be undertaken (see Section 3.6 below).

3.5.2 Review of the DG5 registered sewer flooding events in the London Borough of Richmond Upon Thames Council SFRA online mapping[5], indicates between 0 and 10 reported incidents in the postcode area. Therefore, the risk of sewer flooding to the site is considered to require further scoping.

3.6 Surface Water Drainage

3.6.1 In accordance with the Local Plan Policy LP21, there is a requirement to ensure that the development does not increase surface water runoff from the existing property.

3.6.2 The basement extension will occur below ground level, beneath the proposed building footprint and open space, with a slight increase in impermeable surface, and consequent minor uplift in the rate and volume of surface water generated by the site.

3.6.3 Local Plan Policy LP21 states that there must be an improvement to current surface water runoff rates and volumes. This, coupled with the proposed minor increase in impermeable area, leads to the requirement for further scoping of the surface water drainage requirements. This is explored further within Section 4.6 below.

[5]https://mapping.richmond.gov.uk/map/Aurora.svc/run?script=%5CAurora%5Cpublic_SFRA_Groundwater_Etc_LBRUT.AuroraScript%24&resize=always.

3.7 Foul Drainage

3.7.1 Where additional sanitary facilities are proposed, the Good Practice Guide on Basement Development (2015) require all new basements to be protected from sewer flooding through the installation of a suitable (positively) pumped device. This criterion of the policy will only apply when there is a waste outlet from the basement i.e. a basement that includes toilets, bathrooms, utility rooms etc. No such sanitary facilities are required or proposed for the car parking basement and this can therefore be dismissed.

3.7.2 Due to construction of the secant piled wall limited ground dewatering will be required during construction. Where limited groundwater dewatering is required within the excavation and during the construction phase the groundwater can be diverted into the public sewer. Should this be required then a discharge consent from Thames Water will be required to permit this short-term discharge.

3.8 Drainage Summary

3.8.1 The site is indicated to be at low risk from groundwater and sewer flooding. The risks posed to the proposed development by these sources of flooding therefore require greater assessment.

3.8.2 Further consideration is also required to provide a degree of improvement to the rate and volume of surface water discharged from the site.

3.8.3 No additional foul connections are to be made associated with the basement and therefore an increase in foul flows from the basement is unlikely. The risk of flooding from / to the development from foul drainage therefore requires no further scoping.

3.9 Summary of Risk Screening

Risk	Assessment	Screening	Comments
Structural Stability			
Foundation bearing capacity	Low	Scoping required	See Section 4
Differential settlement	Negligible	Scoping required	See Section 4
Desiccation/heave	Dismissed	Screened out	Kempton Park Gravels underlie the site.
Heave on the basement floor slab	Dismissed	Screened out	No excavation in clay and thick slab.
Lateral load on the basement wall.	Low	Scoping required	See Section 4
Temporary stability of excavations	Low	Scoping required	See Section 4
Temporary stability of the existing foundations.	Low	Scoping required	See Section 4
Land Stability			
Land slide	Dismissed	Screened out	No risk

Groundwater			
Shallow inflow	Low to Medium	Scoping Required	Permeable soils present.
Up lift	Dismissed	Screened out	Basement separated by an aquiclude and uplift pressure is not considered a risk due to the thickness of the London Clay.
Surface Water			
Fluvial flooding	Low	Screened Out	Flood Zone 1; outside the 1 in 1000 annual probability of fluvial/tidal flooding (<0.1% AEP).
Pluvial flooding/Surface Water Flooding	Low	Screened Out	Property indicated to be unaffected by surface water flooding.
Flooding from Sewers	Low	Scoping Required	No recorded incidences of sewer flooding within the vicinity of the Site. There are areas to the north and the west of the Site that show between 0and 10 records of sewer flooding.
Increased Drainage	Low	Screened Out	Minor increase in impermeable area based on the proposed layout of the basement. Betterment required.

3.9 Recommendations

3.9.1 It is recommended that the works set out in Section 4, Scoping Study, are undertaken.

4.0 Scoping Study

4.0 General

4.0.1 It is considered that this Screening Assessment includes sufficient information for a Phase I Desk Study to not be required as it includes a review of available information.

4.0.2 It is considered that a ground investigation is undertaken to provide geotechnical parameters for the design of the basement including temporary works. The investigation should comprise:

- Advance one boreholes using cable percussion boreholes within the area of the proposed basement;
- Installation of a monitoring well to allow groundwater and also ground gas to be monitored;
- Undertake geotechnical testing on selected samples to obtain soil engineering parameters.

4.0.3 It is considered that the following areas require further assessment.

4.1 Bearing Capacity

4.1.1 Bearing capacity for the soils at the proposed formation depth are to be assessed so that the foundation type, bearing capacity and width can be assessed. This information can then be used by the Structural Engineer to finalise the design of the proposed foundations.

4.2 Differential Settlement

4.2.1 Settlement of the proposed basement extension is to be calculated from the ground investigation so that potential differential settlement with the existing foundations and basement can be assessed. Suitable design measures to address differential settlement can then be designed by the structural engineer.

4.3 Lateral Load on Basement Wall

4.3.1 Effective stress properties of the soils are to be calculated from the ground investigation so that the lateral earth pressure on the back of the basement wall can be calculated. From this the requirements for reinforcement and also details of any anchorage of the basement wall can be designed by the structural engineer.

4.4 Temporary Excavation Stability

4.4.1 Where no existing foundations are encountered a methodology should be prepared for undertaking the excavation works and to enable battering back of the excavation in dry excavations with the use of a secant pile surrounding wall.

4.4.2 When excavating the basement existing foundations will be encountered however given the secant pile wall will be outside these existing foundations any temporary instability associated with groundwater will be mitigated. Based on this a methodology should be prepared for undertaking the excavation works in the vicinity of existing foundations and enable battering back of the excavation in dry excavations. Should perched and localised groundwater be encountered around the existing foundations this should be removed from the excavation before excavation works can continue.

4.4.3 During excavation of the basement excavation undrained shear strength values could be undertaken from soils below the formation to help support detailed design.

4.5 Shallow Groundwater Inflow

4.5.1 Monitoring of the wells will be used to determine the presence and depth of any perched groundwater. An assessment of likely permeability of the soils will be undertaken to determine the risk of groundwater inflow to the proposed basement.

4.5.2 Measures to protect the basement from potential groundwater ingress will be provided which can then be detailed by the Structural Engineer.

4.6 Drainage Assessment

4.6.1 As discussed in Section 3, the site will require further scoping of the following study elements:

- Groundwater
- Sewer Flooding
- Sustainable Drainage

Groundwater

4.6.2 The site is indicated to be at risk from groundwater flooding associated with perched water present within the underlying Kempton Park Gravel. It is therefore recommended that the basement area be subject to robust flood proof mitigation measures, including tanking, to prevent groundwater ingress.

4.6.3 Dewatering of the excavated basement area will likely be required during the construction phase. This groundwater needs to be diverted into the public sewer, which in most cases is a combined sewer. A discharge consent from Thames Water is required to permit this short term discharge in accordance with the Basements SPD (2015). Due to the use of secant bored pile walls the volume of groundwater requiring disposal will be minimal.

Sewer Flooding

4.6.4 Sewer water flooding is sporadic, and it is difficult to predict / quantify the precise nature of this form of flooding, since the Thames Water DG5 register does not specify the exact location of recorded flood incidents.

4.6.5 The basement will be constructed in such a way as to prevent water ingress through the walls and basement ceiling (i.e. tanking).

4.6.6 No addition of sanitation facilities will be required.

4.6.7 A threshold level of +150mm at all external entry points (new basement only) and the input of flood proof air bricks to external elevations of proposed basement areas, would offer further protection from residual flood risks.

Sustainable Drainage

4.6.8 Policy LP21 of the current Local Plan requires development to incorporate Sustainable Drainage Systems (SUDs), or other similar measures, to reduce the volume and speed of run-off to the drainage system and to ensure that surface water runoff is managed as close to its source as possible, in line with the hierarchy in the London Plan.

4.6.9 In respect of Sustainable Drainage (SuDS) policies LP11 and LP21 of the Local Plan requires all basement development to:

- Include a sustainable drainage system (SuDS), to be retained thereafter;
- Include a minimum of 1m of soils above any part of the basement beneath a garden.

4.6.10 The above surface water drainage requirements will be met through the incorporation of permeable material beneath the development area.

4.6.11 Water will be conveyed to the porous underlay via permeable paviours or gulley's linking into the porous sub-base material. A down pipe will convey runoff into the porous sub-base.

4.6.12 Any stored water would be infiltrated into the Kempton Park Gravel, which would be in hydraulic continuity with the proposed storage area, thereby reducing potential impacts on surface water flooding and wherever possible providing a betterment to existing conditions.

4.6.13 Care would need to be taken not to undermine the stability of the proposed basement and any adjacent properties by infiltrating water close to their foundations. It is therefore recommended that all proposed SuDS measures be reviewed by a suitably qualified structural engineer.

4.6.14 Typical maintenance activities will include the removal of debris and weeds. There is no established lifetime associated with porous underlay material, although this would be increased with the input of geotextile membranes wrapping the porous material to prevent the ingress of sediments, and regular maintenance. If reconstruction is required, this would include lifting the surface layer, renewing the underlying geotextile layer, and relaying the turf.

4.6.15 Water butts could also be fitted to the downpipes of the proposed development, to allow rainwater harvesting. Whilst these would be expected to overflow into the existing drainage arrangement, water removed from the butts (for gardening etc.) would provide an improvement to existing conditions. In an urban setting, typified by summer storm profiles, which are considered more intense and critical in relation to urban flooding, water butts offer a considerable benefit, since they are utilised more regularly in summer months. They are low maintenance features, requiring intermittent inspection and removal of sediment, removal of blockages from the inlet/outlet pipes, and cleaning/replacement of filters. Additional SuDS measures are proposed as part of the proposed development.

4.6.16 The above SUDS options and maintenance activities are in line with the requirements of the following documents:

SUDS Manual (CIRIA C753);

Defra (2015). Non-Statutory Technical Standards for SuDS;

Mayor of London (2021) ... (Policies SI 12 and SI 13)

APPENDIX A – SUPPORTING INFORMATION

N

1:250m

0 5 10 25

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name: Hill Residential			
Project Name: Ham Close Regeneration			
Drawing Name: Detailed Masterplan Basement Floor			
Drawing Number: HCR-BPTW-S01-B1-DR-A-0127		Rev: C01	Status: A3
Project No: 21-090	RIBA Stage: 03	Drawn By: JB	Scale: 1:250 @ A0

PLANNING ISSUE

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KEY

- Planning red line boundary
- Tree to be retained & RPA
- Proposed buildings
- Basement outline

Storeys | A 4 12 | Block/Terrace Letter, Units

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name: Hill Residential			
Project Name: Ham Close Regeneration			
Drawing Name: Proposed Masterplan			
Drawing Number: HCR-BPTW-S01-ZZ-DR-A-0102		Rev: C01	Status: A3
Project No: 21-090	RIBA Stage: 03	Drawn By: JB	Scale: 1:500 @ A1

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N

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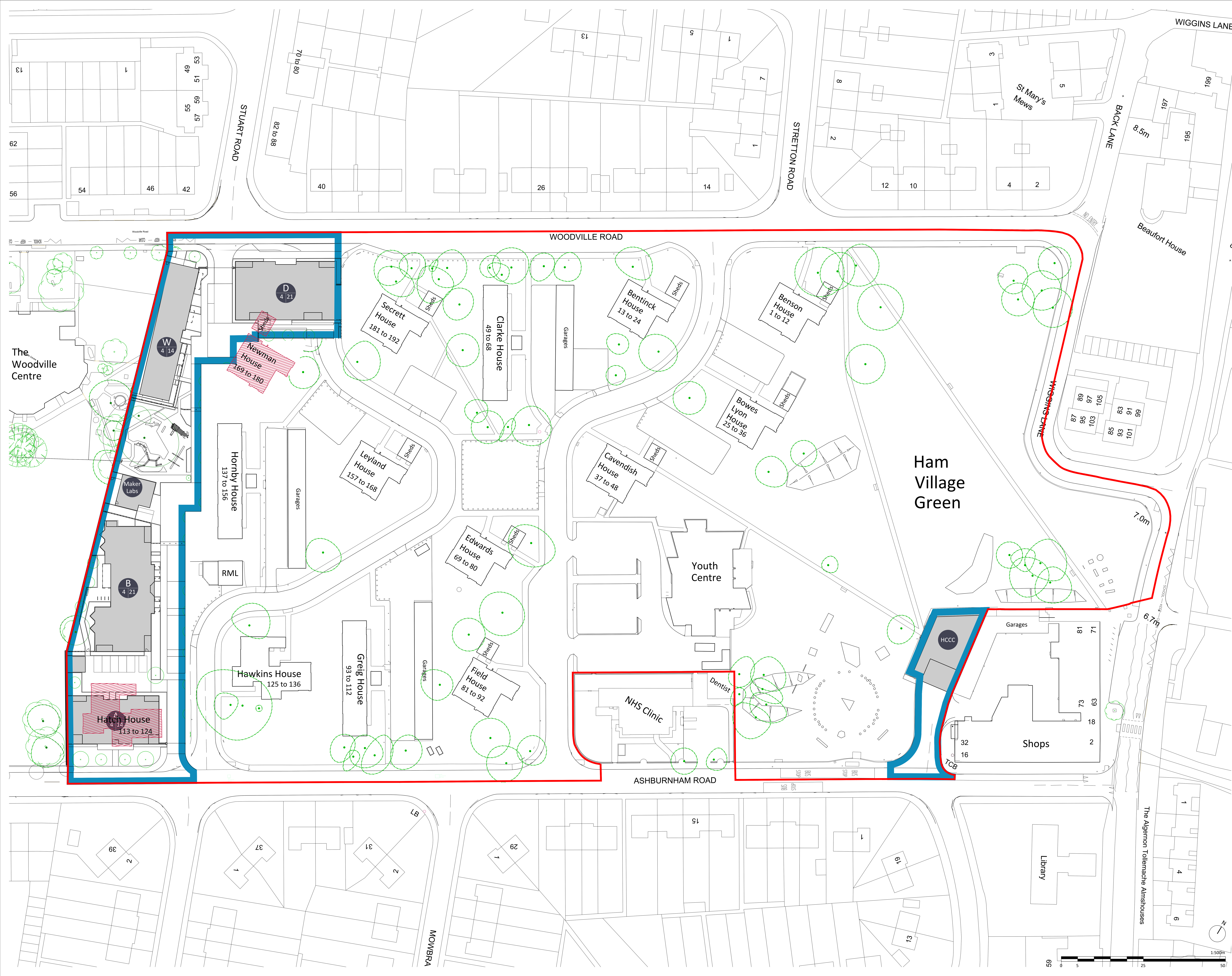
0 5 25 50



KEY

- Planning red line boundary
- Exisiting building to be demolished
- Proposed buildings
- Phase 1
- Storeys / Block/Terrace Letter / Units (A, 4 | 12)

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name: Hill Residential

Project Name: Ham Close Regeneration

Drawing Name: Proposed Phase 1 Masterplan

Drawing Number:	Rev:	Status:
HCR-BPTW-S01-ZZ-DR-A-0114	C01	A3

Project No:	RIBA Stage:	Drawn By:	Scale:
21-090	03	JB	1:500 @ A1

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WIGGINS LANE
STUART ROAD
STRETTON ROAD
BACK LANE
St Mary's Mews
Beaufort House
The Royal Oak (PH)
Grey Court Stables
WIGGINS LANE
The Woodville Centre
Maker Labs
RML
W 4 14
D 4 21
B 4 21
A 4 14
T 4 21
U 4
V 6 42
M 6 52
N 4 18
O 4 12
Secrett House 181 to 192
Clarke House 49 to 68
Garages
Bentinck House 13 to 24
Benson House 1 to 12
Bowes Lyon House 25 to 36
Cavendish House 37 to 48
Leyland House 157 to 168
Hornby House 137 to 156
Edwards House 69 to 80
Field House 81 to 92
Greig House 93 to 112
Hawkins House 125 to 136
Youth Centre
NHS Clinic
Dentist
HCCC
Shops
Sheds
Ham Village Green
ASHBURNHAM ROAD
Library
The Algernon Tollemache Almshouses
MOWBRA
BM 8.48m
8.5m
8.2m
7.0m
6.7m
KEY
Planning red line boundary
Exisiting building to be demolished
Proposed buildings
Phase 2
Basement outline
Block/Terrace Letter
Storeys
Units
Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.
Revisions:
Rev Status Date Description Drn Chkd
C01 A3 26.04.22 Planning Issue JB CD
Client Name: Hill Residential
Project Name: Ham Close Regeneration
Drawing Name: Proposed Phase 2 Masterplan
Drawing Number: HCR-BPTW-S01-00-DR-A-0115
Rev: C01
Status: A3
Project No: 21-090
RIBA Stage: 03
Drawn By: JB
Scale: 1:500 @ A1
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1:500m


WIGGINS LANE
STUART ROAD
STRETTON ROAD
BACK LANE
St Mary's Mews
Beaufort House
The Royal Oak (PH)
Grey Court Stables
The Woodville Centre
Maker Labs
Ham Village Green
NHS Clinic
Dentist
HCCC
Garages
Shops
Library
ASHBURNHAM ROAD
The Algernon Tollemache Almshouses
Secrett House 181 to 192
Clarke House 49 to 68
Leyland House 157 to 168
Hornby House 137 to 156
Edwards House 69 to 80
Hawkins House 125 to 136
Greig House 93 to 112
Field House 81 to 92
KEY
Planning red line boundary
Exisiting building to be demolished
Proposed buildings
Phase 3
Basement outline
Block/Terrace Letter
Storeys
Units
Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.
Revisions:
Rev Status Date Description Drn Chkd
C01 A3 26.04.22 Planning Issue JB CD
Client Name: Hill Residential
Project Name: Ham Close Regeneration
Drawing Name: Proposed Phase 3 Masterplan
Drawing Number: HCR-BPTW-S01-00-DR-A-0116
Rev: C01
Status: A3
Project No: 21-090
RIBA Stage: 03
Drawn By: JB
Scale: 1:500 @ A1
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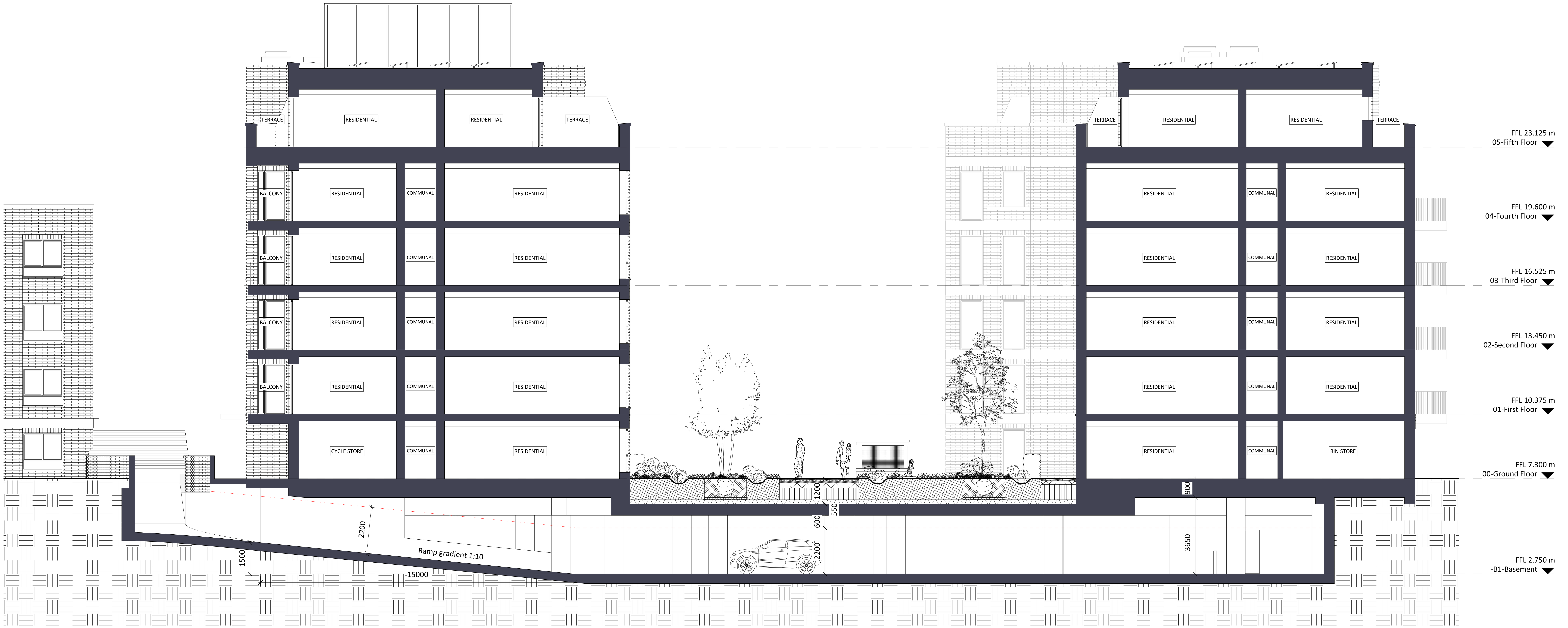
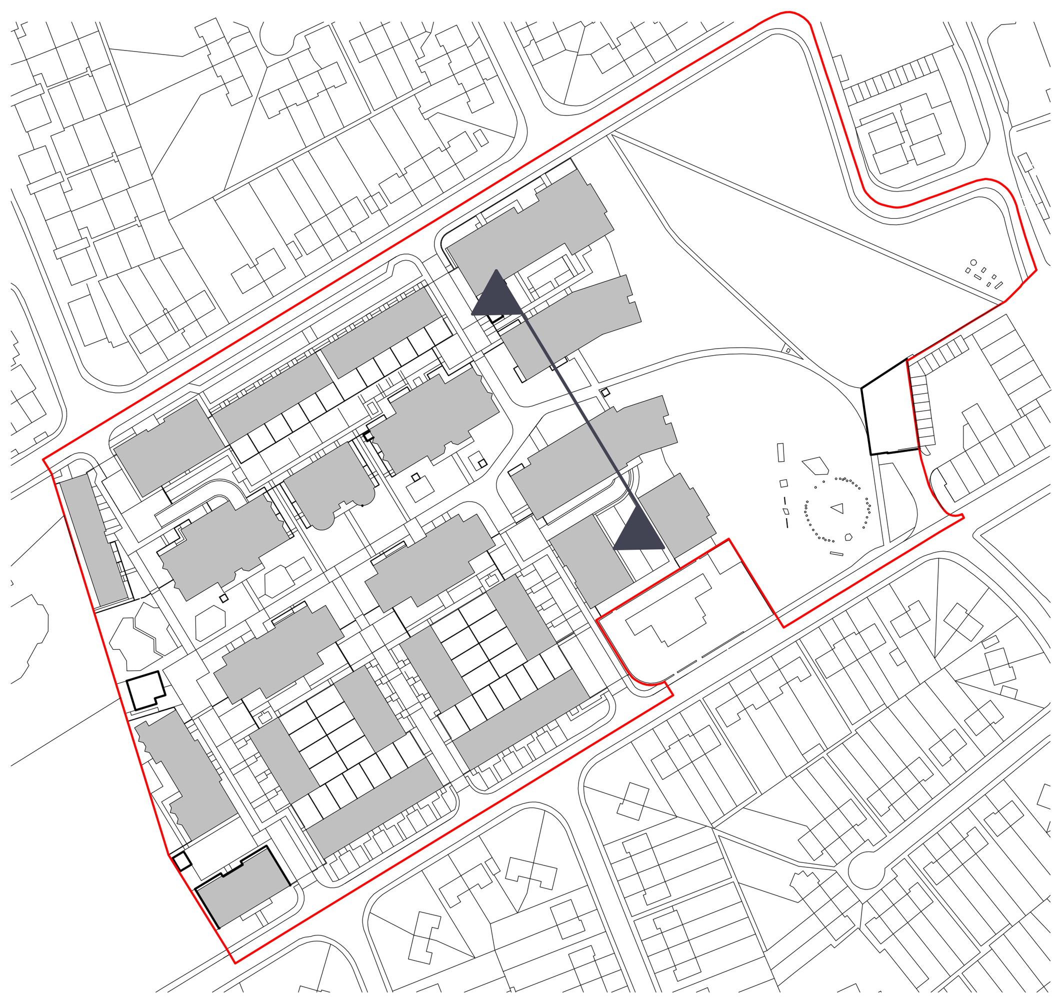


Phase 2 Car Park V/M

1 : 100



Location Plan

1 : 2000

N

1:100m

0 1 5 10

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name:
Hill Residential

Project Name:
Ham Close Regeneration

Drawing Name:
Phase 2 Basement Section

Drawing Number:	Rev:	Status:
HCR-BPTW-S01-ZZ-DR-A-2241	C01	A3

Project No:	RIBA Stage:	Drawn By:	Scale:
21-090	3	JB	1:100 @ A1

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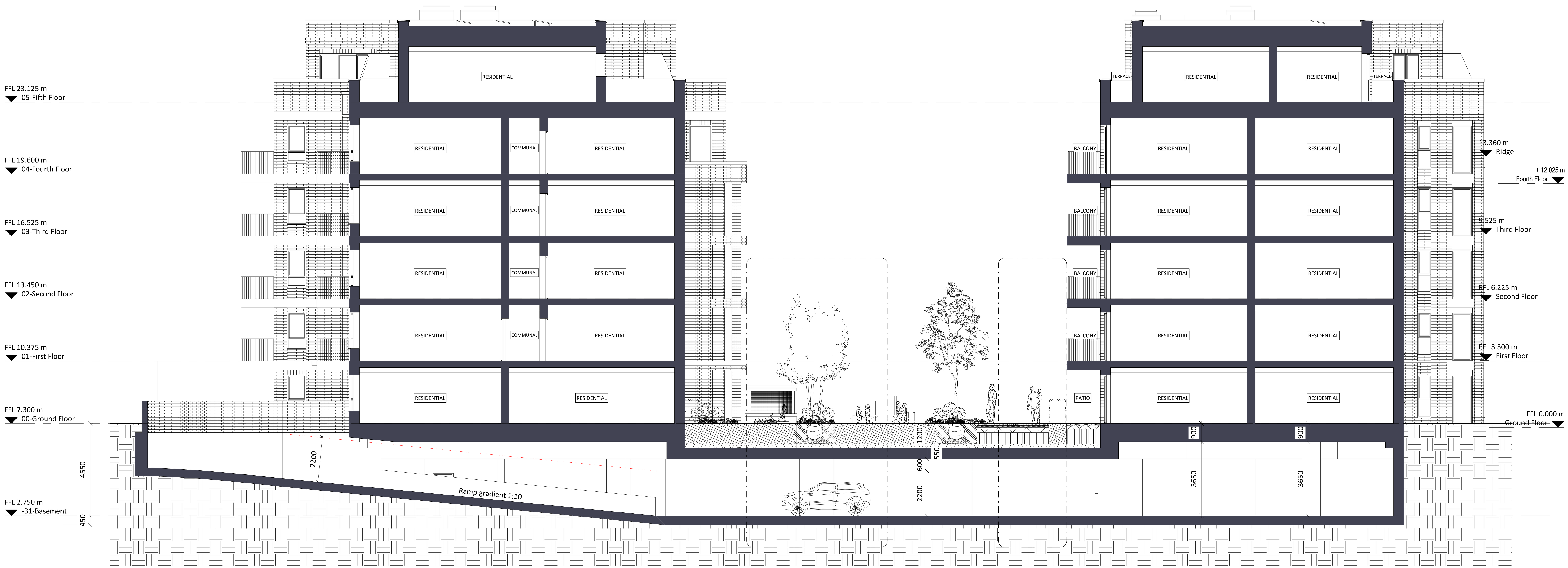
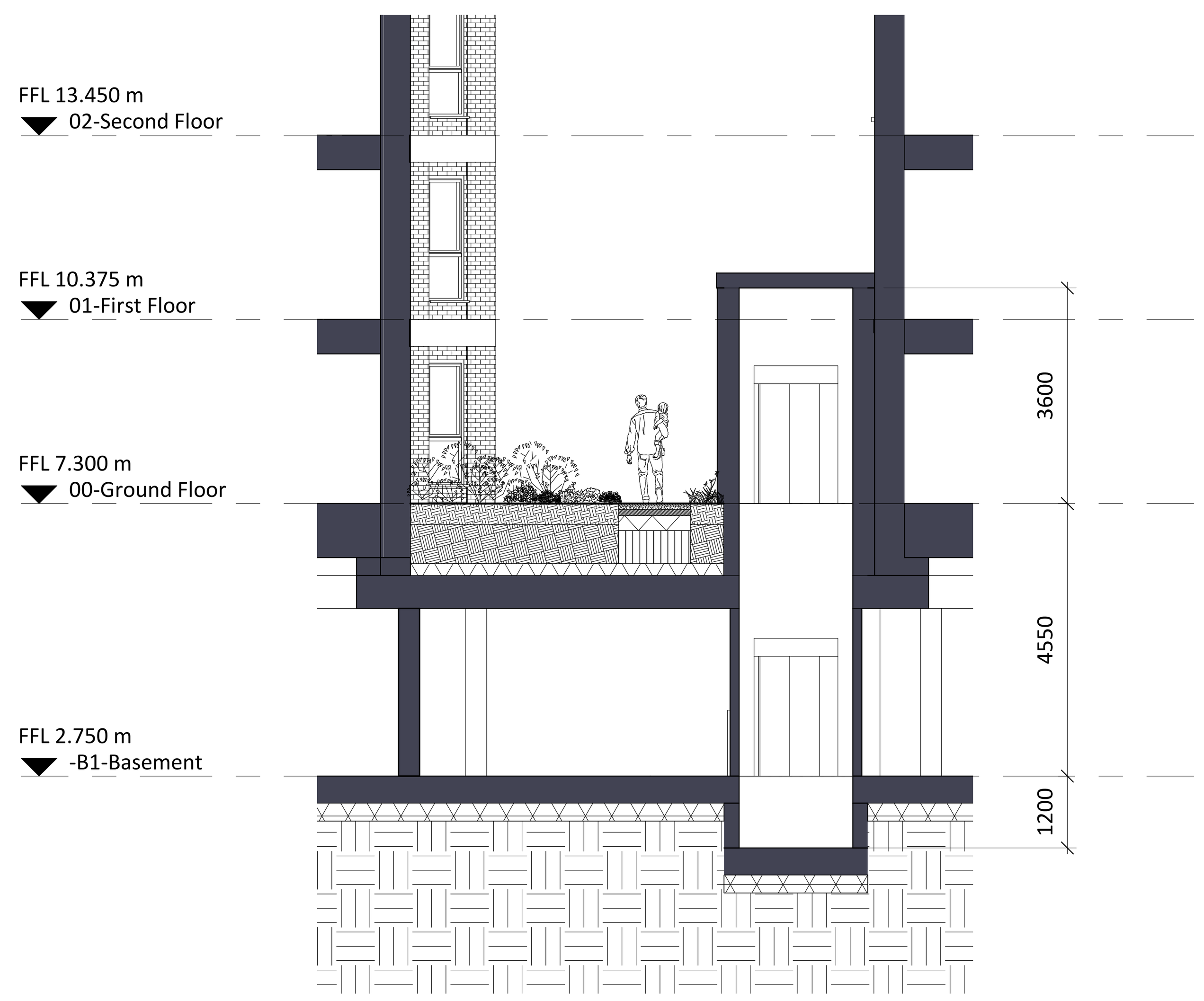


1 **Phase 3 Basement Section E/C**
1 : 100

Location Plan
1 : 2000



2 **Phase 3 Cycle Access Lift Section**
1 : 100

Notes:
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Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name:	Hill Residential
Project Name:	Ham Close Regeneration
Drawing Name:	Phase 3 Basement Section
Drawing Number:	HCR-BPTW-S01-ZZ-DR-A-2242
Rev:	C01
Status:	A3
Project No:	21-090
RIBA Stage:	3
Drawn By:	JB
Scale:	1:100 @ A1

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1:100m
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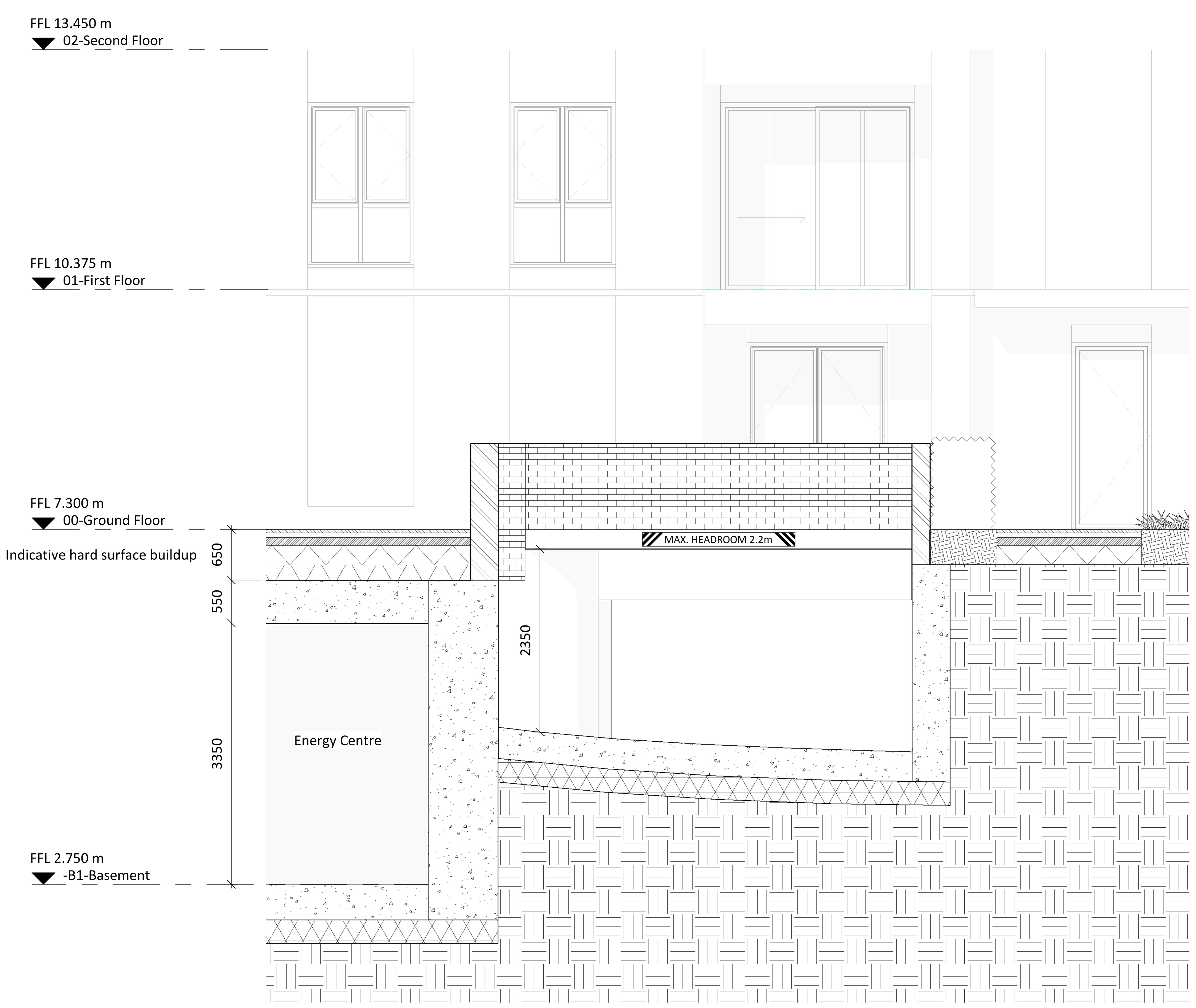
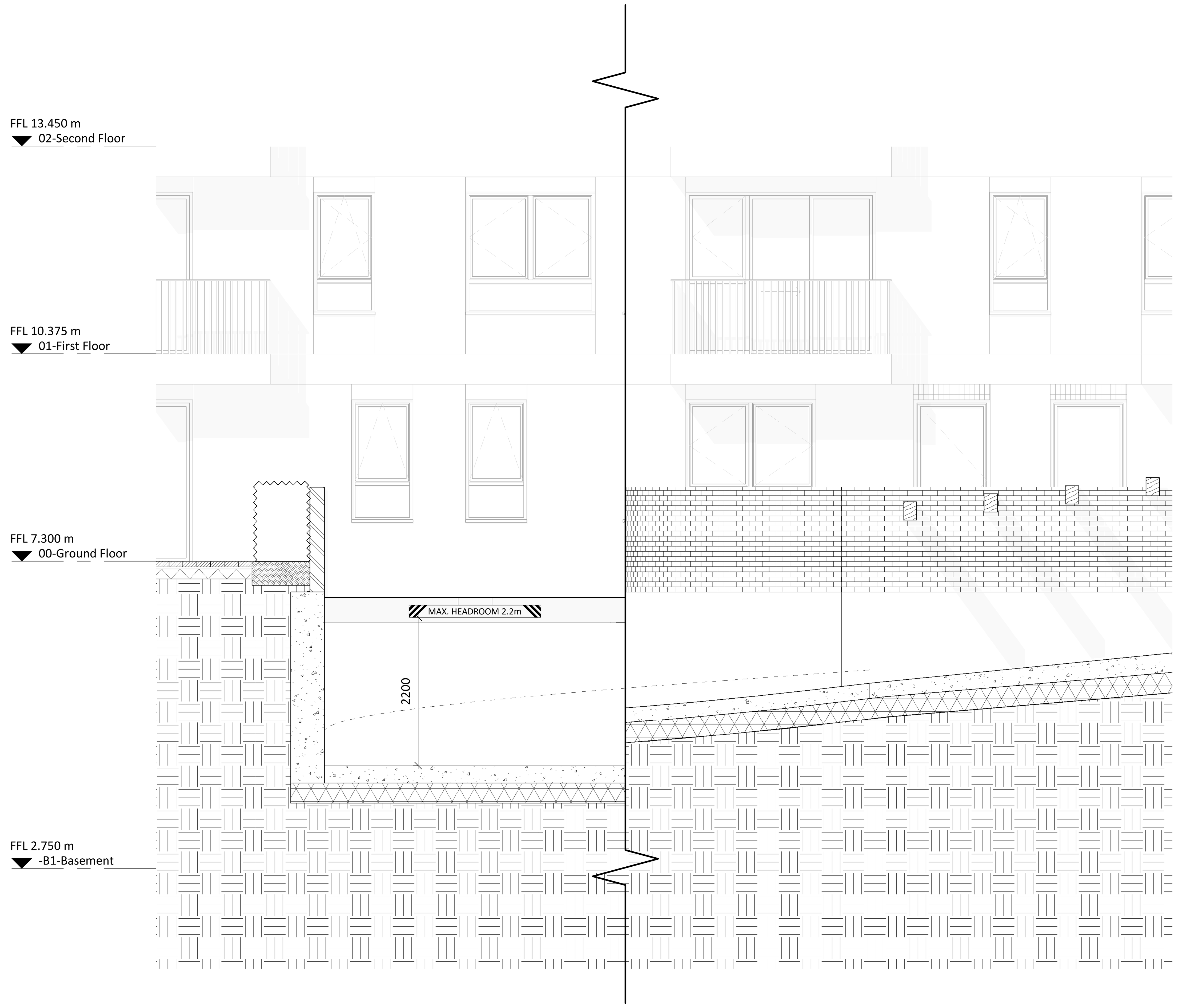
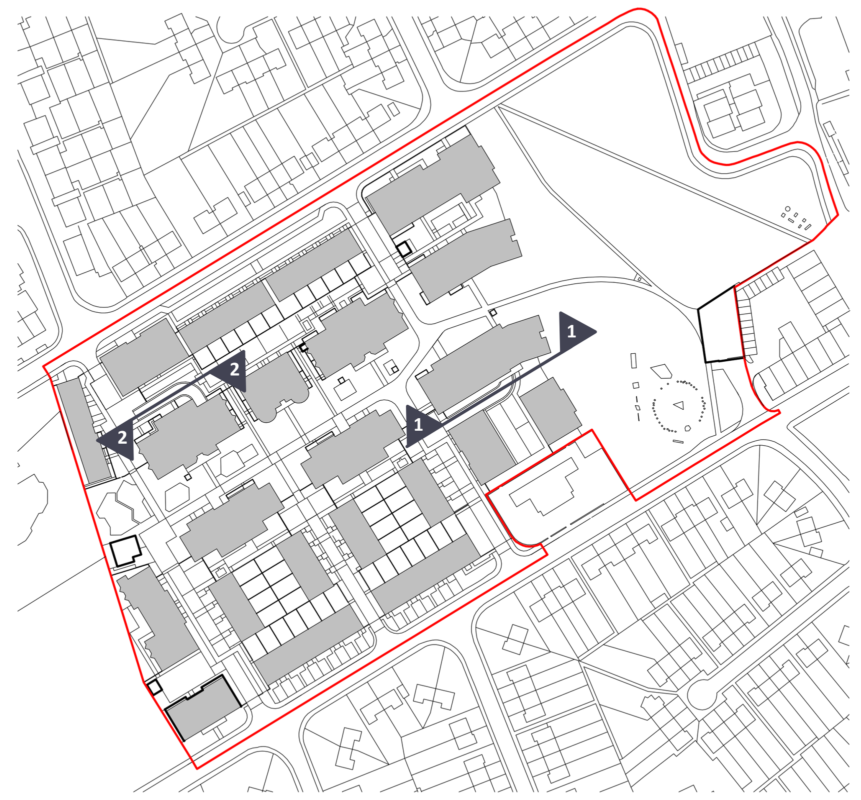


1 **Basement Section Phase 2 Ramp**
1 : 50

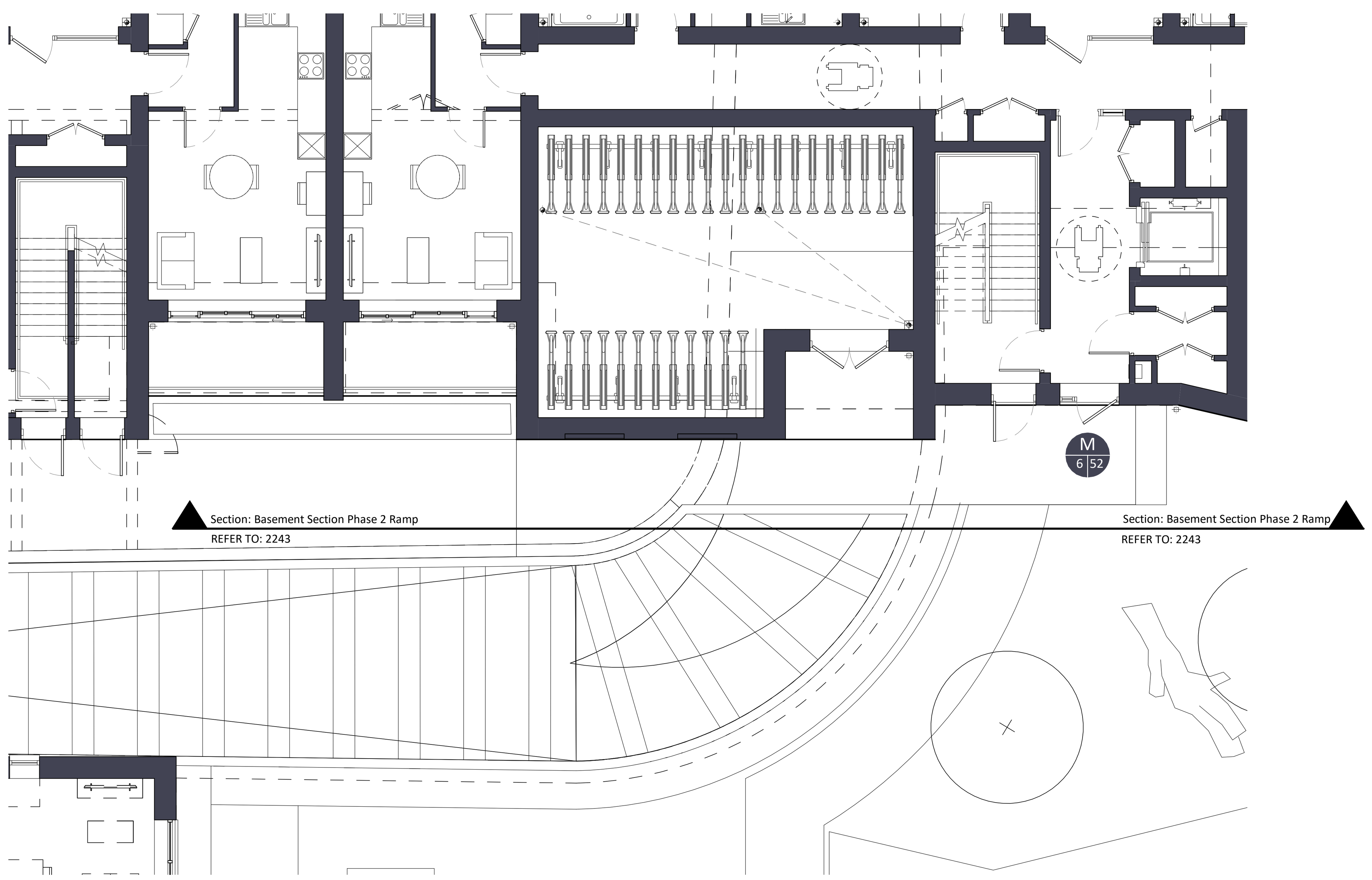


2 **Basement Section Phase 3 Ramp**
1 : 50

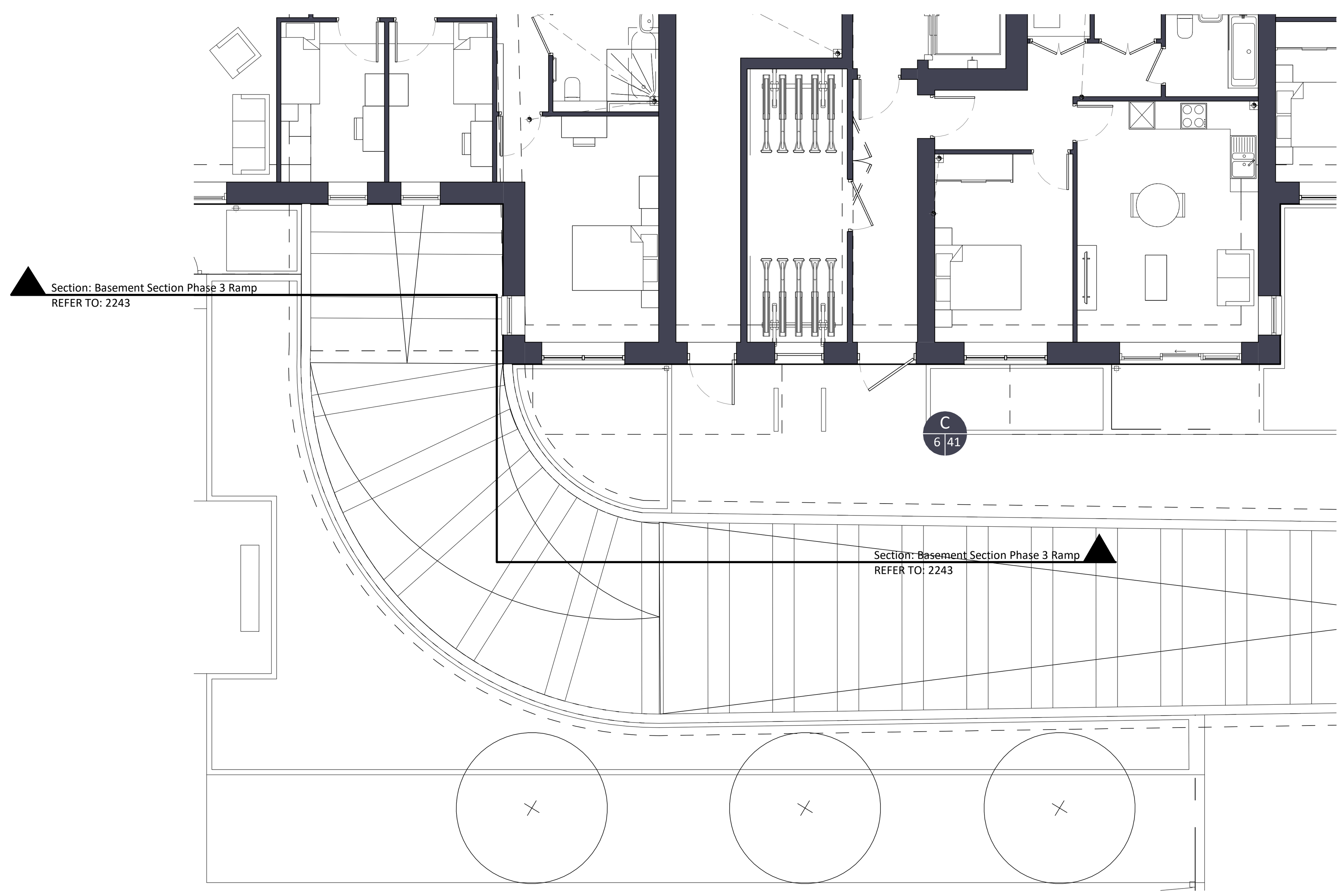
1:50m
0 1 2 5



Location Plan
1 : 2500



Phase 2 Basement Entrance Ramp Plan
1 : 100



Phase 3 Basement Entrance Ramp Plan
1 : 100

1:100m
0 1 5 10

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name: Hill Residential			
Project Name: Ham Close Regeneration			
Drawing Name: Basement Entrance Ramp Details			
Drawing Number: HCR-BPTW-S01-ZZ-DR-A-2243		Rev: C01	Status: A3
Project No: 21-090	RIBA Stage: 3	Drawn By: JB	Scale: As Indicated @ A1

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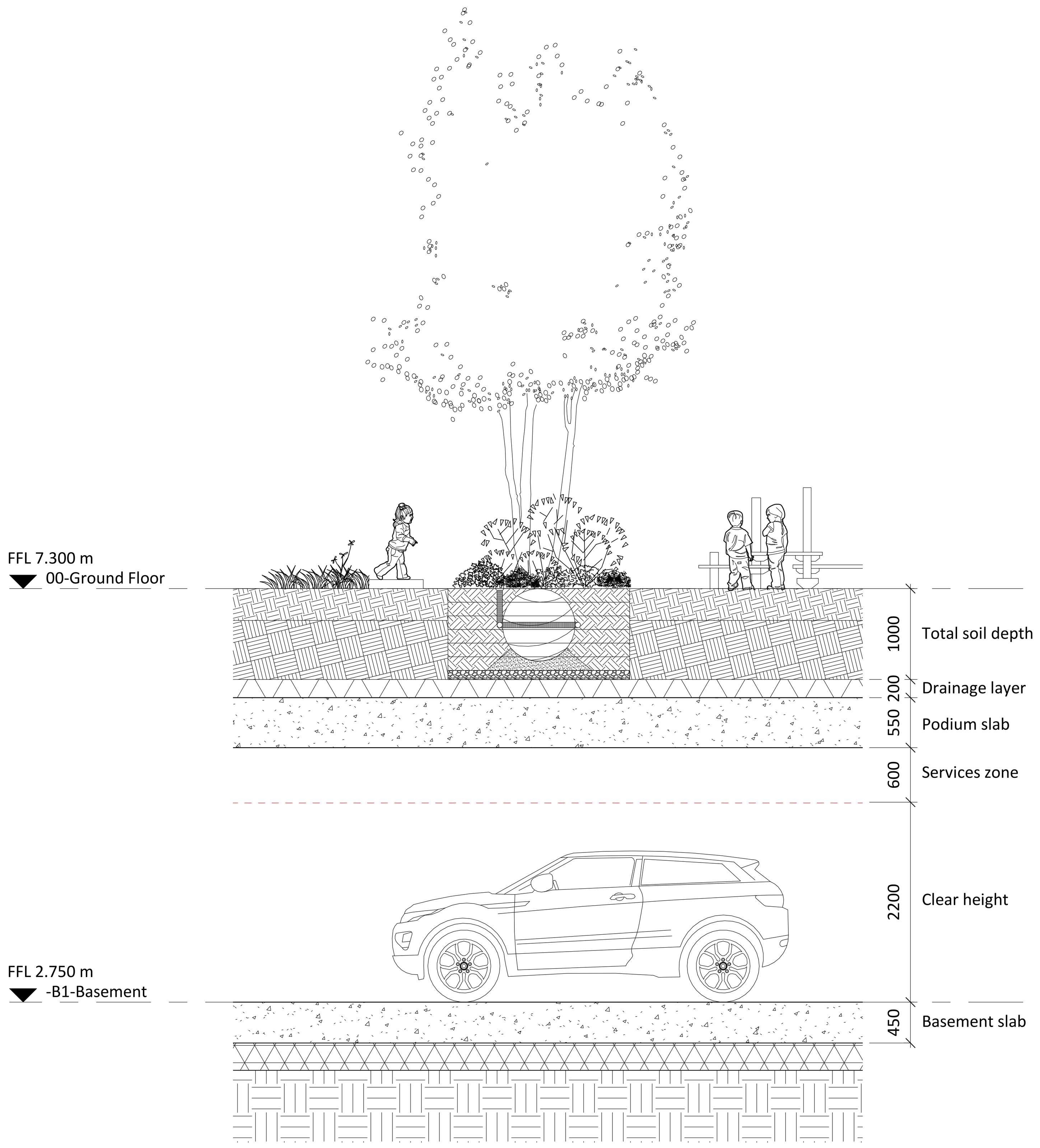

Soft landscaping Indicative Detail
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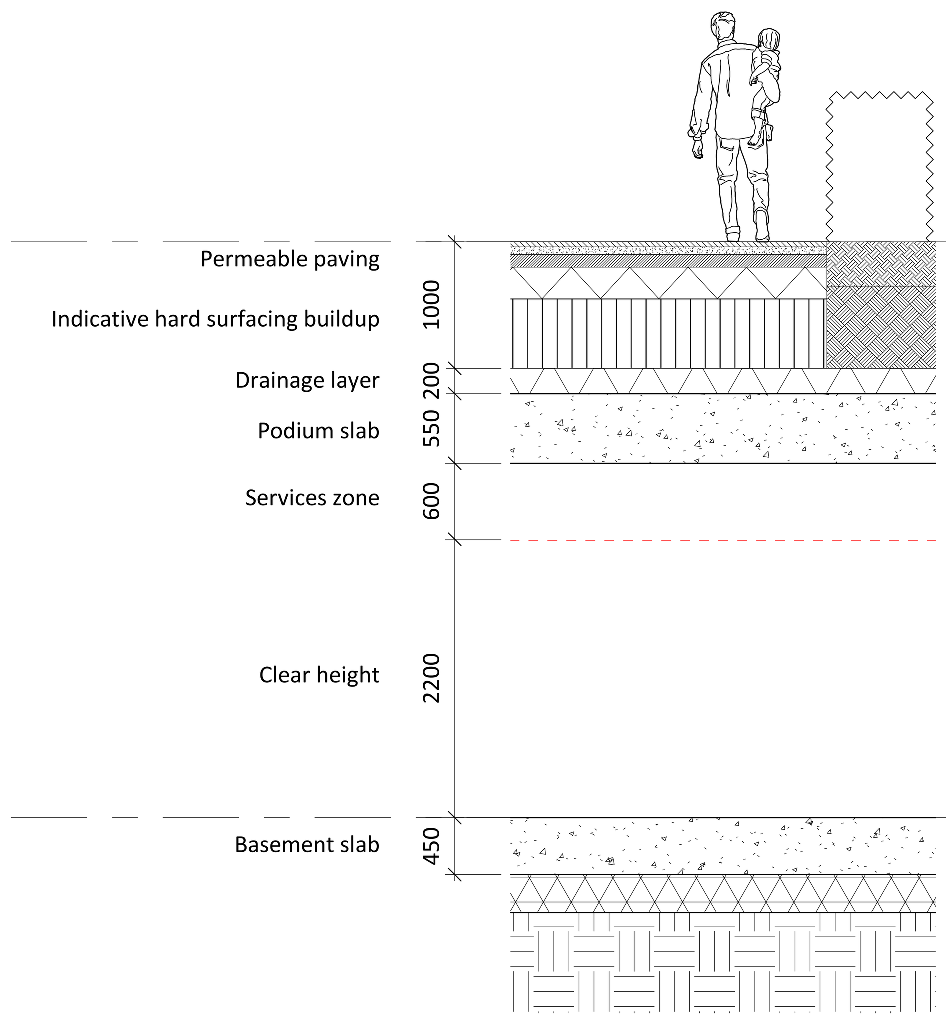
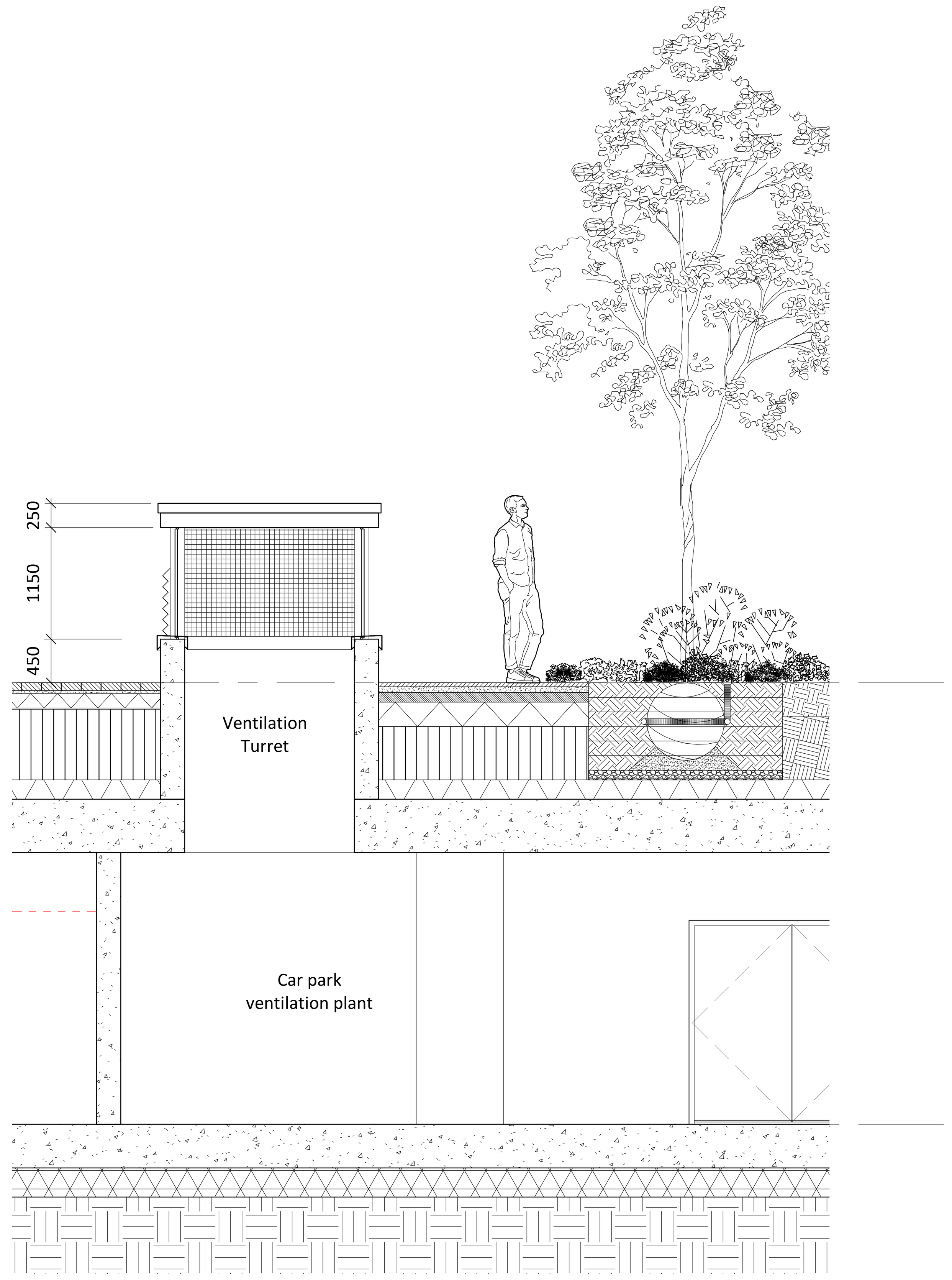


Hard landscaping Indicative Detail
1 : 50



Basement Ventilation Turret Detail
1 : 50

Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:

Rev	Status	Date	Description	Drn	Chkd
C01	A3	26.04.22	Planning Issue	JB	CD

Client Name:
Hill Residential

Project Name:
Ham Close Regeneration

Drawing Name:
Indicative Basement Details

Drawing Number:	Rev:	Status:
HCR-BPTW-S01-ZZ-DR-A-2244	C01	A3

Project No:	RIBA Stage:	Drawn By:	Scale:
21-090	3	JB	1:50 @ A1

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APPENDIX B – DEFRA NON-STATUTORY TECHNICAL STANDARDS FOR SUDS

Department for Environment, Food and Rural Affairs

Sustainable Drainage Systems

Non-statutory technical standards for sustainable drainage systems

March 2015

Contents

Department for Environment, Food and Rural Affairs

Sustainable Drainage Systems

Non-statutory technical standards for sustainable drainage systems

March 2015

Contents

Introduction

This document sets out non-statutory technical standards for sustainable drainage systems. They should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

Flood risk outside the development

S1 Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control standards (**S2** and **S3** below) and volume control technical standards (**S4** and **S6** below) need not apply.

Peak flow control

S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with **S4** or **S5** above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Introduction

This document sets out non-statutory technical standards for sustainable drainage systems. They should be used in conjunction with the National Planning Policy Framework and Planning Practice Guidance.

Flood risk outside the development

S1 Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or a large estuary) the peak flow control standards (**S2** and **S3** below) and volume control technical standards (**S4** and **S6** below) need not apply.

Peak flow control

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S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

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S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with **S4** or **S5** above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

Structural integrity

S10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

S11 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

Designing for maintenance considerations

S12 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

Construction

S13 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

S14 Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.

Flood risk within the development

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

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S10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

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S14 Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.

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Any enquiries regarding this publication should be sent to us at

suds@defra.gsi.gov.uk

PB14308

APPENDIX C – RICHMOND COUNCIL SURFACE WATER MANAGEMENT DOCUMENTS

PRELIMINARY FLOOD RISK ASSESSMENT

DRAIN LONDON

LONDON
BOROUGH OF
RICHMOND
UPON THAMES

GREATERLONDONAUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

LONDON BOROUGH OF RICHMOND UPON THAMES

Quality Management

DOCUMENT INFORMATION

Title:	London Borough of Richmond upon Thames PFRA
Owner:	
Version:	V05
Status:	Final Report
Project Number:	D134786
File Name:	DLT2-GP8-PFRA-RichmondReport-V05.doc

REVISION HISTORY

Summary of Changes	Completed By	Date of Issue	Version
Interim Draft Report	Sarah Littlewood	17-03-2011	V03
Draft Final including comments from LB Richmond	Sarah Littlewood	14-04-2011	V04
Final including comments from LB Richmond	Sarah Littlewood	18-05-2011	V05

AUTHOR

Name	Organisation and Role
Sarah Littlewood	Scott Wilson, Assistant Flood Risk Specialist
Emily Craven	Scott Wilson, Senior Flood Risk Specialist

APPROVALS

Name	Title	Signature	Date
Jon Robinson	PD URS/Scott Wilson		17-05-11
Emily Craven	PM URS/Scott Wilson		13-05-11
Michael Arthur	[Tier 1 PM]		
Kevin Reid	[GLA PM]		
Matthew Graham	Scott Wilson Reviewer		14/03/11
Michael Timmins	Scott Wilson Approver		17/03/2011

DISTRIBUTION

Name	Organisation and Role

RELATED DOCUMENTS

Doc Ref	Document Title	Author	Date of Issue	Version

Executive Summary

This document forms a Preliminary Flood Risk Assessment (PFRA) report for London Borough of Richmond upon Thames as required in accordance with the Flood Risk Regulations 2009.

The PFRA provides a high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The scope of the PFRA is to consider flooding from the following sources; surface runoff, groundwater, sewers and ordinary watercourses and any interaction these have with main rivers and the sea.

According to readily available datasets, the London Borough of Richmond has experienced a number of past surface water flooding events, however they have not been deemed to have had significant consequences for human health, economic activity, the environment and cultural heritage and have therefore not been recorded in Annex 1 of the PFRA spreadsheet.

It has been agreed, in conjunction with Environment Agency and Council members, that the Drain London Surface Water Management Plan (SWMP) outputs from the Drain London Project will form the locally agreed surface water information for the London Borough of Richmond. A review of this information demonstrates that an estimated 28,770 residential properties and 2,170 non-residential properties in the London Borough of Richmond could be at risk of surface water flooding of greater than 0.03m depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 100 residential properties and 15 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Details of these consequences are recorded in Annex 2 of the PFRA spreadsheet.

The London Borough of Richmond is included in the Flood Risk Area for Greater London. No changes are proposed to this Flood Risk Area.

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStSWF	Areas Susceptible to Surface Water Flooding
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CDA	Critical Drainage Area
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LB	London Borough
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone

Term	Definition
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location
Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner.
LPA	Local Planning Authority
LRF	Local Resilience Forum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PA	Policy Area
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act
RMA	Risk Management Authority
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Surface water	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
WaSC	Water and Sewerage Company

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Annexes

1. Introduction

1.1 WHAT IS A PRELIMINARY FLOOD RISK ASSESSMENT?

1.1.1 A Preliminary Flood Risk Assessment (PFRA) is a high level screening exercise to identify areas of significant flood risk within a given study area. The PFRA involves collecting information on past (historic) and future (potential) floods, assembling the information into a PFRA report, and identifying Flood Risk Areas.

1.1.2 This PFRA report for London Borough of Richmond upon Thames provides a high level summary of significant flood risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding. The development of new information is not required, but new analysis of existing information may be needed.

1.1.3 This PFRA has been based on existing and readily available information and brings together information from a number of available sources such as the Environment Agency's national information (for example Flood Map for Surface Water) and existing local products such as Strategic Flood Risk Assessments (SFRAs) and Surface Water Management Plans (SWMPs). The methodology for producing this PFRA has been based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas, both published in December 2010.

1.2 BACKGROUND

1.2.1 The primary driver behind the PFRA is the Flood Risk Regulations 2009, which became law on the 10th December 2009 and seek to transpose the EC Floods Directive (Directive 2007/60/EC on the assessment and management of flood risks) into domestic law in England and Wales and to implement its provisions.

1.2.2 In particular the Regulations place duties on the Environment Agency and Lead Local Flood Authorities (LLFA) to prepare a number of documents including:

- Preliminary Flood Risk Assessments;
- Flood Hazard and Flood Risk Maps;
- Flood Risk Management Plans.

1.2.3 The purpose of the PFRA report under the Regulations is to provide the evidence for identifying Flood Risk Areas. The report will also provide a useful reference point for all local flood risk management and inform local flood risk strategies.

1.2.4 The scope of the PFRA is to consider past flooding and potential future flooding from the sources of flooding other than main rivers, the sea and reservoirs. In particular this includes surface runoff, flooding from groundwater and ordinary watercourses and any interaction these have with local drainage systems.

1.3 Objectives

1.3.1 The key objectives of the PFRA are summarised as follows:

- Collect information on past (historic) and future (potential) floods within the study area and record it within the PFRA spreadsheet;
- Assemble the information into a PFRA report;
- Review the indicative Flood Risk Areas delineated by the Environment Agency and where necessary provide explanation and justification for any amendments required to these;
- Provide a summary of the systems used for data sharing and storing and the provision for quality assurance, security and data licensing arrangements;
- Describe arrangements for partnership and collaboration for ongoing collection, assessment and storage of flood risk data and information;
- Identify relevant partner organisations involved in future assessment of flood risk; and summarise means for future and ongoing stakeholder engagement;
- Provide a useful reference point for all local flood risk management and inform future local strategies.

1.4 Study Area

1.4.1 The study area is defined by the administrative boundary of the London Borough of Richmond upon Thames. LB of Richmond upon Thames is located in west London and covers an area of approximately 60km^2.

1.4.2 A large proportion of the borough comprises green and open spaces including Richmond Park, designated a National Nature Reserve and Site of Special Scientific Interest. Key fluvial systems in the study area include the Beverley Brook and the River Crane which feed into the River Thames which also passes through the borough.

1.4.3 The underlying geology is primarily impermeable London Clay, which is overlain by Alluvium and River Terrace deposits to the north of the River Thames. The borough is served by a Thames Water Utilities surface water drainage network.

1.4.4 The study area falls into the Thames River Basin District (RBD) (as defined by the Environment Agency) and is located in the Environment Agency Thames Region. The water utility provider is Thames Water Utilities Ltd.

2. LLFA Responsibilities

2.1 LEGISLATIVE BACKGROUND

2.1.1 The key drivers behind the PFRA are two pieces of new legislation, the Flood Risk Regulations 2009 which became law on the 10th December 2009, and the Flood & Water Management Act (FWMA) which gained Royal Assent on the 8th April 2010.

2.1.2 The Flood Risk Regulations 2009 were created to transpose the EC Floods Directive (Directive 2007/60/EC) into domestic law in England and Wales. The Floods Directive provides a framework to assess and manage flood risks in order to reduce adverse consequences for human health, the environment (including cultural heritage) and economic activity.

2.1.3 The Flood and Water Management Act 2010 makes specific provision for the recommendations provided by Sir Michael Pitt in his independent review of the flooding experienced across much of England and Wales in 2007.

2.1.4 Under these pieces of legislation, all Unitary Authorities are designated 'Lead Local Flood Authorities' (LLFA) and have formally been allocated a number of key responsibilities with respect to local flood risk management.

2.2 LEADERSHIP & PARTNERSHIP

2.2.1 The Flood and Water Management Act 2010 defines the unitary authority, in this case London Borough of Richmond upon Thames, as the Lead Local Flood Authority (LLFA). As such, the London Borough of Richmond upon Thames is responsible for leading local flood risk management, including establishing effective partnerships within their local authority as well as with external stakeholders such as the Environment Agency, Thames Water Utilities Ltd, Transport for London, Network Rail and London Underground as well as others. Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU).

2.2.2 The flood group is divided into a Strategic Management Group which is responsible for making overall decisions about flood risk management such as severe weather incident management, operational maintenance, future flood risk investments and planning; and the Operational Management Group which serves as the 'day-to-day' flood risk group delivering the flood risk system operations and maintenance on the ground.

2.2.3 The Strategic Flood Group was set up during the Drain London project, meets every 3 months (first meeting held on the 29th March 2011) and will continue with the aim of ensuring collaborative working across relevant stakeholders as described above.

2.2.4 Responsibility for flood risk management at the London Borough of Richmond upon Thames is shared across several departments; however Jon Freer, Assistant Director of Environment (Development & Street Scene) takes on the overall lead on local flood risk management activities within the Council and is representing the borough on the South London Strategic Flood Group.

Figure 2-1 Organogram of Potential South West London Flood Partnership

Thames Regional Flood Defence Committee
Councillor Osborne (RLB Kingston) Environment Agency

South West London Strategic Flood Group
Senior Managers for Croydon, Sutton, Kingston, Merton, Richmond & Wandsworth Environment Agency Thames Water

Technical Working Groups
Representatives from Croydon, Sutton, Kingston, Merton, Richmond & Wandsworth
Highways Strategic Planning Drainage Emergency Planning Parks & Open Spaces Climate Change GIS

2.3 Stakeholder Engagement

2.3.1 As part of the preparation of PFRAs and SWMPs across London, stakeholders have been engaged representing the following organisations and authorities:

- Environment Agency
- Thames Water Utilities Ltd
- Neighbouring London Boroughs
- London Fire Brigade
- Network Rail
- London Underground
- Transport for London
- Highways Agency
- Natural England

2.4 Public Engagement

2.4.1 Members of the public may also have valuable information to contribute to the PFRA and to an improved understanding and management of local flood risk within the study area. Public engagement can afford significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions proposed in future flood risk management plans.

2.4.2 However it is also recognised that it is crucial to plan the level and timing of engagement with communities predicted to be at risk of flooding from surface water, groundwater and ordinary watercourses. This is to ensure that the potential for future management options and actions is adequately understood and costed without raising expectations before solutions can reasonably be implemented.

2.4.3 It is important to undertake some public engagement when formulating local flood risk management plans, following the designation of Flood Risk Areas within the study area as this will help to inform future levels of public engagement. It is recommended that the London Borough of Richmond upon Thames follow the guidelines outlined in the Environment Agency's "Building Trust with Communities" [1] which provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

2.5 Other Responsibilities

2.5.1 Aside from forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Flood & Water Management Act 2010, and the Flood Risk Regulations 2009. These responsibilities include:

- **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.
- **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have an effect on flood risk, including details on ownership and condition as a minimum. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.
- **SuDS Approving Body** – LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area. This responsibility is anticipated to commence from April 2012.
- **Local Flood Risk Management (LFRM) strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The LFRM strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.
- **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.
- **Designation powers** – LLFAs, as well as district councils and the Environment Agency have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it.

[1] Environment Agency, Building Trust with Communities
http://www.ncl.ac.uk/ihs/research/environment/rehmarc/pdfs/workingwithothers.pdf

3. Methodology & Data Review

3.1 Data Sources & Availability

3.1.1 Table 3-1 provides a summary of the data sources held by partner organisations with responsibility for local flood risk management in London Borough of Richmond upon Thames. The table includes a description of the dataset and its availability at the time of writing.

Table 3-1 Data Sources

	Dataset	Description
Environment Agency	Environment Agency Flood Map (Fluvial)	Shows the extent of flooding from rivers with a catchment of more than $3km^2$ and from the sea.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the EA and developed in response to Pitt recommendations.
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.
	Areas Susceptible to Groundwater Flooding	Mapping showing areas susceptible to groundwater flooding.
	National Receptors Dataset	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.
	Indicative Flood Risk Areas	National mapping highlighting key flood risk areas, based on the definition of 'significant' flood risk agreed with the Defra.
	Historic Flood Map	Attributed spatial flood extent data for flooding from all sources.
London Borough of Richmond	Strategic Flood Risk Assessments (SFRA)	SFRAs may contain useful information on historic flooding, including local sources of flooding from surface water and groundwater.
	Historical flooding records	Historical records of flooding from surface water, groundwater and ordinary watercourses.
	Anecdotal information relating to local flood history and flood risk areas	Anecdotal information from authority members regarding areas known to be susceptible to flooding from excessive surface water, groundwater or flooding from ordinary watercourses.
	Highways Flooding Reports	Highways Flooding Reports for a number of locations including analysis of the flood risk at each location.
Thames Water	DG5 Register for Thames Water Utilities areas	DG5 Register logs and records of sewer flooding incidents in each area.
London Fire Brigade	**Historical flooding call-out records**	Records of all London Fire Brigade callouts for 'flooding' events since 2000. However, no flooding source is provided, so could be a result of water mains bursting as well as heavy rainfall / surface water flooding.
	Areas Prone To Flooding	A list of areas prone to flooding across their South East Territory.

	Flooding records – July 2007	Records relating to station closures (location and duration) on 20th July 2007 due to heavy rainfall.

3.2 LIMITATIONS

3.2.1 A number of issues arose during the data collection process, as described below:

3.2.2 The London Borough of Richmond log all incidents of flooding that are reported, however this only captures the incidents that they hear about and does not include specific details about the flooding incidents such as the individual areas that experience flooding or details about the source and consequences of the flooding. Furthermore, there is no standard method for the type of method of recording information that is received, and to whom it is circulated.

3.2.3 No data providers were able to provide comprehensive details of the consequences of specific past flood events, which made accurately assessing the consequences of historic flooding difficult.

3.3 SECURITY, LICENSING AND USE RESTRICTIONS

3.3.1 A number of datasets used in the preparation of this PFRA are subject to licensing agreements and use restrictions.

3.3.2 The following national datasets provided by the Environment Agency are available to local authorities and their consultants for emergency planning and strategic planning purposes:

- Flood Map for Rivers and the Sea;
- Areas Susceptible to Surface Water Flooding;
- Flood Map for Surface Water;
- National Receptor Database.

3.3.3 The analyses to prepare the indicative Flood Risk Areas issued to accompany the final PFRA Guidance were based on the National Receptors Database (NRD) version 1.0 (for the counts of properties and other receptors). Receptor information was prepared for all London Boroughs in December 2010 in order to undertake property counts required for the SWMPs, also using NRD version 1.0. Version 1.1 of the NRD has subsequently been issued and contains modifications and corrections since version 1.0. However, in order to avoid repetition of work, and ensure consistency between the SWMP and the PFRA, it was decided to complete the PFRA using NRD version 1.0.

3.3.4 A number of the data sources used are publically available documents, such as:

- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Surface Water Management Plan.

3.3.5 The use of some of the datasets made available for this PFRA has been restricted and is time limited, licensed to the London Borough of Richmond upon Thames via the Greater London Authority for use under the Drain London project, which includes the production of a PFRA for the London Borough of Richmond upon Thames. The restricted datasets include records of property flooding held by the Council and by Thames Water Utilities Ltd, and data licensed by the Environment Agency. Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the agreement. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

3.4 QUALITY ASSURANCE

3.4.1 The datasets used to inform this PFRA were collected centrally for all London Boroughs as part of the Tier 1 Drain London work package of works. All data received was subject to quality assurance measures to monitor and record the quality and accuracy of the data and information. A data quality score was given to all the data which is a qualitative assessment based on the Data Quality System provided in the SWMP Technical Guidance (March 2010). This system is explained in Table 3-2.

Table 3-2 Data Quality System (SWMP Technical Guidance March 2010)

Data Quality Score	Description	Explanations	Example
1	Best available	No better available; not possible to improve in the near future	2D Pluvial Modelling Outputs
2	Data with known deficiencies	Best replaced as soon as new data is available	Historic Flood Records
3	Gross assumptions	Not invented but based on experience and judgement	Location, extent and depth of surface water flooding
4	Heroic assumptions	An educated guess	Impact of a historic flood event

3.4.2 The use of this system provides a basis for analysing and monitoring the quality of data that is being collected and used in the preparation of the PFRA. As mentioned in Section 3.2, some of the datasets collected for this PFRA were of poor quality, and this has been identified and recorded using this system.

4. Past Flood Risk

4.1 Summary of Past Floods

4.1.1 Table 4-1 provides a summary of past flood incidents in the study area. Not all of these events are considered to have had 'significant harmful consequences' and therefore not all have been included within Annex 1 of the PFRA spreadsheet.

4.1.2 It is noted that to date it has not been the duty of Local Authorities to record flooding incidents, and as such Table 4-1 is not a comprehensive list of historic flooding events in the Borough.

Table 4-1 Past Floods & Consequences

Flood Event	Description
Surface water flooding July 2007	Property and road flooding in Barnes including the following locations; Arundel Terrace, Castelnau, Lonsdale Road, Madrid Road, The Terrace.
Surface water flooding July 2007	Property and road flooding in Hampton; including Gloucester Road, Longford Close, Lower Teddington Road, Hammond Close, Warwick Close.
Surface water flooding July 2007	Property and road flooding in Heathfield, including Ellerman Avenue, Powder Mill Lane.
Surface water flooding July 2007	Flooding of Lower Richmond Park Road, Mortlake High Street, Queens Ride and Worple Street in the Mortlake and Barnes Common area.
Surface water flooding July 2007	Flooding of Cross Deep, Heath Road and Strawberry Vale in South Twickenham.
Surface water flooding July 2007	Flooding of Montague Road and Paradise Road in South Richmond
Surface water flooding July 2007	Flooding of Arlington Road, Beaconsfield Road and Whitton Road in North Twickenham.
Surface water flooding July 2007	Flooding of the following locations in Teddington; Albert Road, Broad Street, Elfin Grove, Ferry Road, High Street, Luther Road, Park Road, Stanley Road, Teddington Park, Thelma Grove.
Surface water flooding July 2007	Flooding of the following locations in Twickenham; Amyand Park Road, First Cross Road, Twickenham Road and Willow Way.
Surface water flooding July 2007	Flooding of the following locations in Whitton; Kneller Road, Nelson Road, Wills Crescent and Redway Drive.

4.1.3 The following figures (maps) are included in Annex 6 and show records of past flooding:

- 1 Surface Water & Fluvial Flooding Incidents;
- 2 Groundwater Flooding Incidents;
- 3 Sewer Flooding Incidents (DG5 Register provided by Thames Water June 2010).

4.2 Significant Harmful Consequences

4.2.1 The Flood Risk Regulations require PFRAs to report detailed information on past flood events that had ‘significant harmful consequences’. There is no national definition of what constitutes ‘significant harmful consequences’; it is a matter for local decision based on local information collected through the PFRA process.

4.2.2 Although there is an indication of some loss of property economic loss in the floods in July 2007, the events described in Table 4.1 are not overall considered to have significant harmful consequences for human health, economic activity, the environment or cultural heritage and therefore have not been included in Annex 1 of the PFRA spreadsheet.

4.2.3 A complete record of locations where flooding has occurred will be kept by the London Borough of Richmond as a future evidence base. This base will be built up in the future through ensuring full details of flood events are recorded; this will then be used to support and inform future PFRA cycles as well as Richmond’s Local Flood Risk Management Strategy.

4.3 Interactions with Other Flooding Sources

4.3.1 Flooding is often the result of water from more than one source, or water building up because another source (such as a river, or the sea) has prevented it from discharging normally. Information about past flooding will often be about an unknown source (i.e. it is not clear where the water came from), or flooding as a result of interactions between sources (in which case more than one source may be recorded).

4.3.2 Where flood records within the study area are known to be from more than one flood source, this has been recorded in the PFRA spreadsheet. Where the source of flooding is not known this has also been recorded.

5. Future Flood Risk

5.1 SUMMARY OF FUTURE FLOOD RISK

5.1.1 Information about future flood risk, or potential flooding, is usually produced by computer models. The Environment Agency has several national datasets showing risk of flooding from surface water, groundwater, main rivers and ordinary watercourses that are available to LLFAs. These datasets have been used to undertake an assessment of the number of properties and any important receptors that may be at risk of future flooding. Further details are provided in Annex 2 of the PFRA spreadsheet.

Surface Water Flooding

5.1.2 The Environment Agency has undertaken a property count for each LLFA for both their national Flood Map for Surface Water (FMfSW) and Areas Susceptible to Surface Water Flooding (AStSWF) datasets. It is intended that these are used to provide an indication of the number of residential and non-residential properties that are a risk from surface water flooding within each LLFA.

5.1.3 Using the Environment Agency Flood Map for Surface Water (FMfSW) dataset, it is estimated that 22,100 residential properties and 2,800 non-residential properties in London Borough of Richmond upon Thames could be at risk of surface water flooding of greater than 0.1m depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 3,400 residential properties and 500 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.3m during the same modelled rainfall event.

5.1.4 Details are provided in Annex 2 of the PFRA spreadsheet.

Ordinary Watercourses

5.1.5 The Detailed River Network has been used to identify the ordinary watercourses and the Environment Agency Flood Map, showing flooding from rivers and the sea, has been used to identify the risk of future flooding from ordinary watercourses.

5.1.6 However there is insufficient data in the Flood Map regarding critical ordinary watercourses within the study area to make an accurate assessment of the future flood risk associated with these watercourses.

5.2 LOCALLY AGREED SURFACE WATER INFORMATION

5.2.1 Surface Water Flooding

5.2.2 In addition to these national datasets more locally specific surface water information is available for the study area. The London Borough of Richmond upon Thames is currently undertaking a Surface Water Management Plan as part of the Drain London Programme. As part of this study, direct rainfall modelling has been undertaken to simulate surface water flooding in the study area.

5.2.3 It has been agreed, in conjunction with Environment Agency and Council members, that the SWMP outputs will form the locally agreed surface water information for London Borough of Richmond upon Thames.

5.2.4 Figures 4 and 5 included in Annex 6 show the results from this modelling for the rainfall event with a 1 in 200 annual chance of occurrence. For a full methodology, the reader is referred to the Surface Water Management Plan for London Borough of Richmond upon Thames.

- Figure 4 Maximum Flood Depth – 1 in 200 chance of rainfall event occurring in any given year (0.5%)
- Figure 5 Flood Hazard – 1 in 200 chance of rainfall event occurring in any given year (0.5%)

5.2.5 Surface water modelling completed as part of Tier 2 of the Drain London Project affords an improved understanding of the level of flood risk facing the London Borough of Richmond. As part of the SWMP produced for each LLFA, a property count has been undertaken using the Environment Agency's National Receptors Dataset (NRD). Using the Drain London property count, it is estimated that 28,770 residential and 2,170 non-residential properties in the London Borough of Richmond could be at risk of surface water flooding of greater than 0.03m[2] depth during a rainfall event with a 1 in 200 annual chance of occurring. Approximately 100 residential and 16 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Further information on the property count methodology and property counts for other return periods are provided in the London Borough of Richmond's SWMP.

Groundwater Flooding

5.2.6 Large areas within the Drain London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique described below aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment.

5.2.7 The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map:

- British Geological Survey (BGS) Groundwater Flood Susceptibility Map;
- Jacobs Groundwater Emergence Maps (GEMs);
- Jeremy Benn Associates (JBA) Groundwater Flood Map; and
- Environment Agency/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps.

5.2.8 To produce the iPEG map for consolidated aquifers, an area was defined as having increased potential for elevated groundwater levels if at least two of the three mapping techniques listed above produced a corresponding area. For the permeable superficial deposits, only Band 1 Very High of the BGS and the TE2100 data were used as this was judged to best represent the hazard.

[2] Building thresholds have been represented in the modelling as 'stubs' raised 100mm above the average ground level within the building footprint. A depth of >0.03m will result in a water level 0.03m above the property threshold, which is therefore considered to flood.

5.2.9 The techniques used to generate the iPEG map produced some small areas of increased potential and some dry islands within increased potential areas. These have not been cleaned in order to best represent the original data.

How to Use and Interpret the Map

5.2.10 The increased Potential for Elevated Groundwater map shows those areas within the Borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2 m of the ground surface.

5.2.11 Groundwater may become elevated by a number of means:

- Above average rainfall for a number of months in Chalk outcrop areas;
- Shorter period of above average rainfall in permeable superficial deposits;
- Permeable superficial deposits in hydraulic continuity with high water levels in the river;
- Interruption of groundwater flow paths; and
- Cessation of groundwater abstraction causing groundwater rebound.

5.2.12 With the exception of groundwater rebound which is not covered, the iPEG map will identify those areas most prone to the mechanisms described above. The map shows those areas considered to have the greatest potential for elevated groundwater. Additional areas within the London Boroughs have permeable geology and therefore could also produce elevated groundwater levels. However, to produce a realistic map, only where there is the highest degree of confidence in the assessment are the areas delineated. This ensures resources are focused on the most susceptible areas. In all areas underlain by permeable substrate, groundwater should still be considered in planning developments.

5.2.13 Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas.

5.2.14 For this reason within iPEG areas, locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the iPEG map should not be used as a “flood outline” within which properties at risk can be counted. Rather it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and if so what would be the major flow pathways that water would take.

5.2.15 The iPEG mapping is presented in Figure 2.

5.3 Impact of Climate Change

5.3.1 There is clear scientific evidence that global climate change is happening now. It cannot be ignored.

5.3.2 Over the past century around the UK we have seen sea level rise and more of our winter rain falling in intense wet spells. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

5.3.3 Greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

5.3.4 We have enough confidence in large scale climate models to say that we must plan for change. There is more uncertainty at a local scale but model results can still help us plan to adapt. For example we understand rain storms may become more intense, even if we can't be sure about exactly where or when. By the 2080s, the latest UK climate projections (UKCP09) are that there could be around three times as many days in winter with heavy rainfall (defined as more than 25mm in a day). It is plausible that the amount of rain in extreme storms (with a 1 in 5 annual chance or rarer) could increase locally by 40%.

Key Projections for Thames River Basin District

5.3.5 If emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 15% (very likely to be between 2 and 32%);
- Precipitation on the wettest day in winter up by around 15% (very unlikely to be more than 31%);
- Relative sea level at Sheerness very likely to be up between 10 and 40cm from 1990 levels (not including extra potential rises from polar ice sheet loss);
- Peak river flows in a typical catchment likely to increase between 8 and 18%.

Implications for Flood Risk

5.3.6 Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability.

5.3.7 Wetter winters and more of this rain falling in wet spells may increase river flooding in both rural and heavily urbanised catchments. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected.

5.3.8 Rising sea or river levels may increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses.

5.3.9 There is a risk of flooding from groundwater-bearing chalk and limestone aquifers across the district. Recharge may increase in wetter winters, or decrease in drier summers.

5.3.10 Where appropriate, we need local studies to understand climate impacts in detail, including effects from other factors like land use. Sustainable development and drainage will help us adapt to climate change and manage the risk of damaging floods in future.

Adapting to Change

5.3.11 Past emission means some climate change is inevitable. It is essential we respond by planning ahead. We can prepare by understanding our current and future vulnerability to flooding, developing plans for increased resilience and building the capacity to adapt. Regular review and adherence to these plans is key to achieving long-term, sustainable benefits.

5.3.12 Although the broad climate change picture is clear, we have to make local decisions against deeper uncertainty. We will therefore consider a range of measures and retain flexibility to adapt. This approach, embodied within flood risk appraisal guidance, will help to ensure that we do not increase our vulnerability to flooding.

Pluvial Modelling Including Allowance for Climate Change

5.3.13 As part of the pluvial modelling completed for the Surface Water Management Plan for London Borough of Richmond upon Thames, a model scenario has been undertaken including an allowance for climate change. Figure 5 in Annex 6 shows the results for the maximum flood depth during the rainfall event with a 1 in 100 annual chance of occurrence, including an allowance for climate change. Figure 6 shows the flood hazard rating for the same return period.

- Figure 6 Maximum Flood Depth – 1 in 100 Chance of rainfall event occurring in any given year (1% AEP) plus Climate Change;
- Figure 7 Flood Hazard – 1 in 100 Chance of rainfall event occurring in any given year (1% AEP) plus Climate Change.

5.3.14 As part of the SWMP produced for each LLFA, a property count has been undertaken using the Environment Agency's National Receptors Dataset (NRD). Using the Drain London property count, it is estimated that 29,690 residential properties and 2,230 non-residential properties in the London Borough of Richmond could be at risk of surface water flooding of greater than 0.03m[3] depth during a rainfall event with a 1 in 100 annual chance of occurring including an allowance for climate change. Approximately 130 residential properties and 20 non-residential properties are estimated to be at risk of flooding to a depth of greater than 0.5m during the same modelled rainfall event. Further information on the property count methodology and property counts for other return periods are provided in the London Borough of Richmond SWMP.

5.4 Major Developments

5.4.1 Recent or upcoming major development sites that may have the potential to affect local surface water flood risk have been listed below.

5.4.2 Sites as identified in the Richmond upon Thames Housing Land Supply (large sites)[4]:

[3] Building thresholds have been represented in the modelling as 'stubs' raised 100mm above the average ground level within the building footprint. A depth of >0.03m will result in a water level 0.03m above the property threshold, which is therefore considered to flood.

[4] The majority of these sites have been taken from the Housing Land Supply (large sites) analysis from the 2009/10 London Borough of Richmond upon Thames Annual Monitoring Report. Further relevant updates are noted for information in italics. *Note that the number of units is taken from the Housing Land Supply assessment; the higher figure has been taken where a range was provided.

- Budweiser Stag Brewery, Mortlake (90 units) – work on draft Planning Brief has suggested could reach 500 units as part of a mixed use development;
- Twickenham Sorting Office, 109 London Road, Twickenham (170 units);
- Twickenham Station (75 units);
- Twickenham Stadium / Rugby Football Union (RFU) Site (115 units);
- Former Inland Revenue Sorting Office, Ruskin Avenue, Kew (50 units);
- Former Seeboard Site, Sandy Lane, Teddington, Hampton Wick (198 units) – part completed;
- Sainsbury's, Manor Road/Lower Richmond Road (255 units);
- Platts Eyott, Hampton (70 units);
- Air Sea House, West Twickenham (67 units) - phase 1 (14 units) completed;
- Gordon Court, Fulwell, Hampton Hill (28 units);
- 1-5 And Outbuildings The Maples, Hampton Wick (10 units);
- Becketts Wharf and Osbourne House, Becketts Place, Hampton Wick (26 units) – part completed;
- Normansfield Hospital, Hampton Wick (89 units);
- 29 Sheen Lane, Mortlake, Barnes Common, (15 units);
- Norcutt House, South Twickenham (22 units);
- 14a King Street Coach House The Old Workshop and CP, South Richmond (13 units);
- 361 to 376 St Margarets Road, St Margaret's & North Twickenham (27 units);
- 209 Waldegrave Road, Teddington (22 units);
- 38-48 High Street, Whitton (12 units);
- Former Goods Yard Land At Queens Ride, Mortlake, Barnes Common (14 units);
- 293 Lower Richmond Road, North Richmond (52 units);
- Friars Lane Car Park, South Richmond (20 units);
- Richmond College, Egerton Road, St Margaret's & North Twickenham (50 units);
- 121 Heath Road, Twickenham (22 units);
- Land at Williams Lane Bowling Green, Mortlake (76 units);
- Royal Star & Garter, Richmond (60 units);
- The Avenue Centre, 1 Normansfield Avenue, Hampton Wick (17 units);
- Lower Richmond Road, Richmond (100 units) – International Mail Express: permission granted for mixed use including 77 units, other sites in locality may come forward for development;
- Greggs Bakery, Gould Road, Twickenham (200 units);
- Hampton Water Treatment Works, Hampton (55 units);
- Gifford House, Popes Avenue, Twickenham (29 units);
- Council Depot, Langhorn Drive, Twickenham (55 units);
- Richmond Station (20 units).

5.4.3 Sites as identified in the Richmond upon Thames Employment Land Supply:

- St Margarets Business Centre, Winchester Rd/ Moor Mead Rd, Twickenham;
- Heathlands Industrial Estate, Heath Rd, Twickenham;
- The Twickenham Centre, Norcutt Rd, Twickenham;
- Mereway Centre, Mereway Road/ Rowntree Rd, Twickenham;
- St George's Industrial Estate, The Green, Twickenham;
- Teddington Business Park, Station Rd, Teddington;
- St Clare Business Park, Holly Rd, Hampton Hill;
- Old Power House, Kew Gardens Station/ Station Approach;
- Sandycombe Centre, Sandycombe Lane, Kew;
- Port Hampton, Platts Eyot, Hampton;
- Kingsway Business Park/ Sandfield Industrial Estate, Oldfield Rd, Hampton;
- Mount Mews, 13-25 High Street, Hampton;
- Third Cross Road, Twickenham;
- Tideway Yard, Mortlake High Street;
- Marlborough Trading Estate, 159 Mortlake Road, Kew TW9.

5.4.4 It is noted that the above lists are not in any order of priority (i.e. in its relevance to surface water flood risk, size or number of housing units) and not exhaustive. There may be additional sites where a (re)development could have the potential to affect local surface water flood risk.

5.5 Long Term Developments

5.5.1 It is possible that long term developments might affect the occurrence and significance of flooding. However current planning policy aims to prevent new development from increasing flood risk.

5.5.2 In England, Planning Policy Statement 25 (PPS25) on development and flood risk aims to "ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall."

5.5.3 Adherence to Government policy ensures that new development does not increase local flood risk. However, in exceptional circumstances the Local Planning Authority may accept that flood risk can be increased contrary to Government policy, usually because of the wider benefits of a new or proposed major development. Any exceptions would not be expected to increase risk to levels which are "significant" (in terms of the Government's criteria).

6. Review of Indicative Flood Risk Areas

6.1 EXTENT OF FLOOD RISK AREAS

6.1.1 The figure included in Annex 5 shows the Indicative Flood Risk Areas that have been identified by the Environment Agency.

6.1.2 The administrative area of Greater London, including London Borough of Richmond upon Thames is shown to be included in an Indicative Flood Risk Area.

6.2 REVIEW COMMENTS

6.2.1 No changes are proposed to the Greater London Indicative Flood Risk Area with respect to the area covered by London Borough of Richmond upon Thames.

7. Identification of Flood Risk Areas

7.1 Amendments to Flood Risk Areas

7.1.1 London Borough of Richmond upon Thames is not proposing any amendments to the Indicative Flood Risk Area for Greater London.

7.2 New Flood Risk Area

7.2.1 London Borough of Richmond upon Thames is not proposing any new Flood Risk Areas.

8. Next Steps

8.1 Scrutiny & Review

8.1.1 As the Local Lead Flood Authority, London Borough of Richmond upon Thames is required to review and approve this PFRA in accordance with their own internal processes, such as consideration by Cabinet, Council or an overview and scrutiny committee.

8.1.2 The PFRA has been through internal management process within London Borough of Richmond Council and subsequently to the Cabinet Member for Environment to be agreed.

8.1.3 The PFRA process will be reviewed on a 6-year cycle and for future iterations of the PFRA for London Borough of Richmond upon Thames an increasing level of information will be required including information which was optional for this first cycle relating to past flooding.

8.1.4 In order to ensure that this information is available for future reviews, a number of steps have been implemented as part of the Action Plan for the Surface Water Management Plan for London Borough of Richmond upon Thames. A number of key actions have been identified in the following sections.

8.2 Data Collection & Management

8.2.1 At the present time there is no consistent approach across the Local Authority for recording flood risk incidents and managing historic datasets including details of the sources and consequences of flood events.

8.2.2 During the course of the discussions on future governance for flood risk management it will be necessary to identify and detail ownership of the processes that will need to be embedded to ensure robust data collection and management arrangements are in place.

8.3 Other Requirements under the Flood Risk Regulations 2009

8.3.1 Table 8-1 provides a summary of the elements of work required from London Borough of Richmond upon Thames under the Flood Risk Regulations 2009, along with the timescales of their respective delivery. The first two elements of work are covered by the preparation of this PFRA report.

Table 8-1 Elements of Work required under the Flood Risk Regulations 2009

22nd June 2011	**Prepare Preliminary Assessment Report.**	*The PFRA should focus on local flood risk from surface water, groundwater, ordinary watercourses and canals.*
22nd June 2011	On the basis of the PFRA, identify **Flood Risk Areas.**	*Flood Risk Areas are areas of significant risk identified on the basis of the findings of the PFRA, national criteria set by the UK Government Secretary of State and guidance provided by the Environment Agency.*
22nd June 2013	Prepare **Flood Hazard Maps** and **Flood Risk Maps** for each Flood Risk Area.	*Used to identify the level of hazard and risk of flooding within each Flood Risk Area to inform Flood Risk Management Plans.*
22nd June 2015	Prepare **Flood Risk Management Plans** for each Flood Risk Area.	*Plans setting out risk management objectives and strategies for each Flood Risk Area.*

8.3.2 As part of the next phase of work, due for submission in June 2013, London Borough of Richmond upon Thames will be required to prepare Flood Hazard Maps and Flood Risk Maps for their local authority area. These will be required to inform Flood Risk Management Plan which will be due for submission in June 2015 setting out risk management objectives and strategies for the Flood Risk Area. The findings of this PFRA as well as that of the Surface Water Management Plan for London Borough of Richmond upon Thames should form the basis of the local flood risk management strategy for the area.

8.3.3 Further information can be found on the Environment Agency PFRA e-Learning module http://learning.environment-agency.gov.uk/courses/FCRM/capacity which has been developed as part of Defra's Capacity Building Strategy and is designed to provide users with an increased knowledge of the background and methodology involved in carrying out a PFRA.

Figure 8-1 Environment Agency e-Learning module

9. References

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Defra/WAG (2010) Selecting and reviewing Flood Risk Areas for local sources of flooding – Guidance to Lead Local Flood Authorities. Available from: http://www.defra.gov.uk/environment/flooding/documents/research/flood-risk-method.pdf

Environment Agency, December 2010, Preliminary Flood Risk Assessment (PFRA) Final Guidance, Report GEHO1210BTGH-E-E

Environment Agency, December 2010, Preliminary Flood Risk Assessment (PFRA) Annexes to the Final Guidance, Report GEHO1210BTHF-E-E

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Greater London Authority, 2011, Surface Water Management Plan for the London Borough of Richmond upon Thames

London Councils Website: http://www.londoncouncils.gov.uk/londonfacts/londonlocalgovernment/londonmapandlinks/default.htm

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Annex 1 – Past Floods

Please refer to Annex 1 of the Preliminary Assessment Spreadsheet. As discussed in Section 4.3, due to the lack of data available regarding the consequences of past flooding, no flood events have been considered to have 'significant harmful consequences', and therefore none have been recorded in this section.

ANNEX 1: Records of past floods and their significant consequences (preliminary assessment report spreadsheet)

Field:	**Flood ID**	**Summary description**	**Name of Location**	**National Grid Reference**	Location Description	Start date	Days duration	Probability	Main source of flooding	Additional source(s) of flooding	Confidence in main source of flooding
Mandatory / optional:	**Mandatory**	**Mandatory**	**Mandatory**	**Mandatory**	Optional	Optional for first cycle	Optional for first cycle	Optional for first cycle	Optional for first cycle	Optional	Optional
Format:	Unique number between 1-9999	Max 5,000 characters	Max 250 characters	12 characters: 2 letters, 10 numbers	Max 250 characters	'yyyy' or 'yyyy-mm' or 'yyyy-mm-dd'	Number with two decimal places	Max 25 characters	Pick from drop-down	Max 250 characters, same source terms	Pick from drop-down
Notes:	A sequential number starting at 1 and incrementing by 1 for each record.	Description of the flood and its adverse or potentially adverse consequences. Where available, information from other fields (Start date, Days duration, Probability, Main source, Main mechanism, Main characteristics, Significant consequences) should be repeated here.	Name of the locality associated with the flood, using recognised postal address names such as streets, towns, counties. If the flood affected the whole LLFA, then record the name of the LLFA.	National Grid Reference of the centroid (centre point, falls within polygon) of the flood extent, or of the area affected if there is no extent information.	A description of the general location that was flooded.	The date when the flood commenced - when land not normally covered by water became covered by water.	The number of days (duration) of the flood - that land not normally covered by water was covered by water. Values should be within the range 0.01 - 999.99 (permitting records to the nearest quarter of an hour, where appropriate).	The chance of the flood occuring in any given year - record X from "a 1 in X chance of occurring in any given year". Where this is difficult to estimate, a range can be recorded.	Pick the source from which the majority of flooding occurred. Refer to the PFRA guidance for definitions of sources.	If flooding occurred from, or interacted with, any other sources (other than the Main source of flooding), report the source(s) here, using the same source terms.	Pick a broad level of confidence in the Main source of flooding from; 'High' (compelling evidence of source - about 80% confident that source is correct), 'Medium' (some evidence of source but not compelling - about 50% confident that source is correct) 'Low' (source assumed - about 20% confident that source is correct) or 'Unknown'.
Example:	1	On the 14 April 1998 an intense storm system produced surface water flooding across Essex, concentrated in the west of the county. The flooding lasted about 6 hours, and 23 residential properties were recorded as suffering internal flooding, in Epping and North Weald. The surface runoff exceeded the drainage capacity in several places, and so probably had a 1 in 30 to 1 in 50 chance of occuring in any given year.	Essex	SX1234512345	Several towns and villages across west Essex	1998-04-15	0.25	20-50	Surface runoff		High
Records begin here:											

Main mechanism of flooding	Main characteristic of flooding	**Significant consequences to human health**	Human health consequences - residential properties	Property count method	Other human health consequences	**Significant economic consequences**	Number of non-residential properties flooded	Property count method	Other economic consequences	**Significant consequences to the environment**	Environment consequences	**Significant consequences to cultural heritage**	Cultural heritage consequences
Optional for first cycle	Optional for first cycle	**Mandatory**	Optional	Optional	Optional	**Mandatory**	Optional	Optional	Optional	**Mandatory**	Optional	**Mandatory**	Optional
Pick from drop-down	Pick from drop-down	Pick from drop-down	Number between 1-10,000,000	Pick from drop-down	Max 250 characters	Pick from drop-down	Number between 1-10,000,000	Pick from drop-down	Max 250 characters	Pick from drop-down	Max 250 characters	Pick from drop-down	Max 250 characters
Pick a mechanism from; 'Natural exceedance' (of capacity), 'Defence exceedance' (floodwater overtopping defences), 'Failure' (of natural or artificial defences or infrastructure, or of pumping), 'Blockage or restriction' (natural or artificial blockage or restriction of a conveyance channel or system), or 'No data'.	Pick a characteristic from; 'Flash flood' (rises and falls quite rapidly with little or no advance warning), 'Natural flood' (due to significant precipitation, at a slower rate than a flash flood), 'Snow melt flood' (due to rapid snow melt), 'Debris flow' (conveying a high degree of debris), or 'No data'. Most UK floods are 'Natural floods'.	Were there any significant consequences to human health when the flood occurred, or would there be if it were to re-occur?	Record the number of residential properties where the building structure was affected either internally or externally by the flood, or that would be so affected if the flood were to re-occur.	Where residential or non-residential properties have been counted, it is important to record the method of counting, to aid comparisons between counts. Choose from; 'Detailed GIS' (using property outlines, as per Environment Agency guidance), 'Simple GIS' (using property points), 'Estimate from map', or 'Observed number'.	If there were other <u>Significant consequences to human health</u>, describe them including information such as the number of critical services flooded.	Were there any significant economic consequences when the flood occurred, or would there be if it were to re-occur?	Record the number of non-residential properties where the building structure was affected either internally or externally by the flood, or that would be so affected if the flood were to re-occur.	Where residential or non-residential properties have been counted, it is important to record the method of counting, to aid comparisons between counts. Choose from; 'Detailed GIS' (using property outlines, as per Environment Agency guidance), 'Simple GIS' (using property points), 'Estimate from map', or 'Observed number'.	If there were other <u>Significant economic consequences</u>, describe them including information such as the area of agricultural land flooded, length of roads and rail flooded.	Were there any significant consequences to the environment when the flood occurred, or would there be if it were to re-occur?	If there were <u>Significant consequences to the environment</u>, describe them including information such as national and international designated sites flooded, and pollution sources flooded.	Were there any significant consequences to cultural heritage when the flood occurred, or would there be if it were to re-occur?	If there were <u>Significant consequences to cultural heritage</u>, describe them including information such as the number and type of heritage assets flooded.
Natural exceedance	Natural flood	Yes	23	Observed number		No				No		No	

Comments	Data owner	Area flooded	Flood event outline confidence	Flood event outline source	Survey date	Photo ID	Lineage	Sensitive data	Protective marking descriptor	European Flood Event Code
Optional Max 1,000 characters Any additional comments about the past flood record.	Optional Max 250 characters	Optional Number with two decimal places The total area of the land flooded, in km^2	Optional Pick from drop-down Choose from; 'High' (data includes one of: Aerial video, Aerial photos, Professional survey, Flood level information, EA flood data recording staff notes), 'Medium' (data includes one of: EA/LA ground video, EA/LA ground photos, EA/LA flood event outline map, LA/professional partner officer site records, Public ground video), 'Low' (not confident) or 'Unknown'.	Optional Pick from drop-down	Optional 'yyyy' or 'yyyy-mm' or 'yyyy-mm-dd'	Optional Max 50 characters Provide references to relevant specific photographs, or to a set of relevant photographs. It may not be practical to reference all relevant photographs for each flood event.	Optional Max 250 characters Lineage is how and what the data is made from. Has this data been created by using data owned or derived from data owned by 3rd party (external) organisations? If yes please give details.	Optional Pick from drop-down Has the information been classified under the Government's Protective Marking Scheme? Include protective marking time limit where known. Note: If "Approved for Access" then report "Unmarked".	Optional Max 50 characters For use where organisations apply the Government's Protective Marking Scheme.	Auto-populated Max 42 characters This field will autopopulate using the LLFA name provided on the "Instructions" tab, and the Flood ID. It is an EU-wide unique identifier and will be used to report the flood information. Format: UK<ONS Code><P or F><LLFA Flood ID>. "ONS Code" is a unique reference for each LLFA. "P or F" indicates if the event is past or future. "LLFA Flood ID" is a sequential number beginning with 0001.
	Epping Forest District Council		Medium	Site survey	1998-04-20		Ordnance Survey AddressPoint; CEH 1:50k River Centreline; NextMap DTM.	Unmarked	Private	UKE10000012P0001

Annex 2 – Future Floods

Please refer to Annex 2 of the Preliminary Assessment Spreadsheet.

ANNEX 2: Records of future floods and their consequences (preliminary assessment report spreadsheet)

Field:	Flood ID	Description of assessment method	Name of Location	National Grid Reference	Location Description	Name	Flood modelled	Probability	Main source of flooding	Additional source(s) of flooding	Confidence in main source of flooding
Mandatory / optional:	Mandatory	Mandatory	Mandatory	Mandatory	Optional	Optional	Optional	Mandatory	Mandatory	Optional	Optional
Format:	Unique number between 1-9999	Max 1,000 characters	Max 250 characters	12 characters: 2 letters, 10 numbers	Max 250 characters	Max 250 characters	Max 250 characters	Max 25 characters	Pick from drop-down	Max 250 characters, same source terms	Pick from drop-down
Notes:	A sequential number starting at 1 and incrementing by 1 for each record.	Description of the future flood information and how it has been produced. Cover Regulation 12(6) requirements of (a) topography, (b) the location of watercourses, (c) the location of flood plains that retain flood water, (d) the characteristics of watercourses, and (e) the effectiveness of any works constructed for the purpose of flood risk management. Information from other relevant fields (Probability, Main source, Name) should be repeated here.	Name of the locality associated with the flood, using recognised postal address names such as streets, towns, counties. If the flood affects the whole LLFA, then record the name of the LLFA.	National Grid Reference of the centroid (centre point, falls within polygon) of the flood extent, or of the area affected if there is no extent information. If the flood affects the whole LLFA, then record the centroid of the LLFA.	A description of the general location that could be flooded.	Name of the model or map product or project which produced the future flood information	Background, or additional information on the probability of the flood modelled - such as whether Probability refers to probability of rainfall or water on the ground.	The chance of the flood occuring in any given year - record X from "a 1 in X chance of occurring in any given year".	Pick the source which generates the majority of flooding. Refer to the PFRA guidance for definitions of sources.	If the flood is generated by, or interacts with, any other sources (other than the Main source of flooding), report the source(s) here, using the same source terms.	Pick a broad level of confidence in the Main source of flooding from; 'High' (compelling evidence of source - about 80% confident that source is correct), 'Medium' (some evidence of source but not compelling - about 50% confident that source is correct) 'Low' (source assumed - about 20% confident that source is correct) or 'Unknown'.
Example:	1	See records below for examples of description of assessment method.	Essex	SX1234512345		Flood Map for Surface Water - 1 in 200 deep	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.3m depth.	200	Surface runoff		High
Records begin here:	1	• Topography is derived from LIDAR (in larger urban areas, on 1, 2 and 3m grids; original accuracy ± 0.15m) and Geoperspective data (original accuracy ± 1.5m), processed to remove buildings and vegetation, then degraded to a composite 5m DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; no allowance made for manmade drainage. The DTM may miss flow paths below bridges. • Areas that may flood are defined by dynamically routing a 6.5 hour duration storm with 1 in 200 chance of occurring in any year, over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 is used throughout, to allow broad scale effects of buildings and other obstructions to be approximated. • No allowance made for drainage, pumping or other works constructed for the purpose of flood risk management. • The 'less susceptible' layer shows where modelled flooding is 0.1-0.3m deep; you must not interpret this as depth of flooding, rather as indicative of susceptibility to flooding	Richmond	TQ1772072687		Areas Susceptible to Surface Water Flooding (AStSWF) - Less	Probability refers to the probability of the rainfall event. This identifies areas which are 'less susceptible' to surface water flooding. For more information refer to "What are Areas Susceptible to Surface Water Flooding" Environment Agency December 2010.	200	Surface runoff		High
	2	• Topography is derived from LIDAR (in larger urban areas, on 1, 2 and 3m grids; original accuracy ± 0.15m) and Geoperspective data (original accuracy ± 1.5m), processed to remove buildings and vegetation, then degraded to a composite 5m DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; no allowance made for manmade drainage. The DTM may miss flow paths below bridges. • Areas that may flood are defined by dynamically routing a 6.5 hour duration storm with 1 in 200 chance of occurring in any year, over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 is used throughout, to allow broad scale effects of buildings and other obstructions to be approximated. • No allowance made for drainage, pumping or other works constructed for the purpose of flood risk management. • The 'intermediate susceptibility' layer shows where modelled flooding is 0.3-1.0m deep; you must not interpret this as depth of flooding, rather as indicative of susceptibility to	Richmond	TQ1772072687		Areas Susceptible to Surface Water Flooding (AStSWF) - Intermediate	Probability refers to the probability of the rainfall event. This identifies areas with 'intermediate susceptibility' to surface water flooding.	200	Surface runoff		High
	3	• Topography is derived from LIDAR (in larger urban areas, on 1, 2 and 3m grids; original accuracy ± 0.15m) and Geoperspective data (original accuracy ± 1.5m), processed to remove buildings and vegetation, then degraded to a composite 5m DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; no allowance made for manmade drainage. The DTM may miss flow paths below bridges. • Areas that may flood are defined by dynamically routing a 6.5 hour duration storm with 1 in 200 chance of occurring in any year, over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 is used throughout, to allow broad scale effects of buildings and other obstructions to be approximated. • No allowance made for drainage, pumping or other works constructed for the purpose of flood risk management. • The 'more susceptible' layer shows where modelled flooding is >1.0m deep; you must not interpret this as depth of flooding, rather as indicative of susceptibility to flooding	Richmond	TQ1772072687		Areas Susceptible to Surface Water Flooding (AStSWF) - More	Probability refers to the probability of the rainfall event. This identifies areas which are 'more susceptible' to surface water flooding.	200	Surface runoff		High

4	• Topography is derived from 64.5% LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m) and 35.5% NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation, then combined on a 2m grid; buildings added with an arbitrary height of 5m based on OS MasterMap 2009 building footprints, then resampled to a 5m grid DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; a uniform allowance of 12mm/hr has been made for manmade drainage in urban areas. Infiltration allowance reduces runoff to 39% in rural areas and 70% in urban areas. • Areas that may flood are defined by dynamically routing a 1.1 hour duration storm with 1 in 30 chance of occurring in any year over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 in rural areas; 0.03 in urban areas, to reflect explicit modelling of buildings in urban areas. • No allowance made for local variations in drainage, pumping or other works constructed	Richmond	TQ1772072687	Flood Map for Surface Water (FMfSW) - 1 in 30	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.1m depth.	30	Surface runoff		High
5	• Topography is derived from 64.5% LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m) and 35.5% NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation, then combined on a 2m grid; buildings added with an arbitrary height of 5m based on OS MasterMap 2009 building footprints, then resampled to a 5m grid DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; a uniform allowance of 12mm/hr has been made for manmade drainage in urban areas. Infiltration allowance reduces runoff to 39% in rural areas and 70% in urban areas. • Areas that may flood are defined by dynamically routing a 1.1 hour duration storm with 1 in 30 chance of occurring in any year over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 in rural areas; 0.03 in urban areas, to reflect explicit modelling of buildings in urban areas. • No allowance made for local variations in drainage, pumping or other works constructed	Richmond	TQ1772072687	Flood Map for Surface Water (FMfSW) - 1 in 30 deep	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.3m depth.	30	Surface runoff		High
6	• Topography is derived from 64.5% LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m) and 35.5% NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation, then combined on a 2m grid; buildings added with an arbitrary height of 5m based on OS MasterMap 2009 building footprints, then resampled to a 5m grid DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; a uniform allowance of 12mm/hr has been made for manmade drainage in urban areas. Infiltration allowance reduces runoff to 39% in rural areas and 70% in urban areas. • Areas that may flood are defined by dynamically routing a 1.1 hour duration storm with 1 in 200 chance of occurring in any year over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 in rural areas; 0.03 in urban areas, to reflect explicit modelling of buildings in urban areas. • No allowance made for local variations in drainage, pumping or other works constructed	Richmond	TQ1772072687	Flood Map for Surface Water (FMfSW) - 1 in 200	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.1m depth.	200	Surface runoff		High
7	• Topography is derived from 64.5% LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m) and 35.5% NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation, then combined on a 2m grid; buildings added with an arbitrary height of 5m based on OS MasterMap 2009 building footprints, then resampled to a 5m grid DTM. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Flow routes dictated by topography; a uniform allowance of 12mm/hr has been made for manmade drainage in urban areas. Infiltration allowance reduces runoff to 39% in rural areas and 70% in urban areas. • Areas that may flood are defined by dynamically routing a 1.1 hour duration storm with 1 in 200 chance of occurring in any year over the DTM using JBA's JFLOW–GPU model. • Manning's n of 0.1 in rural areas; 0.03 in urban areas, to reflect explicit modelling of buildings in urban areas. • No allowance made for local variations in drainage, pumping or other works constructed	Richmond	TQ1772072687	Flood Map for Surface Water (FMfSW) - 1 in 200 deep	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.3m depth.	200	Surface runoff		High
8	• Modelling developed from combination of national (2004) and local (generally 1998-2010) modelling. • Topography derived from LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m), NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation. For local modelling, topography may include ground survey. • Location of watercourses and tidal flow routes dictated by topographic survey. • Areas that may flood are defined for catchments >3km² by routing appropriate flows for that catchment through the model to ascertain water level and thus depth and extent. • Manning's n of 0.1 used for national fluvial modelling; variable (calibrated) values for national tidal modelling; appropriate values selected for local modelling. Channel capacity assumed as QMED for national fluvial modelling; local survey methods used for local modelling. • For the purpose of flood risk management, models assume that there are no raised defences	Richmond	TQ1772072687	Flood Map (for rivers and sea) - flood zone 3	Fluvial 1 in 100, tidal 1 in 200	100	Main rivers	Sea, ordinary watercourses	Medium

9	• Modelling developed from combination of national (2004) and local (generally 2004-2010) modelling. • Topography derived from LIDAR (on 0.25m-2m grids; original accuracy ± 0.15m), NEXTMap SAR (on 5m grid; original accuracy ± 1.0m), processed to remove buildings & vegetation. For local modelling, topography may include ground survey. • Location of watercourses and tidal flow routes dictated by topographic survey. • Areas that may flood are defined for catchments >3km² by routing appropriate flows for that catchment through the model to ascertain water level and thus depth and extent. • Manning's n of 0.1 used for national fluvial modelling; variable (calibrated) values for national tidal modelling; appropriate values selected for local modelling. Channel capacity assumed as QMED for national fluvial modelling; local survey methods used for local modelling. • For the purpose of flood risk management, models assume that there are no raised defences.	Richmond	TQ1772072687	Flood Map (for rivers and sea) - flood zone 2	Extreme flood outline is 1 in 1000, and includes some historic where judged that this gives an indication of areas at risk of future flooding.		1000	Main rivers	Sea, ordinary watercourses	Medium
10	• Topography derived from LIDAR (1m grid; original accuracy ±0.15m). Buildings added with arbitrary height of 0.1m based on OS MasterMap 2010 building footprints. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Design rainfall generated using FEH methodology. Parameters set on 10km2 grid across Greater London area. • Uniform allowance of 6.5mm/hr made for manmade drainage in urban areas, as directed by Thames Water. • Runoff coefficients and Manning's N set for each OS MasterMap land classification as defined in Drain London Data & Modelling Framework, GLA, December 2010. • Areas that may flood defined by dynamically routing 3 hour duration storm with 1 in 200 chance of occurring in any year over the DTM using TuFLOW modelling software. • No allowance made for local variations in drainage, pumping or other works constructed for purpose of flood risk management. • '>0.03m' layer shows where modelled flooding is greater than 0.03m deep.	Richmond	TQ1772072687	Pluvial Modelling - 1 in 200	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.03m depth.		200	Surface runoff		High
11	• Topography derived from LIDAR (1m grid; original accuracy ±0.15m). Buildings added with arbitrary height of 0.1m based on OS MasterMap 2010 building footprints. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Design rainfall generated using FEH methodology. Parameters set on 10km2 grid across Greater London area. • Uniform allowance of 6.5mm/hr made for manmade drainage in urban areas, as directed by Thames Water. • Runoff coefficients and Manning's N set for each OS MasterMap land classification as defined in Drain London Data & Modelling Framework, GLA, December 2010. • Areas that may flood defined by dynamically routing 3 hour duration storm with 1 in 200 chance of occurring in any year over the DTM using TuFLOW modelling software. • No allowance made for local variations in drainage, pumping or other works constructed for purpose of flood risk management. • '>0.5m' layer shows where modelled flooding is greater than 0.5m deep.	Richmond	TQ1772072687	Pluvial Modelling - 1 in 200	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.5m depth.		200	Surface runoff		High
12	• Topography derived from LIDAR (1m grid; original accuracy ±0.15m). Buildings added with arbitrary height of 0.1m based on OS MasterMap 2010 building footprints. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Design rainfall generated using FEH methodology. Parameters set on 10km2 grid across Greater London area. • Uniform allowance of 6.5mm/hr made for manmade drainage in urban areas, as directed by Thames Water. • Runoff coefficients and Manning's N set for each OS MasterMap land classification as defined in Drain London Data & Modelling Framework, GLA, December 2010. • Areas that may flood defined by dynamically routing 3hr duration storm with 1 in 100 chance of occurring in any year+30% allowance for climate change over DTM using TuFLOW modelling software. • No allowance made for local variations in drainage, pumping or other works constructed for purpose of flood risk management. • '>0.03m' layer shows where modelled flooding is greater than 0.03m deep.	Richmond	TQ1772072687	Pluvial Modelling - 1 in 100 + 30% Climate Change allowance	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.03m depth.	100 + 30%		Surface runoff		High
13	• Topography derived from LIDAR (1m grid; original accuracy ±0.15m). Buildings added with arbitrary height of 0.1m based on OS MasterMap 2010 building footprints. Manual edits applied where flow paths clearly omitted e.g. below bridges. • Design rainfall generated using FEH methodology. Parameters set on 10km2 grid across Greater London area. • Uniform allowance of 6.5mm/hr made for manmade drainage in urban areas, as directed by Thames Water. • Runoff coefficients and Manning's N set for each OS MasterMap land classification as defined in Drain London Data & Modelling Framework, GLA, December 2010. • Areas that may flood defined by dynamically routing 3hr duration storm with 1 in 100 chance of occurring in any year+30% allowance for climate change over the DTM using TuFLOW modelling software. • No allowance made for local variations in drainage, pumping or other works constructed for purpose of flood risk management. • '>0.5m' layer shows where modelled flooding is greater than 0.5m deep.	Richmond	TQ1772072687	Pluvial Modelling - 1 in 100 + 30% Climate Change allowance	Probability refers to the probability of the rainfall event, in this case producing flooding of greater than 0.5m depth.	100 + 30%		Surface runoff		High

14	The following data sources have been utilised to produce the increased Potential for Elevated Groundwater (iPEG) map (areas where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface): • BGS Groundwater Flood Susceptibility Map; • Jacobs Groundwater Emergence Maps; • JBA Groundwater Flood Map; • EA/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps. For consolidated aquifers, an area was defined as having increased potential for elevated groundwater levels if at least 2 of the mapping techniques produced a corresponding area. For permeable superficial deposits, only Band 1 Very High of the BGS and the TE2100 data were used as this was judged to best represent the hazard. The techniques used to generate the iPEG map produced some small areas of increased potential and dry islands within increased potential areas. These have not been cleaned in order to best represent the original data.	Richmond	TQ1772072687		Increased Potential for Elevated Groundwater (iPEG)	Does not describe a probability, but shows places where groundwater emergence more likely to occur.	Unknown	Groundwater		High