Flood Risk Assessment and SuDS Report

J3932 Twickenham Riverside

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Revision: 12

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1. INTRODUCTION

Webb Yates Engineers (WYE) is part of a design team commissioned to undertake a Flood Risk Assessment (FRA) for the development associated with Twickenham Riverside Project. The FRA is to support a planning application for the proposed development

An FRA has been required for this specific site as the proposed development partially lies within Flood Zone 3.

This study considers the issues relating to Flood Risk and drainage associated with the development proposals. The purpose of this assessment is to assess how the development proposal affects flood risk both to the site and the surrounding areas and ensure the development will be safe for its lifetime considering the vulnerability of its users. This will be in accordance with national guidance and local guidance provided by the London Borough of Richmond upon Thames (LBRuT) the Lead Local Flood Authority (LLFA) for the site.

This document has been prepared with reference to:

- National Planning Policy Framework (NPPF) 2021
- National Planning Practice Guidance (NPPG) July 2018
- Sustainable Drainage Systems: Non-Statutory technical standards for sustainable drainage systems, March 2015.
- Assessing and Managing Flood Risk in Development Code of Practice BS8533:2011.
- Flood Risk and Costal change guidance: August 2022
- Design and Construction Guidance for foul and surface water sewers offered for adoption

  under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England ("the Code"): Approved Version 2.0 10 March 2020.
- Environment Agency (EA) Flood Maps (https://flood-map-for-planning.service.gov.uk/).
- Defra's MAGIC Map (https://magic.defra.gov.uk/MagicMap.aspx.
- London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA), 2021
- The London Borough of Richmond Upon Thames (LBRuT) SuDS Guidance Document
- The LBRuT Surface Water Management Plan (SWMP).
- The LBRuT Local Flood Risk Management Strategy.
- London Borough of Richmond upon Thames Adopted Local Plan (2020)
- The London Plan (2021)
- The London Supplementary Planning Guidance (SPG) – Sustainable Design and Construction (www.london.gov.uk) 2014.
- London Borough of Richmond upon Thames: Guidance on Producing a Flood Emergency Plan, November 2011.

- Thames Estuary 2100 (TE2100) Plan
- Phase 1 and Phase 2 – Site Investigation Report, GeoSphere Environmental 4955,GI/GROUND/ PC,SG,JD,19-11-20/V2, 19/11/2020
- Sequential Test and Exceptions Test for Twickenham Riverside undertaken by Savills

2. GENERAL DESCRIPTION OF SITE

Details of the site location are included below in Table 1 supported by Figure 1 and Figure 2.

Table 1: Site location

Description	Site Location
Nearest post code	TW1 3DX
Lead Local Flood Authority	London Borough of Richmond upon Thames
Area	1.34 ha
Lat, Long	51.445646, -0.327590
Nat Grid	TQ163731 / TQ1632173177
OS X (Eastings)	516321
OS Y (Northings)	173177
Nearest watercourse	River Thames

Figure 1. Site location (Satellite image)

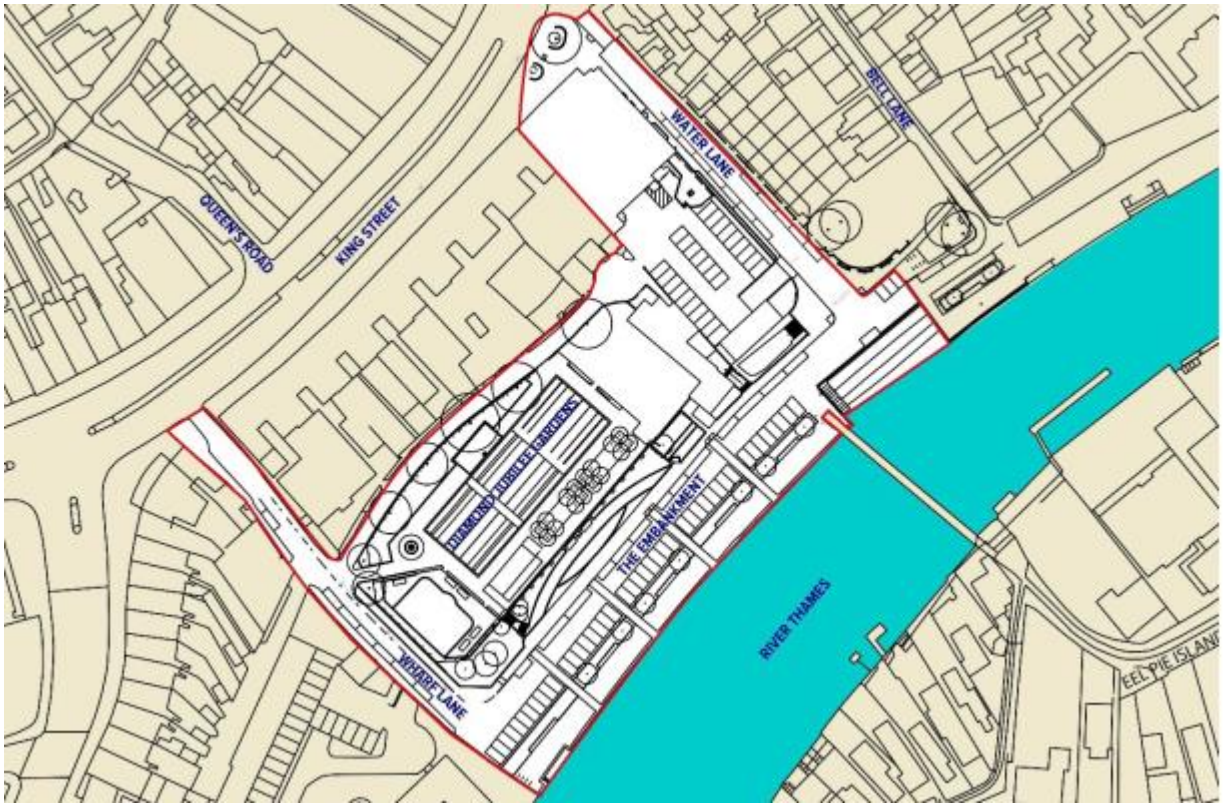


Figure 2. Site location

The site is bound by Water Lane to the north-east, retail units and Diamond Jubilee Gardens to the north-west, Wharf Lane to the south-west and The Embankment to the south-east. The total site area is approximately 1.34 ha. Currently, the southwestern portion of the site is occupied by the Diamond Jubilee Gardens. A car park is situated to the south-east of the site and commercial buildings occupy the north-east of the site. A topographical survey of the site can be found in Appendix A.

3. SITE CONTEXT

3.1. Geology

A desktop review of the geology in the area was undertaken using the British Geological Survey (BGS) maps. For more detailed geological information refer to the Phase 1 and Phase 2 – Site Investigation Report completed by Geosphere Environmental 08.12.2020, report reference: 4955,GI/GROUND/ PC,SG,JD,08-12-20/V3.

The bedrock material of the site was identified as The London Clay (refer to Figure 3). This material mainly comprises bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. It commonly contains thin courses of carbonate concretions ('cementstone nodules') and disseminated pyrite. It also includes a few thin beds of shells and fine sand partings or pockets of sand, which commonly increase towards the base and towards the top of the formation. At the base, and at some other levels, thin beds of black rounded flint gravel occurs in places. Glauconite is present in some of the sands and in some clay beds, and white mica occurs at some levels.

Figure 3. BGS Bedrock Material

The site superficial ground material was identified as Langley Silt Member- Clay and Silt. (refer to Figure 4).

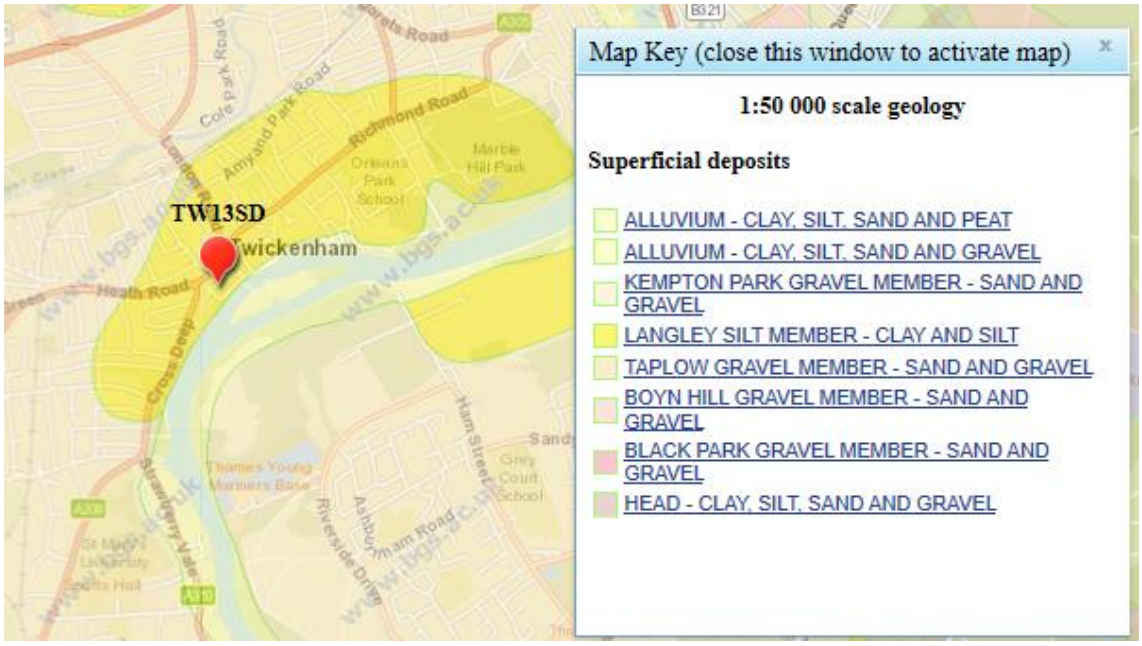


Figure 4. BGS Superficial Material

Historical boreholes, within the site boundary, were identified on the BGS website, refer to Figure 5.

Figure 5. BGS Historical Boreholes

The results shall be subject to site specific investigation.

3.2. Existing drainage

Figure 6 shows the existing drainage infrastructure including the existing pipe network, flood defences and permeable area.

Figure 6. Existing drainage

3.2.1. Flood defences

The product 4 data for the site states the following bout the existing flood defences.

"The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP; they are designed to defend London up to a 1 in 1000 year tidal flood event. The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure that they are maintained to a crest level of 6.02 m mAOD (the Statutory Flood Defence Level in this reach of the Thames). We inspect them twice a year to ensure that they remain fit for purpose. The current condition grade for defences in the area is 2 (good), on a scale of 1 (very good) to 5 (very poor). There are no planned improvements in this area."

The infrastructure protected by the existing flood defence includes the Diamond Jubilee Park, Carparks and disused buildings.

3.2.2. Existing Sewer/ Surface Water

Details of the existing sewer network was provided by Thames Water.

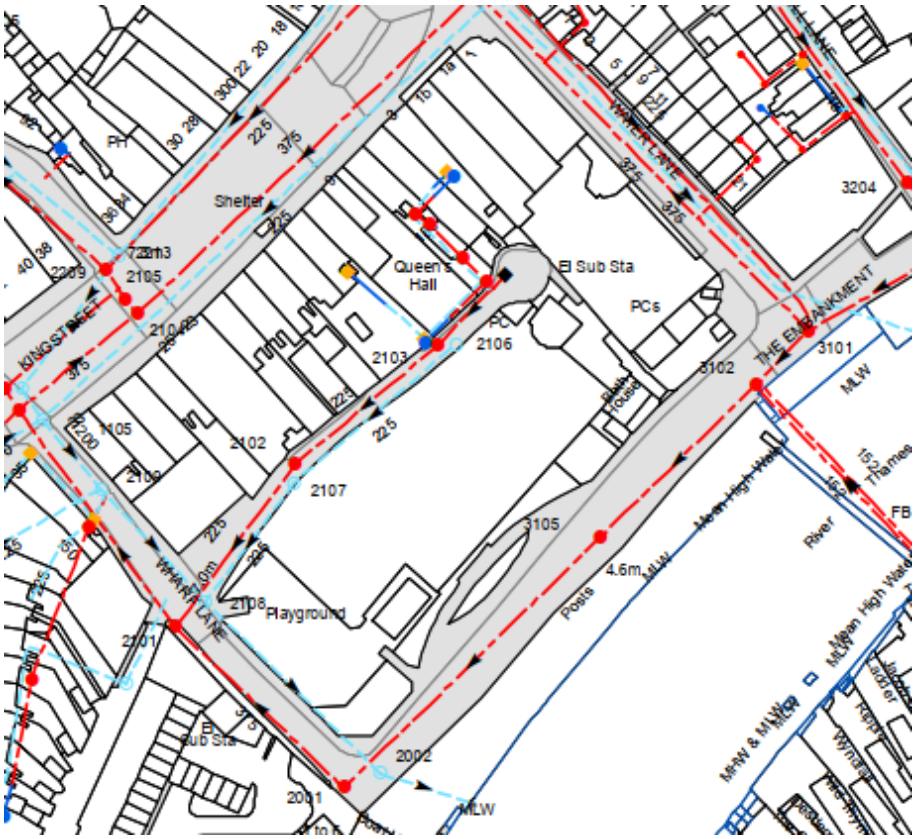


Figure 7. Extract from Thames Water Asset Search

4. PROPOSED DEVELOPMENT

The proposed development includes the removal of the existing buildings from the site and includes 2 proposed buildings, referred to as the Wharf Lane building and the Water Lane building.

The Water Lane development is 4 stories high and contains 21 residential dwellings above ground level. Ground level shall contain a café space, retail space, bike storage and plant room.

The Wharf Lane building is 5 stories high with a basement. The top 4 floors of the building are proposed to be 24 residential apartments. The ground floor contains a pub and office/retail space. The basement is proposed for WC, storage, pub kitchen and plant room.

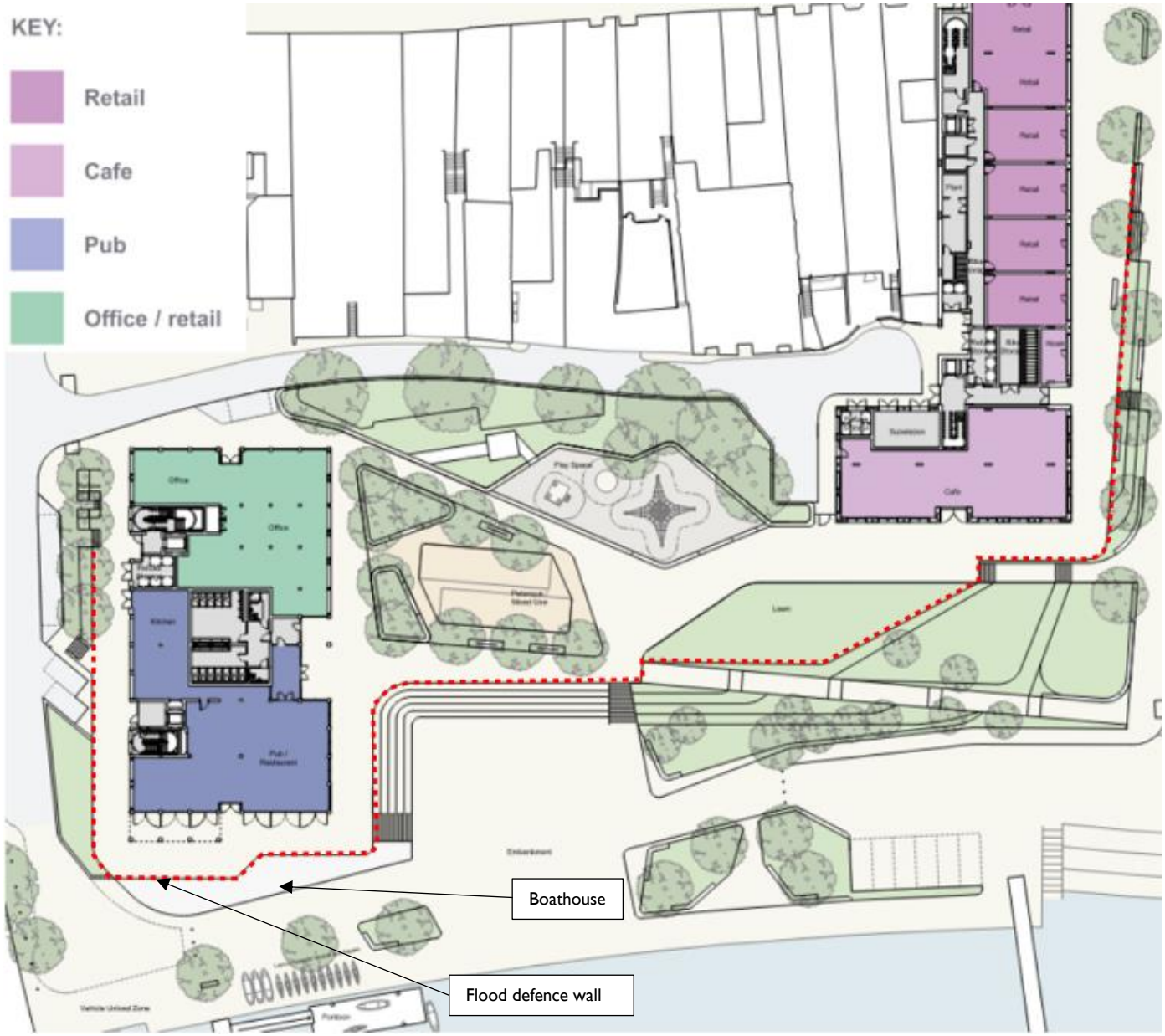


Figure 8: Proposed Site

In December 2020 a meeting was held with the Environment Agency to discuss the possibility of locating a boat storage facility in front of the food defence wall by the Wharf Lane building. It was agreed that this would be possible provided it met certain criteria:

- Flood defence wall to be visible through structure (no back) for inspection
- Top of food defence wall to be visible from above for inspection
- Structure to be water permeable and floodable
- Structure to be easily removable/demountable to allow repair work to the food defence wall

The image below shows the intent for the removable boathouse which has been designed to meet EA requirements. Refer to Stage 3 report for more details of this structure.

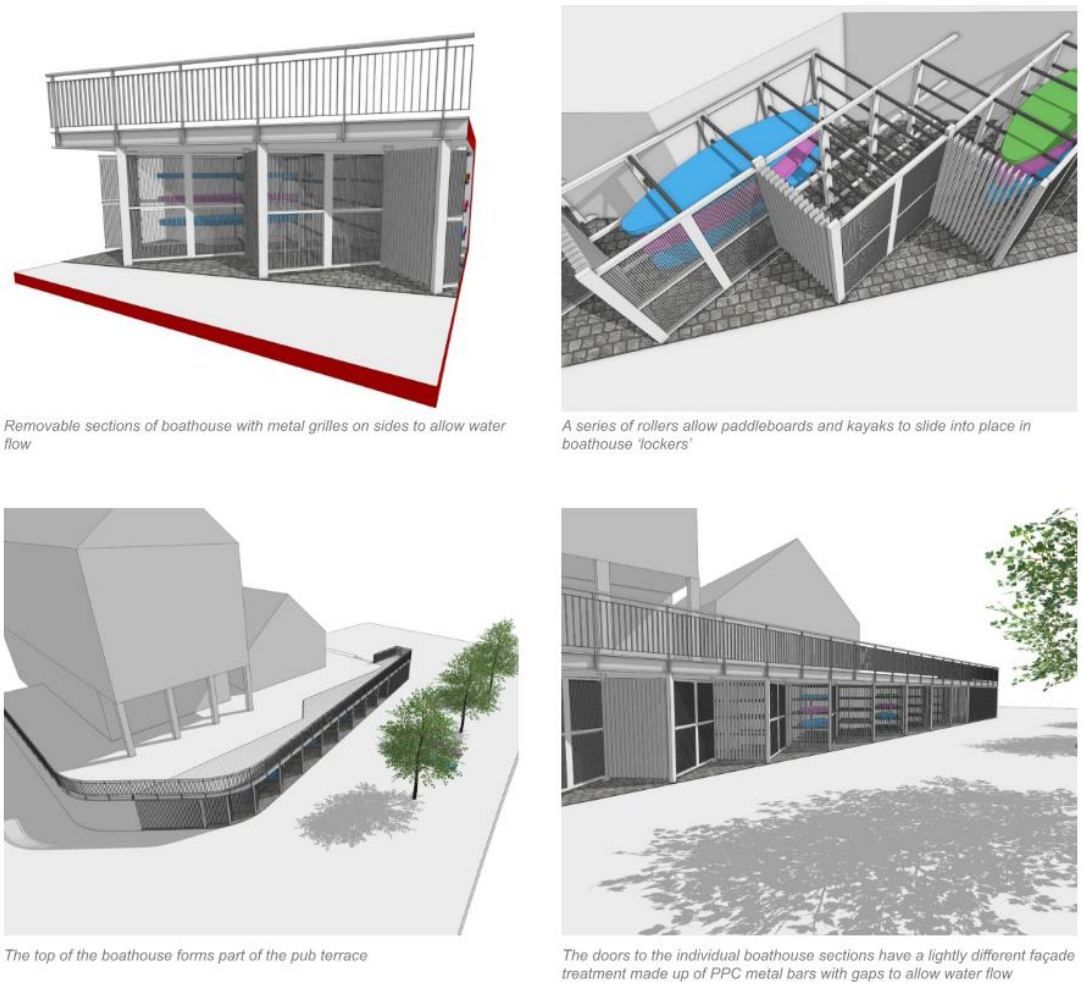


Figure 9. Proposed boathouse design.

A large area of open space has been provided in the centre of the site, this area is required to be above the 1 in 100-year rainfall event + 35% climate change as part of the project conditions.

The project also includes the removal of parking from The Embankment area and alteration to the existing retaining walls flood defence wall and landscaping. Refer to Appendix B for drawings of the proposed design.

4.1. Proposed Flood Defences

The proposed design shall remove the existing flood defence and provide new flood defence structures around the proposed development. The flood defence wall shall provide protection equal or greater than the TE2100 defence level of 6.90 m. The level of the proposed flood defence structure has been set to suit the proposed design 7.40 m, significantly greater than then minimum requirement of 6.90 m.

To ensure no increase in flood risk for the area, the new flood wall location and the proposed design has been assessed to confirm there is no loss of flood storage in a level for level volume assessment. The Stage 3 Flood Storage Assessment is included in Appendix B.

5. PLANNING POLICY AND GUIDANCE

5.1. National Planning Policy Framework and Planning Practice Guidance

The revised National Planning Policy Framework (NPPF), published in 2021, sets out the UK Government's planning policies for England, and how these are expected to be implemented. The Planning Practice Guidance (PPG) provides advice on how to account for and address the risks associated with flooding. It was first published in 2014 and is updated on a regular basis to meet the changes in the NPPF.

The NPPF aims to steer development away from areas at high risk of flooding. In order to achieve this, development types are classified according to vulnerability. The "Flood Risk and Coastal Change" chapter of the PPG details acceptable compatibility between Flood Zones and development types and is based on revised NPPF technical guidance (see tables below).

The NPPF states that a site-specific Flood Risk Assessment is required to identify and assess the risks of all forms of flooding to and from the development for all developments greater than 1.0 (ha) in Flood Zone. The Flood Zone definitions are provided in the "Flood risk and Coastal Change" chapter of the PPG, indicated below.

Table 2. Flood Zone definition

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).

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

Source: Planning Practice Guidance, Flood Risk and Coastal Change

Figure 10: Government Long term flood risk assessment for locations in England map showing Flood Zones [https://flood-map-for-planning.service.gov.uk/]

From the extract of the flood map in Figure 8 above one can see that the bottom half of the site lies within Flood Zone 3.

The "Flood Risk and Coastal Change" chapter of the PPG provides guidance on the suitable development types for each Flood Zone classification (see Table 3).

Table 3. Flood Risk Vulnerability and Flood Zone Compatibility

Flood risk vulnerability classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	×	Exception Test Required	✓
Zone 3b "Functional Floodplain"	Exception Test Required	✓	×	×	×

Key *✓Exception test is not required.* *×Development should not be permitted.*

Source: Planning Practice Guidance, Flood Risk and Coastal Change

The proposed design includes a variety of development types. The risk vulnerability classification of each development type, in accordance with "Flood Risk and Coastal Change" chapter of the PPG, is summarised in Table 4 below.

Table 4 Site specific Flood Risk Vulnerability

Development Type	Flood risk vulnerability classification
Basement/Plant room	Highly Vulnerable
Residential	More Vulnerable
Pub	
Café	Less Vulnerable
Commercial/Retail	
Workspace	
Boathouse	Water compatible

5.1.1. National Planning Policy Framework steps in assessing Flood Risk

The National Planning Policy Framework sets out strict tests to protect people and property from flooding which all local planning authorities are expected to follow. Where an assessment shows that flood risk is something that needs to be considered the main steps to be followed in addressing flood risk are set out below (as per paragraph 004 of the Flood Risk and costal change https://www.gov.uk/guidance/flood-risk-and-coastal-change#contents)

Avoid

- In plan-making, a sequential approach should be employed. This involves applying the 'Sequential Test' and, if needed, the 'Exception Test'.
- In decision-making, where necessary, planning authorities also apply the Sequential Test and, if needed, the Exception Test, to ensure that flood risk is minimised and appropriately addressed.
- Where the sequential and the exception tests have been applied as necessary and not met, development should not be allowed.
- Substitute lower vulnerability uses for higher vulnerability uses.
- Within sites, using site layout to locate the most vulnerable aspects of development in areas of lowest flood risk, unless there are overriding reasons to prefer a different location. In addition, measures to avoid flood risk vertically can then be taken, by locating the most vulnerable uses on upper storeys, and by raising finished floor and/or ground levels, where appropriate and that such techniques are suitably designed. Such measures should also account for residual flood risks from flood risk management infrastructure.

Control

- Planning authorities and developers can investigate measures to control the risk of flooding affecting the site. Early discussions with relevant flood risk management authorities, reference to Strategic Flood Risk Assessments and any programme of flood and coastal erosion risk management schemes will help to identify such opportunities.

Mitigate

- Use flood resistance and resilience measures to address any residual risks remaining after the use of the avoidance and control measures described above. Passive measures should be prioritised over active measures as they are likely to be more effective and more reliable.

Manage residual risk

- Consider further management measures to deal with any residual risk remaining after avoidance, control and mitigation have been utilised. Provide safe access and escape routes.
- Consider whether adequate flood warning would be available to people using the development. Residual risks will need to be safely managed to ensure people are not exposed to hazardous flooding

5.2. The London Plan (2021)

Under the legislation establishing the Greater London Authority (GLA), the Mayor is required to publish a Spatial Development Strategy (SDS) and keep it under review. The SDS is known as the London Plan. As the overall strategic plan for London, it sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20-25 years.

Policy SI 12 Flood risk management states:

A. Current and expected flood risk from all sources (as defined in paragraph 9.2.12) across London should be managed in a sustainable and cost-effective way in collaboration with the Environment Agency, the Lead Local Flood Authorities, developers and infrastructure providers.

B. Development Plans should use the Mayor's Regional Flood Risk Appraisal and their Strategic Flood Risk Assessment as well as Local Flood Risk Management Strategies, where necessary, to identify areas where particular and cumulative flood risk issues exist and develop actions and policy approaches aimed at reducing these risks. Boroughs should cooperate and jointly address cross-boundary flood risk issues including with authorities outside London.

C. Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.

D. Developments Plans and development proposals should contribute to the delivery of the measures set out in Thames Estuary 2100 Plan. The Mayor will work with the Environment Agency and relevant local planning authorities, including authorities outside London, to safeguard an appropriate location for a new Thames Barrier.

E. Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.

F. Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading. Unless exceptional circumstances are demonstrated for not doing so, development proposals should be set back from flood defences to allow for any foreseeable future maintenance and upgrades in a sustainable and cost-effective way.

G. Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

Policy SI 13 Sustainable drainage states:

A. Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.

B. Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

    a. rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)

    b. rainwater infiltration to ground at or close to source

    c. rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)

d. rainwater discharge direct to a watercourse (unless not appropriate)

e. controlled rainwater discharge to a surface water sewer or drain

f. controlled rainwater discharge to a combined sewer.

C. Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

D. Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation.

5.3. London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA), 2021

The purpose of this Level 1 Strategic Flood Risk Assessment (SFRA) is to deliver the planning and flood risk requirements as defined by the National Planning Policy Framework (NPPF). This SFRA supersedes the 2016 SFRA, enabling Richmond upon Thames to be compliant with the latest policy requirements and utilise the latest data to better assess flood risk.

5.4. London Borough of Richmond Upon Thames Local Plan

The London Borough of Richmond upon Thames (LBRT) Local Plan was adopted in July 2018. The Local Plan sets out policies and guidance for development in the borough over the next 15 years and replaces previous policies within the Core Strategy and Development Management Plan.

Policy LP21 of the Local Plan deals with Flood Risk and Sustainable Drainage. This policy states:

A. All developments should avoid, or minimise, contributing to all sources of flooding, including fluvial, tidal, surface water, groundwater and flooding from sewers, taking account of climate change and without increasing flood risk elsewhere. Development will be guided to areas of lower risk by applying the 'Sequential Test' as set out in national policy guidance, and where necessary, the 'Exception Test' will be applied. Unacceptable developments and land uses will be refused in line with national policy and guidance, the Council's Strategic Flood Risk Assessment (SFRA) and as outlined in the table below.

In Flood Zones 2 and 3, all proposals on sites of 10 dwellings or more or 1000sqm of non-residential development or more, or on any other proposal where safe access/egress cannot be achieved, a Flood Emergency Plan must be submitted.

Where a Flood Risk Assessment is required, on-site attenuation to alleviate fluvial and/or surface water flooding over and above the Environment Agency's floodplain compensation is required where feasible.

Zone	Land uses and developments – restrictions	Sequential Test	Exception Test	Flood Risk Assessment
3b	The functional floodplain as identified in the Council's Strategic Flood Risk Assessment will be protected by not permitting any form of development on undeveloped sites unless it: • is for Water Compatible development. • is for essential utility infrastructure which has to be located in a flood risk area and no alternative locations are available and it can be demonstrated that the development would be safe, without increasing flood risk elsewhere and where possible would reduce flood risk overall. Redevelopment of existing developed sites will only be supported if there is no intensification of the land use and a net flood risk reduction is proposed; any restoration of the functional floodplain will be supported. Proposals for the change of use or conversion to a use with a higher vulnerability classification will not be permitted.	Required for essential utility infrastructure	Required for essential utility infrastructure	Required for all development proposals
3a	Land uses are restricted to Water Compatible, Less Vulnerable and More Vulnerable development. Highly Vulnerable developments will not be permitted. Self-contained residential basements and bedrooms at basement level will not be permitted.	Required for all developments unless exceptions outlined in the justification apply	Required for more vulnerable development	Required for all development proposals
2	No land use restrictions Self-contained residential basements and bedrooms at basement level will not be permitted.	Required for all developments unless exceptions outlined in the justification apply	Required for highly vulnerable development	Required for all development proposals unless for change of use from water compatible to less vulnerable
1	No land use restrictions	Not applicable	Not applicable	A Drainage Statement is required for sites all major developments. Required for all other development proposals where there is evidence of a risk from other sources of flooding, including surface water, ground water and sewer flooding.

B. Basements within flood affected areas of the borough represent a particularly high risk to life, as they may be subject to very rapid inundation. Applicants will have to demonstrate that their proposal complies with the following:

Flood Zone 3b (Functional Floodplain)	Basements, basement extensions, conversions of basements to a higher vulnerability classification or self-contained units will not be permitted
Flood Zone 3a (Tidal / Fluvial)	In areas of Extreme, Significant and Moderate Breach Hazard (as set out in the Council's SFRA): New basements: • restricted to Less Vulnerable / Water Compatible use only. • 'More Vulnerable' uses will only be considered if a site-specific Flood Risk Assessment demonstrates that the risk to life can be managed. Bedrooms at basement levels will not be permitted. • 'Highly Vulnerable' such as self-contained basements/bedrooms use will not be permitted. Existing basements: • No basement extensions, conversions or additions for 'Highly Vulnerable' uses. • 'More Vulnerable' uses will only be considered if a site-specific Flood Risk Assessment demonstrates that the risk to life can be managed. In areas of Low or No Breach Hazard (as set out in the Council's SFRA): • New basements: if the Exception Test (where applicable) is passed, basements may be permitted for residential use where they are not self-contained or used for bedrooms. • Existing basements: basement extensions, conversions or additions may be permitted for existing developments where they are not self-contained or used for bedrooms. If a basement, basement extension or conversion is acceptable in principle in terms of its location, it must have internal access to a higher floor and flood resistant and resilient design techniques must be adopted.
Flood Zone 2	In areas of Extreme, Significant and Moderate Breach Hazard (as set out in the Council's SFRA): • New Basements: if the Exception Test (where applicable) is passed, basements may be permitted for residential use where they are not self-contained or used for bedrooms. • Existing Basements: basement extensions, conversions or additions maybe permitted for existing developments where they are not self-contained or used for bedrooms. If a basement, basement extension or conversion is acceptable in principle in terms of its location, it must have internal access to a higher floor and flood resistant and resilient design techniques must be adopted.
Flood Zone 1	No restrictions on new or extensions to existing basements

C. The Council will require the use of Sustainable Drainage Systems (SuDS) in all development proposals. Applicants will have to demonstrate that their proposal complies with the following:

   a. A reduction in surface water discharge to greenfield run-off rates wherever feasible.

   b. Where greenfield run-off rates are not feasible, this will need to be demonstrated by the applicant, and in such instances, the minimum requirement is to achieve at least a 50% attenuation of the site's surface water runoff at peak times based on the levels existing prior to the development

D. Applicants will have to demonstrate that their proposal complies with the following:

   a. Retain the effectiveness, stability and integrity of flood defences, riverbanks and other formal and informal flood defence infrastructure.

   b. Ensure the proposal does not prevent essential maintenance and upgrading to be carried out in the future.

c. Set back developments from riverbanks and existing flood defence infrastructure where possible (16 metres for the tidal Thames and 8 metres for other rivers).

d. Take into account the requirements of the Thames Estuary 2100 Plan and the River Thames Scheme, and demonstrate how the current and future requirements for flood defences have been incorporated into the development.

e. The removal of formal or informal flood defences is not acceptable unless this is part of an agreed flood risk management strategy by the Environment Agency

5.5. Thames Estuary 2100 (TE2100)

The TE2100 plan is the overarching flood management strategy for the Thames Estuary and therefore any development planning should be based on the same underlying data.

The TE2100 in-channel levels take into account operation of the Thames Barrier when considering future levels.

In west London there is a heavy influence from upriver flows (fluvial flows). The flood defences are built to manage tidal flood risk only. With very high fluvial flows, the river levels in west London could be above the 0.1% annual probability tidal level.

The climate change levels are assessed to determine the future tidal defence levels. For this reason, they only account for extreme tidal events and not extreme fluvial flow events.

The EA Product 4 data shows that the closest node to the site is 2.3. The present-day water level at this node is 5.8 m AOD and future water level, in 2100, is 6.42 m AOD. New development should either include future defence raising or demonstrate that future raising will be feasible to a level of 6.90 m AOD.

6. SURFACE WATER DRAINAGE STRATEGY

6.1. Design Assumptions, Constraints and Parameters

This section outlines the engineering principles and design criteria which have been followed to produce the proposed design. These include British & European standards, codes of best practice and guidance which were used by Webb Yates Engineers during the design process.

6.1.1. Climate Change Effects

In accordance with the National Planning Policy Framework (NPPF), the effects of climate change are included within the assessment to reduce future flood risk. Following the recommended contingency allowances from the 19th February 2016, the following allowances should be made for the proposed development:

- Peak Rainfall Intensity: +40% (Upper End Allowance) for 2070 to 2115
- Peak Rainfall Intensity: +20% (Central Allowance) for 2070 to 2115

The new surface water drainage systems for the site will include SUDS and will be designed to accommodate increases in peak rainfall intensity.

6.1.2. Impermeable Areas

The table below compares the hardstanding areas for the proposed and existing developments.

Table 5. Table of Impermeable Areas

		Impervious Area		
Surface Description	PIMP (%)	Existing (m^2)	Proposed (m^2)	Difference (m^2)
Building roof	95%	1201	1993	+792
Green roof	95%	0	32	+32
Paving	50%	1219	975	-244
Soft landscaping areas	0%	0	0	0
Road and hardstand areas	90%	7628	6908	-720
Playground	50%	205	140	-65
Total		10253	10048	-205

6.1.3. Hydrological Parameters.

A MicroDrainage model was developed to assess the performance of the proposed drainage network using the hydrological parameters found in Table 7.

Table 6. Assumed Hydrological Parameters

Hydrological Character	Parameter	Unit	Value
Rainfall Model	-	-	FSR Rainfall*
	M5-60 (mm)		20.4
	Ration R		0.428
Summer Volumetric Run-off Coefficient	-	-	1.0
Winter Volumetric Run-off Coefficient	-	-	1.0

*FSR rainfall data was used as it is considered conservative when the critical storm duration is less than 60 minutes.

6.2. SuDS Hierarchy

The development of the site is in-line with the relevant policies of London Plan (refer to Section 4.2). The London Plan states that the development should utilise sustainable urban drainage systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the drainage hierarchy in Table 8

Table 7. SuDS hierarchy

	SuDS hierarchy	Constraints/ Opportunities
1	Store rainwater for later use	Water reuse is not proposed as part of the development. The financial viability of the project was considered along with the additional space and materials required for water reuse throughout the buildings.
2	Use infiltration techniques, such as porous surfaces in non-clay areas	Infiltration shall be used across the site. Soft landscaped areas have been increased by 547 m^2 from the existing condition. The paved areas of the site are also assumed to be 50% impervious with the other 50% of water lost to evaporation and infiltration. An attenuation tank is proposed for the site, located where the historic lido was located. The lido was buried with unknown materials. The tank has been sized assuming no infiltration is possible since attempts to collect borehole and infiltration rate data from this location has been unsuccessful due to buried obstructions assumed to be associated with the lido. However, infiltration tests shall be carried out at the base of the tank prior to installation to determine if infiltration at that level is possible.
3	Attenuate rainwater in ponds or open water features for gradual release.	37 m^2 of green roof is proposed for the Water Lane building. This option has not been considered viable for the site at ground level since open space at low level on the embankment has been to maximised to provide flood storage within Flood Zone 3b. Areas within Flood Zone 3b are freely draining to ensure flood waters can flow freely across the site. This also ensures no ponded water at the time of a flood event to maximise available storage.

	SuDS hierarchy	Constraints/ Opportunities
4	Attenuate rainwater by storing in tanks or sealed water features for gradual release.	Two cellular attenuation tanks are proposed for the upper area of the site. This shall attenuate flow to 10 l/s prior to discharge into the existing Thames Water Sewer. The catchment for this area shall be the roof of both building and any landscaped areas with either trapped low points or are unable to safely drain directly to the Thames River. Please see the Webb Yates drainage drawing J3932-C-DR-0100 for more details
5	Discharge rainwater direct to watercourse.	Runoff from areas of Wharf Lane, Water Lane, and The Embankment within Flood Zone 3b shall drain via gravity to the river edge. This is consistent with the existing condition. Areas of paving and which grade towards the river shall also discharge directly into the River Thames.
6	Discharge rainwater to a surface water sewer/drain.	Attenuated rainwater from the proposed buildings shall be discharged into an existing surface water sewer.
7	Discharge rainwater to the combined sewer.	There is no proposed discharge of surface water into a combined sewer.

6.3. Greenfield Runoff

The total catchment area of the site is approximately 1.34 ha. The Greenfield runoff rate was calculated using UKSUDS.com tool, a summary is in Table 8. Full UKSUDS output is included in Appendix D.

Table 8. Greenfield Runoff Rates

Storm Event	Greenfield runoff rates (l/s)
Q_{BAR}	2.04
1 in 1 year	1.73
1 in 30 year	4.68
1 in 100 year	6.49

6.4. Existing runoff rate

There are existing catchpits and gullies located within the Diamond Jubilee Park and the raised carpark. However, details of the connection points are unknown and therefore have conservatively been excluded from the peak runoff calculation. No flow control devices or existing attenuation infrastructure have been found on the site.

The calculation of the existing runoff, draining to the existing Thames Water surface water network, has been limited to the building roof area and assessed using MicroDrainage Source Control. The results of this assessment are summarised in Table 9.

6.5. Proposed Development

The proposed drainage strategy is shown in the drawing in Appendix B.

The conveyance network is designed to prevent flooding in the 1 in 100 year event plus allowance for 40% climate change.

The results of the MicroDrainage assessment are shown outlined in the table below to compare the existing and proposed runoff rates to the existing Thames Water network.

Table 9. Surface water design performance

	Existing	**Proposed**	**Change is flow rate**
1:1 yr Max outflow (l/s)	21.7	8.1	**63%**
1:30 yr Max outflow (l/s)	47.3	10.0	**79%**
1:100 yr + 40%CC Max outflow (l/s)	61.3	10.0	**84%**
Maximum flooding 1: 100 yr + 40%CC	NA	0(m^3)	

The MicroDrainage results are included in Appendix E. The existing runoff calculation is conservative as it does not allow for runoff from landscaped areas. The actual reduction in runoff rate is likely to be larger than those stated in the table above.

From the table above, the proposed design does not reduce the runoff rate into existing surface water network to greenfield runoff rates. However, the runoff rate is reduced by more than 50% which is in line with the requirements of LBRuT LP21 Policy requirements. The justification for not aiming for greenfield run-off rates is that the space available for sub-surface storage on the upper levels is constrained:

- by landscaping (e.g. tree pits and garden beds);
- by obstructions in the ground left over from previous site use i.e. a swimming pool and its associated infrastructure (confirmed by site investigations), these would pose a significant risk to project time and budget as the extent of obstructions is unknown;
- by the Flood Defence wall. No drainage structure or attenuation may be within 4 m of the back of the wall;
- by distance from the existing Thames Water connection since it is proposed to connect by gravity.

Based on the constraints of the site, the space feasibly available for surface water attenuation is very limited. Therefore, to find a balance between:

- feasibility,
- landscaping and planting, and,
- providing a significant betterment to the existing site runoff rate,

As a result a maximum flow rate slightly less than half the existing 1:1 year flow rate (10 l/s) is proposed which is in line with the requirements set out in the SFRA and the London Plan.

Runoff from the roadways which enters the existing Thames Water surface network is assumed to remain the same as the existing condition where gullies have been retained or reinstated. The Embankment and southern extents of Water Lane and Wharf Lane shall drain directly into the River Thames. This shall prevent flood waters entering the surface water network via road gullies during fluvial or tidal flooding from the River Thames. Therefore, the runoff rate from roadways into the existing Thames Water network has been reduced from the existing condition.

The remainder of the site shall drain via infiltration or by overland flow directly into the River Thames. This is in accordance with the Non-Statutory Technical Standards for Sustainable Drainage Systems S1 requirement which identifies that:

"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."

6.5.1. Exceedance Flow

If the storage within the below ground proprietary 'crate' system was to be exceeded and flooding was to occur, water would follow topographic gradients and flow southwards down onto The Embankment and into the Thames River as shown in Figure 11.

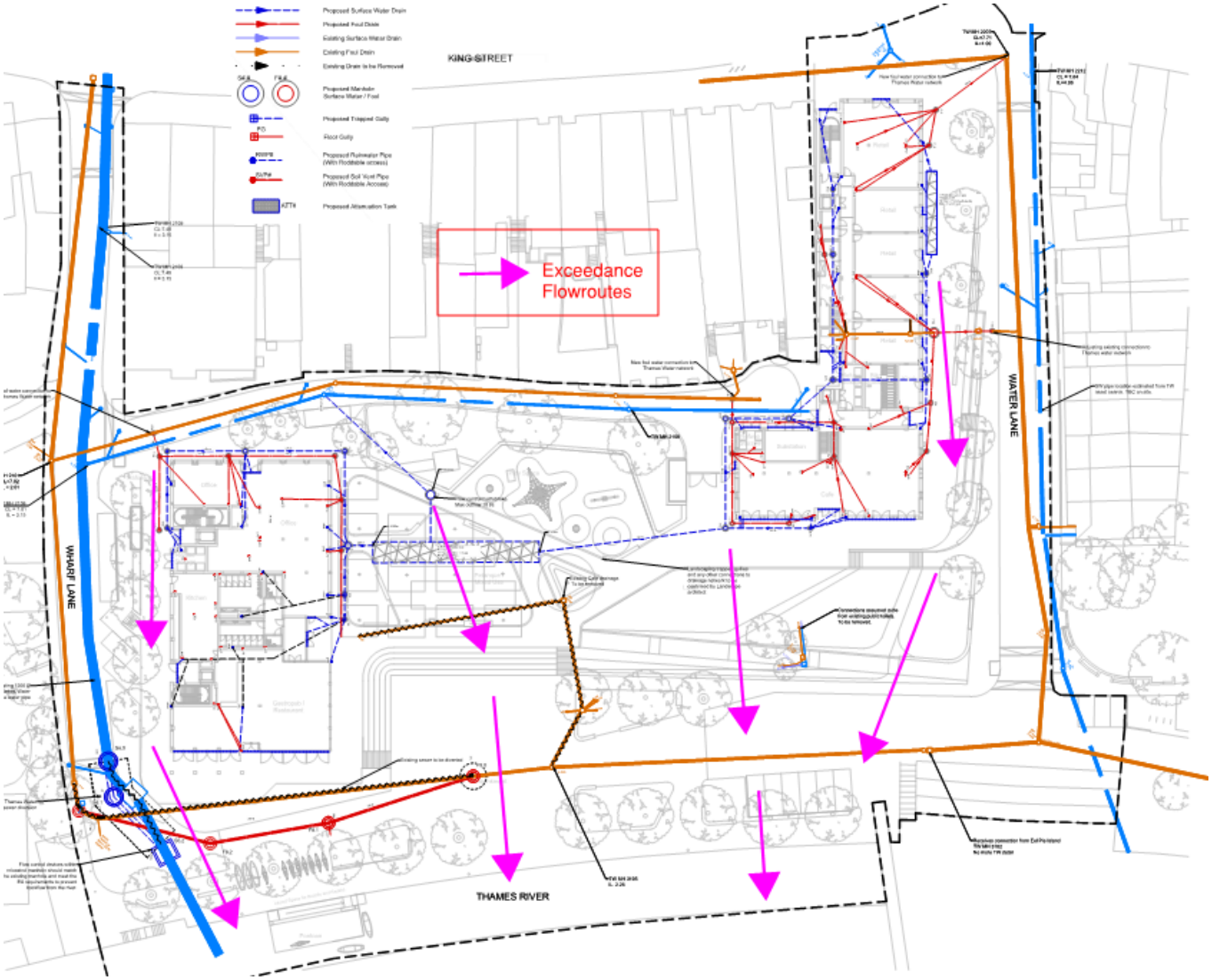


Figure 11: Exceedance flow paths

6.6. Water Quality

The proposed design removes an existing carpark from Water Lane and reduces vehicle movement along the embankment from the existing condition. This will significantly reduce pollution from vehicle movements which may be washed into the adjacent River Thames. The Embankment is in Flood Zone 3 and therefore is unsuitable for installation of oil interceptors.

Garden beds are proposed along The Embankment and Wharf lane which provide some filtration of site runoff prior to discharge into the river. Catch pits upstream of the proposed attenuation tank will remove particulates from the proposed roof runoff.

6.7. Foul Water Drainage

It is proposed to keep the new above ground foul drainage runs separate from the surface water drainage and connect into the existing Thames Water foul network. Thames Water has confirmed their foul drainage network has capacity for the proposed development to be connected to the network, refer to Appendix F for correspondence from Thames Water.

During the next design stage Thames Water shall be contacted to coordinate connection points and diversion approvals. Appendix B contains the Below Ground Drainage Layouts for the proposed site.

7. MAINTENANCE

The drainage system will be designed to minimise maintenance requirements; however, a full maintenance scheme will be established for those elements not being offered for adoption and they will be maintained by the Freeholder. The maintenance program will be based on the manufacturer's recommendations as well as the recommended maintenance schedule stated in the SuDS manual as part of their property maintenance program. A typical maintenance program for each item has been provided below however as some of these items are Contractors Design Portion items the full maintenance programs for them cannot be established at this stage until the specification and design of these items has been finalized.

7.1.1. Below Ground Drainage Piped Systems

The below ground piped system (based on assessed flood risk) should be inspected every 10 years as a minimum and repaired and cleansed where necessary.

7.1.2. Sewage Treatment Plants

This will be maintained as per the manufacturer's requirements.

7.1.3. Permeable Pavement

The pervious pavement should be inspected annually, particularly for silt accumulation, to establish brushing frequencies. During the first 6 months after installation the pavement should be inspected, for evidence of poor operation, within 48 hours of each major storm. Additional maintenance shall be as per the manufacturer's requirements.

7.1.4. Surface water and foul pumps

These will be maintained as per the manufacturer's requirements.

7.1.5. Green Roof

These will be maintained as per the manufacturer's requirements.

7.1.6. Flood Defence Structure

The flood defence structure shall be maintained by the Environment Agency in accordance with their inspection and repair requirements. The design ensures that access is available for inspection of the structure in accordance with the EA requirements.

7.1.7. Boathouse

The boathouse has been designed to have all elements be removable and to allow water to flow through during flood events. After every flood event the boathouse should be inspected, and any debris or silt removed.

7.1.8. Attenuation Storage tanks

Inspection and maintenance shall be in line with the SuDS manual.

Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	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

8. POTENTIAL SOURCES OF FLOODING

8.1. Flooding from Sea and Rivers

8.1.1. Climate change

In accordance with the NPPF guidance, the effects of climate change should be included within the assessment of future flood risk. Peak river flow allowances show the anticipated changes to peak flow by river basin district. The table below is an extract of the NPPF peak river flow climate change allowances for the River Thames basin within the London area.

Table 10. London Management Catchment peak River flow allowances (https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow)

	Central	Higher	Upper
2020s	10%	14%	26%
2050s	7%	14%	30%
2080s	17%	27%	54%

This map contains information generated by UK Centre for Ecology and Hydrology using UK Climate projections.

To determine which allowance category to apply, it is necessary to consider the Flood Zone and the flood vulnerability risk classification. From the PPG it was assessed that the following climate change allowances are appropriate:

1. highly vulnerable – use higher central and upper end allowances to assess a range of allowances – 27% - 54%
2. more vulnerable – use the higher central and upper end allowances to assess a range of allowances - 27% - 54%
3. less vulnerable – use the higher central allowances - 27%
4. water compatible – use the central allowance – 17%

The proposed Diamond Jubilee Park area is required to have a 35% climate change allowance applied as part of the project conditions.

8.1.2. Existing flood risk

Fluvial and tidal flooding occurs when the capacity of a watercourse is exceeded such that water overtops the channel. The risk of flooding from rivers or seas is classified as **High**, based on Figure 12.

The EA's modelled floodplain map shows that part of the site is within Flood Zone 3. Therefore, it is at risk of flooding from the River Thames. Land in Flood Zone 3 is assessed as having annual probability of fluvial flooding greater than 1% or tidal flooding greater than 0.5% and comprises of land utilise for flow and storage in times of flood.

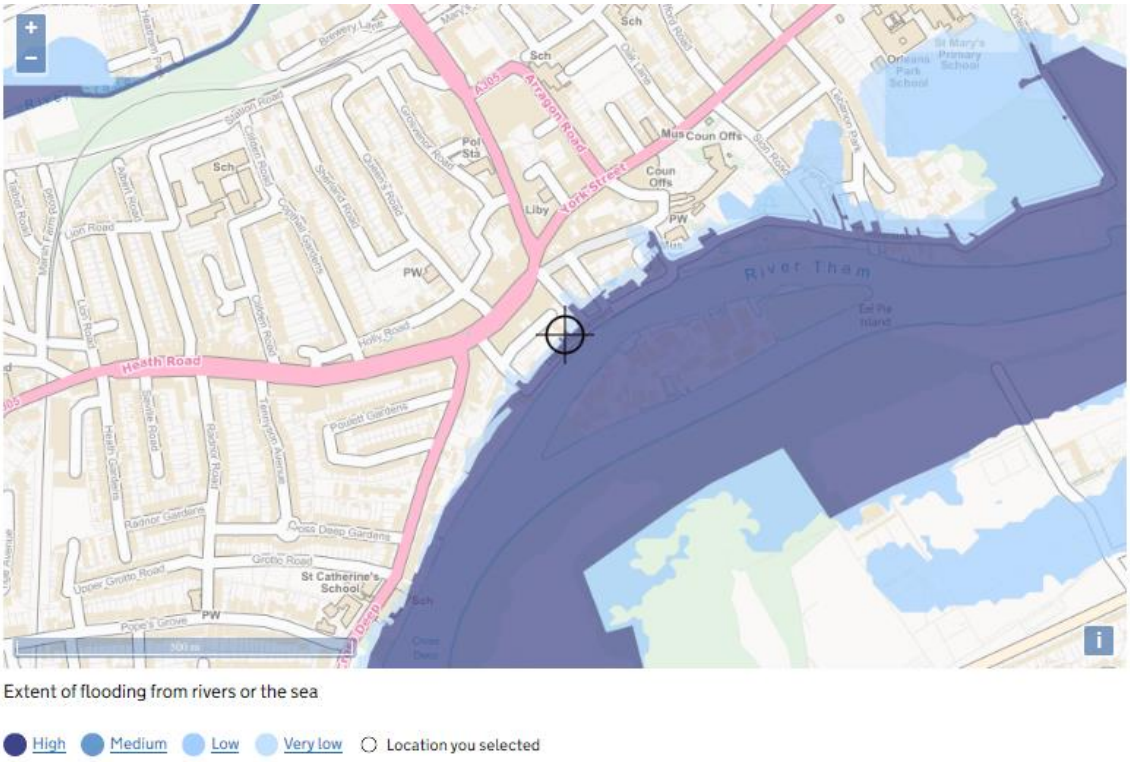


Figure 12: EA Online Flood Map from Sea and Rivers (Source: https://flood-map-for-planning.service.gov.uk).

The tidal flood risk was provided by the EA with the product 4 information. The TE2100 flood level is 6.45 m and the TE2100 flood defence level is 6.90 m AOD.

Product 7 fluvial flood information was provided by the EA which identified that the maximum flood level for the site in a 1 in 100-year event + 35% allowance for climate change was 6.94 m AOD.

8.2. Flooding from groundwater

The Site Investigation report notes that the Envirocheck data indicates the site is not in an area with potential for groundwater flooding to occur.

A perched groundwater table is anticipated to be present within the Kempton Park Gravels based on the groundwater monitoring data at around 2.6 m OD. The site and the general surrounding areas are relatively flat. The site has an external elevation of approximately +7.0 m OD that is at a higher elevation approximately 2 m higher than the surrounding street level.

Furthermore, the SFRA shows that the site is not situated in an area susceptible to groundwater flooding. The "Area Susceptible To Groundwater Flood © Environment Agency" data does identify the area as at risk of groundwater flooding, however, this data is very coarse and therefore highly inaccurate.The data "Susceptibility to Groundwater Flooding Version 6 © British Geological Survey" is based on smaller assessment grid and therefore is more reliable for the proposed site. The risk of flooding from groundwater is considered **Low.**

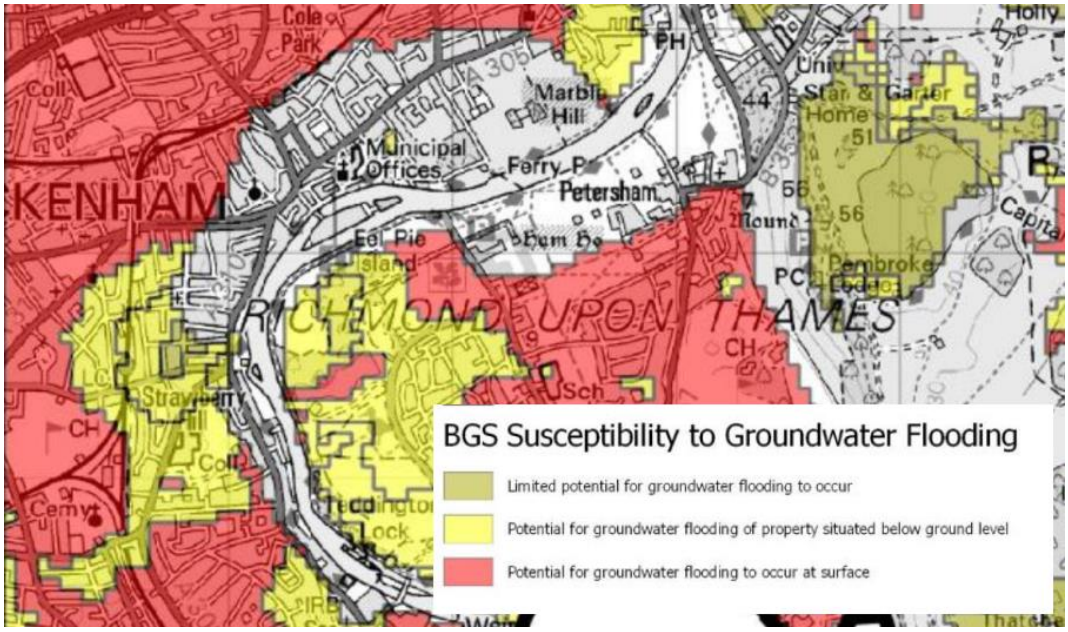


Figure 13: BGS Susceptibility to Groundwater Flooding.

According to the LBRuT SFRA maps, the site is located in a Throughflow Catchment Area. The LRBuT SFRA requires a screening assessment is carried out as part of the planning application submission for all basement and cellar proposals within the throughflow and groundwater policy zones. A Basement Impact Assessment has been completed as part of this design. Refer to 'Twickenham Riverside TW1 3SD- Basement Impact Assessment *(1829-A2S-XX-XX-RP-Y-0001-00)* for full details.

8.3. Flooding from Sewers

The LBRuT SFRA identified zero sewer flooding incidents at the proposed site. An extract from the SFRA Sewer Flooding map is below in Figure 14. Therefore, the risk of flooding from sewer is considered **Low.**

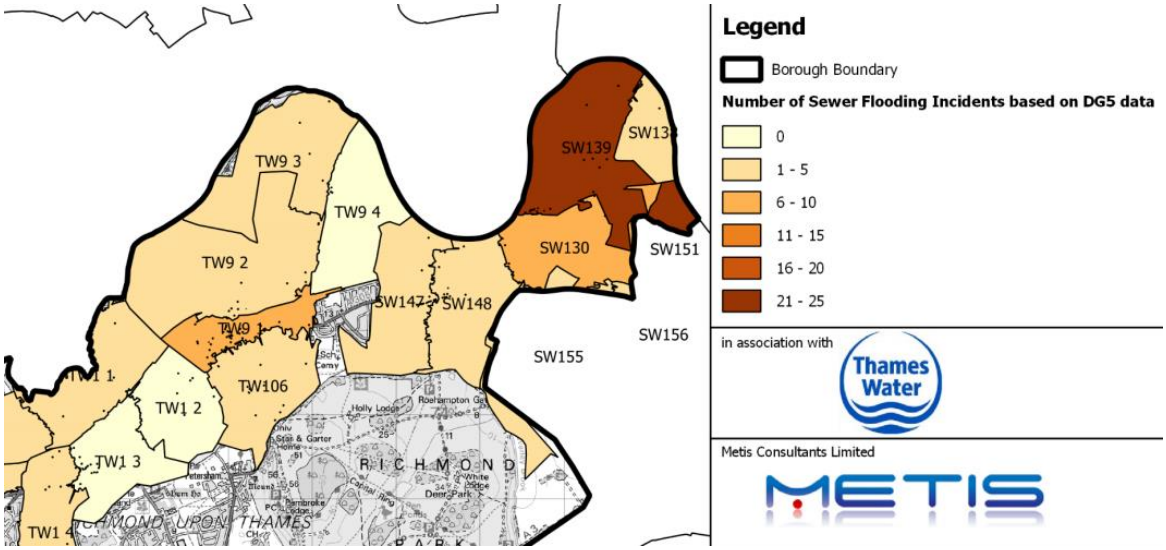


Figure 14: Sewer Flooding Incidents Map (LBRuT SFRA Extract)

8.4. Flooding from Surface Water

8.4.1. Climate change

In accordance with the NPPF guidance, the effects of climate change should be included within the assessment of future flood risk. As the site area is less than 5 km^2, the site is classified as 'small' and therefore the climate change allowances in NPPF Technical Guidance Table 2 are appropriate. This table has been included below for reference.

Table 11. Table showing climate change allowances (Extract from NPPF Technical Guidance, Table 2)

Table 2: peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Based on these values the hydraulic drainage design for the proposed drainage network has been modelled for a range of rainfall intensities up to and including ones for a 1 in 100-year event plus 40% allowance for climate change.

8.4.2. Existing flood risk

Flooding from surface water maps provided by the Environment Agency have been used to assess the effects of flooding from pluvial effects. There are four levels of risk as defined by the Environment Agency:

- High – each year, the area has a chance of flooding of greater than 1 in 30 (3.3%)

- Medium – each year, the area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)
- Low – Each year, the area has a chance of flooding of less than 1 1000 (0.1%) and 1 in 100 (1%)
- Very low – each year, the area has a chance of flooding of less than 1 in 1000 (0.1%)

Figure 15: EA Online Surface Water Flood Map (Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map).

Figure 15 identifies that there is a **Low** risk of flooding on Water Lane and the majority of Wharf Lane with a tiny area of **Medium** to **High** Risk at the top part of Wharf Lane.

The proposed changes to Wharf Lane and Water Lane are not likely to change the risk of surface water flooding in these areas. Overflow and flood waters will continue to flow by gravity to the edge of The Embankment into the River Thames.

Surface water in Flood Zone 3b shall drain directly into the river. Surface water in the areas protected by the flood structures shall either infiltrate into the proposed soft landscaping, or be captured within a drainage network and attenuated prior to discharge into the existing Thames Water network which outfalls through the River Thames wall. Therefore, the risk of surface water flooding remains **Low** for Water Lane and the majority of Wharf Lane and **Very Low** for the area protected by the flood defence structures. Besides resurfacing and landscaping no further development is proposed in the tiny area of **Medium** to **High** Risk at the top part of Wharf Lane as the main development will be in the area of **Very Low** risk of surface water flooding.

8.5. Flooding from Reservoirs, Canals and Other Artificial Sources

The 'Risk of flooding from reservoirs' map, produced by the Environment Agency (Figure 13) indicates that there is a Negligible Risk of flooding from this source at the location of the Proposed Development buildings which will be protected by the elevated topography. There is some residual risk to the areas of the site within Flood Zone 3b however this is not increased from the existing condition. There are no other known sources of flood risk that would pose a risk to the development site.

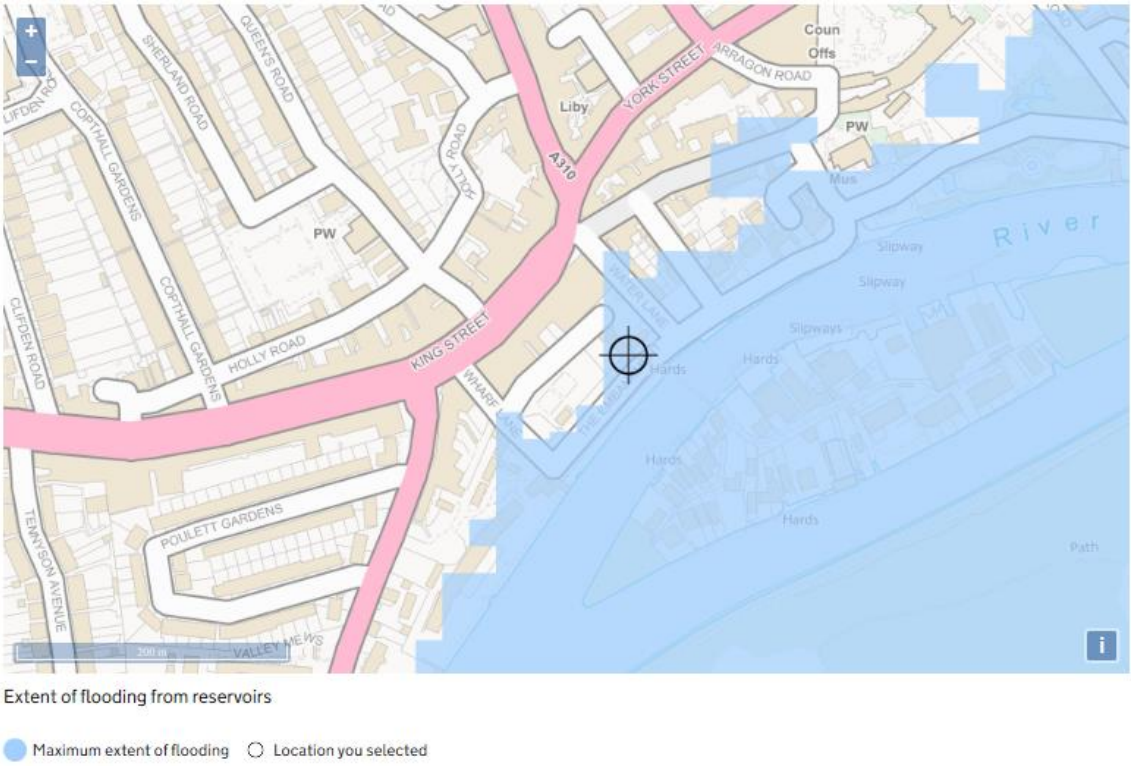


Figure 16: EA Online Flooding from Reservoirs Map (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map).

9. SEQUENTIAL AND EXCEPTIONS TEST

The NPPF requires that a sequential, risk-based approach to the location of development is taken to avoid, where possible, the risk of flooding to people and property and if required an exception test to show how flood risk will be managed on site and that the sustainability benefits of the development outweigh the flood risk. The approach needs to take both current and future impacts of climate change into account. The Sequential Test requires that proposed development sites are located within areas of lowest flood risk.

9.1. Site Sequential Test

The hatched area in Figure 17 shows the Twickenham Area Action Plan (TAAP) area 7, this area has previously passed the sequential test and as such any development which falls under this area would be deemed to have passed the sequential test. However, there is a small area of the Wharf Lane building which extends past the TAAP 7 extent and as such a sequential test would need to be carried out for the building which will need to assessed in its entirety and part of the site falls within Flood Zone 3.

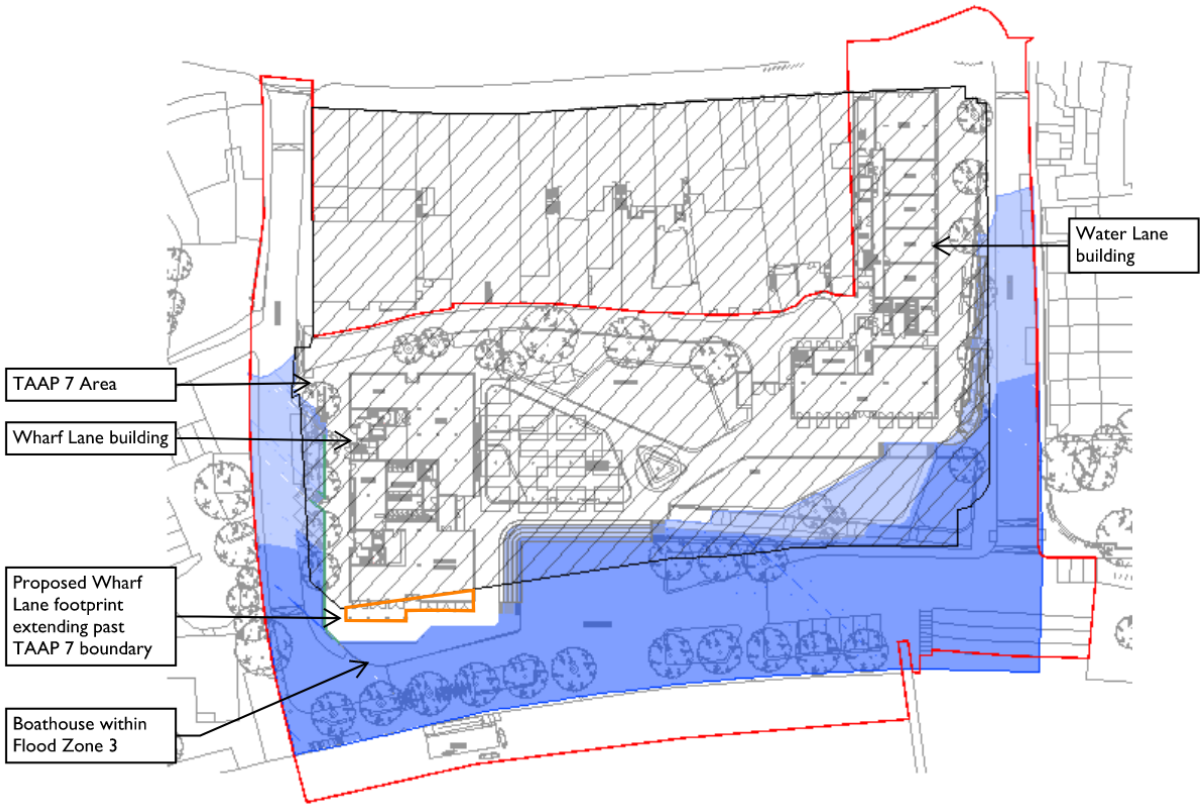


Figure 17. TAAP overlay

Below is a table summary of the flood risk vulnerability classification for the proposed Wharf Lane building uses which are subject to the sequential assessment.

Table 13 Site specific Flood Risk Vulnerability Classification for the Wharf Lane building uses being assessed as part of the sequential test.

Development Type	Flood risk vulnerability classification
Residential	More Vulnerable
Pub/Restaurant	
Office	Less Vulnerable

It has been agreed with Officers that the uses contained within the proposed Wharf Lane building should be disaggregated to provide as accurate a site search as possible. The uses therefore considered in the sequential test are:

- Residential;
- Office; and
- Pub/Restaurant

For the sequential test to be passed it will need to be demonstrated that no alternative sites are identified within the London Borough of Richmond upon Thames that are:

a. At lower risk of flooding;

b. Appropriate for the proposed development; and

c. Are 'reasonably available' for development. A site is only considered to be reasonably available if it is both 'deliverable' and 'developable' as defined by the NPPF.

The Glossary to the NPPF states;

"To be considered deliverable, sites for housing should be available now, offer a suitable location for development now, and be achievable with a realistic prospect that housing will be delivered on the site within five years."

"To be considered developable, sites should be in a suitable location for housing development with a reasonable prospect that they will be available and could be viably developed at the point envisaged."

For the full sequential test please refer to the Sequential Test and Exceptions Test for Twickenham Riverside undertaken by Savills

9.2. NPPF Paragraph 167

NPPF paragraph 167 states;

"*When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment* [55]*. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*

a) *within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*

b) *the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*

c) *it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*

d) *any residual risk can be safely managed; and*

e) *safe access and escape routes are included where appropriate, as part of an agreed emergency plan."*

9.2.1. Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

The scheme is composed of a number of interrelated elements that stem from the clients' aim to regenerate the area and create a new focal point for the town.

Central to this is the need to replace the existing Diamond Jubilee Gardens with a coherent piece of public open space that is open and accessible with views of the river with minimal overshadowing and located above the flood level. The ability for the Twickenham Riverside Trust and others to put on events was also considered to be an extremely important element of the proposals as they have a 125 year lease for the current gardens area so have a invested interest. Due to the restricted area available it has not been possible to locate this function above the flood level but the scheme proposes a new public square located at embankment level that has a direct relationship with the rest of the gardens so that it all feels part of the same space.

In order to help enliven and animate the space new retail, commercial and residential accommodation is proposed which is also helping to contribute to covering the cost of carrying out the development as well as providing much needed affordable housing. The Environment Agency require an offset from this accommodation to the flood defence structures that sit on the boundaries of the flood zones that has a significant impact on how things can be laid out.

Whilst it might be physically possible to reconfigure the buildings to fit within the TAAP 7 area it has not been possible to do so without detrimentally affecting a lot of the other elements and relationships between them that are so important to the scheme as highlighted above. Public space that is spread out in a strip around the building to meet the Environment Agency's offset requirements is not acceptable to the Trust as replacement for the Diamond Jubilee Gardens. Moving elements of the gardens down to embankment level would also put them into a flood zone, thereby affecting their availability for use compared to the current site and would create additional maintenance challenges by putting landscaping or pétanque areas within a flood zone.

It should be noted that the proposed design changes the topography of the site significantly including relocation of the flood defence wall which would have an impact on the flood zones across the site. Below is a table showing the current water levels for each of the flood zones which has been estimated using the EA Flood Zone Extent map and existing site levels.

Table 12 Site specific Flood Zone elevations

Flood Zone	Tidal flood level	Fluvial flood level	Critical flood level
Flood Zone 1	≥ 6.9 m	≥ 6.98* m	≥ 6.98* m
Flood Zone 2	5.8 m - 6.90 m	5.69 m – 6.94 m	5.8 m - 6.98* m
Flood Zone 3**	≤ 5.8 m	≤ 5.69 m	≤ 5.8 m

*Conservatively estimated from existing EA Flood Zone extent map. Flood Zone 2 appears to extend higher on both Water Lane and Wharf Lane in the proposed Flood Zones. This is not due to change in road levels but due to the maximum level for Flood Zone 2 being conservative estimate.

**LBRuT SFRA classifies the Flood Zone 3 area of the site as Flood Zone 3b Functional Floodplain.

Figure 17 below shows the extent of the Flood Zones following the proposed topography changes.

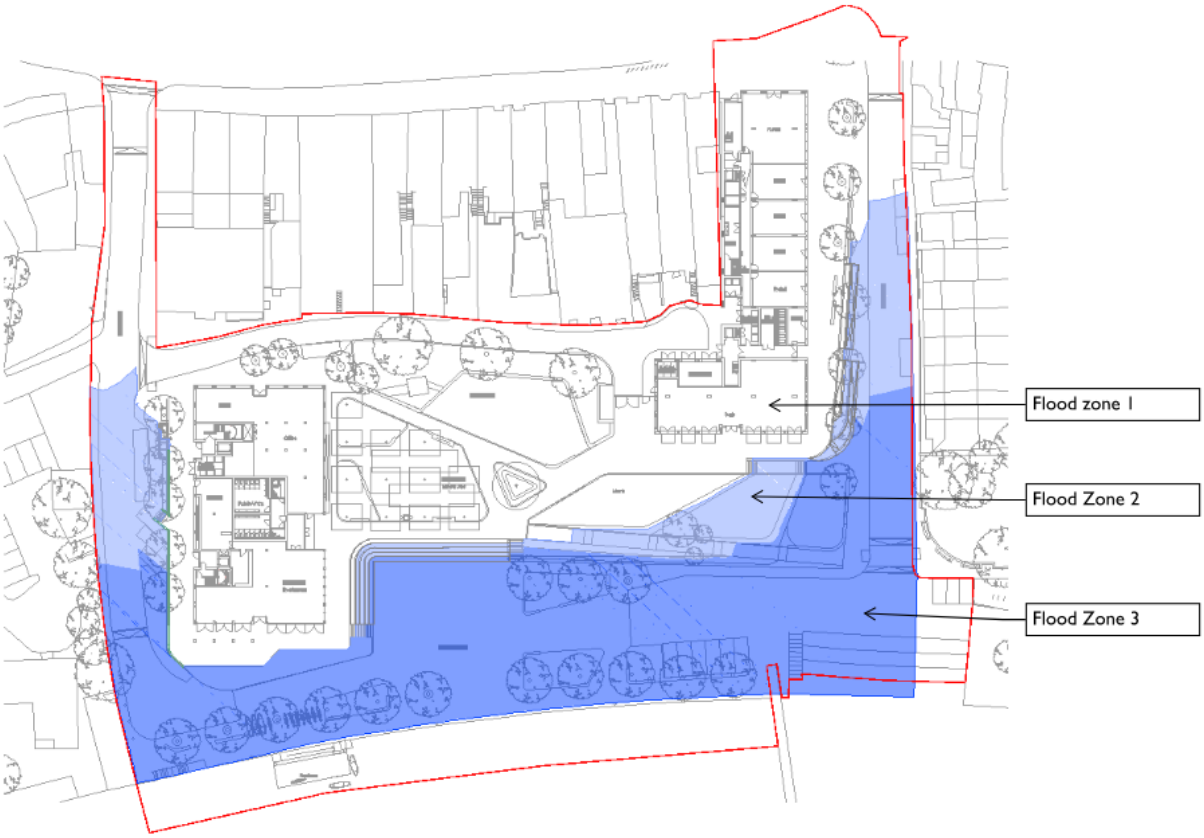


Figure 17: Flood Zone extents after proposed design changes

As one can see from above all the proposed Highly Vulnerable, More Vulnerable and Less Vulnerable development would be in Flood Zone 1 and the boathouse and landscaping would be within Flood Zone 3, which is considered Water Compatible development. The proposed development also must go hand in hand with the diversion of the flood defence wall and cannot be built without first diverting the flood defence wall.

The Proposed Development also results in no reduction in flood storage volumes, overall reducing flood risk by increasing the volume of storage within Flood Zone 3b. Refer to drawing J3932-C-DR-2000 Flood Storage Assessment (located in Appendix B) for full details.

9.2.2. The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

As stated in section 10.2 the majority of the new proposed development would be located above the fluvial flood level for the 1 in 100 year event + 35% climate change. This is greater than the minimum freeboard of 300 mm specified by the LBRuT SFRA and the boat house and landscaping which are located below this level are water compatible developments so would be brought back into use following a flood without any significant refurbishment.

9.2.3. It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

This has been outlined in section 6.

9.2.4. Any residual risk can be safely managed; and

Flood Risk Mitigations for the site are outlined in Section 10 below.

9.2.5. Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Safe access and escape routes are outlined in the Webb Yates Flood Emergency Plan. Refer to J3932-C-RP-0003.

10. FLOOD RISK MITIGATION MEASURES

The following flood risk mitigation measures shall continue to be developed as the design progresses.

10.1. EA Flood Warnings Direct Service Subscription

The site will subscribe to the EA Flood Warnings Direct Service which is a free service offered by the EA that provides flood warnings direct to people by telephone, mobile, email, SMS text message and fax. The EA aims to provide 2 hours' notice of flood warnings day or night which will allow timely evacuation of the site before the onset of flooding.

The agency operates a 24 hour telephone service on 0345 988 1188 that provides frequently updated flood warnings and associated floodplain information. In addition, this information can also be found at https://fwd.environment-agency.gov.uk/app/olr/home along with recommendations on what steps should be taken to prepare for floods, what to do when warnings are issued, and how best to cope with the aftermath of floods.

10.2. Location of Utility Services

The building will be located behind the new flood defence wall and all utility services such as fuse boxes, meters, main cables, gas pipes, phone lines and sockets will be positioned above the fluvial flood level for the 1 in 100 year event + 35% climate change. Central heating pipe work shall be easily accessible to allow easy maintenance in event of a possible flood.
Where this is not possible (such as lighting and any other power requirements for the lower landscaped areas and boathouse) best practice will be followed to ensure any cabling and fittings are water resistant and can easily be reinstated once the flood waters have subsided. Also, the main fuse boards for those mains are to be located above the fluvial level to ensure those circuits can be isolated and turned off easily during a flood event.

10.3. Flood Emergency Plan

A Flood Emergency Plan has been produced for the site in accordance with the LBRuT document: Guidance on Producing a Flood Emergency Plan – November 2011. Refer to J3932-C-RP-0003.

10.4. Freeboard

The proposed development ground floor level has an FFL of 7.4 m AOD which provides 0.5 m of freeboard above the TE2100 future defence level. This provides 0.46 m freeboard above the fluvial flood level for the 1 in 100 year event + 35% climate change. This is greater than the minimum freeboard of 300 mm specified by the LBRuT SFRA.

10.5. Building design – Resilience to flooding

Where it is not practicable to raise floor levels above the flood level, or to construct the building using resistant materials, the building should be constructed using materials that are not affected by water or are sacrificial. Paragraph 068 of the Flood Risk and Costal change guidance (https://www.gov.uk/guidance/flood-risk-and-coastal-change#para68) states;

"Flood resilience measures (also called recoverability measures, or wet-proofing), accept that water will enter the building, but through careful design and changes to the construction will minimise damage and allow faster cleaning, drying, repairing and re-occupancy of the building after a flood. Measures are preferably passive, such as the use of resilient building materials, or active such as moving sensitive equipment or belongings to upper floors when flooding is expected."

As the main buildings are to be located 0.46m above the fluvial level for the 1 in 100 year event plus 35% climate change this section is applicable to the proposed boathouse and the lower landscaping which will be constructed using materials that are not affected by water. Furthermore any services serving the boathouse will be located above the fluvial flood level for the 1 in 100 year event + 35% climate change which will allow these areas to be easily brought back into operation once the flood waters have subsided.

10.6. Building design – Resistance to flooding

Paragraph 068 of the Flood Risk and Costal change guidance (https://www.gov.uk/guidance/flood-risk-and-coastal-change#para68) states;

"Flood resistance measures, or dry-proofing, stops water entering a building up to a safe structural limit. Resistance measures can be passive, such as flood doors which are normally closed; or active, such as air brick covers or removable flood barriers. Flood resistant construction can prevent entry of water or minimise the amount that may enter a building where there is short duration flooding with water depth up to approximately 0.6 metres, depending on the building's characteristics".

As stated in section 10.5 as the main buildings are to be located 0.46m above the fluvial level for the 1 in 100 year event plus 35% climate change this section is only applicable to the boathouse and landscaping areas below the flood defence wall which have all been designed for flood resilience.

10.7. Flood Compensation

Loss of available floodplain storage due to changes to flood defence walls locations and landscaping can result in an increase in the risk of flooding elsewhere along the river and the EA will not accept an increase in flood risk off site. The flood storage volume has been assessed for the pre and post development surfaces to assess the impact on the flood storage, with a requirement that there is no net reduction in storage at any level.

The Proposed Development showed no reduction in flood storage volumes. Refer to drawing J3932-C-DR-2000 Flood Storage Assessment (located in Appendix B) for full details. As the design develops the flood storage assessment shall be adjusted to confirm that there is no reduction in flood storage from the existing condition.

10.8. Flood Risk Permit

A Flood Risk Activity Permit is required from the EA prior to construction and all works to the flood defence line will be in accordance with the EA's flood defence guidance and specifications.

The proposed flood defence strategy has been reviewed with the EA and the overall principles were viewed positively. Key elements of the strategy are as follow:

- Maintain an adequate offset between the flood defence wall and adjacent structures to allow for access to inspect, maintain and repair.
    - Typically, 4 m offset at on the high side of the proposed structure.
    - Typically, 8 m minimum offset at the base of the retaining structure.
- Ensure that there is potential for future extension / raising of the flood defence line
- Flood defence level set to the TE2100 level
- Ensure that the flood defences are independent of any other structure.
- Flood defence shall be suitable to withstand interaction with moving flood waters including the salinity of the sea water.

11. CONCLUSION

The site is partially within Flood Zone 3b and Flood Zone 1 and though most of the site falls under TAAP7 a sequential test for the site is required due to part of the Wharf lane building falling outside of that area. A sequential and Exceptions test has been undertaken by Savills as a result which the site passes.

On top of that the boathouse and new landscaping/public space is a community amenity which provides benefit to the wider community and the development will result in the delivery of new homes, affordable homes, employment space, animation of the river, as well as greening of the streetscape, resulting in biodiversity gain. It will also result in revitalisation and re-use of this town centre site, and this benefit is specific to the location of Twickenham Riverside and cannot be realised on a site elsewhere.

It should also be noted that the proposed development will change the topography of the site and result in the existing flood defence wall being diverted. As a result the flood zones for the developed site will be different to the existing site and when this is taken into account it can be demonstrated that the proposed development will be "water compatible" within Flood Zone 3b and all other proposed buildings would be located in Flood Zone 1 protected by the new flood defence structures.

This report assessed the risk of flooding from a variety of sources. A summary of these risks is included in the table below:

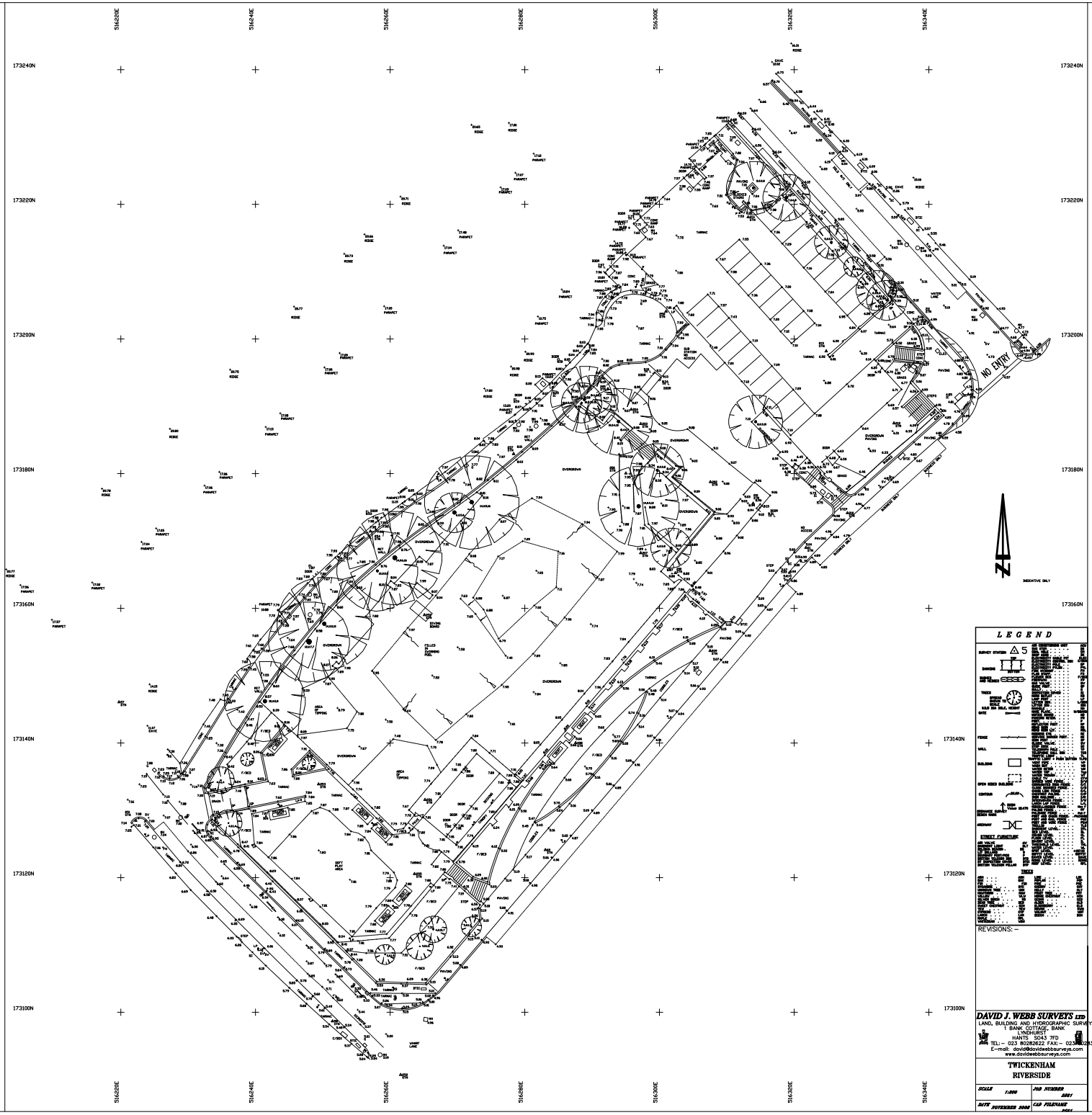
Table 13: Flood Risk Summary Table

Source of flooding	Risk summary and mitigations
Rivers and the Sea (Raised land FZ1)	Very Low risk of flooding including in a breach scenario.
Rivers and the Sea The Embankment and areas of the site lower than 6.94m	High Risk of flooding. Flood evacuation plan has been developed and only Water Compatible development is within the high risk area.
Groundwater	Based on the SFRA information and the Site Investigation report the risk of groundwater flooding is Low.
Sewers	Low risk based on historic data available in the SFRA.
Surface Water	Low risk of surface water flooding for Water Lane, Wharf Lane and The Embankment. Very Low risk of surface water flooding for the raised residential area of the site. The runoff rate to the surface water network has been reduced and new site attenuation is proposed. Therefore, the risk of surface water flooding has been reduced.
Reservoirs, Canals	There is some risk of flooding from reservoirs and canals, however this flood risk is contained to areas with Water Compatible infrastructure. The reminder of the proposed development is at a topographic level above this flood risk.

The proposed design includes the relocation of flood defence structures. In accordance with LBRuT and Environment Agency requirements the proposed flood defence structures have been designed to a level greater than the minimum prescribed by the TE2100 level. The design allows essential maintenance and upgrading to be carried out in the future.

The EA has been consulted regarding minimum offset from the flood defence structures and the river wall in accordance with LBRuT SFRA. This design will still require final approval by the EA. To ensure that there is no increase in risk of flooding to the adjacent areas, a flood storage capacity check has been undertaken. The Proposed Development provides the required level for level storage to prevent an increase to the site flood risk.

12. APPENDIX A TOPOGRAPHIC SURVEY



LEGEND

REVISIONS: –

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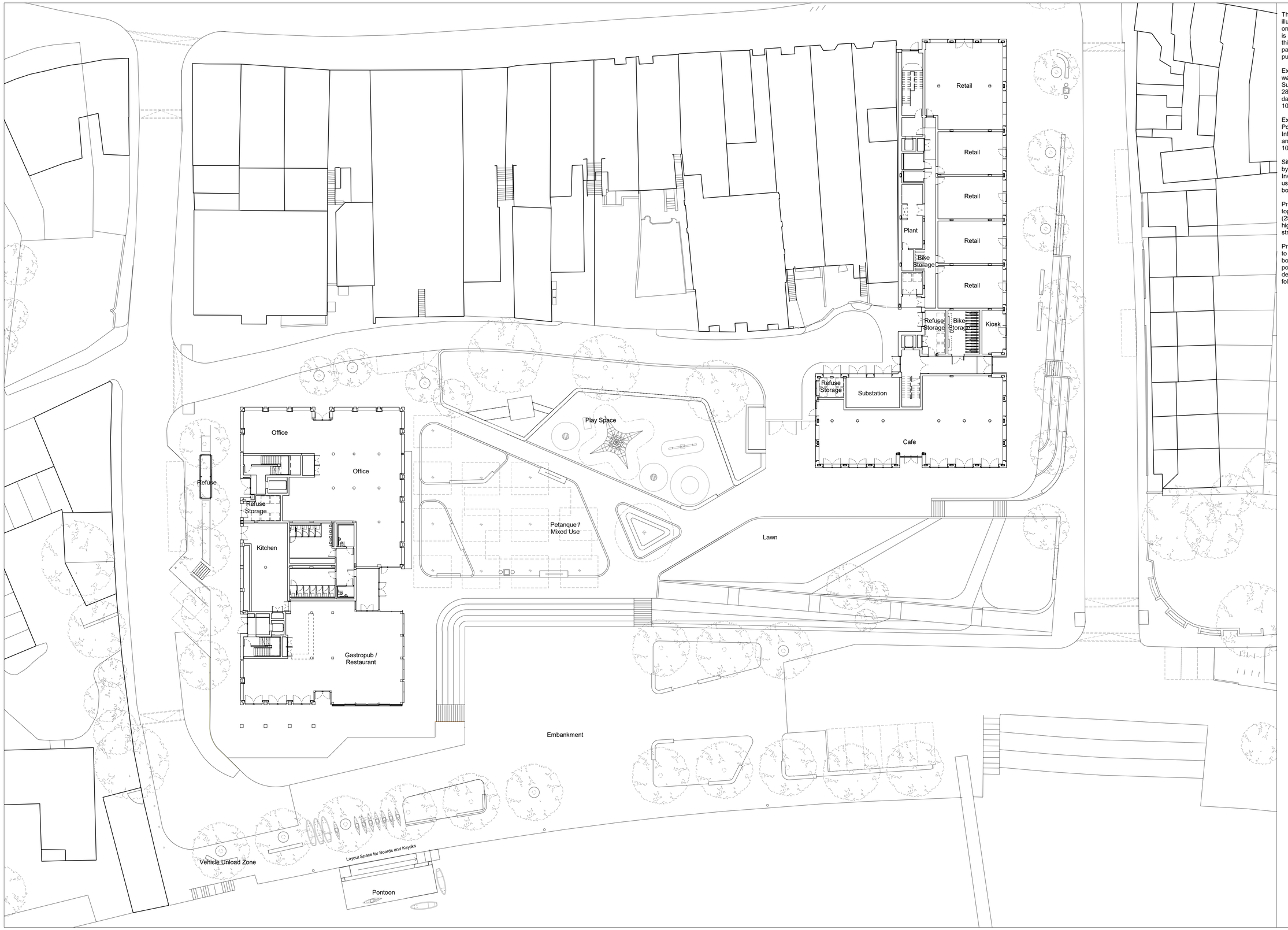
TWICKENHAM
RIVERSIDE

SCALE	1:200	JOB NUMBER	5001
DATE	NOVEMBER 2008	CAD FILENAME	5001

13. APPENDIX B PROPOSED DESIGN DRAWINGS



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Date	Rev.	Description	Approved By
08/02/2021	P14	M055 - Issue to Arcadis	MB
17/02/2021	P15	M061 - Issue to Planners	MB
19/02/2021	P16	M062 - Issue to Design Team	MB
26/02/2021	P17	M064 - Issue to Arcadis	MB
19/03/2021	P18	M075 - Issue to Design Team	MB
25/03/2021	P19	M079 - Issue to Design Team	MB
06/05/2021	P20	M095 - Issue to Consultants for Background	MB
14/05/2021	P21	M103 - Issue to LDA	MB
21/05/2021	P22	M107 - Stage 3 Draft Issue	MB

Date	Rev.	Description	Approved By
27/05/2021	P23	M110 - Issue to WSP	MB
28/05/2021	P24	M115 - Issue to Design Team and Building Control	MB
08/06/2021	P25	M123 - Issue to Arcadis	MB
07/07/2021	P26	M144 - Stage 3 Issue	MB
13/09/2021	P27	M175 - Issue to Design Team	MB
18/10/2021	P28	M196 - Issue to Webb Yates	MB
19/11/2021	P29	M217 - Issue to Building Control	MB
19/11/2021	P30	M218 - Issue to Security Consultants	MB
17/12/2021	P31	M234 - Draft Cost Issue	MB

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Scale at 1:250

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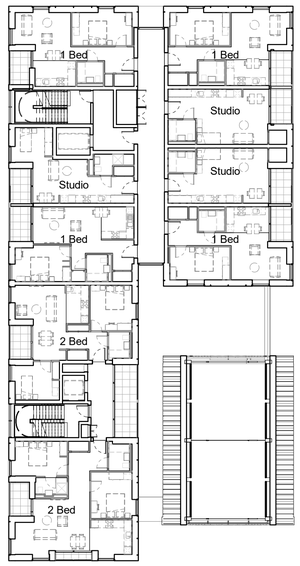
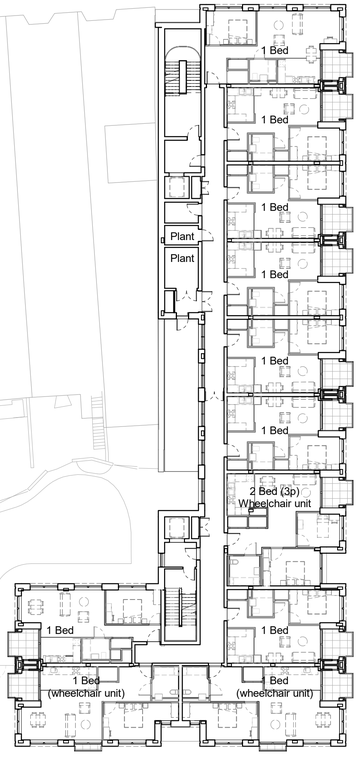
Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Ground Floor Plan			TRS-HAL-00-00-DR-A-	3101 P31
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 30/07/19	Scale 1 : 250 at A1





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Proposed buildings and landscaping subject to design development, which may affect boundary conditions and areas. Wharf Lane podium edge subject to change. Landscape design and levels subject to change following further design development.

Date	Rev.	Description	Approved By
28/08/2020	P01	M009 - Issue of Draft GA Plans for Design Team Coordination	MB
11/09/2020	P02	M011 - Issue of Gound Floor Plan to LDA	MB
16/09/2020	P03	M013 - Issue of GA Plans to All Consultants	MB
28/09/2020	P04	M018 - Issue to Structure Engineer	MB
01/10/2020	P05	M019 - Stage 2 Draft Issue	MB
03/11/2020	P06	M032 - Issue to Client and Cost Consultant	MB
25/11/2020	P07	M041 - Issue to Planners	MB
27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
08/02/2021	P10	M055 - Issue to Arcadis	MB
17/02/2021	P11	M061 - Issue to Planners	MB
19/02/2021	P12	M062 - Issue to Design Team	MB
07/07/2021	P13	M144 - Stage 3 Issue	MB
17/12/2021	P14	M234 - Draft Cost Issue	MB

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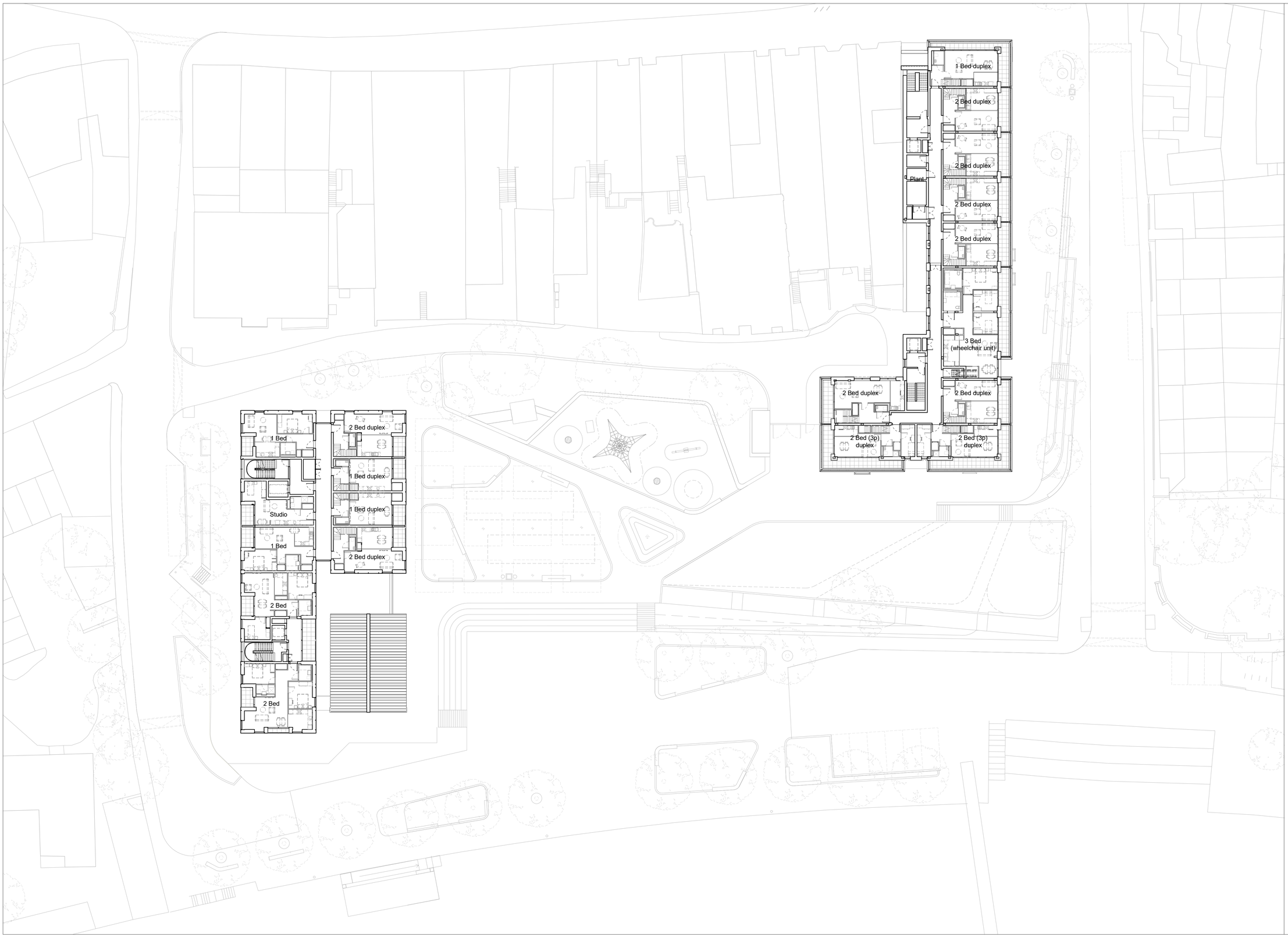
Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	First Floor Plan			TRS-HAL-00-01-DR-A-	3102 P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 26/03/20	Scale 1 : 250 at A1



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Proposed plan uses Survey Solutions topographical survey information (25/06/2020) to determine edges of existing highways, river features and adjacent structures (drawing reference: 26576se-01).

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Date	Rev.	Description	Approved By
28/08/2020	P01	M009 - Issue of Draft GA Plans for Design Team Coordination	MB
11/09/2020	P02	M011 - Issue of Gound Floor Plan to LDA	MB
16/09/2020	P03	M013 - Issue of GA Plans to All Consultants	MB
28/09/2020	P04	M018 - Issue to Structure Engineer	MB
01/10/2020	P05	M019 - Stage 2 Draft Issue	MB
03/11/2020	P06	M032 - Issue to Client and Cost Consultant	MB
25/11/2020	P07	M041 - Issue to Planners	MB
27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
08/02/2021	P10	M055 - Issue to Arcadis	MB
17/02/2021	P11	M061 - Issue to Planners	MB
19/02/2021	P12	M062 - Issue to Design Team	MB
07/07/2021	P13	M144 - Stage 3 Issue	MB
17/12/2021	P14	M234 - Draft Cost Issue	MB

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Scale at 1:250

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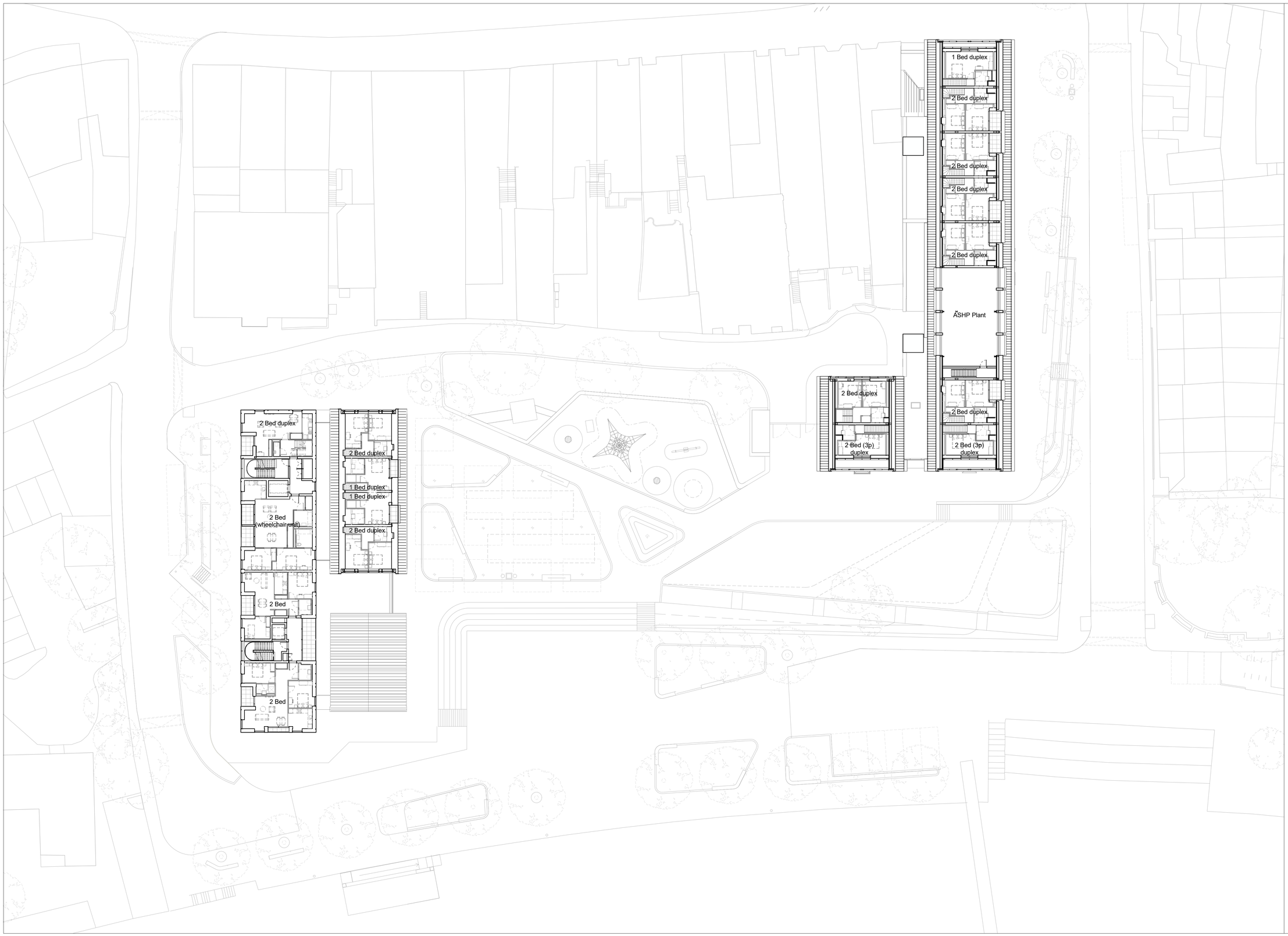
Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Second Floor Plan			TRS-HAL-00-02-DR-A-	3103 / P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 26/03/20	Scale 1 : 250 at A1



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28/08/2020	P01	M009 - Issue of Draft GA Plans for Design Team Coordination	MB
11/09/2020	P02	M011 - Issue of Gound Floor Plan to LDA	MB
16/09/2020	P03	M013 - Issue of GA Plans to All Consultants	MB
28/09/2020	P04	M018 - Issue to Structure Engineer	MB
01/10/2020	P05	M019 - Stage 2 Draft Issue	MB
03/11/2020	P06	M032 - Issue to Client and Cost Consultant	MB
25/11/2020	P07	M041 - Issue to Planners	MB
27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
08/02/2021	P10	M055 - Issue to Arcadis	MB
17/02/2021	P11	M061 - Issue to Planners	MB
19/02/2021	P12	M062 - Issue to Design Team	MB
07/07/2021	P13	M144 - Stage 3 Issue	MB
17/12/2021	P14	M234 - Draft Cost Issue	MB

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Scale at 1:250

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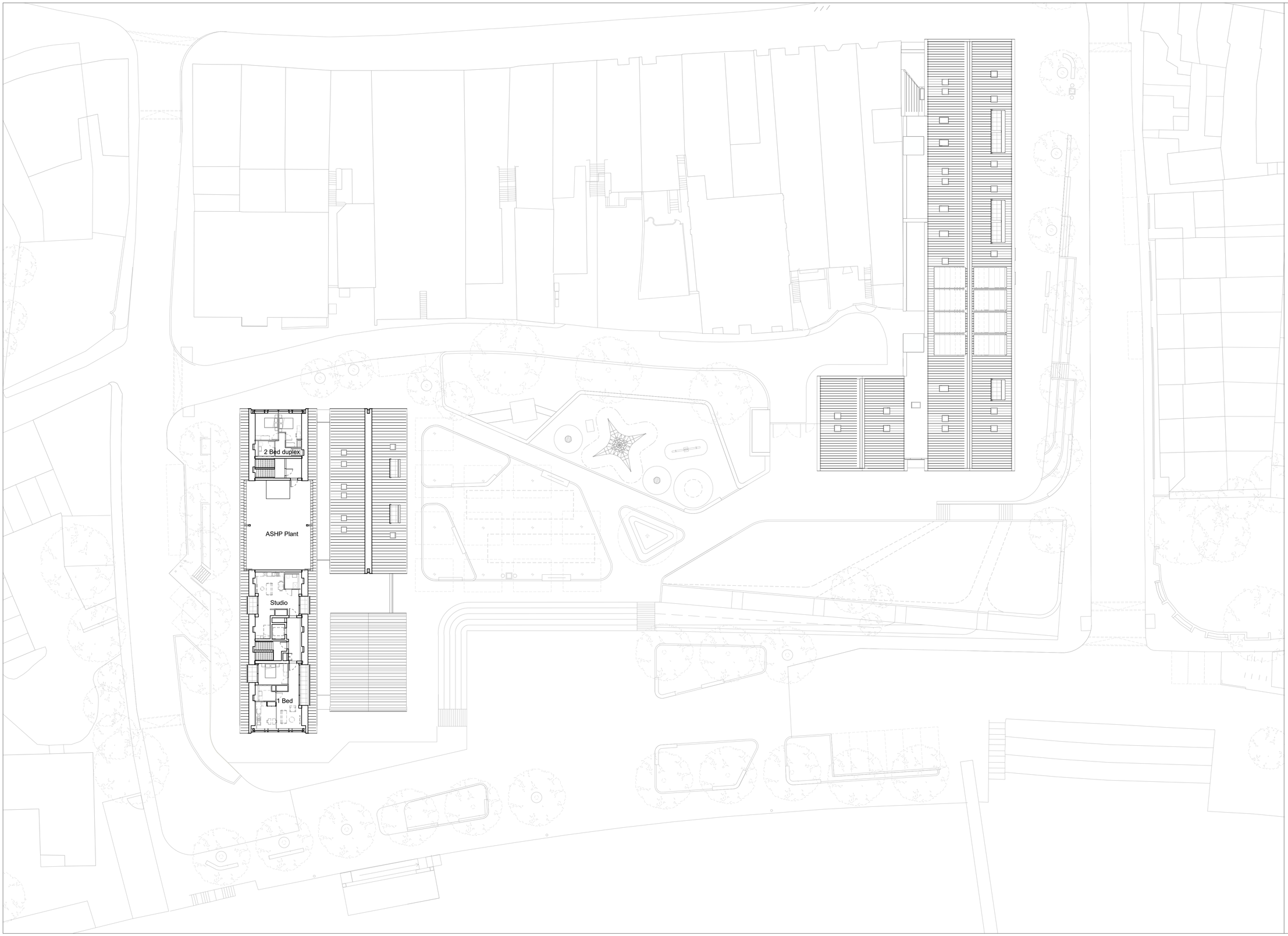
Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Third Floor Plan			TRS-HAL-00-03-DR-A-	3104 / P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 26/03/20	Scale 1 : 250 at A1



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03/11/2020	P06	M032 - Issue to Client and Cost Consultant	MB
25/11/2020	P07	M041 - Issue to Planners	MB
27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
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17/02/2021	P11	M061 - Issue to Planners	MB
19/02/2021	P12	M062 - Issue to Design Team	MB
07/07/2021	P13	M144 - Stage 3 Issue	MB
17/12/2021	P14	M234 - Draft Cost Issue	MB

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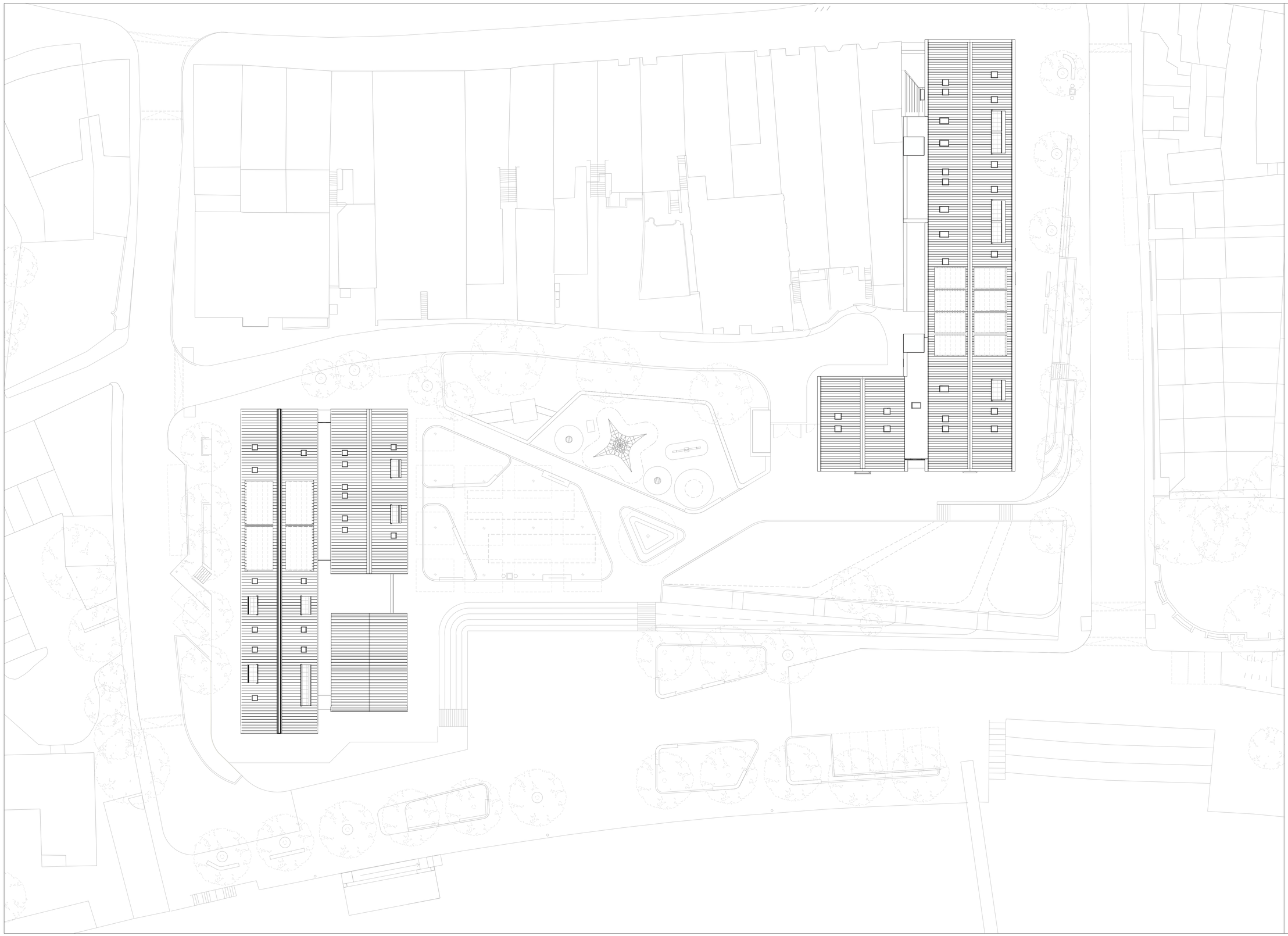
Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Fourth Floor Plan			TRS-HAL-00-04-DR-A-	3105 / P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 07/06/20	Scale 1 : 250 at A1



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27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
08/02/2021	P10	M055 - Issue to Arcadis	MB
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17/12/2021	P14	M234 - Draft Cost Issue	MB

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Scale at 1:250

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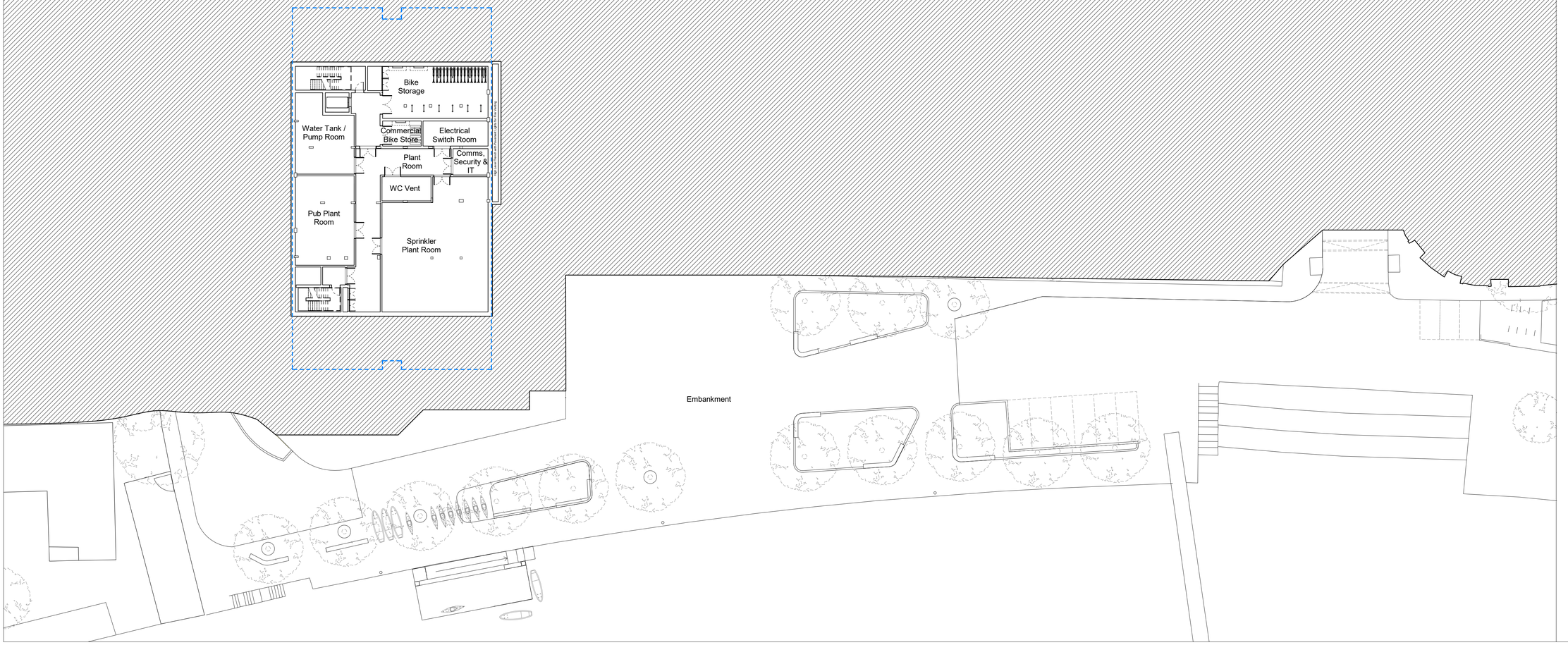
Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Roof Plan			TRS-HAL-00-05-DR-A-	3106 / P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 26/03/20	Scale 1 : 250 at A1



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16/09/2020	P03	M013 - Issue of GA Plans to All Consultants	MB
28/09/2020	P04	M018 - Issue to Structure Engineer	MB
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03/11/2020	P06	M032 - Issue to Client and Cost Consultant	MB
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27/11/2020	P08	M042 - Stage 2 Report Addendum Issue	MB
22/01/2021	P09	M050 - Issue to Structural Engineer	MB

Date	Rev.	Description	Approved By
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17/02/2021	P11	M061 - Issue to Planners	MB
19/02/2021	P12	M062 - Issue to Design Team	MB
07/07/2021	P13	M144 - Stage 3 Issue	MB
17/12/2021	P14	M234 - Draft Cost Issue	MB

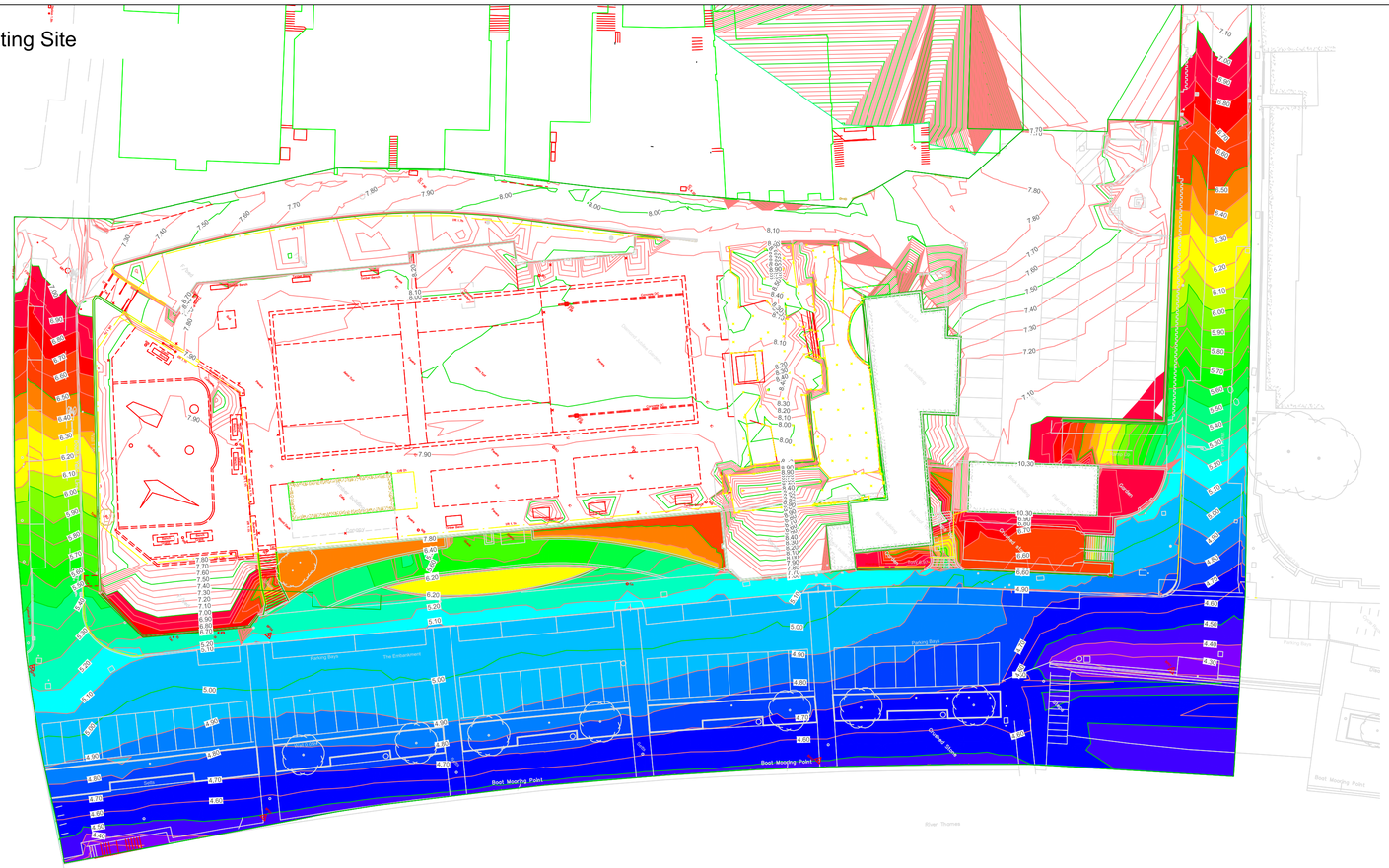
DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Lower Ground Floor Plan			TRS-HAL-00-B1-DR-A-	3100 P14
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 26/03/20	Scale 1 : 250 at A1

Existing Site



Proposed Site

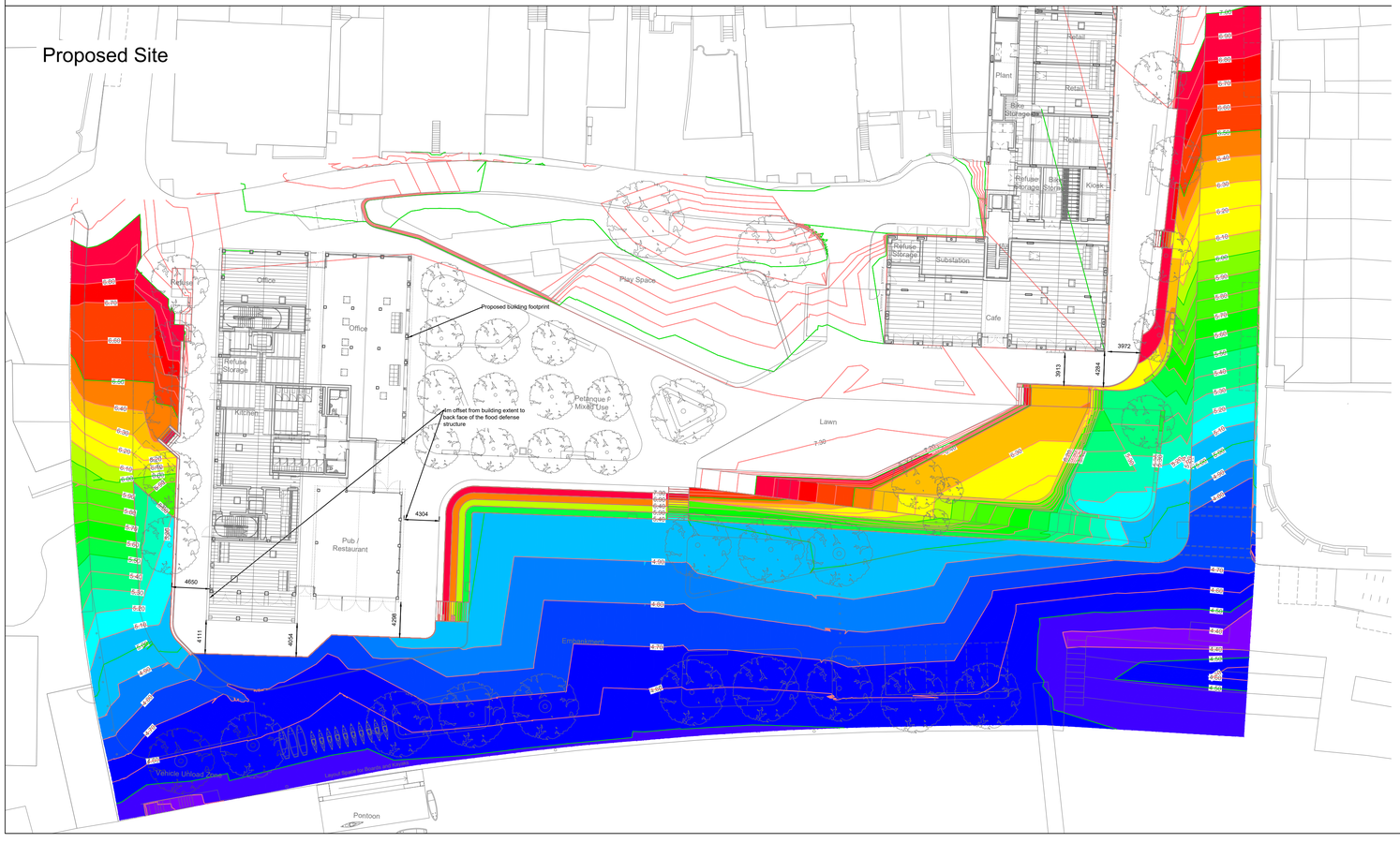


Table 1: Flood Storage Assessment

Maximum Elevation	Minimum Elevation	Existing	Proposed	Surface comparison	
		Volume (m3)	Volume (m3)	Difference	
6.9	6.8	488.0	511.9	23.95	
6.8	6.7	478.6	503.4	24.79	
6.7	6.6	468.7	495.1	26.41	
6.6	6.5	456.5	485.2	28.74	
6.5	6.4	443.5	473.0	29.54	
6.4	6.3	430.7	456.1	25.44	
6.3	6.2	423.2	440.3	17.12	
6.2	6.1	413.4	429.7	16.27	
6.1	6	408.0	421.3	13.35	
6	5.9	402.2	413.1	10.88	
5.9	5.8	396.2	406.5	10.30	
5.8	5.7	390.6	399.8	9.24	
5.7	5.6	381.0	392.9	11.95	
5.6	5.5	373.0	382.2	9.17	
5.5	5.4	364.9	372.5	7.60	
5.4	5.3	356.1	362.5	6.43	
5.3	5.2	344.3	351.2	6.93	
5.2	5.1	320.0	338.9	18.88	
5.1	5	294.0	330.2	36.22	
5	4.9	239.5	291.0	51.47	
4.9	4.8	188.3	247.4	59.14	
4.8	4.7	144.3	196.8	52.57	
4.7	4.6	104.4	137.0	32.63	
4.6	4.5	65.5	75.1	9.63	
4.5	4.4	22.1	19.8	-2.26	Refer to Note 7.
4.4	4.3	7.7	3.1	-4.64	Refer to Note 7.
4.3	4.2	1.8	0.1	-1.64	Refer to Note 7.
				529.02	

Notes

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4. From EA Product 4 and Product 7 data:
   - TE2100 = 6.90 m
   - 1 in 100 year + 35% Climate change = 6.94 m
5. Through discussions with EA, flood defence structure to be at least 4 m away from proposed building extent.
6. The existing surface was created using multiple site topographic surveys, small discrepancies from the actual surface levels may result from the triangulation process. An effort has been made to review the model and any remaining discrepancies are considered negligible to the accuracy and overall outcome of this assessment.
7. No area of the existing site with an elevation below 4.5mAOD is proposed to be raised as part of the proposed works. The flood storage assessment table shows a decrease in storage volume between 4.5 m AOD and 4.2 m AOD. This is a result of the surface triangles changing at the interface of the proposed and existing surface in Civil 3D.

Rev	Date	Description	Drn	App
01	02.06.21	Stage 3 submission	GB	GPD
00	07.12.20	Stage 2 submission	GB	GPD

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Project
Twickenham Riverside

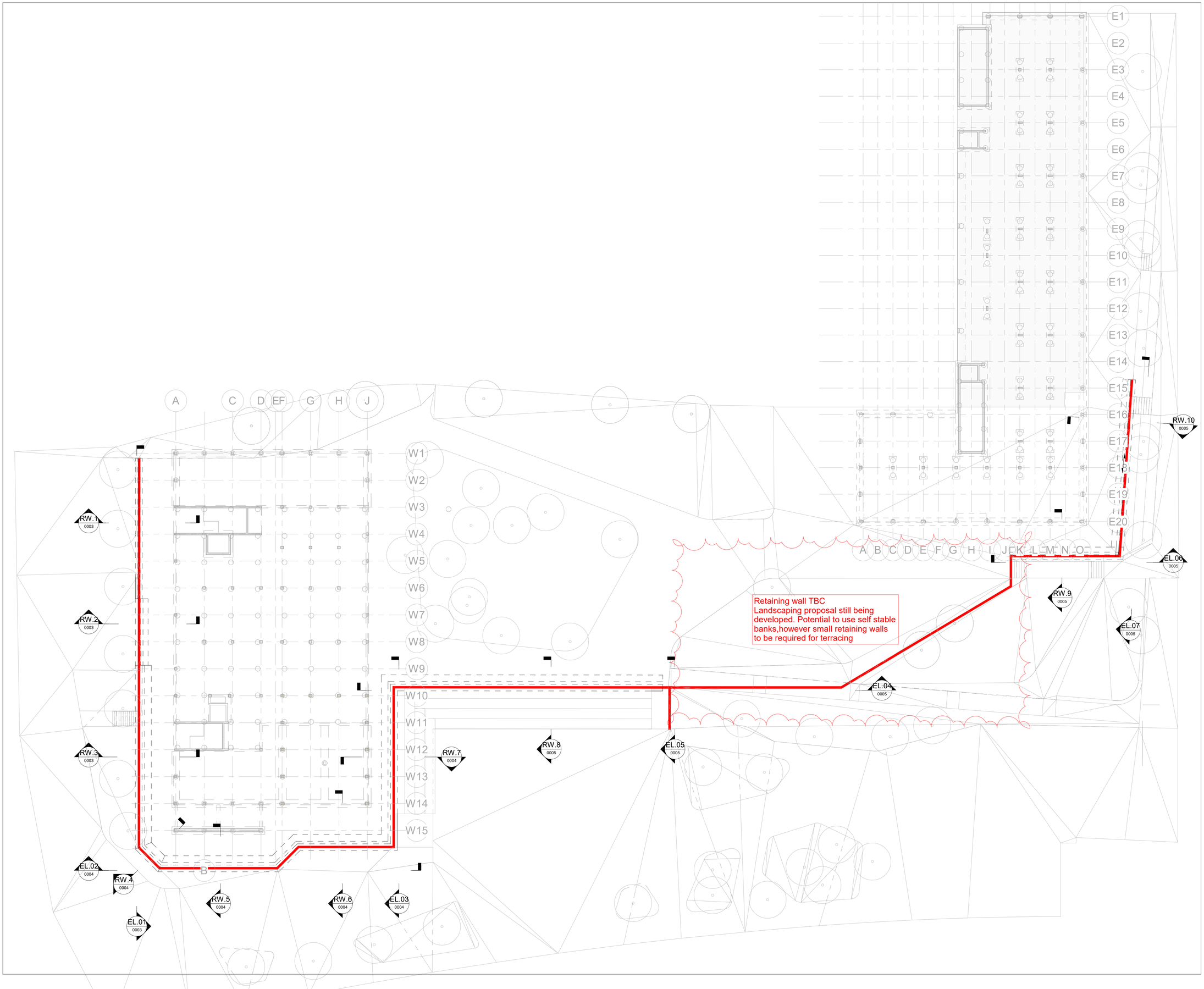
Drawing Title
Flood Storage Assessment

Drawing Status
For Information

Drawn by	Checked by	Sheet size	Scale	Rev status
GB	AM	A1	NTS	S9

Drawing Number
J3932-C-DR-2000

Revision
01



Notes

SAFETY, HEALTH AND ENVIRONMENT
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :
Construction
Maintenance & Cleaning
Decommissioning & Demolition
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev	Date	Description	Drn	App
00	21.05.21	Draft Stage 3 Issue	SNE	LB

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Project
Twickenham Riverside Site

Drawing Title
Retaining Wall General Arrangement

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev Status
MM	LB	A1	1 : 200	S3

Drawing Number
J3932-S-GA-00-0002

Revision
00

DRAINAGE KEY

- Proposed Surface Water Drain
- Proposed Foul Drain
- Existing Surface Water Drain
- Existing Foul Drain
- Existing Drain to be Removed
- S#.# / F#.# — Proposed Manhole Surface Water / Foul
- Proposed Trapped Gully
- FG — Floor Gully
- RWP# — Proposed Rainwater Pipe (With Roddable access)
- SVP# — Proposed Soil Vent Pipe (With Roddable Access)
- ATT# — Proposed Attenuation Tank

KING STREET

TW MH 2207
CL=7.71
IL=1.99

New foul water connection to Thames Water network

TW MH 2212
CL = 7.64
IL=4.06

WATER LANE

F1.1
F1.0
F2.3
F2.2
F2.1
F2.0
S1.2
S1.1
S1.3
S1.4
S1.5
F3.2
F3.1
F3.0
S5.0
F4.1
F4.0

Retail
Refuse Storage
Bike Storage
Kiosk
Plant
Substation
Cafe

Adjusting existing connection to Thames water network

New foul water connection to Thames Water network

TW MH 2109
CL:7.49
Il = 3.15

New foul water connection to Thames Water network

TW MH 2106

S1.7
F6.5
S2.0
S2.1
S2.2
F6.4
F6.3
F6.2
F6.1
S2.3
F6.0
F5.0
S3.1

Refuse
Office
Refuse Storage
Kitchen
Pub / Restaurant

Play Space

S1.6
Flow control hydrobrake.
Max outflow 10 l/s

Cellular attenuation tank
Porosity: 0.95
10 m(L) x 10m(W) x 1.2m (D)

Petanque / Mixed Use

Existing Cafe drainage To be removed

Lawn

Inspection manhole.

Connections assumed to be from existing public toilets. To be removed.

TW MH 2101
CL=7.02
IL = 2.01

TW MH 2108
CL = 7.01
IL = 3.15

WHARF LANE

Existing 1200 Ø Thames Water surface water pipe

S6.0
S6.1
S6.2
F8.2
F8.1
F8.0

Thames Water sewer diversion

Existing sewer to be diverted

Embankment

Flow control devices within relocated manhole should match the existing manhole and meet the EA requirements to prevent backflow from the river.

Vehicle Unload Zone

Layout Space for Boards and Kayaks

Pontoon

TW MH 3105
IL 2.26

Receives connection from Eel Pie Island
TW MH 3102
No more TW detail

THAMES RIVER

Notes

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4. For below ground drainage drawings for Water Lane building refer to J3932-C-DR-1001
5. For below ground drainage drawings for Wharf Lane building refer to J3932-C-DR-1002 and 1003

General Notes to Drainage

1. This drawing is to be read in conjunction with the drainage details and other relevant Architects and Engineers drawings and specifications.
2. Comply with technical standards and British standards as detailed in the specification.
3. All pipework is to be installed to the recommended falls with suitable provision for venting and cleaning as required by the British standards.
4. RWP locations are to be determined at the next design stage.
5. Allow for rodding access points in all locations to conform to specification. Notify contractor and architect of places where access in required to these rodding points in addition to those shown on plans.
6. Provide 25mm foil face mineral wool insulation to all RWPs & SVPs.
7. Provide rodding points to RWPs and SVPs before the below ground connection.
8. Appliances connecting to the drainage system shall be installed with a trap to prevent escape of foul air into the building.
9. Appliances, pipes and fittings shall comply with relevant European standards where applicable.
10. Any part of the existing drainage system retained as part of the new scheme shall be cleaned and inspected. Any defects shall be reported to the Engineer.
11. All pipes passing through fire compartments shall be provided with fire collars and fire seals. Fire stopping detailed shall be submitted for approval
12. Existing drainage connectivity & condition to be confirmed by Contractor. Before starting work, check invert levels & positions of existing drains, sewers, inspection chambers & manholes against drawings. Report discrepancies.
13. Ventilating pipes open to outside air should finish at least 900mm above any opening into the the building within 3m and should be finished with a wire cage or other perforated cover, fixed to the end of the ventilating pipe, which does not restrict the flow of air.
14. Private foul water and surface water drainage is to be constructed in accordance with the building regulations part H (2015), BS EN 12056:2000 (inside buildings), BS EN 752:2017 (outside buildings) and all relevant agreement certificates.
15. All rodding eyes and access points shall be of 'double-seal' type.
16. HEALTH AND SAFETY: The works shall be carried out by specialist competent and experienced contractors who are members of a recognised national organisation. Operatives shall have received full and appropriate training for the operations they are to undertake. All work shall be carried out in accordance with all pertinent Health and Safety Regulations.
17. HEALTH AND SAFETY: Care should be taken to locate services prior to any excavation.

Rev	Date	Description	Drn	App
00	09.06.21	Stage 3 submission	GB	GPD

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Project
Twickenham Riverside

Drawing Title
Below Ground Drainage Layout Site Wide

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev status
GB	GPD	A1	1:250	S3

Drawing Number
J3932-C-DR-1000

Revision
00

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DRAINAGE KEY

- Proposed Surface Water Drain
- Proposed Foul Drain
- Existing Surface Water Drain
- Existing Foul Drain
- Existing Drain to be Removed
- S#.# / F#.# — Proposed Manhole Surface Water / Foul
- CH — Proposed Drainage Channel
- FG — Floor Gully
- RWP# — Proposed Rainwater Pipe (With Roddable access)
- SVP# — Proposed Soil Vent Pipe (With Roddable Access)
- Foul Pipe Transfer at High Level
- Surface WaterPipe Transfer at High Level
- SS# — Proposed Stub Stack Connection
- ATT# — Proposed Attenuation Tank
- SPC#.# / FPC#.# — Proposed Pumping Chamber Surface Water / Foul

TW MH 2106
IL 5.94
225 Ø
S1.5
S5.0
F3.0
F3.1
150 Ø
F3.2
IL 6.17
New connection to existing Thames Water Sewer
Refuse Storage
Substation
Cafe
Ø 150
225 Ø
S1.4
S1.3
F4.1
F4.0
AR
7.75
Existing manhole to be retained. Connections from neighboring building to be retained, redundant connections to be removed or grouted.
Plant
Bike Storage
Refuse Storage
Bike Storage
Kiosk
Retail
Retail
Retail
Retail
Retail
Retail
S1.2
S1.1
S1.0
F2.0
F2.1
F2.2
F1.0
F1.1
IL 6.52
IL 6.28
100 Ø
150 Ø
RWP
SVP
FG
DR
150
Old Quay Pot
IL 7.18
UTR
Existing Thames Water manhole to be retained and altered to be a buried junction mnahole with no access.
New mnahole connection to existing pipe with backdrop to lower level
Existing manhole to be removed
IL 2.63
New connection to existing Thames Water Sewer
F2.3
New connection to existing Thames Water Sewer
WATER LANE
6.74

Rev	Date	Description	Dm	App
00	09.06.21	Stage 3 submission	GB	GPD

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Project
Twickenham Riverside

Drawing Title
Below Ground Drainage Layout
Water Lane Lane Ground Level

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev status
GB	GPD	A1	1:100	S3

Drawing Number
J3932-C-DR-1001

Revision
00

WHARF LANE

Diversion of existing 1200 Ø surface water main

Approx Position of Sewer CCTV required

F8.2

S6.0

S6.1

S6.2

IL 2.11

IL 2.58

IL 3.15

MH CL 7.07 IL 2.01

Back Drop 2.59Ø

SVPs and RWP to be relocated further northeast as high level trasfer during net design stage. Exact location TBC with above ground drainage designer.

Ø 300

Diversion of existing 300 Ø foul water main

Kitchen

Refuse Storage

Refuse

Office

Pub / Restaurant

Office

F5.0

F6.4

F6.5

F6.3

F6.2

F6.0

F6.1

150 Ø

S2.0

S2.1

S2.2

S2.3

S3.0

S3.1

New connection to existing Thames Water Sewer

Foul water rising main from basement

Surface water rising main from basement

New connection to existing Thames Water Surface Water. Invert level 5.55 m

225 Ø

150 Ø

S1.7

MH CL 5.54 IL 3.74

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Project

Twickenham Riverside

Drawing Title

Below Ground Drainage Layout
Wharf Lane Ground Level

Drawing Status

Developed Design

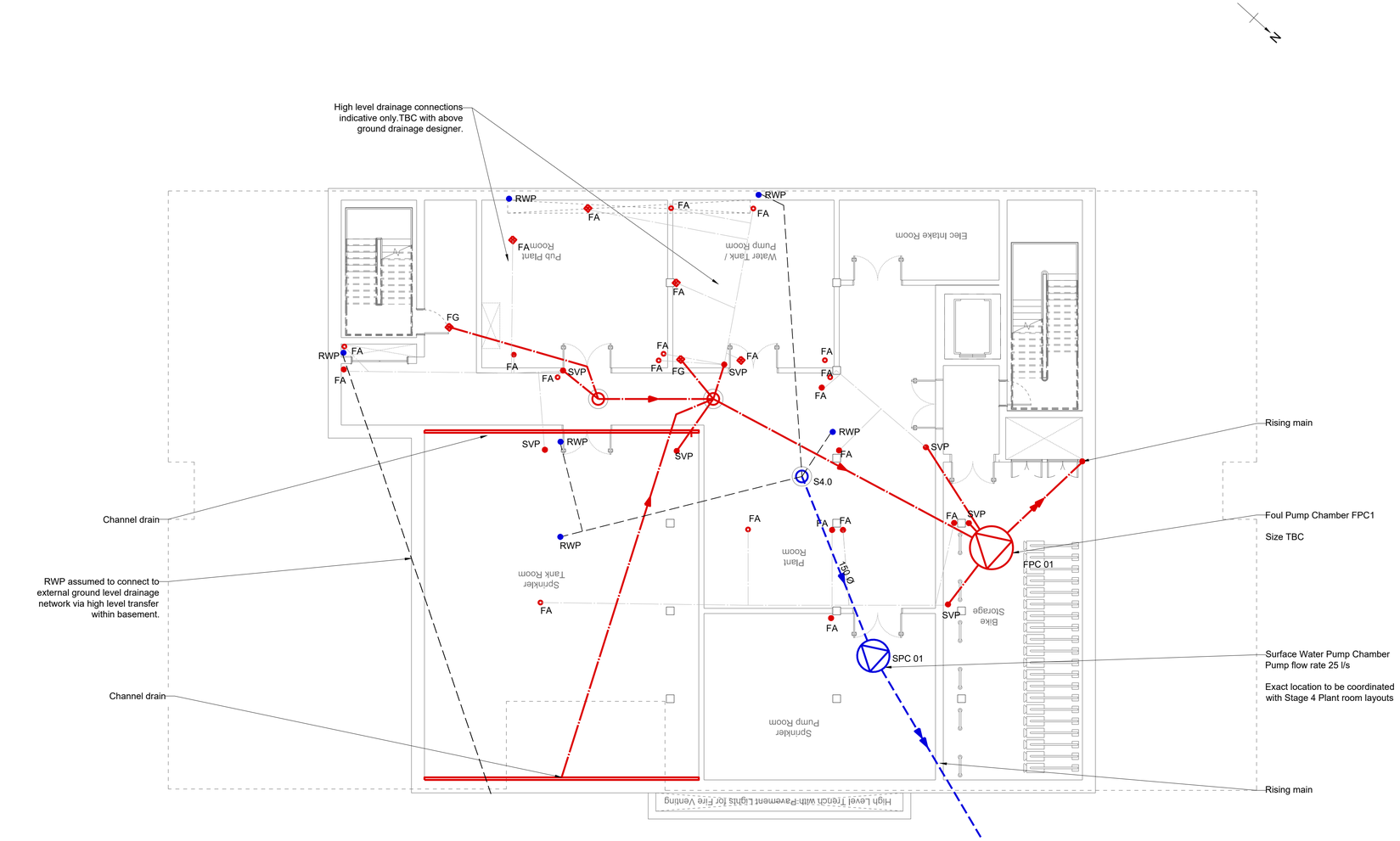
Drawn by	Checked by	Sheet size	Scale	Rev status
GB	GPD	A1	1:100	S3

Drawing Number

J3932-C-DR-1002

Revision

00



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00	09.06.21	Stage 3 submission	GB	GPD

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Project
Twickenham Riverside

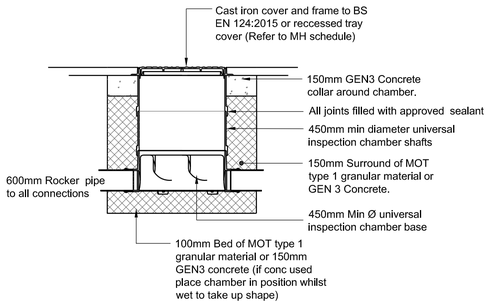
Drawing Title
Below Ground Drainage Layout
Wharf Lane Basement Level

Drawing Status
Developed Design

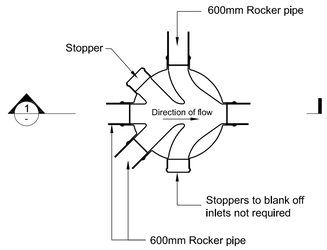
Drawn by	Checked by	Sheet size	Scale	Rev status
GB	GPD	A1	NTS	S3

Drawing Number
J3932-C-DR-1003

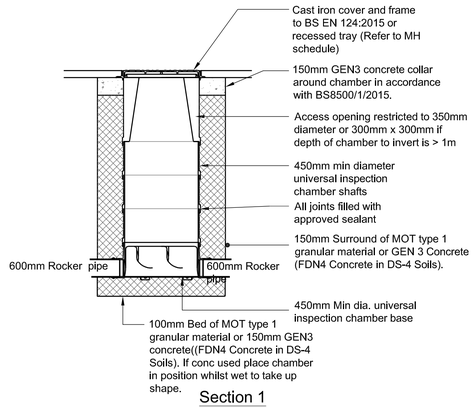
Revision
00



1.2m Max depth to invert

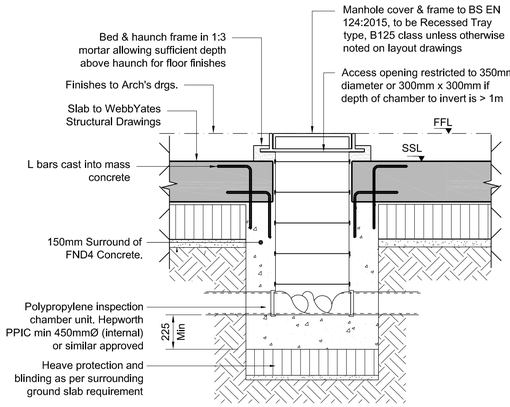


Typical Plan View 450Ø/600Ø PPIC Inspection Chamber Base



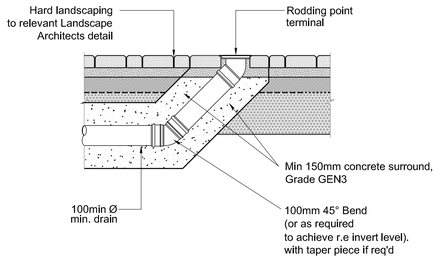
Section 1

Polypropylene Inspection Chamber Within External Landscaping 3.0m Max depth to invert

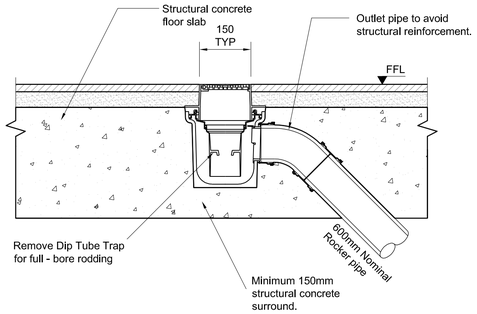


Section 1

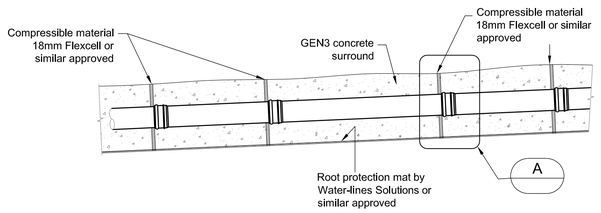
Polypropylene Inspection Chamber Within New Slab 3.0m Max depth to invert

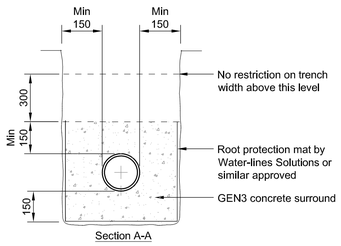


Rodding Eye



Internal Trapped Gulley Typical Connection Detail - Within New Slab

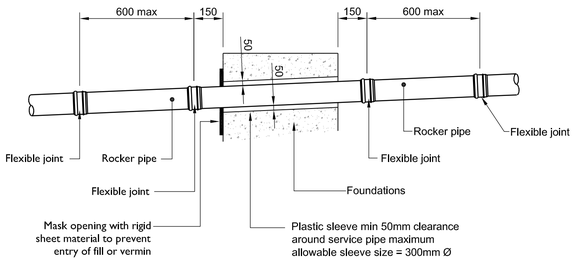




Section A-A

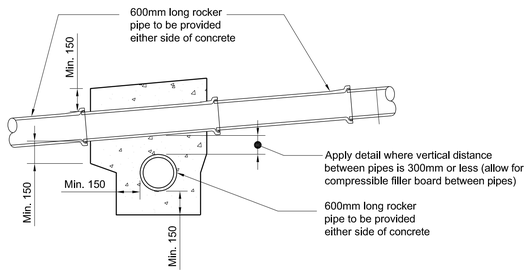
Pipe Protection Against Root Intrusion

(Flexible joints at joint of pipes)
Scale NTS



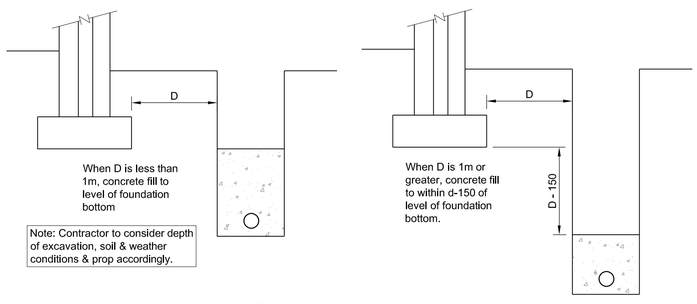
Pipes Passing Through Foundations

Scale 1:20



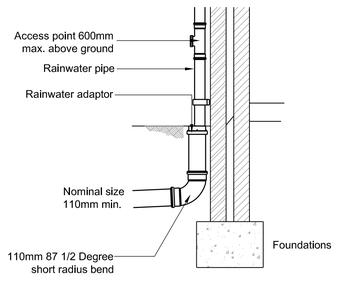
Pipes Passing Within 300mm

Scale NTS



Pipes Near Buildings

Scale NTS



Typical External Rainwater Pipe to Drain

Scale 1:20

Notes

1. Do not scale the drawing
2. All dimensions are in millimetres unless noted otherwise
3. Any discrepancies between structural and architectural setting out dimensions must be brought to the attention of the Architect and Engineers

Rev	Date	Description	Drn	App
00	09.06.21	Stage 3 submission	GB	GPD

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Project
Twickenham Riverside

Drawing Title
Below Ground Drainage Details Sheet 2

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev status
GB	GPD	A1	As Shown	S3

Drawing Number
J3932-C-DE-0401

Revision
00

14. APPENDIX C EXSITING SEWER/WATER MAPS

Asset Location Search Sewer Map - ALS/ALS Standard/2016_3373517

The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 516279,173177

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

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

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

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

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

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

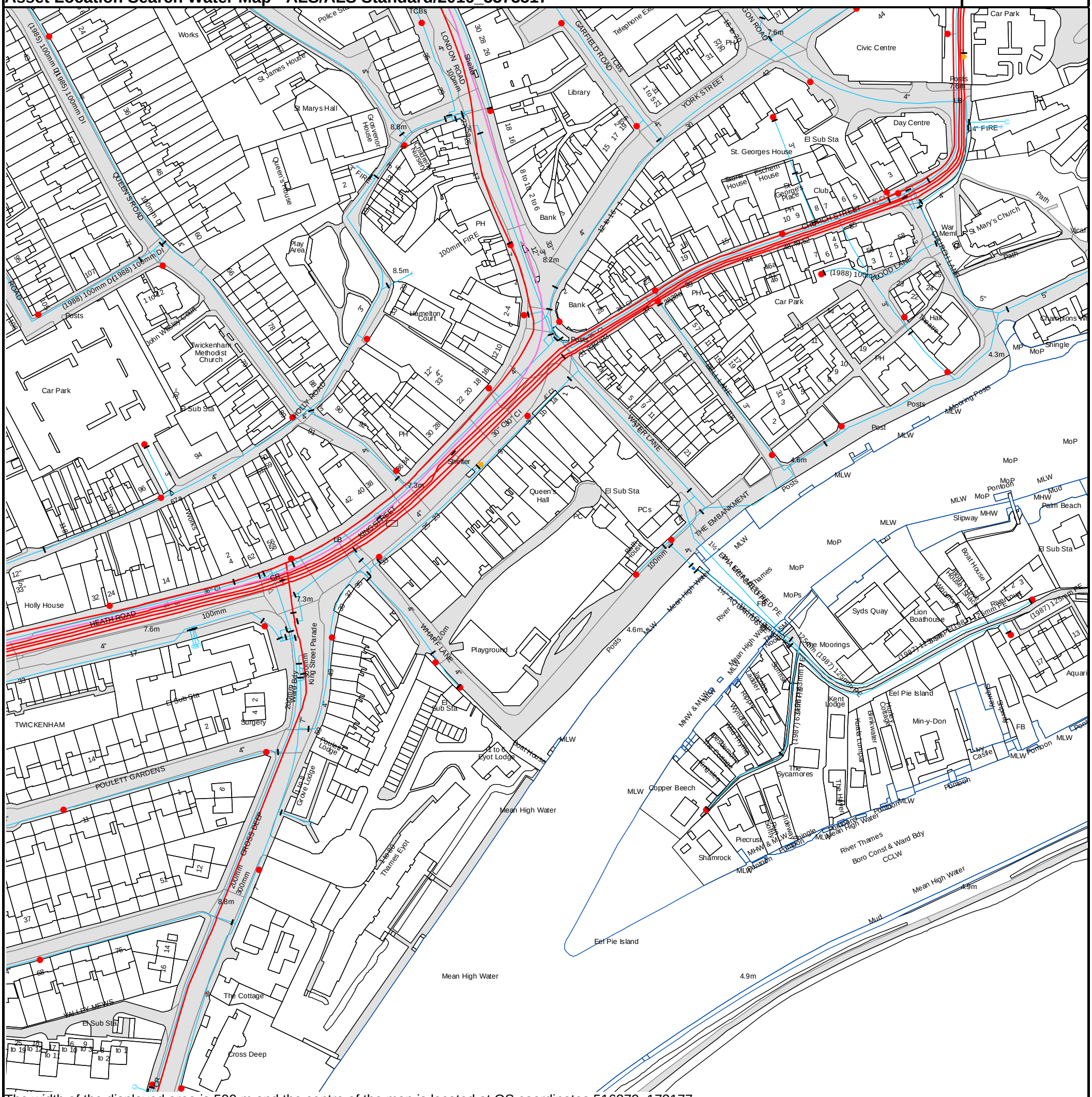
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2016_3373517



The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 516279, 173177.

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

15. APPENDIX D GREENFIELD RUNOFF RATES

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Georgia Bertram
Site name:	Twickenham Riverside
Site location:	Twickenham

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.44545° N
Longitude:	0.32801° W
Reference:	2566204234
Date:	Jul 19 2021 23:05

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 1.34

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	599	599
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

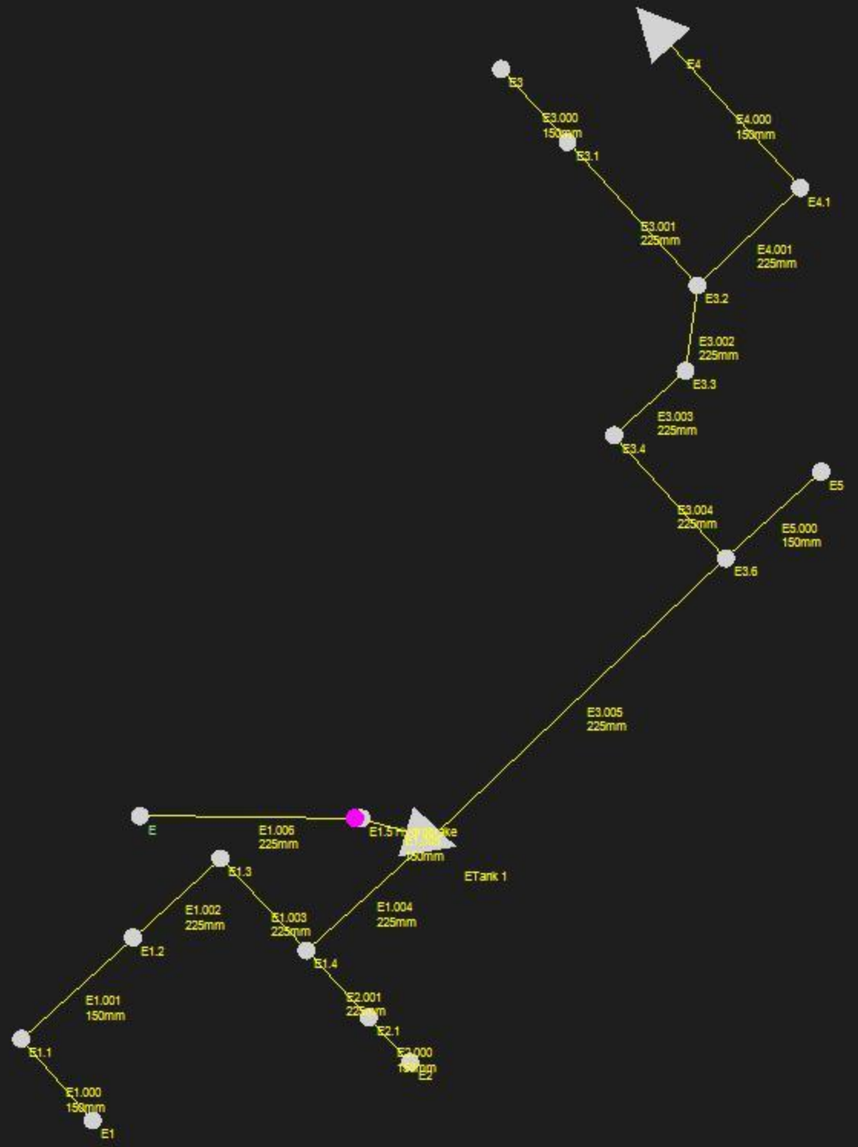
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	2.04	2.04
1 in 1 year (l/s):	1.73	1.73
1 in 30 years (l/s):	4.68	4.68
1 in 100 year (l/s):	6.49	6.49
1 in 200 years (l/s):	7.61	7.61

16. APPENDIX E MICRODRAINAGE CALCULATIONS

Microdrainage model layout



Existing Network Details for Existing

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
E1.000	10.313	0.103	100.1	0.011	5.00	0.0	0.600	o	150	Pipe/Conduit
E1.001	14.326	0.143	100.2	0.004	0.00	0.0	0.600	o	150	Pipe/Conduit
E1.002	11.220	0.112	100.2	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit
E1.003	11.988	0.120	99.9	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit
E2.000	5.778	0.070	82.5	0.035	5.00	0.0	0.600	o	150	Pipe/Conduit
E2.001	8.703	0.103	84.5	0.024	5.00	0.0	0.600	o	225	Pipe/Conduit
E1.004	15.912	0.159	100.1	0.001	0.00	0.0	0.600	o	225	Pipe/Conduit
E3.000	9.376	0.063	150.0	0.014	5.00	0.0	0.600	o	150	Pipe/Conduit
E3.001	18.389	0.184	100.0	0.017	0.00	0.0	0.600	o	225	Pipe/Conduit
E4.000	20.703	0.157	131.9	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit
E4.001	13.465	0.180	74.8	0.012	0.00	0.0	0.600	o	225	Pipe/Conduit
E3.002	8.219	0.055	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
E3.003	9.131	0.072	126.8	0.015	0.00	0.0	0.600	o	225	Pipe/Conduit
E3.004	15.817	0.105	150.6	0.004	0.00	0.0	0.600	o	225	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
E1.000	6.575	0.011	0.0	1.00	17.7
E1.001	6.472	0.015	0.0	1.00	17.7
E1.002	6.329	0.030	0.0	1.31	51.9
E1.003	6.217	0.036	0.0	1.31	52.0
E2.000	6.270	0.035	0.0	1.11	19.6
E2.001	6.200	0.059	0.0	1.42	56.6
E1.004	6.097	0.096	0.0	1.31	52.0
E3.000	6.460	0.014	0.0	0.82	14.5
E3.001	6.397	0.032	0.0	1.31	52.0
E4.000	6.550	0.024	0.0	0.87	15.4
E4.001	6.393	0.037	0.0	1.51	60.2
E3.002	6.213	0.068	0.0	1.07	42.4
E3.003	6.158	0.083	0.0	1.16	46.1
E3.004	6.086	0.087	0.0	1.06	42.3

Existing Network Details for Existing

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type
E5.000	12.246	0.245	50.0	0.014	5.00	0.0	0.600	o	150	Pipe/Conduit
E3.005	7.191	0.072	99.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
E3.006	31.496	0.157	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
E1.005	6.935	0.060	115.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit
E1.006	21.026	0.140	150.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
E5.000	6.500	0.014	0.0	1.43	25.2
E3.005	5.981	0.101	0.0	1.31	52.0
E3.006	5.909	0.101	0.0	0.92	36.6
E1.005	5.750	0.197	0.0	0.93	16.5
E1.006	5.690	0.197	0.0	1.06	42.3

Manhole Schedules for Existing

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdro (mm)
E1	7.500	0.925	Open Manhole	450	E1.000	6.575	150				
E2	7.400	0.928	Open Manhole	450	E1.001	6.472	150	E1.000	6.472	150	
E3	7.400	1.071	Open Manhole	600	E1.002	6.329	225	E1.001	6.329	150	
E4	7.400	1.183	Open Manhole	600	E1.003	6.217	225	E1.002	6.217	225	
E5	7.400	1.130	Open Manhole	450	E2.000	6.270	150				
E5	7.400	1.200	Open Manhole	600	E2.001	6.200	225	E2.000	6.200	150	
E5	7.400	1.303	Open Manhole	900	E1.004	6.097	225	E1.003	6.097	225	
								E2.001	6.097	225	
E7	7.750	1.290	Open Manhole	450	E3.000	6.460	150				
E8	7.450	1.053	Open Manhole	450	E3.001	6.397	225	E3.000	6.397	150	
E9	7.600	1.050	Open Manhole	450	E4.000	6.550	150				
E10	7.600	1.207	Open Manhole	600	E4.001	6.393	225	E4.000	6.393	150	
E9	7.600	1.387	Open Manhole	600	E3.002	6.213	225	E3.001	6.213	225	
								E4.001	6.213	225	
E10	7.600	1.442	Open Manhole	600	E3.003	6.158	225	E3.002	6.158	225	
E11	7.600	1.514	Open Manhole	600	E3.004	6.086	225	E3.003	6.086	225	
E15	7.500	1.000	Open Manhole	450	E5.000	6.500	150				
E12	7.500	1.519	Open Manhole	600	E3.005	5.981	225	E3.004	5.981	225	
								E5.000	6.255	150	19
E15	7.500	1.591	Open Manhole	600	E3.006	5.909	225	E3.005	5.909	225	
ETank 1	7.300	1.550	Open Manhole	1200	E1.005	5.750	150	E1.004	5.938	225	26
								E3.006	5.752	225	7
EHydrobrake	7.400	1.710	Open Manhole	1200	E1.006	5.690	225	E1.005	5.690	150	
E	7.400	1.850	Open Manhole	0		OUTFALL		E1.006	5.550	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
E1	516244.184	173130.833	516244.184	173130.833	Required	
E2	516237.391	173138.593	516237.391	173138.593	Required	

Manhole Schedules for Existing

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
E3	516248.006	173148.214	516248.006	173148.214	Required	
E4	516256.318	173155.751	516256.318	173155.751	Required	
E5	516274.360	173136.383	516274.360	173136.383	Required	
E5	516270.421	173140.611	516270.421	173140.611	Required	
E5	516264.489	173146.979	516264.489	173146.979	Required	
E7	516283.003	173230.824	516283.003	173230.824	Required	
E8	516289.300	173223.877	516289.300	173223.877	Required	
E9	516297.512	173234.862	516297.512	173234.862	Required	
E10	516311.415	173219.523	516311.415	173219.523	Required	
E9	516301.650	173210.252	516301.650	173210.252	Required	
E10	516300.513	173202.112	516300.513	173202.112	Required	
E11	516293.748	173195.980	516293.748	173195.980	Required	
E15	516313.408	173192.525	516313.408	173192.525	Required	
E12	516304.370	173184.261	516304.370	173184.261	Required	

Manhole Schedules for Existing

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
E15	516299.162	173179.302	516299.162	173179.302	Required	
ETank 1	516276.353	173157.583	516276.353	173157.583	Required	
EHydrobrake	516269.708	173159.569	516269.708	173159.569	Required	
E	516248.683	173159.767			No Entry	

PIPELINE SCHEDULES for Existing

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E1.000	o	150	E1	7.500	6.575	0.775	Open Manhole	450
E1.001	o	150	E2	7.400	6.472	0.778	Open Manhole	450
E1.002	o	225	E3	7.400	6.329	0.846	Open Manhole	600
E1.003	o	225	E4	7.400	6.217	0.958	Open Manhole	600
E2.000	o	150	E5	7.400	6.270	0.980	Open Manhole	450
E2.001	o	225	E5	7.400	6.200	0.975	Open Manhole	600
E1.004	o	225	E5	7.400	6.097	1.078	Open Manhole	900
E3.000	o	150	E7	7.750	6.460	1.140	Open Manhole	450
E3.001	o	225	E8	7.450	6.397	0.828	Open Manhole	450
E4.000	o	150	E9	7.600	6.550	0.900	Open Manhole	450
E4.001	o	225	E10	7.600	6.393	0.982	Open Manhole	600
E3.002	o	225	E9	7.600	6.213	1.162	Open Manhole	600
E3.003	o	225	E10	7.600	6.158	1.217	Open Manhole	600

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E1.000	10.313	100.1	E2	7.400	6.472	0.778	Open Manhole	450
E1.001	14.326	100.2	E3	7.400	6.329	0.921	Open Manhole	600
E1.002	11.220	100.2	E4	7.400	6.217	0.958	Open Manhole	600
E1.003	11.988	99.9	E5	7.400	6.097	1.078	Open Manhole	900
E2.000	5.778	82.5	E5	7.400	6.200	1.050	Open Manhole	600
E2.001	8.703	84.5	E5	7.400	6.097	1.078	Open Manhole	900
E1.004	15.912	100.1	ETank 1	7.300	5.938	1.137	Open Manhole	1200
E3.000	9.376	150.0	E8	7.450	6.397	0.903	Open Manhole	450
E3.001	18.389	100.0	E9	7.600	6.213	1.162	Open Manhole	600
E4.000	20.703	131.9	E10	7.600	6.393	1.057	Open Manhole	600
E4.001	13.465	74.8	E9	7.600	6.213	1.162	Open Manhole	600
E3.002	8.219	150.0	E10	7.600	6.158	1.217	Open Manhole	600
E3.003	9.131	126.8	E11	7.600	6.086	1.289	Open Manhole	600

PIPELINE SCHEDULES for Existing

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E3.004	o	225	E11	7.600	6.086	1.289	Open Manhole	600
E5.000	o	150	E15	7.500	6.500	0.850	Open Manhole	450
E3.005	o	225	E12	7.500	5.981	1.294	Open Manhole	600
E3.006	o	225	E15	7.500	5.909	1.366	Open Manhole	600
E1.005	o	150	ETank 1	7.300	5.750	1.400	Open Manhole	1200
E1.006	o	225	EHydrobrake	7.400	5.690	1.485	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
E3.004	15.817	150.6	E12	7.500	5.981	1.294	Open Manhole	600
E5.000	12.246	50.0	E12	7.500	6.255	1.095	Open Manhole	600
E3.005	7.191	99.9	E15	7.500	5.909	1.366	Open Manhole	600
E3.006	31.496	200.0	ETank 1	7.300	5.752	1.323	Open Manhole	1200
E1.005	6.935	115.6	EHydrobrake	7.400	5.690	1.560	Open Manhole	1200
E1.006	21.026	150.2	E	7.400	5.550	1.625	Open Manhole	0

Simulation Criteria for Existing

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 1
Number of Online Controls 2 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Region	England and Wales
Return Period (years)	100	M5-60 (mm)	20.600

Synthetic Rainfall Details

Ratio R	0.438	Cv (Winter)	0.840
Profile Type	Summer	Storm Duration (mins)	30
Cv (Summer)	1.000		

Online Controls for Existing

Hydro-Brake® Optimum Manhole: E15, DS/PN: E3.006, Volume (m³): 0.7

Unit Reference	MD-SHE-0161-1300-1200-1300
Design Head (m)	1.200
Design Flow (l/s)	13.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	161
Invert Level (m)	5.909
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	13.0	Kick-Flo®	0.796	10.7
Flush-Flo™	0.362	13.0	Mean Flow over Head Range	-	11.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.8	1.200	13.0	3.000	20.1	7.000	30.2
0.200	12.2	1.400	14.0	3.500	21.6	7.500	31.2
0.300	12.9	1.600	14.9	4.000	23.1	8.000	32.2
0.400	13.0	1.800	15.8	4.500	24.4	8.500	33.2
0.500	12.8	2.000	16.6	5.000	25.7	9.000	34.1
0.600	12.5	2.200	17.3	5.500	26.9	9.500	35.0
0.800	10.7	2.400	18.1	6.000	28.0		
1.000	11.9	2.600	18.8	6.500	29.1		

Hydro-Brake® Optimum Manhole: EHydrobrake, DS/PN: E1.006, Volume (m³): 2.0

Unit Reference	MD-SHE-0143-1000-1200-1000
Design Head (m)	1.200
Design Flow (l/s)	10.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	143
Invert Level (m)	5.690
Minimum Outlet Pipe Diameter (mm)	225

Hydro-Brake® Optimum Manhole: EHydrobrake, DS/PN: E1.006, Volume (m³): 2.0

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	10.0	Kick-Flo®	0.778	8.2
Flush-Flo™	0.357	10.0	Mean Flow over Head Range	-	8.7

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	1.200	10.0	3.000	15.4	7.000	23.2
0.200	9.4	1.400	10.8	3.500	16.6	7.500	23.9
0.300	9.9	1.600	11.5	4.000	17.7	8.000	24.7
0.400	10.0	1.800	12.1	4.500	18.7	8.500	25.4
0.500	9.8	2.000	12.7	5.000	19.7	9.000	26.1
0.600	9.5	2.200	13.3	5.500	20.6	9.500	26.8
0.800	8.3	2.400	13.9	6.000	21.5		
1.000	9.2	2.600	14.4	6.500	22.3		

Storage Structures for Existing

Cellular Storage Manhole: E9, DS/PN: E4.000

Invert Level (m) 6.550 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	16.0	0.0	0.401	0.0	0.0
0.400	16.0	0.0			

Cellular Storage Manhole: E12, DS/PN: E3.005

Invert Level (m) 5.981 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	22.5	0.0	1.201	0.0	0.0
1.200	22.5	0.0			

Cellular Storage Manhole: ETank 1, DS/PN: E1.005

Invert Level (m) 5.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	46.0	0.0	1.201	0.0	0.0
1.200	46.0	0.0			

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 1
Number of Online Controls 2	Number of Storage Structures 3	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.438
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	20.600	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
E1.000	E1	15 minute 100 year Summer I+40%	7.500	6.903	0.178	0.000	0.56	
E1.001	E2	15 minute 100 year Summer I+40%	7.400	6.872	0.250	0.000	0.72	
E1.002	E3	15 minute 100 year Summer I+40%	7.400	6.796	0.242	0.000	0.55	
E1.003	E4	15 minute 100 year Summer I+40%	7.400	6.713	0.271	0.000	0.64	
E2.000	E5	15 minute 100 year Summer I+40%	7.400	6.937	0.517	0.000	1.74	
E2.001	E5	15 minute 100 year Summer I+40%	7.400	6.723	0.298	0.000	1.06	
E1.004	E5	15 minute 100 year Summer I+40%	7.400	6.608	0.286	0.000	1.68	
E3.000	E7	15 minute 100 year Summer I+40%	7.750	6.952	0.342	0.000	0.91	
E3.001	E8	15 minute 100 year Summer I+40%	7.450	6.901	0.279	0.000	0.55	
E4.000	E9	15 minute 100 year Winter I+40%	7.600	6.906	0.206	0.000	0.76	
E4.001	E10	15 minute 100 year Summer I+40%	7.600	6.891	0.273	0.000	0.31	
E3.002	E9	15 minute 100 year Summer I+40%	7.600	6.876	0.438	0.000	1.10	
E3.003	E10	15 minute 100 year Summer I+40%	7.600	6.842	0.459	0.000	1.28	
E3.004	E11	15 minute 100 year Summer I+40%	7.600	6.811	0.500	0.000	1.34	
E5.000	E15	15 minute 100 year Summer I+40%	7.500	6.794	0.144	0.000	0.50	

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status
E1.000	E1		8.8	SURCHARGED
E1.001	E2		11.8	SURCHARGED
E1.002	E3		24.3	SURCHARGED
E1.003	E4		28.4	SURCHARGED
E2.000	E5		28.3	SURCHARGED
E2.001	E5		47.9	SURCHARGED
E1.004	E5		77.1	SURCHARGED
E3.000	E7		11.6	SURCHARGED
E3.001	E8		25.7	SURCHARGED
E4.000	E9	13	11.1	SURCHARGED
E4.001	E10		16.2	SURCHARGED
E3.002	E9		36.2	SURCHARGED
E3.003	E10		48.3	SURCHARGED
E3.004	E11		50.2	SURCHARGED
E5.000	E15		11.4	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Existing

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
E3.005	E12	15 minute 100 year Winter I+40%	7.500	6.787	0.581	0.000	0.36
E3.006	E15	15 minute 100 year Summer I+40%	7.500	6.792	0.658	0.000	0.36
E1.005	ETank 1	15 minute 100 year Summer I+40%	7.300	6.510	0.610	0.000	0.84
E1.006	EHydrobrake	960 minute 100 year Summer I+40%	7.400	6.032	0.117	0.000	0.26

PN	US/MH Name	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
E3.005	E12		56	13.8	SURCHARGED
E3.006	E15			12.5	SURCHARGED
E1.005	ETank 1		72	11.8	SURCHARGED
E1.006	EHydrobrake			10.0	SURCHARGED

17. APPENDIX F THAMES WATER FOUL CAPACITY CHECK

Miss G Bertram
Webb Yates Eng
48-50 Scrutton St
Hackney London EC2A 4HH

Our ref: DS6081327

0800 009 3921
Monday to Friday, 8am to 5pm

19th Feb 2021

Pre-planning enquiry: Wastewater Capacity check

Dear Miss Bertram

Thank you for providing details of your development with the Pre-Planning application dated 11th Feb 21 for development @ Twickenham Riverside Wharf Ln The Embk Water Ln Twick TW1 3SG

Brownfield site developed to {49Flats+404m2 Offices+1044m2 Comm. area } as detailed in your above application.

We have completed the current assessment of the foul water flows & surface water discharges based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network, in liaison with TW Asset Planners.

Foul

If your proposals progress in line with the details you've provided as above, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent TW sewer network to serve your foul discharges from your proposed development, provided its by gravity, to TW foul sewer network as detailed in your application.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity and has to be investigated again.

Surface Water

When developing a site, policy 5.13 of the London Plan and Policy 3.4 of the Supplementary Planning Guidance (Sustainable Design And Construction) states that every attempt should be made to use flow attenuation and SuDS/Storage to reduce the surface water discharge from the site as much as possible.

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
3. attenuate rainwater in ponds or open water features for gradual release.
4. attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. discharge rainwater direct to a watercourse.;; *and if above cannot be achieved*
6. discharge rainwater to a surface water sewer/drain.
7. discharge rainwater to the combined sewer.
8. discharge rainwater to the foul sewer

Where connection to the public sewerage network is still required after examining the hierarchy {1-5} to manage surface water flows we will accept these flows at a discharge rate in line with ***CIRIA's best practice guide on SuDS or that stated within the sites planning approval.***

We note that you are using SUDS and discharging most surface water to the River. The rest should be attenuated and discharged as per your application.

Please see the attached 'Planning your wastewater' leaflet for additional information. At the appropriate time, you will have to apply for a S106 connection application to DS Connection team

Source Protection Zone

Please check whether your development falls within a Source Protection Zone for groundwater abstraction. These zones may be at particular risk from polluting activities on or below the land surface. To prevent pollution, the Environment Agency and Thames Water (or other local water undertaker) will use a tiered, risk-based approach to regulate activities that may impact groundwater resources. The applicant is encouraged to read the Environment Agency's approach to groundwater protection (available at https://www.gov.uk/government/publications/ groundwater-protection-position-statements) and may wish to discuss the implications for their development with a suitably qualified environmental consultant.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

Please note that you must keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient sewerage capacity.

What happens next?

Please make sure you submit your connection application, when you are ready, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me.

Yours sincerely

Sgd: *Siva.sivarajan*

Siva Sivarajan

Developer Services- Wastewater Adoptions Engineer

Office:0203 577 7752 Mobile: 07747842608
siva.sivarajan@thameswater.co.uk

Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, Berkshire, RG1 8DB
Find us online at developers.thameswater.co.uk

TW Int ref;DTS65539

18. APPENDIX G SUDS PROFORMA

LONDON BOROUGH OF RICHMOND UPON THAMES

GREATER**LONDON**AUTHORITY

LoDEG

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	Twickenham Riverside
Address & post code	TW1 3DX
OS Grid ref. (Easting, Northing)	E 516321
	N 173177
LPA reference (if applicable)	
Brief description of proposed work	Existing park,buildings and carpark to be removed to allow 2 multistory buildings. Work will involve relocation of the flood defence structure and relandscaping.
Total site Area	13400 m^2
Total existing impervious area	10253 m^2
Total proposed impervious area	10048 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	yes, within critical drainage area
Existing drainage connection type and location	Refer to Section 7.4
Designer Name	Georgia Bertram
Designer Position	Civil Engineer
Designer Company	Webb Yates Engineers

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Langley Silt Member- Clay and Silt.
Bedrock geology classification	London Clay formation
Site infiltration rate	1.86x10-5 m/s
Depth to groundwater level	2.4 to 12.24 m below ground level
Is infiltration feasible?	Partial

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	N	N
2 use infiltration techniques, such as porous surfaces in non-clay areas	Y	Y
3 attenuate rainwater in ponds or open water features for gradual release	Y	Y
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	Y	Y
6 discharge rainwater to a surface water sewer/drain	Y	Y
7 discharge rainwater to the combined sewer.	N	N

2c. Proposed Discharge Details

Proposed discharge location	xisting surface water pipe, direct to Thames
Has the owner/regulator of the discharge location been consulted?	Yes.

LONDON BOROUGH OF RICHMOND UPON THAMES

GREATERLONDONAUTHORITY

LoDEG

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	2.04			
1 in 1	1.73	21.7	30	
1 in 30	4.68	47.3	57	10
1 in 100	6.49	61.3	72	10
1 in 100 + CC			108	10
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Hydrobrake		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	37	0	0.185
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	1516	0	0
Pervious pavements	0	0	0
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	2320		114
Total	**3873**	**0**	**114.185**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Phase 1 and Phase 2 – Site Investigation Report completed by Geosphere Environmental 19/11/2020, report reference: 4955,GI/GROUND/ PC,SG,JD,19-11
Drainage hierarchy (2b)	J3932-C-RP-0001_03_S3 Table 10
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Appendix C
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Section 7, Appendix E
Proposed SuDS measures & specifications (3b)	Section 7.2
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Section 5
Detailed drainage design drawings, including exceedance flow routes	Section 7.5 and Appendix B
Detailed landscaping plans	Appendix B
Maintenance strategy	Section 9
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Section 7.6
b) biodiversity?	Refer to Landscape Architect Repor
c) amenity?	Refer to Landscape Architect Repor