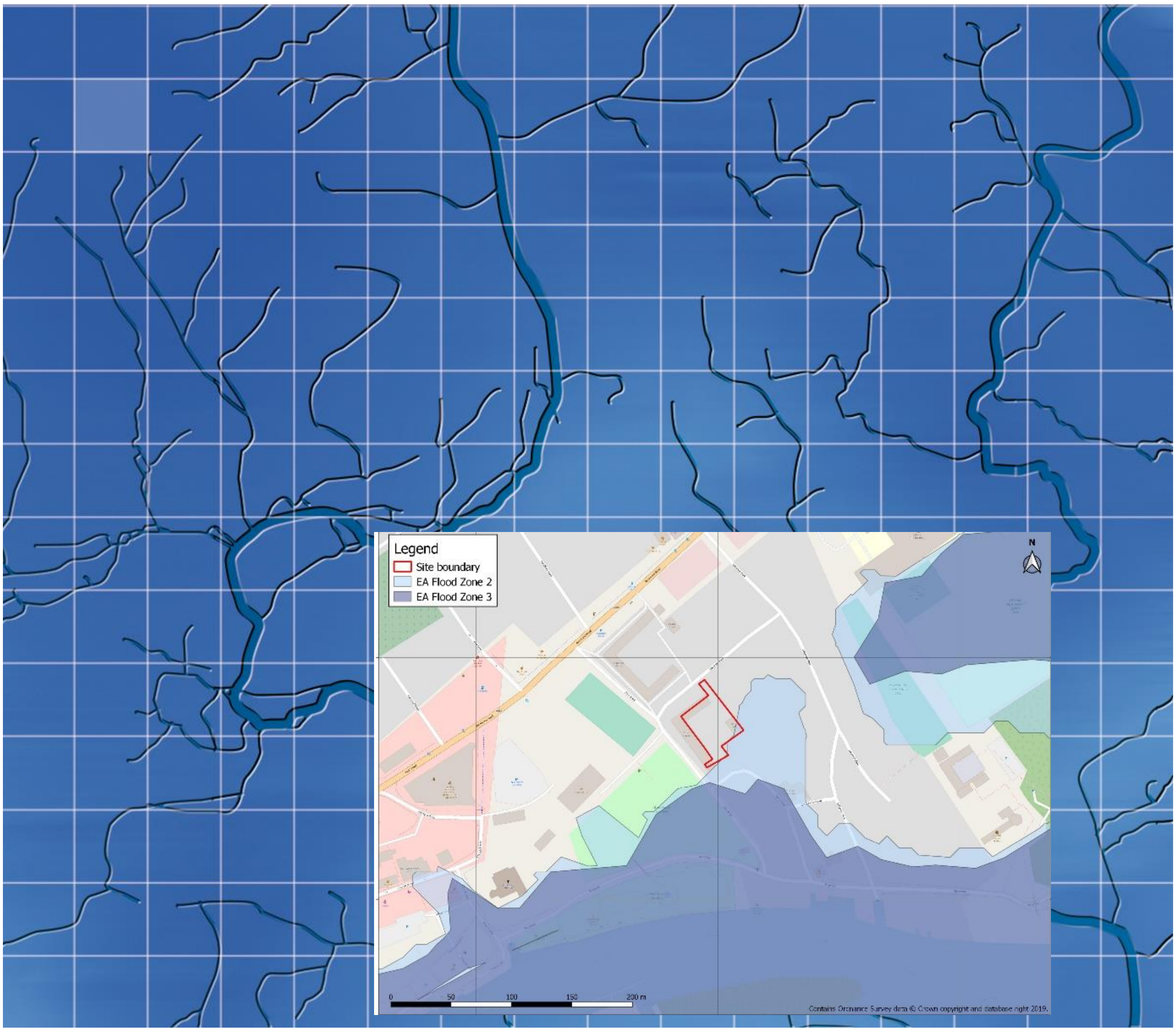
Moreland Residential Ltd

June 2024

Sion Court Level 2 FRA



WHS

Moreland Residential Ltd

Sion Court Level 2 FRA

Document issue details

WHS10136

Version	Issue date	Issue status	Prepared By	Approved By
1.0	23/07/2019	Draft	Jessica Pearce (*Consultant*)	Brett Park (*Senior Consultant*)
2.0	16/07/2021	Draft	Brett Park (*Senior Consultant*)	Paul Blackman (*Director*)
3.0	10/09/2021	Draft	Joel Leyshon-Jones (*Senior Consultant*)	Paul Blackman *(Director)*
4.0	19/01/2023	Draft	Sam Pucknell (*Consultant*)	Brett Park (*Principal Consultant*)
5.0	20/06/2024	Draft	Ajani Jacobs (Graduate Consultant)	Brett Park (*Principal Consultant*)

For and on behalf of Wallingford HydroSolutions Ltd.

CERTIFIED ISO 9001 · ISO 14001 UKAS MANAGEMENT SYSTEMS 001

The WHS Quality & Environmental Management system is certified as meeting the requirements of ISO 9001:2015 and ISO 14001:2015 providing environmental consultancy (including monitoring and surveying), the development of hydrological software and associated training.

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Contents

1 Introduction

Wallingford HydroSolutions Ltd (WHS) has been commissioned by Tal Architects Ltd to complete a Flood Risk Assessment (FRA) for a proposed residential development of five dwellings located at Sion Court, Twickenham, TW1 3DD, NGR: TQ 16661 73457. The development involves the conversion of 19 garage units and one flat into five residential developments with associated amenity space, as such, an FRA is required in accordance with the National Planning Policy Framework (NPPF)[1].

This report will detail the findings of a comprehensive desk-based review detailing flood risk to the site and provide outline recommendations for the management of surface water runoff on-site, utilising SUDS options where appropriate.

The proposed development is classed as "highly vulnerable" and lies partially within Flood Zone 2, therefore, as a requirement of the NPPF, the exceptions test will be completed following a review of available flood risk data to demonstrate that the development can remain safe for its lifetime without causing an increase in flood risk elsewhere.

1.1 Scope

The Environment Agency (EA) online flood maps indicate that the south east corner of the proposed development lies within Flood Zone 2 and is therefore at risk of flooding between the 1% and 0.1% AEP fluvial events.

The proposed development includes the conversion of garage units (less vulnerable) into residential dwellings (more vulnerable), as such an FRA is required in accordance with NPPF. Due to the increased vulnerability of the development an exceptions test is required to demonstrate that the development can remain safe for its lifetime and detail how flood risk will be managed at the site.

This report provides a level 2 FRA appropriate for submission with an outline planning application.

In summary, the report;

- Introduces the site in terms of its location, topography and development proposal
- Reviews a range of flood risk information from publicly available sources relating to the site
- Reviews flood risk based on data obtained from the EA in the form of an existing 1D/2D hydraulic model.
- Provides an outline assessment of surface water flood risk and recommendations for managing surface water on site.
- Summarises the risk to the site and management options.

[1] National Planning Policy Framework, July 2018, Ministry of Housing and Local Government, accessed: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

1.2 Sources of Information

The main sources of data used to inform this FRA include;

- EA online fluvial and pluvial flood maps[2]
- The British Geological Survey (BGS) online geology of Britain viewer[3]
- LiDAR data[4]
- Proposed development layouts provided by the client[5]
- Hydraulic model data supplied by the EA[6]
- Asset plan provided by Thames Water[7]
- Thames Water pre-planning enquiry response[8]

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[2] Environment Agency online Flood Map for Planning: https://flood-map-for-planning.service.gov.uk/ accessed May 2019.
[3] The British Geological Survey Geology of Britain Viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html accessed May 2019.
[4] Open Access LiDAR Composite 1m DTM data: https://data.gov.uk/dataset/6a117171-5c59-4c7d-8e8b-8e7aefe8ee2e/lidar-composite-dtm-1m
[5] Proposed development drawings provided by Tal Arc Ltd in April 2021.
[6] Thames Tidal Upriver Breach Inundation Assessment Model, P5 and P6 for the Thames (Thames Domain), P5, P6 and P7 for the Thames (Hammersmith Domain) and P5, P6 and P7 for the Thames (Trib dominated Domain).
[7] Asset location search, reference: ALS/ALS Standard/2023_4770543. Thames Water, January 2023.
[8] Prep-planning enquiry: Confirmation of sufficient capacity, reference: DS6101937. Thames Water, January 2023.

2 Site Description

2.1 Location

The proposed development site is located at Sion Court, Sion Road, Twickenham, TW1 3DD (NGR: TQ 16661 73457). The development is situated approximately 155m north of the River Thames in a heavily built up residential area, with existing flats existing to the west of the proposed development. The location of the development is shown in Figure 1.

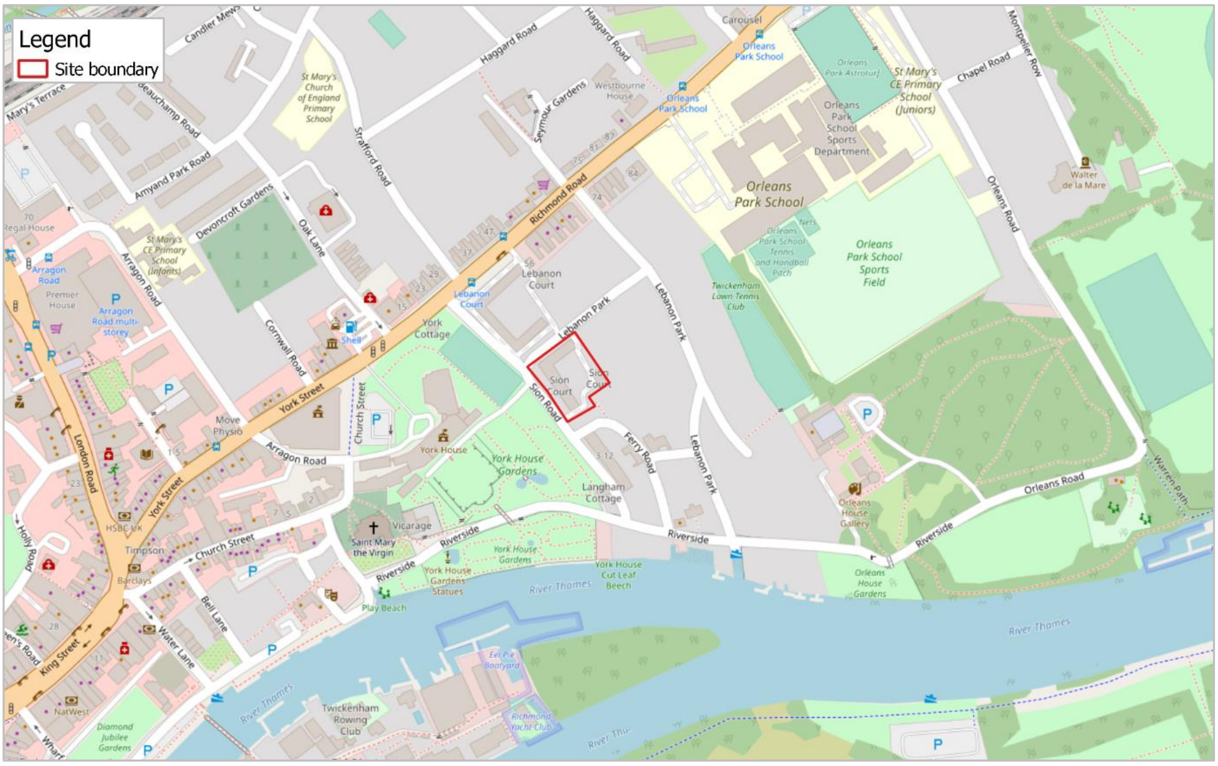

Figure 1- Site Location

2.2 Topography

The topography of the site has been assessed using 1m resolution LiDAR DTM data which was flown in 2003. Ground levels within the site are shown to range from 7.58m AOD to 7.92m AOD. Ground levels across the site are relatively flat with the surrounding topography shown to slope to the south towards the banks of the River Thames. Areas of lower ground are seen to the immediate south east of the site boundary this area sits approximately 1m lower than the ground to the north and lie outside of the development area.

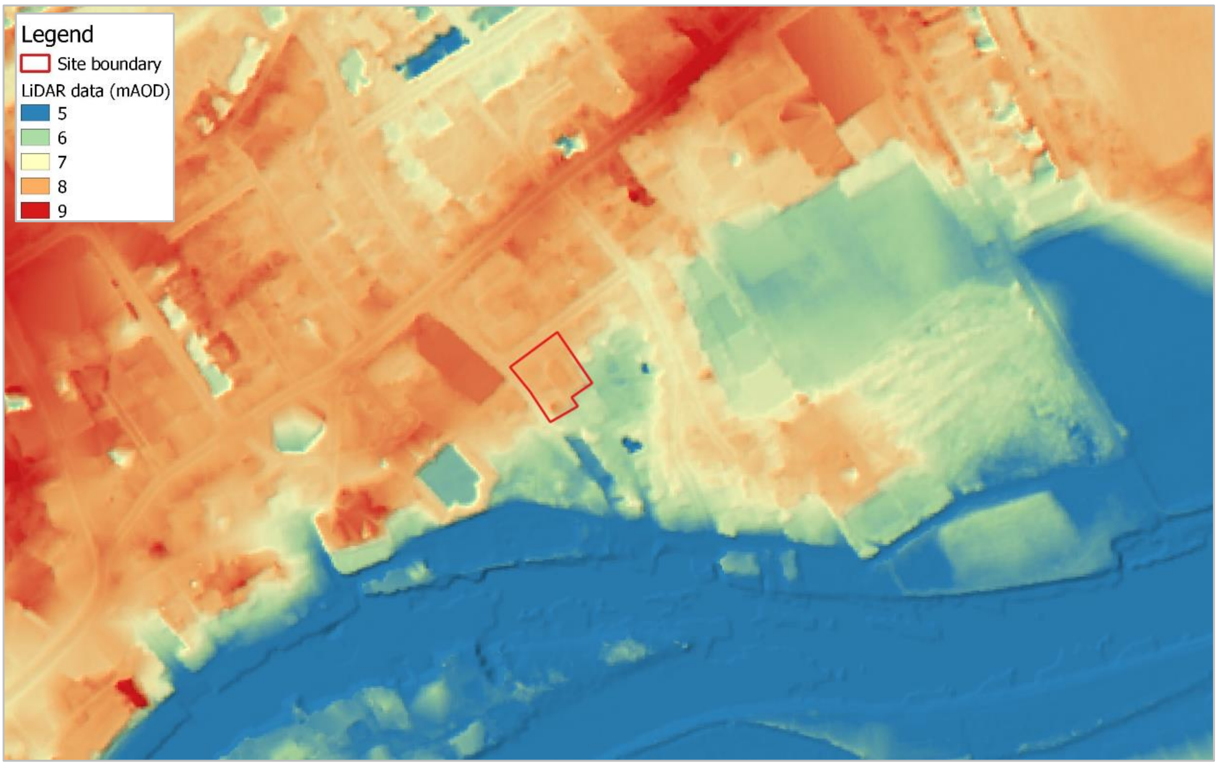

Figure 2- Site topography

2.3 Proposed Development

The proposed development comprises of converting 19 existing garage units and 1 existing flat into five new residential developments with associated green roofs, amenity space, green areas, permeable paving for pedestrian access and bike storage, Figure 3.

The proposed work will result in a significant decrease in the impermeable area, primarily as a result of the removal of Garages A and their replacement with a larger soft landscaping area within the centre of the development. A summary of the change in impermeable area is shown in Table 1.

The footprint of the buildings will be increased from 275m^2 to 346.4m^2, however this increase of 71.4m^2 will be offset by the enlarged green area in the centre of the courtyard, which is over 200m^2 larger than the existing grassed area. This is in addition to the private gardens at the front of the proposed dwellings and behind unit 1. The increase in green area and the use of permeable paving, results in a net decrease in impermeable area within the development site.

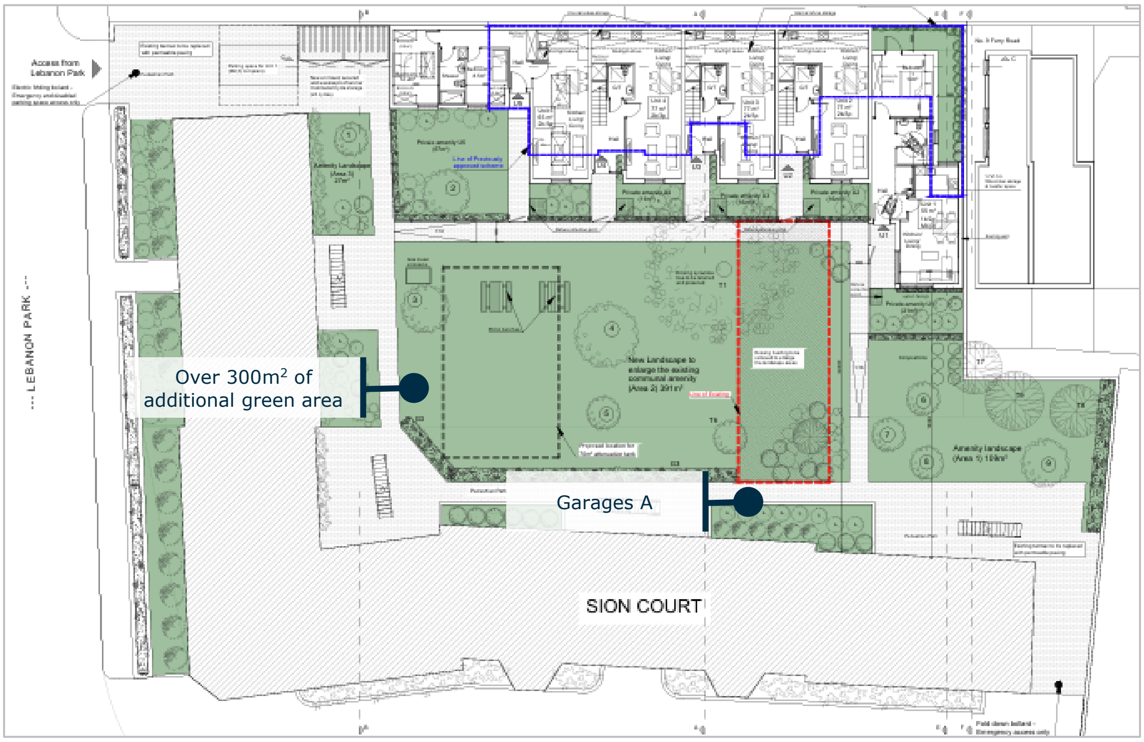

Figure 3 - Proposed Development, Tel Arc DWG: SC-PP4-05.

Table 1 - Impermeable and Permeable areas within the development boundary

Area	Pre-development (ha)	Post-development (ha)	Change (ha)
Impermeable Area	0.112	0.011	-0.101
Green Roof Area*	-	0.019	+0.019
Permeable Paving*	-	0.042	+0.042
Permeable area	0.027	0.063	+0.036
Total area (ha)	**0.139**	**0.14**	**-**

**Although permeable, area will be connected to the Surface Water Sewer*

3 Flood Risk

3.1 EA Fluvial Flood Maps

To assess the risk of fluvial flooding at the site the Environment Agency (EA) flood maps were reviewed, these are shown in Figure 4.

Figure 4 indicates that the majority of the site lies within Flood Zone 1, an area defined as having less than a 0.1% Annual Exceedance Probability of flooding from main rivers or sea flooding. There is a small corner in the south east of the development that is shown to lie within Flood Zone 2 and is therefore considered to be at risk of flooding between the 1% AEP and 0.1% AEP fluvial events and 0.5% AEP to 0.1% AEP coastal flood events. Due to the proximity of the development to the River Thames the dominant source of flooding is assumed to be fluvial in nature. The development is not shown to lie within an area benefiting from flood defences.

Figure 4- EA Online Flood Maps

3.2 Tidal flood risk

The water level in the Thames is heavily influenced by changes in the tide therefore the site is at potential risk from tidal flooding. The normal tidal limit of the Thames is approximately 2.3km upstream[9] of the site at NGR: TQ 16750 71490. The influence of the tide on flooding within the Thames is controlled through the operation of the Thames Barrier during times of fluvial flooding. Modelled results of tidal events will be discussed in Section 4 below.

3.3 Surface Water Flood Risk

The EA surface water flood map has been reviewed to assess the risk of pluvial flooding to the site. The mapping indicates that the site is at low risk of surface water flooding, with the entire development lying outside of the 0.1% AEP surface water flood event. The EA flood map is shown in Figure 5.

Figure 5- EA Surface water flood map, 0.1% AEP Event

[9] Environment Agency, TH024 River Thames Reach 4 2D Modelling Study 2010, Modelling Report, November 2010

3.4 Historical Flood Risk

The EA historic flood map indicates that there have been no recorded flood events within the vicinity of the proposed development. The historic flood map is based upon records beginning in 1946 and indicates recorded flood outlines. Furthermore, the Twickenham Flood Map indicated that the proposed development lies within an area of very low flood risk.

The Richmond Preliminary Flood Risk Assessment[10] provides information from past flood incidents recorded by the local authority, the document does not indicate any history of flooding in or around Sion court.

3.5 Other Sources of Flooding

A review of the EA flood map indicates that the south eastern corner of the proposed development may be at risk of flooding should a reservoir dam breach occur. However, reservoir flooding is an extremely rare event with a low probability of occurring due to the obligation to maintain and repair any damage to prevent flooding from occurring.

Groundwater flooding is defined as the emergence of groundwater at ground level or the rising of groundwater into basements that exceed the normal range of groundwater. A BGS infiltration SUDS GeoReport[11], attached as Appendix 1, has been obtained to assess the risk of groundwater flooding at the development site. The BGS report indicates that there is a high-water table across the site at a depth likely to be less than 3m below the ground surface for at least part of the year. The bedrock of the site is made up of deposits of London Clay formation and is likely to be poorly draining with low permeability providing significant constraints to infiltration.

Given the high-water table at the site and poor drainage the risk of groundwater flooding is considered to be moderate. Any groundwater flooding may be mitigated against by raising the finished flood levels of the proposed development above fluvial modelled flood levels.

[10] London Borough of Richmond upon Thames Preliminary Flood Risk Assessment, Scott Wilson, May 2011.
[11] British Geological Survey, Infiltration SuDS GeoReport. June 2019.

4 EA Model Data

4.1 Fluvial Flood Risk

A data request was submitted to the EA to obtain product 6 data, which returned three hydraulic models;

- P5 and P6 for the Thames (Thames Domain)
- P5, P6 and P7 for the Thames (Hammersmith Domain)
- P5, P6 and P7 for the Thames (Trib dominated Domain)

The downstream extent of the Thames model domain is located approximately 12.5km upstream of the proposed site at NGR: 512545, 168989. As this model domain doesn't cover the proposed site, it is not used in this assessment.

The two model domains that do cover the proposed site are the Hammersmith Domain and Trib dominated Domain. As the flood extents from the Hammersmith Domain are larger at the proposed development site, the results from the Hammersmith Domain will be used to assess flood risk.

4.2 Summary of Fluvial Flood Levels

The modelled flood levels at the location of the proposed site from the Hammersmith Domain are provided in Table 2 and details on flood depths are provided in 4.2.2 to 4.2.5.

The modelling shows that the site is not at risk during the present day 1.0% AEP flood event, however it will become at risk as the impacts of climate change are realised, where a flood level of 6.83m AOD has been modelled for the higher central climate change scenario. For the 0.1% AEP flood event a flood level of 6.89mAOD has been modelled.

Table 2 - Summary of Flood Levels

Event	Defended Flood Level (m AOD)	Undefended Flood Level (m AOD)
1.0%	NF*	NF*
1.0% + 35% Climate Change Higher Central Estimate	6.83	**
1.0% + 70% Climate Change Upper End Estimate	7.85	**
0.1%	6.89	6.80

*Not Flooded
** Modelling Results Not Available

4.2.1 Defended 1.0% AEP Fluvial Flood Event

The modelled results for the 1% AEP flood event are presented in Figure 6. These results indicate that the proposed development is not at risk during this flood event.

Figure 6- Defended 1.0% AEP modelled flood depths

4.2.2 Defended 1.0% AEP + Higher Central Climate Change Fluvial Flood Event

The modelled results for the 1% AEP Climate Change Higher Central (CC-HC) estimate are presented in Figure 7, where a climate change allowance of 35% has been applied to the peak inflows into the model.

The modelled results indicate that the south eastern edge of the proposed development is at risk of flooding during the 1.0% AEP CC-HC scenario, with an average flood depth of 0.06m and a maximum depth of 0.11m.

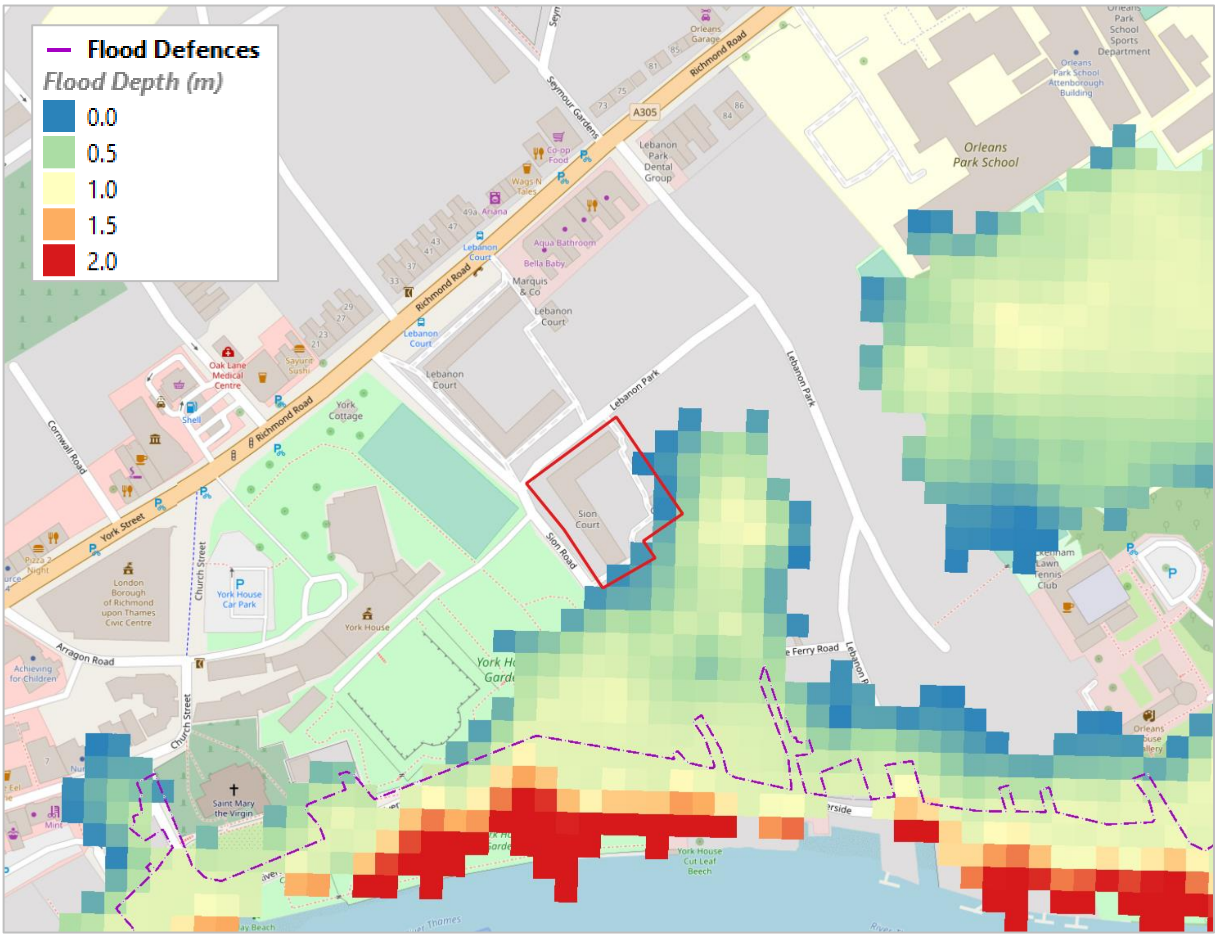

Figure 7- Defended 1.0%CC-HC AEP modelled flood depths

4.2.3 Defended 1.0% AEP + Upper End Climate Change Fluvial Flood Event

The modelled results for the 1% AEP Climate Change Upper End (CC-UE) estimate are presented in Figure 8, where a climate change allowance of 70% has been applied to the peak inflows into the model.

The modelled results indicate that a significant proportion of the proposed development is at risk of flooding during the 1.0% AEP CC-HC scenario, with an average flood depth of 0.27m and a maximum depth of 0.65m.

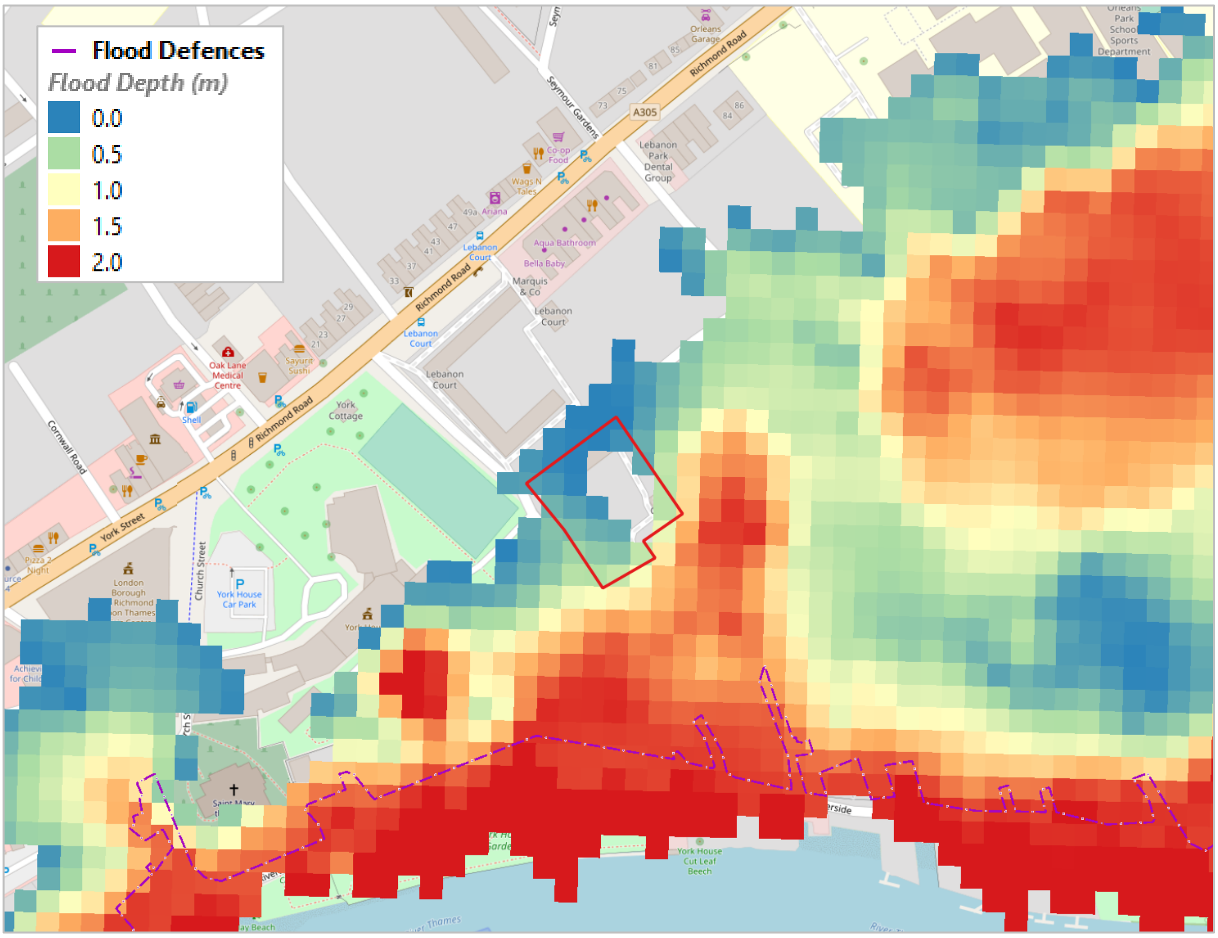

Figure 8- Defended 1.0%CC-HC AEP modelled flood depths

4.2.4 Defended 0.1% AEP Fluvial Flood Event

The modelled results for the 0.1% AEP fluvial flood event are shown in Figure 9. The results indicate that a small portion of the far south eastern corner of the site is at risk of flooding during the 0.1% AEP event, with an average flood depth of 0.07m and a maximum depth of 0.14m.

The model results provided by the EA were also used to assess the velocity of flood waters at the proposed development site, the maximum modelled flood velocity within the development boundary reaches 0.4m/s.

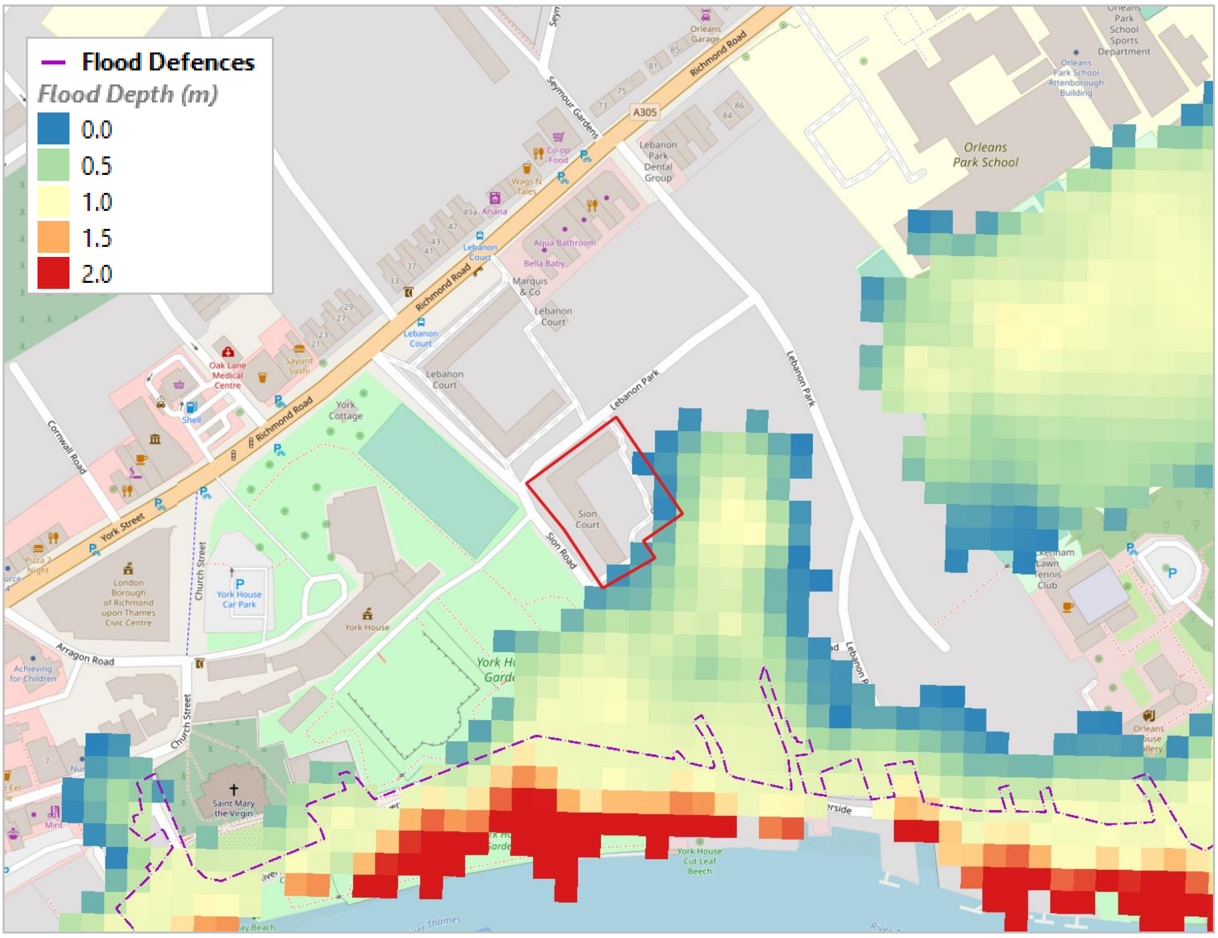

Figure 9- Defended 0.1% AEP modelled fluvial flood depths

4.2.5 Undefended 0.1% AEP Fluvial Flood Event

The modelled results for the undefended 0.1% AEP fluvial flood event are shown in Figure 10. The results indicate that a small portion of the far south eastern corner of the site is at risk of flooding during this event, with an average flood depth of 0.18m and a maximum depth of 0.56m.

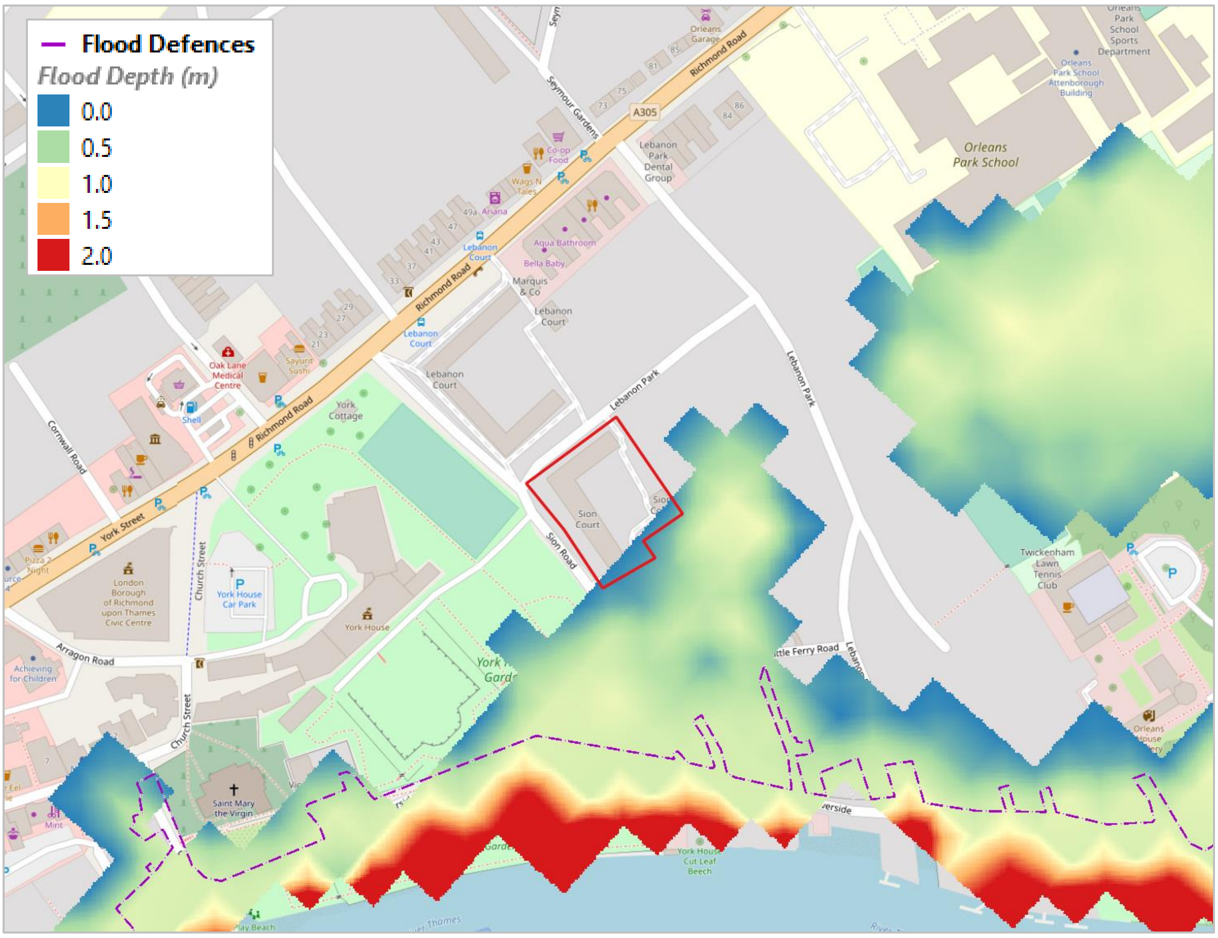

Figure 10- Undefended 0.1% AEP modelled fluvial flood depths

4.3 Tidal Flood Risk

In order to assess the risk of tidal flooding via the River Thames to the proposed development site the existing hydraulic model of the Thames Breaches was obtained from the EA. The model was updated in May 2017 by Atkins. The model was run for two events, a present day and future condition of the Thames named as the 2005 and 2100 events respectively. The modelled results are presented below.

4.3.1 Flood Defences

A review of the EA rivers and sea spatial flood defences dataset[12] indicates that flood defences exist along the banks of the River Thames to the south of the proposed development, however, the EA flood map does not identify the proposed site as being in an area benefiting from defences.

Multiple breach events were simulated by applying the relevant 2005 and 2100 ML WL (maximum likely water level) level hydrograph to identified breach locations at 5679 locations along the Thames reach[13], Figure 11 shows the locations of the modelled breaches in relation to the site boundary.

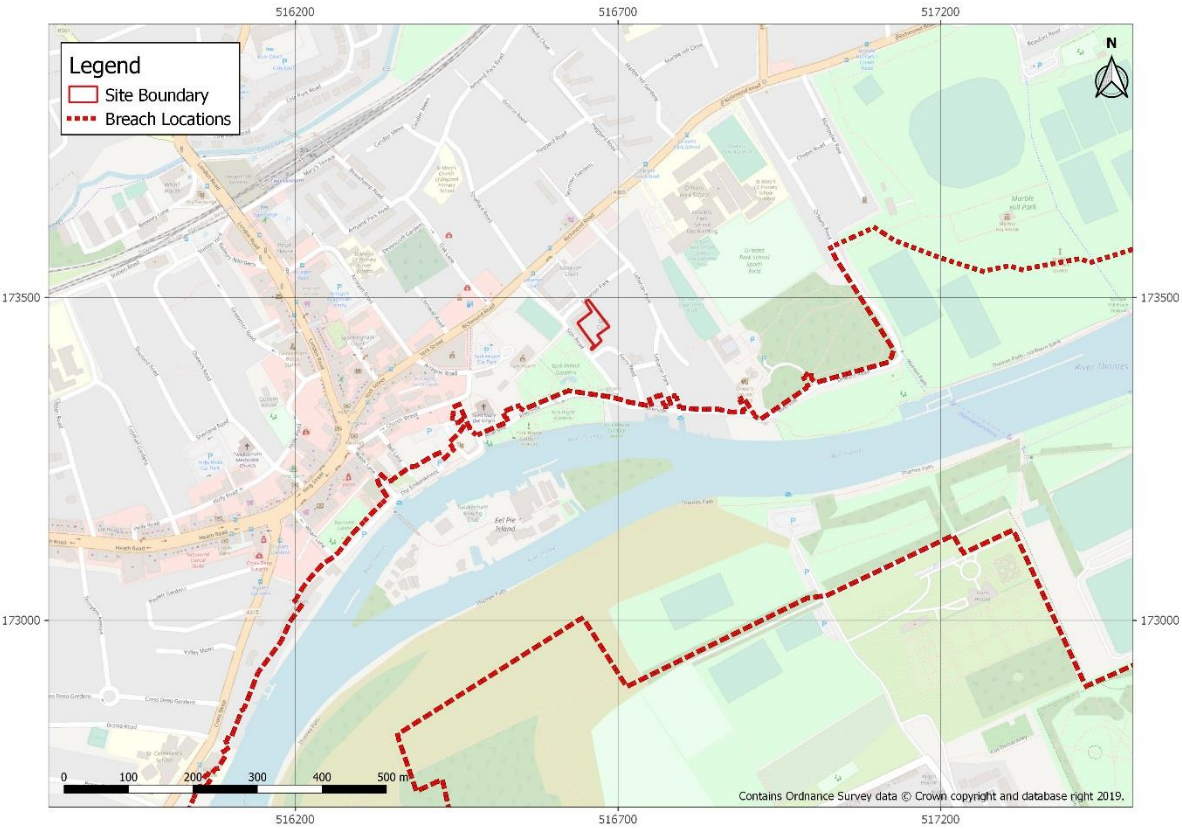

Figure 11- Line of breach modelling, with breaches modelled every 20m for hard defences and 50m for soft defemces

[12] Environment Agency Flood Map for planning (Rivers and Sea) Spatial Flood Defences Shapefile, downloaded via: https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/FloodMapForPlanningRiversAndSeaSpatialFloodDefences&Mode=spatial

[13] Thames Tidal Upriver Breach Assessment Methodology Report, Atkins, May 2017.

4.3.2 2005 River Thames Breach Event Modelled Results

The proposed development is not shown to be at risk of flooding during the present day (2005) tidal breach event. The modelled results are shown in Figure 12 below.

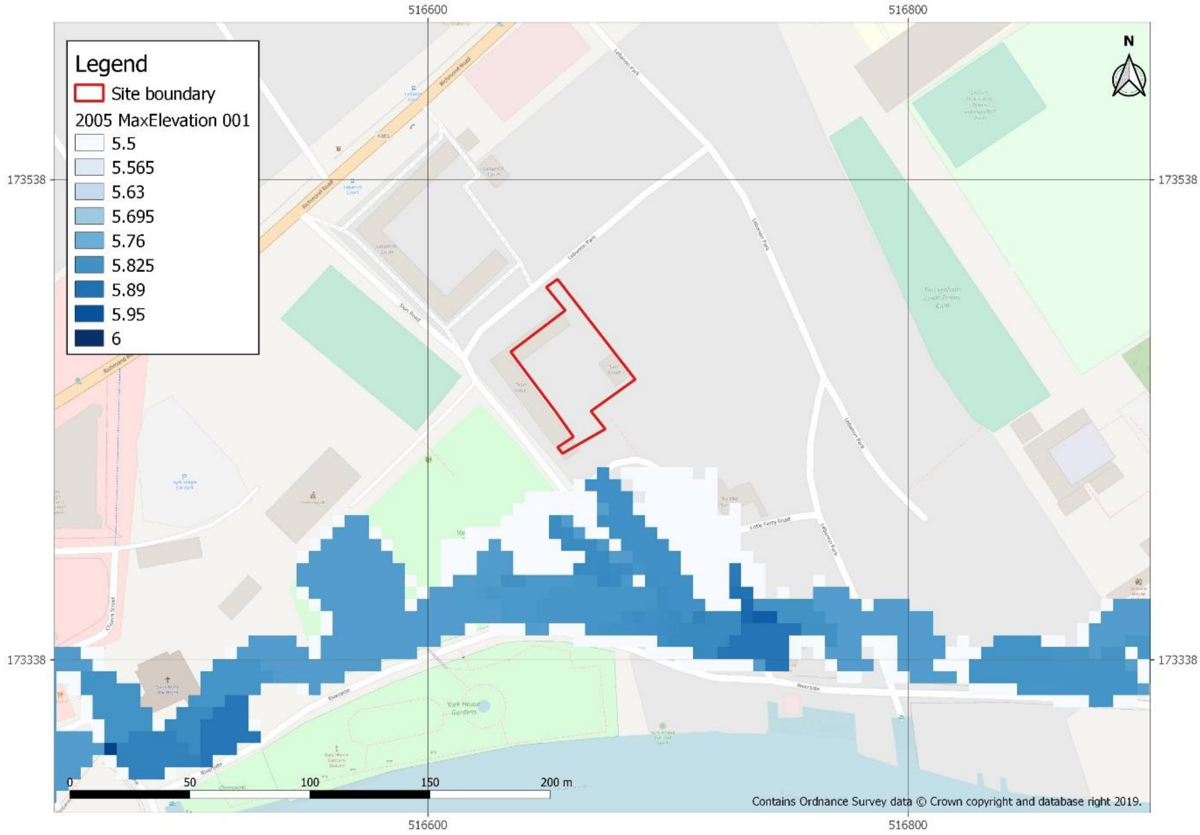

Figure 12- 2005 Tidal breach event modelled flood elevation

4.3.3 2100 River Thames Breach Event

The modelled results for the 2100 breach event are shown below. Figure 13 indicates that only a small portion of the far east of the site is at risk of flooding during this event. Flood elevations within the site reach a maximum level of 6.38m AOD, with a maximum depth of 0.27m.

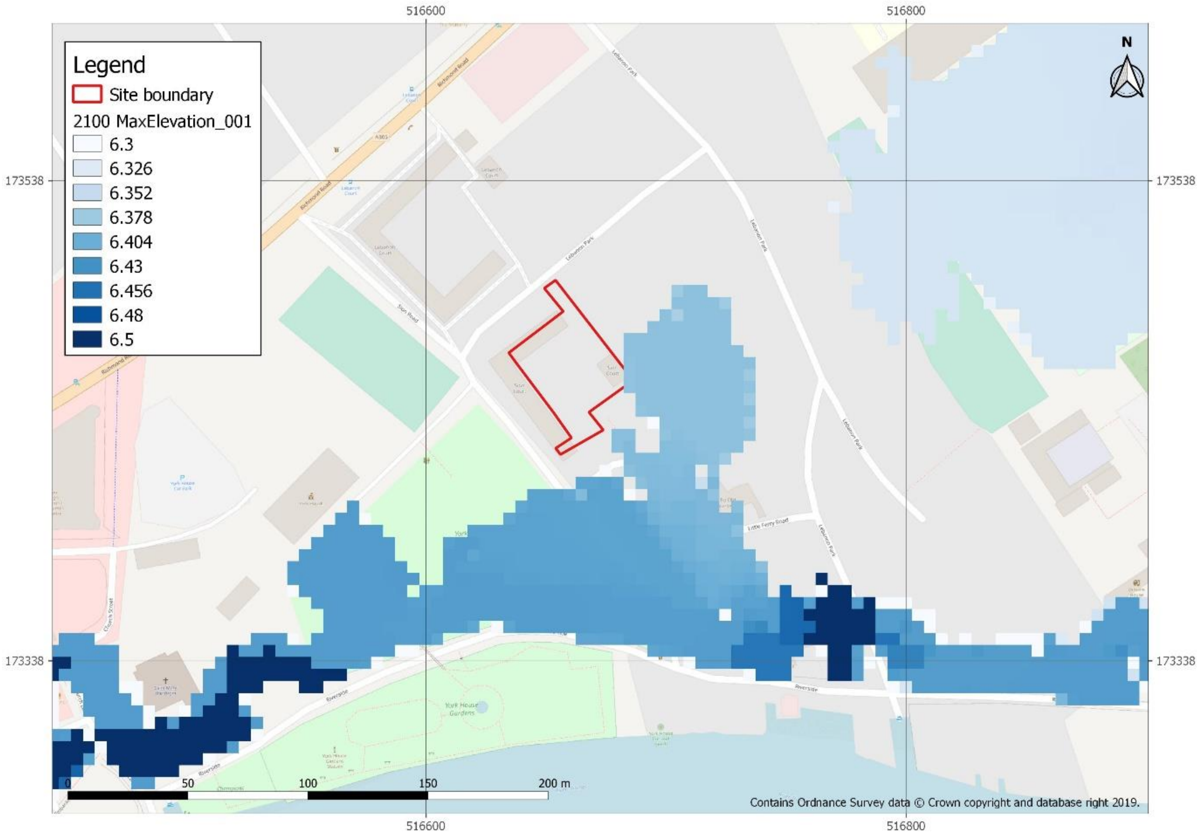

Figure 13 - 2100 Tidal Breach modelled results

The maximum modelled flood depth during the tidal breach scenario of 0.27m is lower than that modelled during the 0.1% AEP fluvial event, where flood depths reached 0.56m. Therefore, it is considered that fluvial flooding is the greatest source of flood risk to the proposed development.

5 Management of Surface Water run-off

5.1 Planning requirements

Based on the guidance set out in the NPPF, any development should include measures to manage post development surface water runoff. The Richmond Local Plan (LP21)[14] also states that proposals should reduce surface water discharge to greenfield rates where feasible or achieve a betterment of at least a 50% reduction in rates, based on the levels existing prior to the development; whilst The London Plan (SI 13) states that development proposals should aim to get as close to greenfield rates as possible, depending on site conditions[15].

As the proposed development includes a small increase in building footprint over the existing garages, an assessment of surface water runoff is required, however it should be noted that there will be no increase in impermeable area as a result of the development as the area is currently heavily paved.

The following sections describe how changes to the volume and rate of surface water runoff at the site due to the proposed development will be suitably managed to ensure that there is no increase in surface water flood risk to the area. This will provide an assessment of greenfield and current brownfield runoff rates, indicating the current level of discharge from the development site.

In order to reduce current brownfield runoff rates and ensure no increase in surface water flood risk, SUDS options will be assessed to manage surface water runoff from the development.

5.2 Existing Surface water drainage

Given the heavily urbanised nature of the surrounding area it is assumed that surface water is currently being routed into a surface water sewer network. A site asset plan has been acquired from Thames Water[16]. Based on the surrounding network it is presumed that the existing foul and surface water connections are at manholes 6505 and 6506 respectively located on Lebanon Park. No levels are available for the surface water manhole but a cover level of 7.67m AOD is provided for the foul manhole. As the manholes are adjacent to each other the same cover level has been adopted to inform the drainage design.

A pre-planning enquiry was submitted to Thames Water to confirm the existing connection is suitable and has capacity. The response is provided in Appendix 2 and confirms sufficient capacity within the foul and surface water sewers underneath Lebanon Park. The agreed surface water discharge rate of 0.2l/s is based on calculations completed in the remainder of section 5 of this report.

[14] London Borough of Richmond Upon Thames. 2018. Local Plan.
[15] Greater London Authority. 2021. The London Plan 2021.
[16] Asset location search, reference: ALS/ALS Standard/2023_4770543. Thames Water, January 2023.

5.3 Greenfield and Brownfield Runoff rates

Run-off rates have been calculated using ReFH2, which is the current recommended method outlined in the CIRIA SuDS manual[17] where information regarding the existing network is unknown. Run-off rates have therefore been estimated using an area of 50ha before being linearly scaled based on the developed area of the site. Pre-development brownfield rates have been utilised in these calculations, with the current impermeable area of 0.112ha input to ReFH as 'Urban area' and the imperviousness factor set to 1. Table 3 below presents the greenfield and brownfield runoff rates as the unit rate per hectare. The associated calculations are provided in Appendix 3.

Table 3 - Greenfield runoff rates

Return Period	Greenfield Peak runoff rate (l/s/ha)	Brownfield Peak runoff rate (l/s/ha)
1:1	0.36	5.06
1:30	1.15	13.82
1:100	1.61	18.12
1:100 + Climate Change (40%[18])	2.51	25.48

The run-off rates presented are based on a Standard Average Annual Rainfall (SAAR) of 600mm, a base flow index (BFIHOST19) of 0.92 and a proportion of time soils are wet (PROPWET) of 0.29mm.

5.4 Groundwater Protection Zones

A review of the EA Groundwater Source Protection Zones (GWSPZ) via Defra's Magic Map[19] application indicates that the site does not lie within a GWSPZ, therefore no further consideration is required.

[17] CIRIA (2015). The SuDS Manual. C753
[18] Based on the Upper end EA climate change allowance for peak rainfall intensity allowance in the London Management Catchment, https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances accessed January 2022.
[19] Magic Map accessed via: https://magic.defra.gov.uk/MagicMap.aspx

5.5 Proposed Mitigation

5.5.1 Hierarchy of SuDS Strategies

A SuDS approach should be utilised to manage surface water runoff generated from the impermeable areas on site. To ensure that surface water run-off from the site does not result in an increase in flood risk, the management of run-off has been considered using a sequential approach, in line with The London Plan (Policy SI 13). The following options for the disposal of surface water run-off have been assessed in order of preference;

- Rainwater used as a resource.
- Rainwater infiltration to ground.
- Rainwater attenuation in green infrastructure.
- Rainwater discharge to a watercourse.
- Controlled rainwater discharge to a surface water sewer.
- Controlled rainwater discharge to a combined sewer.

5.5.2 Rainwater used a resource

Water butts will be adopted at the 5 proposed properties to capture and utilise rainwater falling on the roofs.

5.5.3 Infiltration SuDS

A BGS report was obtained to inform the potential suitability of the site for infiltration SUDS and the use of permeable paving. The BGS report indicates that there are significant constraints to infiltration with made ground present at the ground surface and poorly draining superficial deposits and bedrock. The superficial deposits are identified as being of the Langley silt member (clay and silt) with bedrock deposits of London Clay formation. Therefore, infiltration SuDS is not currently deemed a viable option for the proposed development.

An infiltration survey is due to be conducted to confirm this is the case. If infiltration capacity is available, then the proposed drainage strategy will be modified to suit this.

5.5.4 Green Infrastructure

It is proposed to utilise green roofs on the converted garages to provide a range of benefits including visual, ecological value, enhanced building performance and a reduction in surface water runoff. Green roofs can help to reduce peak flow rates to the surface water drainage system through increasing storage and interception for small and medium sized events. The impact of green roofs is most significant during short duration summer events. The performance of green roofs during autumn and winter conditions in terms of reducing runoff volumes is small and as such cannot be relied upon to reduce runoff rates from the proposed development. The design of the proposed green roofs should follow the guidance outlined in the CIRIA SuDS manual[20]. Furthermore, additional greenspaces on site are proposed in the form of soft landscaping and private amenity, providing opportunity for interception of surface water runoff.

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[20] CIRIA C753 SuDS Manual 2015

5.5.5 Attenuated Discharge to a Watercourse

There is no watercourse in the vicinity of the development therefore this option has been discounted.

5.5.6 Attenuated discharge to a Sewer

It has been conservatively assumed that the permeable paving proposed across the site will not allow water to naturally drain away given the ground conditions identified when assessing infiltration viability. Therefore, in addition to the rainwater harvesting and green infrastructure, attenuated discharge is proposed. This will utilise the existing surface water connection to manhole 6506 at NGR: 516652, 173504. As outlined in section 5.1, this will be discharged at the greenfield equivalent rate.

Above ground attenuation has been considered but due to the limited availability of non-amenity green space and relative size of the storage proposed to achieve greenfield rates, this has currently been discounted. Underground storage will therefore be taken forward.

5.6 Outline Drainage Strategy

The proposed surface water drainage is attached in Appendix 4 and an overview is displayed in Figure 14. To summarise, the following mitigations are proposed:

- Rainwater butts
- Green roofs
- Permeable paving
- Attenuated discharge to the surface water sewer

The rainwater butts and green roofs will intercept initial rainfall falling onto the roofs whilst the rest of the site will utilise permeable paving. The green roofs and paving will treat the runoff and provide a nominal amount of storage. The permeable paving will allow a certain amount of water to be infiltrated into the ground, but this has conservatively not been accounted for in the storage calculations.

For larger storm events and up to the 1 in 100 year plus 40% climate change attenuated discharge will be utilised. A storage tank is proposed underneath the central landscaping area which will serve the proposed buildings and paved areas (0.07ha in total). A series of manholes and sewers are proposed to direct surface water to it and through a Hydrobrake® Optimum (product number CTL-SHE-0020-2000-1000-2000) before discharging into the surface water sewer at manhole 6506 (as identified in section 5.2). It should be noted that to drain the 'L-shaped' green space behind unit 1, the proposed system will include a sewer running under the building and connecting to the nearest manhole. The inlet for this section of the sewer will be isolated and as such there is a potential increased risk of flooding if it becomes blocked. Therefore, the inlet should be regularly maintained to reduce the likelihood of blockage and the associated risk of flooding.

The limiting discharge from the system is set at 0.2 l/s, which is the greenfield 1 in 100 year plus climate change rate in l/s/ha over the proposed area (0.07ha) that will be connected to the surface water sewer network, principally this consists of the green roofs and permeable paving. The proposed rate is considered to be lowest that can be reasonably achieved given the small size of the site.

This discharge rate has been agreed with by Thames Water, see Appendix 2.

Runoff volume is based on FEH13 rainfall, and the strategy has been informed by a drainage model using Causeway Flow, see results in Appendix 5. This demonstrates the effectiveness of the attenuation system in reducing outflows to a maximum of 0.2 l/s for the 1 in 2yr event up to the 1 in 100yr plus climate change event. This conservatively ignores any storage associated with the water butts, green roofs and permeable paving. To prevent flooding and provide a suitable freeboard the storage tank has a volume of 65m^3 as a result of the above limiting discharge.

Due to the nature of the existing topography the sewer system does have a reduced cover of 0.9m minimum, meaning additional reinforcement will be required within the detailed design. A 225mm diameter sewer is proposed and a minimum velocity of 1m/s achieved for self-cleansing.

As a drainage survey is not available, it is recommended that one is completed to confirm the current sewer arrangements, their condition and to identify if any of the existing infrastructure can be re-used. Additionally, it is recommended that the location of any services is identified to inform the detailed design.

As an invert level for manhole 6506 was not identified this was assumed. If a drainage survey identifies this is higher than the assumed manhole depth of 1.5m, then the design will need to be revised and potential consideration into the use of a surface water pump will be made (subject to the constraints around buried services).

The completed London Sustainable Drainage Proforma for Richmond upon Thames has been completed and provided in Appendix 6.

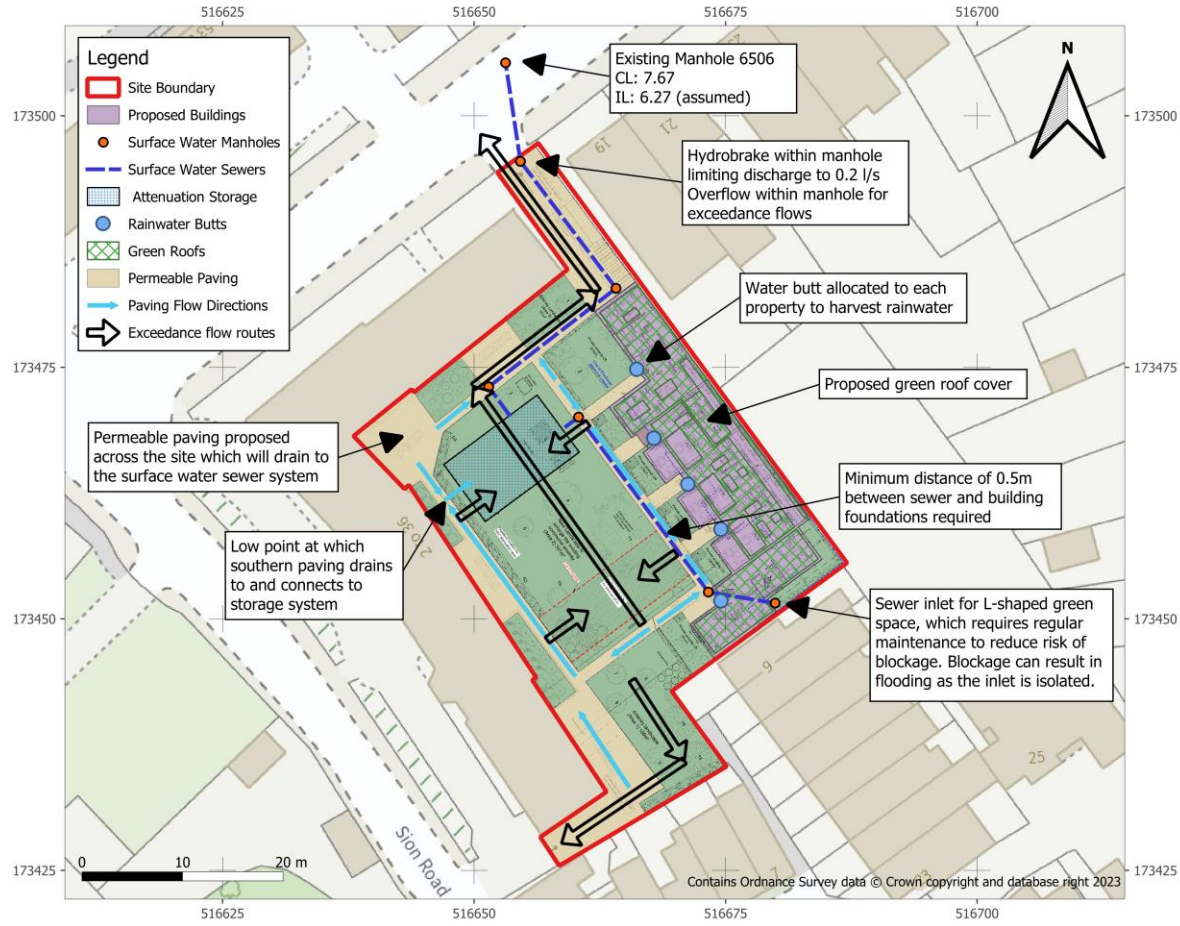

Figure 14 - Outline Drainage Strategy Overview

5.6.1 Water Quality

Current best practice takes a risk-based approach to managing discharge of surface water runoff to the receiving environment. The SuDS manual has been used to classify the hazard rating associated with this type of residential development.

Table 4 -Hazard Ratings

Land Use	Pollution Hazard Level	Requirement for discharge of surface waters
Residential Roofs	Very low	Removal of gross solids and sediments only
Individual property driveways, residential car parks and low traffic roads	Low	Simple Index Approach

The management approach for water quality where the hazard is low can be assessed using the Simple Index Approach. The Simple Index Approach is a three staged approach, where;

- Stage 1 – Define suitable pollution hazard indices for the proposed land use.
- Stage 2- Select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index.
- Stage 3 - If the discharge is to a protected surface water or ground water, consider the need for a more precautionary approach.

Table 5 - Simple Index Approach

	Total Suspended Solids (TSS)	Metals	Hydro-carbons
Hazard Indices for Proposed Development[21]	0.5	0.4	0.4
Mitigation Index for permeable paving[22]	0.7	0.6	0.7
Mitigation ≥ Hazard Index	Yes	Yes	Yes

As shown above, permeable paving provides the necessary amount of treatment for residential roofs and low traffic roads.

5.6.2 Exceedance Flow Routes

In the unlikely event that the outfall is blocked or failure of the system, it should be demonstrated that exceedance flow routes are managed to minimise risk to people and property.

As the flow control is restricted the surface water sewer may have additional capacity that will not be utilised under day to day drainage conditions. Therefore, an overflow above the flow control device is specified to mitigate against flooding of the surrounding urban area. Additionally, floodwater will be directed towards the central green area at the first instance. As there are urban developments on all sides of the development this strategy is considered appropriate.

[21] Table 26.2 – Pollution Hazard Indices for Different Land Use Classifications, SuDS Manual
[22] Table 26.3 – Indicative SuDS mitigation indices for discharges to surface waters, SuDS Manual

5.7 Maintenance

The key maintenance items associated with the proposed SuDS are shown in Table 6. The maintenance plan has been produced using the guidance in the CIRIA SuDS Manual[23].

Table 6 - Maintenance plan

SuDS Feature	Maintenance Act	Frequency
Attenuation Storage Tank (Table 21.3 – CIRIA SuDS Manual)	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for first 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly
	Remove sediment from pre-treatment structures and/or internal forebays.	Annually, or as required
	Repair/rehabilitate inlets, outlet, overflows and vents.	As required
	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required
Permeable Paving (Table 20.15)	Brushing and vacuuming (standard cosmetics sweep over whole surface).	Once a year, or reduced frequency as required
	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weeds or management using glyphosphate applied directly into the weeds by an applicator rather than spraying.	As required
	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required

[23] CIRIA SuDS Manual C753. 2015.

SuDS Feature	Maintenance Act	Frequency
	Initial Inspection.	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action.	Three monthly
	Inspect silt accumulation rates and establish appropriate brushing techniques.	Annually
	Monitor Inspection Chambers.	Annually
Green roofs (Table 12.5)	Inspect all components including soil substrate, vegetation, drains, membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources. Any erosion channels should be stabilised with extra soil.	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system, removing debris and litter.	Annually and after severe storms
	Inspect underside of roof for evidence of leakage.	Annually and after severe storms
	Replace dead plants as required and remove nuisance vegetation, including weeds.	Monthly (first year) annually thereafter
	Mow grasses, prune shrubs and manage other planting as required, removing any clippings.	Six monthly or as required
Water butts	Check operation of receiving drains and pipes following heavy rainfall.	Annually
	Inspect tank for debris and sediment build-up, including any blockages to inlets and outlets, cleaning as appropriate.	Annually

6 Flood Risk Assessment

6.1 Planning Policy

This FRA is required in line with the NPPF and its associated technical guidance alongside local planning guidance. Although development already exists within the proposed development site, a change of use is proposed from the "less vulnerable" garage developments to "more vulnerable" residential dwellings. Due to the vulnerability of the proposed development and a small portion of the eastern corner of the site shown to lie within Flood zone 2, an Exception Test is required in accordance with national planning policy and according to Richmond Local Plan (Policy LP 21). The exceptions test is required to demonstrate that:

a) The development will provide wider sustainability benefits to the community that outweigh the flood risk
b) The development will remain safe for its lifetime (100 years plus an allowance for climate change) without increasing flood risk elsewhere

6.2 Justification for development (Exception Test)

The Richmond Local Development Management Plan from November 2011 indicated the substantial need for housing within the borough, and stated that change of use of developments to housing within the area will normally be encouraged ensuring compliance with relevant policies.

The most recent local plan references the requirement and target for 3,150 extra homes to be constructed in the borough between 2015 and 2025[24]. Thus, the proposed development works towards this target, furthermore the plan states that additional housing may be provided through conversions and change of use of existing developments to housing. It is also stated that proposals should optimise the potential of currently developed sites and that the majority of housing is expected to be on previously developed land. As the proposed development involves a change of existing development and residential housing it contributes to supporting the local development plan and addresses the growing need for housing demands.

A review of flood risk to the proposed development has indicated that none of the site is in Flood Zone 3, with only a small part located in Flood Zone 2. There is no evidence of historic flooding in the area and the surrounding area is densely residentially populated, thus it is expected that residential development at the site is achievable. Given the proposed change of use of development includes a reduction in impermeable area there will be no increase in flood risk to the surrounding area as a result of the development.

It is required that the development remains safe for its lifetime (100 years plus an allowance for climate change). Hydraulic modelling has indicated that the development is at risk during the 1.0% AEP+35% CC-HC fluvial event with an allowance for climate change. The results indicate that during this event flood levels within the site reach a maximum level of 6.83m AOD in the far south eastern corner of the site. It is therefore proposed that finished floor levels are raised above this level to ensure the properties remain flood free. This is discussed in 6.3 below.

[24] London Borough of Richmond Upon Thames. 2018. Local Plan.

6.3 Proposed Mitigation

The proposed development is shown to flood to a maximum level of 6.83m AOD in the far south eastern corner during the 1.0% AEP CC-HC flood event. The London Plan Policy SI 12 (C)[25] requires development proposals to ensure flood risk is minimised and mitigated. As such, in order to ensure the development remains safe for its life time, finished floor levels should be raised above this 1.0% AEP CC-HC modelled flood level.

During the 1.0% + 35% Climate Change Higher Central Estimate, flood levels within the site reach a maximum level of 6.83m AOD in the south west corner of the site. To ensure that the development remains flood free during this design event, a 600mm freeboard should be applied to this modelled flood level, providing a minimum finished floor level of 7.43m AOD for the residential developments. This design level will provide a 540mm freeboard over the 0.1% event, however there will be no freeboard and some inundation during the 1.0% + 70% Climate Change Upper End flood event.

A review of the current topography of the site indicates that ground levels along the north eastern boundary where the garages are situated range from 7.80m AOD along the north of the eastern boundary to 7.49m AOD at the southern end where they drop to a minimum of 6.3m AOD along the south eastern boundary, therefore a proposed finished flood level of a minimum of 7.43m AOD is achievable. This provides a minimum freeboard of 600mm above the maximum modelled flood level for the extreme fluvial event. Modelled flood levels were lower for the tidal event; thus, this finished floor level will ensure the development is not at risk of flooding during tidal flood events.

The proposed development will reduce existing impermeable areas due to the removal of Garages B and the larger soft landscaping areas, as such it is expected that surface water runoff from the site will decrease.

Residents of the development should sign up to the flood warning service to ensure appropriate warnings are received of potential flood events to allow preparedness and evacuation if required.

[25] Greater London Authority. 2021. The London Plan 2021.

6.4 Access/Egress

If a flood event were to occur, it is important to highlight a potential access/egress route from the proposed development to ensure that occupiers can evacuate the area safely following the notification of a flood event or flood warning (this addresses residual risk to the development, in line with London Plan requirements, Policy SI 12[26]). The proposed access route is to exit the properties via Lebanon Park, turning onto Sion Road and heading in a northernly direction where flood free routes are available to the east and south east via the A305 Richmond Road. An indicative access/egress route is displayed in Figure 15.

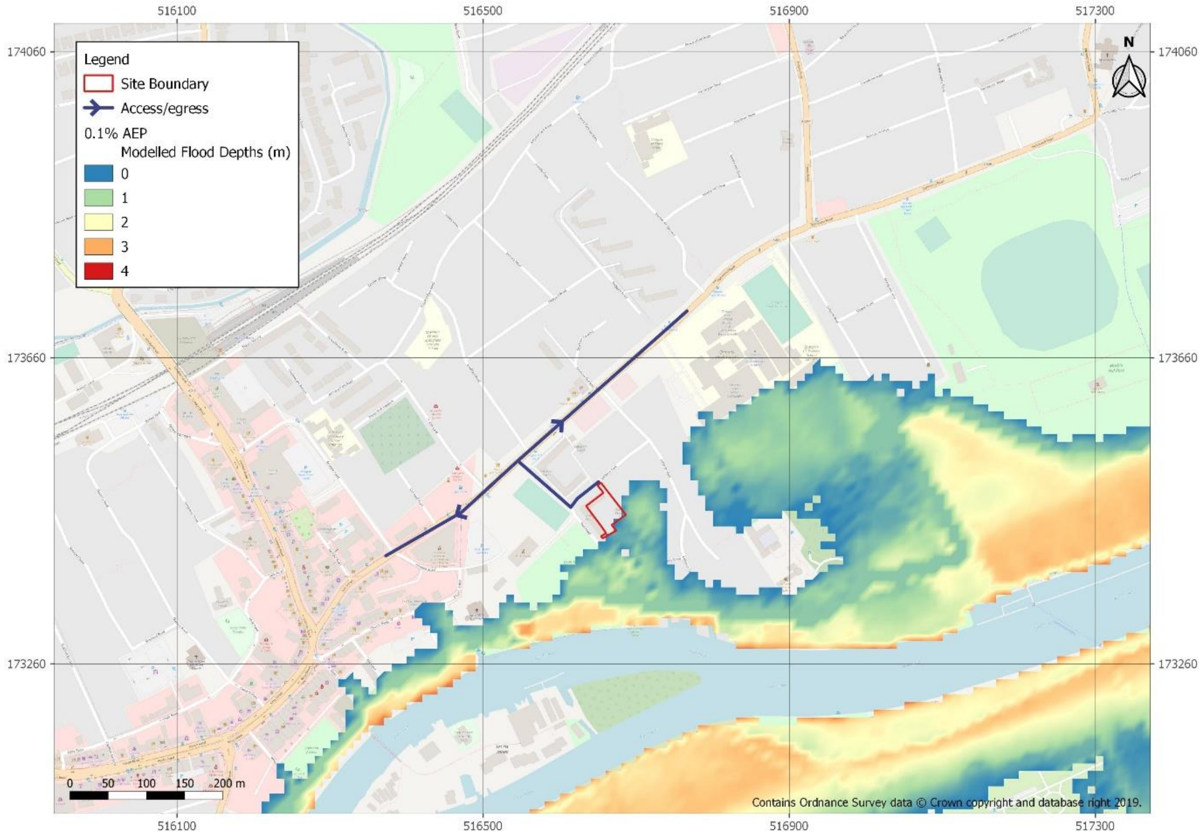

Figure 15- Access and egress

The eastern corner of the site lies within a flood warning area; therefore, people will be alerted to potential floods to allow people to take action to protect themselves and their property.

As the dominant source of flooding is fluvial from the River Thames, and the area is heavily residential, there should be sufficient flood warnings in place should a flood event be expected to occur. This will allow sufficient time for residents to evacuate if required. As such the residual risk to the development and its residents is considered low.

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[26] Greater London Authority. 2021. The London Plan 2021, 9.12.6.

7 Conclusions and Recommendations

The conclusions and recommendations from this FRA are outlined below:

- The proposed change of use of development is situated at Sion Court, Twickenham, NGR: TQ 16661 73457, converting 19 existing garages and one flat into five new residential developments with associated amenity space, green areas and bike storage.
- There is no proposed increase in impermeable area.
- Most of the site is located within Flood Zone 1 with only a small portion of the south east corner situated within Flood Zone 2. There is no evidence of historic flooding at the development site.
- The proposed development is not at risk of surface water flooding.
- The results of the existing hydraulic model of the River Thames indicate that the development is not at risk of flooding during the 1.0% AEP fluvial event, however it is at risk during higher order events such as the 0.1% AEP fluvial event and climate change events. During the 0.1% AEP event, the predicted flood level is 6.89m AOD.
- The development is not at risk of tidal flooding during the present-day breach scenario event, but is predicted to flood to a maximum level of 6.38m AOD in the far south eastern corner during the 2100 modelled tidal breach event.
- Finished floor levels should be set no lower than 7.43m AOD, given the modelled flood levels of 6.83mAOD during a 1.0% + 35% Climate Change Higher Central Estimate and a minimum freeboard of 600mm. In addition to this, finished flood levels should be set at least 300mm above local ground levels.
- Liaison with Thames Water has confirmed that the location of existing surface water sewers and confirmed capacity for the proposed discharge rate.
- Water butts, green roofs and permeable paving are proposed to intercept surface water runoff. For larger storm events an attenuation tank will be utilised with restricted discharge to the surface water sewer at a maximum rate of 0.2 l/s, the 100 year plus climate change greenfield equivalent.
- Infiltration testing and a drainage survey are required to determine infiltration capacity and the position the existing surface water sewers. Once acquired the proposed drainage strategy will be updated accordingly.
- The development is required in terms of meeting housing demands within Twickenham as part of the Richmond Local Development plan which states support for change of use of existing development into residential dwellings.
- The residential developments have been shown to remain safe and flood free for their lifetime with flood free access and egress during all modelled flood events.
- The proposed development meets the requirements of the National Planning Policy Framework in terms of flood risk, in addition to The London Plan (policies SI 12 and 13) and the Richmond Local Plan.

Appendix 1 BGS SuDS report

Appendix 2 Thames Water pre-planning enquiry

Appendix 3 Greenfield and brownfield runoff rates

Appendix 4 Outline Surface Water Strategy

Appendix 5 Causeway Flow Calculations

Appendix 6 London Sustainable Drainage Proforma