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4.1 INTRODUCTION

4.1.1 This Chapter has been prepared by Dr Paul Webster of Hydro-Logic Services LLP (HLS), hydrological consultants. HLS were appointed to undertake the Flood Risk Assessment (FRA) during 2013 and to provide general guidance to the project team on matters of hydrology and flood risk.

Scope of Assessment

4.1.2 This Chapter considers the effects of the proposed redevelopment on flood risk and local drainage infrastructure. The potential effects during the construction period are also identified and assessed.

4.1.3 The contents of this Chapter are drawn extensively from the Flood Risk Assessment (FRA). This has been prepared as a separate document for submission and review by the Environment Agency.

Data Collection Methodology

4.1.4 Baseline conditions relating to hydrology, flood risk and drainage at the site have been established using published information, consultation and site surveys. These include:

- Site visits and walkover surveys;
- Consultation with and provision of data from the Environment Agency;
- Consultation with and provision of data from Thames Water
- Consultation with London Borough of Richmond upon Thames (LBRT)
- Spatial data from the Flood Estimation Handbook (FEH);
- Riverflow data from the National River Flow Archive (NRFA)
- Topographic survey of the site and surrounding areas provided via TP Bennett Architects.

4.1.5 The FRA referred to above, has been prepared in line with the National Planning Policy Framework, the Technical Guidance to the National Planning Policy

Framework and the LBRT Strategic Flood Risk Assessment (SFRA). These in turn have drawn from the policies outlined in its predecessor, PPS25. The FRA considered the following:

- Site hydrology and drainage;
- Potential sources of flooding;
- Impact of the Development on flood risk;
- Mitigation measures required to reduce flood risk to the Development and elsewhere to an acceptable level and;
- The management of surface water so as not to increase and if possible decrease flood risk elsewhere.

4.2 POLICY CONTEXT

a. National Planning Policy

4.2.1 Section 10 of the National Planning Policy Framework (NPPF) presents Government policy on development and flood risk (Meeting the challenge of climate change, flooding and coastal change). Paragraphs 100 to 104 aim to ensure that flood risk is taken into account at all stages of the planning process, to avoid inappropriate development in areas at risk of flooding by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. The NPPF advocates the use of the risk-based 'Sequential Test', to direct new development to areas with the lowest probability of flooding. The NPPF states that Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. Further, the NPPF requires that the development is appropriately flood resilient and resistant, including safe access and escape routes where required, that any residual risk can be safely managed, including by emergency planning and it encourages the use of sustainable drainage systems.

b. Regional Planning Policy

4.2.2 The London Plan provides relevant planning guidance under the headings of Flood Risk Management (4A.13) and Sustainable Drainage (4A.14).

4.2.3 Where development in areas at risk from flooding is permitted, (taking into account the provisions of PPS 25), the Mayor will, and boroughs and other agencies should, manage the existing risk of flooding, and the future increased risk and consequences of flooding as a result of climate change, by

- protecting the integrity of existing flood defences
- setting permanent built development back from existing flood defences to allow for the management, maintenance and upgrading of those defences to be undertaken in a sustainable and cost effective way
- incorporating flood resilient design
- establishing flood warning and emergency procedures.

4.2.4 Boroughs and Agencies should take fully into account the emerging findings of the Thames Estuary 2100 Study, the Regional Flood Risk Appraisal and the Thames Catchment Flood Management Plan.

4.2.5 The use of **sustainable urban drainage** systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much run-off as possible on site and explore sustainable methods of managing the remainder as close as possible to the site.

4.2.6 Developers should aim to achieve greenfield run off rates from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing or at least not increasing the amount of hard standing associated with existing homes.

c. Local Planning Policy

4.2.7 The Local Plan, also known as Local Development Framework (LDF), will replace the Unitary Development Plan (UDP) with Development Plan Documents (DPDs). The DPDs have development plan status, similar to the existing UDP, and are subject to independent examination before an Inspector. In relation to flood risk, the LDF references three study areas, which are outlined further in subsequent paragraphs:

- Strategic Flood Risk Assessment (SFRA);
- Surface Water Management Plan; and
- Flood Risk and Development Sequential Test.

4.2.8 Local Planning Policy in relation to flood risk is articulated in the Strategic Flood Risk Assessment (SFRA) prepared by LBRT (Level 1 Update) in August 2010 which provides the following:

- It collates all known sources of flooding, including river, surface water (local drainage), sewers and groundwater, that may affect existing and/or future development within the Borough;
- Delineates areas that have a 'low', 'medium' and 'high' probability of flooding within the Borough, in accordance with Planning Policy Statement 25 (PPS25), and to map these:
 - Within flood affected areas, recommends appropriate land uses (in accordance with the PPS25 Sequential Test) that will not unduly place people or property at risk of flooding
 - Where flood risk has been identified as a potential constraint to future development, recommend possible flood mitigation solutions that may be integrated into the design (by the developer) to minimise the risk to property and life should a flood occur (in accordance with the PPS25 Exception Test).

4.2.9 The SFRA (Section 7.4.4) also provides guidance to developers on the requirements of any FRA and these are cross-referenced in the accompanying FRA.

4.2.10 The SFRA is currently being revised by LBRT, in conjunction with the Environment Agency. Where appropriate to this Project, the revised findings have been provided to the Consultant.

4.2.11 LBRT has also issued a Planning Advice Note giving Guidance on Producing a Flood Emergency Plan for planning applicants and developers to accompany a planning application. This has formed the basis for the Emergency Plan that is presented in the accompanying FRA.

4.2.12 The Surface Water Management Plan (SWMP) has been produced for the London Borough of Richmond upon Thames, along with the Preliminary Flood Risk Assessment, as part of the Drain London project. This deals with the risk of surface water flooding (pluvial flooding). Whilst this risk is also covered by the SFRA, the SWMP provides a more detailed analysis to support strategy.

4.2.13 The Flood Risk and Development Sequential Test Report reflects the requirements of the NPPF and PPS25, on which it has been based. The guidance is also embraced by the overarching SFRA.

4.2.14 The following adopted Local Planning Policies are also relevant to this FRA:

- Core Strategy policy CP3, which restricts development in areas of high flood risk in accordance with PPS25 (now superseded by the NPPF), the Borough's SFRA and site specific FRAs.
- The Development Management Plan (DMP) policy DM SD 6, which is the local flood risk policy that sets out what types of developments and land uses are acceptable in the various flood probability areas. In addition, it requires all proposals on sites of 10 dwellings or more to submit a Flood Emergency Plan.
- DMP policy DM SD 7 on sustainable drainage, which requires all developments to follow the drainage hierarchy and to reduce any discharge to greenfield run-off rates where feasible.
- DMP policy DM SD 8 on flood defences is relevant in relation to the effectiveness, stability and integrity of the flood defences and river bank.

It also encourages the set back of developments from defences where there are opportunities.

- DMP policy DM SD 10 requires developers to submit written confirmation from Thames Water to confirm that sufficient capacity exists in the water supply, surface water, foul drainage and sewerage treatment to serve the development.

4.3 BASELINE CONDITIONS

4.3.1 The Development Site is currently used by Haymarket Media for office and media activity. On the landward side of the tidal defences, the site is relatively flat with elevations between approximately 6.4 mAOD near the site entrance from Broom Road to approximately 5.6 mAOD in the north-east corner of the site. A topographic survey completed in 2013 has provided level information for the project. The site is essentially 100% impermeable, made up of roofs, car parking, paths and other minor hard-standing.

4.3.2 The northern boundary of the site abuts the River Thames, along which are located tidal defences, whose crest is at a nominal level of 6.1 mAOD. These defences extend along most of the eastern boundary and part of the western boundary where they link to existing buildings.

4.3.3 The River Thames is tidal as far as Teddington Weir, which is located 200 m to the east and upstream of the site. This means that water levels in the Thames are affected by both tidal and fluvial factors. Furthermore, the tidal levels are subject to the operation of the Thames Barrier.

4.3.4 The establishment of design flood levels is accordingly a complex process, requiring the use of extensive hydraulic models and a range of assumptions to describe the boundary conditions (ie fluvial and tidal factors). The models have been developed and refined in recent years by the Environment Agency. These models have been provided to the Consultant along with the design levels and other outputs obtained from them.

- 4.3.5 Flood zone maps provided by the Environment Agency and discussed with LBRT have confirmed that the majority of the site lies in Flood Zone 3, with a small area in Flood Zone 2. Mapping that has been prepared by LBRT as part of the revised SFRA has confirmed that the entire site lies in Flood Zone 3a. This is due to the protection that is afforded by the existing tidal defences to a probability of flooding of 5% (1 in 20 annual probability). This is of major relevance to the planning policy, since residential development is deemed “appropriate” in flood zone 3a, though this is subject to satisfying both the Sequential and Exception Tests.
- 4.3.6 The modelled water levels provided by the Environment Agency have shown that fluvial flooding is the dominant flood mechanism for extreme floods that are relevant to setting finished floor levels (i.e. 1% with the effects of climate change). Accordingly, the 1% (1 in 100) fluvial level with the effects of climate change of 6.97 mAOD (nominally 7.0 mAOD) has been used as the reference flood level for the site.
- 4.3.7 Recent modelled data provided by the Environment Agency has incorporated the effects of the Thames Estuary Strategic Management Project (TE2100). This provides a strategic framework for the entire estuary, including Richmond and Teddington. The management of the Thames Barrier is a critical feature of the Strategy.
- 4.3.8 Levels provided by the TE2100 are subject to the influence of the Thames Barrier. The levels are also provided as an “extreme”, without reference to return period. For Teddington, these “extreme” levels for 2065 and 2100 are **lower** than the fluvial extremes given above. However, for the present day levels, the extreme is **higher** than the fluvial extremes.
- 4.3.9 This is an unusual situation and is challenging from a planning viewpoint. Whilst some uncertainty attends these levels, it has been decided to retain the fluvial extremes as a basis for design.
- 4.3.10 Stormwater is collected on site via conventional storm drainage systems and is discharged from the site either to a Thames Water sewer running along Broom

Road or to the River Thames via an outfall in the north-west corner of the site. Stormwater via this latter route is routed via a detention tank located beneath the car park.

- 4.3.11 It is a requirement of any FRA that the risks from **all** sources of flooding be addressed. The risks from **fluvial and tidal** flooding have been addressed through use of the latest hydraulic modelling output and in discussion with the Environment Agency. As the site lies on unproductive bedrock strata, the Environment Agency considers **groundwater flooding** at the site to be unlikely. Furthermore, there is no history of groundwater flooding in the immediate vicinity of the site. The elevated position of the site in relation to adjacent areas means that the risk of **surface water** flooding or **sewer** flooding are extremely limited. In terms of **infrastructure** failure, the key local infrastructure is the tidal defence. Since this is only at a level of 5% (1 in 20), its failure would be of limited impact, given the reference design flood level which is over 0.8 m higher than the defences.

4.4 PREDICTING THE IMPACTS OF DEVELOPMENT

- 4.4.1 The impacts of the development need to be assessed in relation to the impact on flood levels (which may affect the site and adjacent areas) and on runoff from the site that may affect third parties.

Construction

- 4.4.2 The construction activities will involve demolition of existing buildings (excluding the Cottage), construction of new dwellings and associated landscaping. These will involve storage of waste materials, prior to being transferred off-site and storage of building materials and plant. Such storage may impact on flow paths across the site and flood storage, in the event of extreme flooding. The magnitude of these impacts cannot be ascertained at this stage as the construction schedule is not available. However, given the extent of buildings on the site and the likely requirement for reasonably low levels of material storage on site, it is most unlikely that there will be an adverse impact during the construction period.

- 4.4.3 Construction activity may lead to wash off of silt and pollutants to the surface drainage system.

Completed development

- 4.4.4 The impacts of the development on flood levels have not been evaluated using models. This is largely because the proposed development has a much smaller building footprint than the existing footprint and is in an elevated and protected position on the flood plain. The proposed development has also enabled the existing flow routes across the site to be matched. Furthermore, the landscaping of the site is such that there is an increase in the volume of flood plain storage. It is also demonstrated in the accompanying FRA that this satisfies the requirement for “level-for-level” compensation using 0.1 m contours.
- 4.4.5 Finished floor levels for the principal residential Blocks (A, B, C and D) plus Affordable Housing (part of Block E) have been set at 300 mm above the reference flood level (1% level with allowance for climate change) of 7.3 mAOD. Finished floor levels for the Townhouses will be at 6.2 mAOD. Flood resistance measures will be provided for these properties giving protection to a level of 7.1 mAOD. The Finished Floor Level of Weir Cottage is at 6.92 mAOD and flood resistance measures should be installed as part of its refurbishment.
- 4.4.6 Safe access/egress under extreme flood conditions have been provided in the development from all properties at a level of 6.8 mAOD. Residents of the townhouses in Block E would reach need to traverse their rear gardens, to reach the raised safe access/egress route. However, the rear gardens would be protected from flooding. This would give a maximum depth of 0.17 m for the 1% climate change event. As detailed in the FRA, the low flow velocities mean that this access is classed as Very Low Hazard for residents in the principal Blocks.
- 4.4.7 The proposed development will result in a significant decrease in impermeable proportion on the site. The FRA shows that the peak rate of runoff for the site for the 1% storm will fall from 24.0 l/s to 11.0 l/s, which is 46% of the pre-

development rate. There will accordingly, be a substantial reduction in the peak rate of runoff from the site, to the River Thames and to Thames Water’s sewers.

4.4.8 The FRA has reviewed the scope for implementation of SUDS measures in line with guidelines in CIRIA (2007) and the London Plan. Source control measures will include the use of permeable paving, soakaways, green roofs and rainwater harvesting. It is expected that permeable paving will perform satisfactorily, given the proximity to the Thames and likely presence of permeable soils on the site – clearly, it has not been possible to verify this given the current impermeable cover.

Table 4.1: Summary of Impacts

Topic Area (Flood Risk)	Description of Impact	Geographical Importance					Impact	Nature	Significance Before Mitigation
		N	R	S	D	L			
Construction - Flood risk - Runoff – water - Runoff – silt	Storage of materials					*	A	S	L
	To drains				*	*	A	S	M
	To drains				*	*	A	S	M
Post development - Flood risk - Flood risk	On site				*	*	N	L	L
	Off site				*	*	B	L	L

KEY:

Geographical Level of Importance	Impact	Nature of Impact	Significance
National	Adverse	Long Term	Significant
Regional	Neutral	Short Term	Moderate
Sub-Regional	Beneficial		Low
District			No Effect
Local			

4.5 MITIGATION

Construction

- 4.5.1 In order to ensure that there are no adverse effects from the storage of materials during the construction phase, it should be confirmed that the flood storage areas and volumetric requirements identified in the FRA are satisfied for all stages of construction. As stated above, given the current extent of buildings on site, satisfying this condition should not be onerous.
- 4.5.2 Dewatering may be required due to excavations for the basement car park. The excavations may be undertaken following piling, so the need for dewatering is not certain. Since the ground under the site is likely to be in reasonable hydraulic conductivity with the river, the water is likely to be of similar quality. This can be confirmed during site investigations. Prior to discharge to the Thames, the water from excavations should be passed through a settling facility to allow sediment to settle out.
- 4.5.3 The potential for impacts resulting from storage of materials will be minimised by the following measures:
- Storage compounds (for the storage of construction materials or temporary stockpiling of material from demolished buildings) will be located away from the Thames and drains;
 - Drums and barrel will be stored in a designated bunded safe area within a site compound; and
 - All drums and barrels will be fitted with flow control taps and will be properly labelled.

Completed development

- 4.5.4 There are no adverse effects, so no additional mitigation is required. However, in response to general aspirations to provide drainage benefits, the site will include soakaways, rainwater harvesting and green roofs as outlined in the FRA.

4.5.5 The Environment Agency has advised under TE2100 of their intention to raise the defence levels from the existing 6.1 mAOD to 6.9 mAOD. Whilst this is slightly below the reference flood level, the raised defences will reduce the probability of the site being affected by flooding considerably.

5.6 RESIDUAL IMPACTS

Construction

4.6.1 With appropriate mitigation, there will be no residual impacts on flood risk and drainage.

Completed development

4.6.2 No mitigation was required so there are no residual impacts.

Table 4.2: Summary of Residual Impacts

Topic Area (Flood Risk)	Description of Impact	Geographical Importance					Impact	Nature	Significance after Mitigation
		N	R	S	D	L			
Construction - Flood risk - Runoff – water - Runoff - silt	Storage of materials					*	N	S	L
	To drains				*	*	B	S	L
	To drains				*	*	N	S	L
Post development - Flood risk - Flood risk	On site				*	*	B	L	L
	Off site				*	*	B	L	L

KEY:

Geographical Level of Importance	Impact	Nature of Impact	Significance
National	Adverse	Long Term	Significant
Regional	Neutral	Short Term	Moderate
Sub-Regional	Beneficial		Low
District			No Effect
Local			

4.7 CUMULATIVE IMPACTS

Construction

4.7.1 During development of the site, there will be a short-term, low, beneficial impact on surface water (pluvial) flooding at the site. This will be realised by the progressive exposure of permeable material under the existing buildings and hard standing. This will deliver benefits for the surrounding area.

Completed Development

4.7.2 Following development of the site, there will be a long-term, low, beneficial impact on surface water (pluvial) flooding at the site. This will deliver benefits for the surrounding area.

4.8 SUMMARY AND CONCLUSIONS

4.8.1 During construction and by ensuring appropriate storage arrangements for materials, there would be a short-term, low beneficial effect on flood risk at the site and on flood risk elsewhere.

4.8.2 The development has provided for the following measures, without the need for additional mitigation:

- The majority of building finished floor levels are set 300mm above the 1 in 100 year (+20% for climate change) flood level with flood resistance measures provided where finished floor levels are lower;
- There is a net gain of flood plain storage resulting from the development;
- The post development peak rate of runoff for the 1% storm is attenuated to 46% of the pre-development rate of runoff;
- There is safe access/egress route is available from the site during a 1 in 100 (climate change) event.

4.8.3 Collectively, these measures will result in a long-term, low beneficial effect on flood risk for land adjacent to the site.