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Flood risk, water and environment

Flood Risk Assessment and Surface Water Drainage Strategy AEG0786_TW11_Teddington_07

Site Address: High Wigsell
35 Twickenham Road
Teddington
TW11 8AH

UK Experts in Flood Modelling, Flood Risk Assessments, and Surface Water Drainage Strategies

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Document Issue Record

Project: Flood Risk Assessment and Surface Water Drainage Strategy

Prepared for: Jonathan Foster Kenny

Reference: AEG0786_TW11_Teddington_07

Site Location: High Wigsell, 35 Twickenham Road, Teddington, TW11 8AH

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Please Note:

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Summary

Development Description	Existing	Proposed
Development Type	Garages	Demolition of existing garages and construction of two houses.
EA Vulnerability Classification	Less Vulnerable	More Vulnerable
Ground Floor Level	Approximately 8.64m AOD to 8.92m AOD based on 1m LiDAR	Approximately 6.50m AOD to 8.92m AOD based on client plans showing lower ground floor approximately 1.17m below street level
Level of Sleeping Accommodation	None	(Upper) Ground Floor
Impermeable Surface Area	Approximately 267m^2	Approximately 210m^2
Surface Water Drainage	N/A[1]	Proposed to attenuate runoff in below ground geocellular crate systems prior to discharging into Thames Water surface water sewer at 1 l/s (as close to greenfield rates as practical).
Site Size	Approximately 267m^2	No change
Risk to Development	**Summary**	**Comment**
EA Flood Zone	Flood Zone 1	
Flood Source	Groundwater	Groundwater
SFRA Available	London Borough of Richmond SFRA[1] (2021)	
Management Measures	**Summary**	**Comment**

[1] https://www.richmond.gov.uk/media/20529/sfra_level_1_report.pdf

Ground floor level above extreme flood levels	Yes	Site in Flood Zone 1 and outside modelled 1:1000 year pluvial extent. Also as per Stephen Buss Environmental Consulting Ltd Report Ref 2022-089-003-001: "*It is expected that there will always be at least 2.75 m clearance between the water table and the lower ground floor.*"
Safe Access/Egress Route	Yes	Safe access/ egress should be possible in modelled 1:1000 year event due to low hazard ratings.
Flood Resilient Design	Yes	Section 5 of this report
Site Drainage Plan	Yes	Proposed to attenuate runoff in below ground geocellular crate systems prior to discharging into Thames Water surface water sewer at 1 l/s (as close to greenfield rates as practical).
Flood Warning & Evacuation Plan	N/A[1]	N/A[1]
Offsite Impacts	**Summary**	**Comment**
Displacement of floodwater	None	Site in Flood Zone 1 and outside modelled 1:1000 year pluvial extent.
Increase in surface run-off generation	Negligible	Proposed to attenuate runoff in below ground geocellular crate systems prior to discharging into Thames Water surface water sewer at 1 l/s (as close to greenfield rates as practical).
Impact on hydraulic performance of channels	None	Development should not impact watercourses

[1] not required for this assessment

[2] data not available.

1. Introduction

1.1. Aegaea were commissioned by Jonathan Foster Kenny to undertake a Flood Risk Assessment (FRA) and Surface Water Drainage Strategy (SWDS) to facilitate a planning application for the proposed development. This FRA has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance.

1.2. This report is intended to support a full planning application and as such the level of detail included is commensurate and subject to the nature of the proposals.

Site Overview

1.3. The site of the proposed development is High Wigsell, 35 Twickenham Road, Teddington, TW11 8AH (Figure 1). The site is currently a row of garages.

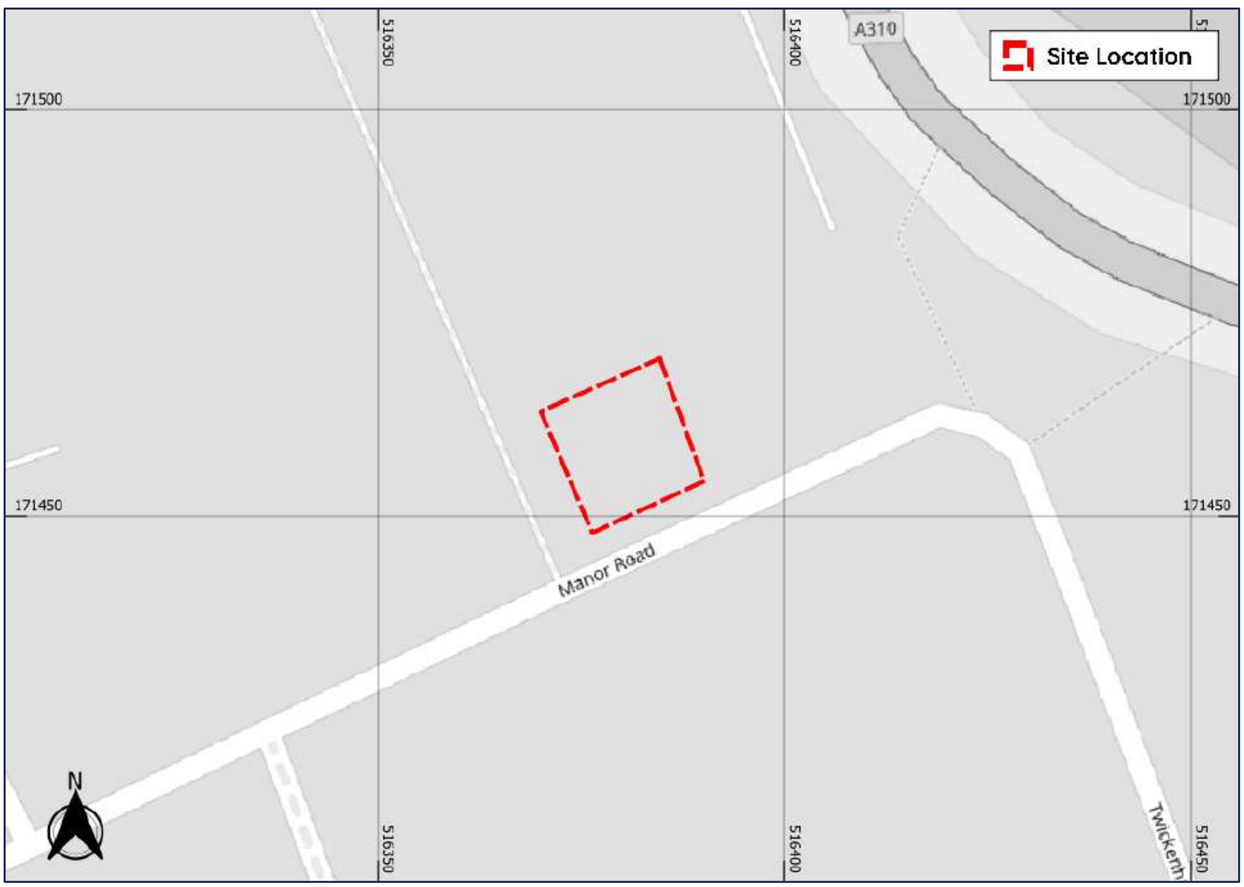

Figure 1: Site Location (Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors)

1.4. The proposed development is for the demolition of the existing garages and the construction of two houses. See proposed plans in Appendix A. The proposed development will provide residential accommodation at the lower ground floor level with garden spaces at the lower ground floor. Proposed section drawings provided by the client indicate that the proposed lower ground floor will be set approximately 1.17m below street level (and 3m below upper ground floor level).

1.5. In the absence of a topographical survey, Environment Agency Light Detection and Ranging (LiDAR) data Digital Terrain Model (1m resolution) has been utilised to review the topography of the site (Figure 2). The LiDAR data shows the ground elevation of the site to vary between approximately 8.64 metres Above Ordnance Datum (mAOD) to 8.92mAOD (2m LiDAR data).

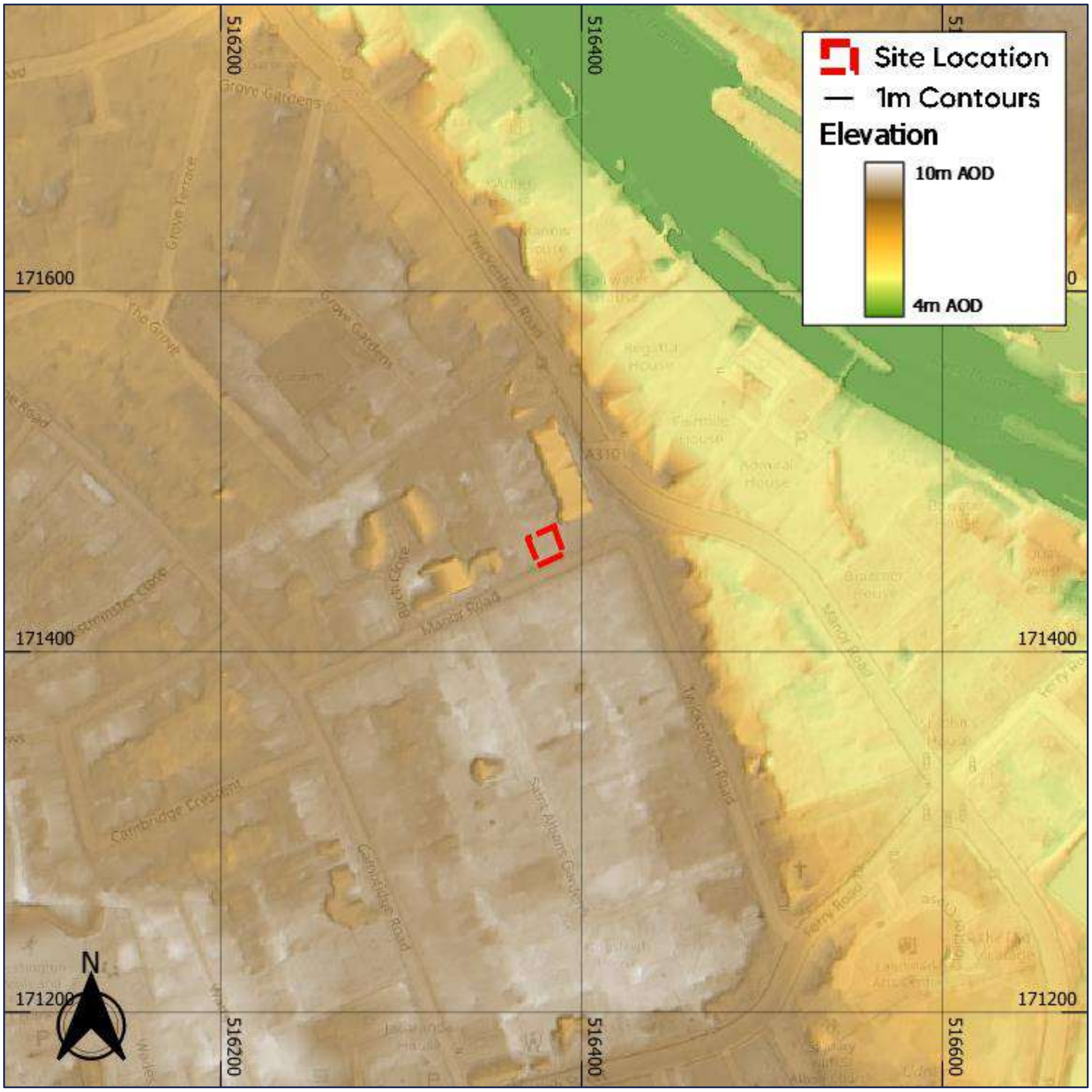

Figure 2: Site Topography (Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors)

1.6. Richmond Council is the Local Planning Authority (LPA) for the site, and also the designated Lead Local Flood Authority (LLFA). The site sits within the Environment Agency's Kent South London and East Sussex region.

Planning Policy and Guidance

1.7. UK government planning guidance states[2] that an FRA is required for sites which are:

- *In Flood Zone 2 or 3 including minor development (in terms of flood risk) and change of use*
- *More than 1 hectare in Flood Zone 1*
- *Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than river and the sea (for example surface water drains or reservoirs)*
- *In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency*

1.8. The site is located within Flood Zone 1. However, we understand that the LPA have identified the site to be in an area at risk of groundwater flooding.

1.9. The objective of this FRA is to demonstrate that the proposals are acceptable in terms of flood risk. This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Fluvial/ tidal flood risk
- Surface water flood risk
- Risk of flooding from other sources

[2] **https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications#when-you-need-an-assessment**

2. Planning Policy

National Planning Policy Framework

2.1. Inappropriate development in a flood risk area could pose significant risk in terms of personal safety and damage to property for the occupiers of the development or for people elsewhere. The approach taken in the assessment of flood risk at the planning stage is set out in national, regional, and local planning policy and associated guidance. This section summarises the key policies and guidance relevant to the proposed development.

2.2. The National Planning Policy Framework[3] (NPPF) (DLUHC, 2021) which includes UK Government policy on development and flood risk states:

> *"159. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.*
>
> *167. 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. 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;*

[3] https://www.gov.uk/guidance/national-planning-policy-framework, **last updated July 2021**

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.

2.3. Footnote 55 of the NPPF states:

"A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use."

2.4. Flood Zones in England are defined as follows:

Table 1: Flood Zone Definitions

Flood Zone	Definition
Zone 1 Low Probability	Land having less than 1 in 1,000 annual probability of river or sea flooding (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.
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.
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)

2.5. An FRA should be appropriate to the scale, nature, and location of the development. It should identify and assess the risk from all sources of flooding to and from the development and demonstrate how any flood risks will be managed over the lifetime of the development.

2.6. An assessment of hydrological impacts should be undertaken, including to surface water runoff and impacts to drainage networks in order to demonstrate how flood risk to others will be managed following development and taking climate change into account.

Local Plan

2.7. The Local Plan prepared by the Local Planning Authority, Richmond Council, sets out the policies for development in the local area.

2.8. Policy LP 21 Flood Risk and Sustainable Drainage outlines the requirements for new development within the area. It states:

> *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.*

The London Plan

2.9. The London Plan (2021)[4] provides an 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. The proposed development lies within the jurisdiction of the London Plan and therefore should consider the policies contained within the document. Policy SI 12, quoted below, contains guidance on flood risk management and sustainable drainage;

> *Policy SI 12 Flood risk management*

[4] **https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf**

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.

Policy SI 13 Sustainable drainage

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:

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

2) rainwater infiltration to ground at or close to source

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

4) rainwater discharge direct to a watercourse (unless not appropriate)

5) controlled rainwater discharge to a surface water sewer or drain

6) controlled rainwater discharge to a combined sewer.

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.

Sequential and Exception Tests

2.10. The Sequential and Exception Tests are applied in specific cases defined by UK Government policy. Their purpose is to drive development to areas of low flood risk and to support developments which improve flood risk for developments in areas at risk of flooding.

Sequential Test

2.11. The proposed development site is located in Flood Zone 1 (low risk from fluvial and tidal flooding). The proposed footprint is also sequentially located on site to be outside the modelled 1:1000 year pluvial extent. As such, the proposed development is considered to be sequentially located with regards to fluvial, tidal and pluvial flooding.

Exception Test

2.12. The Exception Test is applied to sites based on the Flood Zone and the nature of the development. As the proposed development consists of a number of residential dwellings it would be classed as 'More Vulnerable' in line with government development use classes.

2.13. The Flood Risk Vulnerability Classification table[5] provided below in Table 2 shows which vulnerabilities are appropriate in each Flood Zone.

2.14. Table 2 shows Flood Zone 1 is an appropriate location for 'More Vulnerable' uses without the need for an Exception Test.

Table 2: Flood Risk Vulnerability Classification

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	x	Exception Test required	✓	✓
Zone 3b	Exception Test required	x	x	x	✓

Summary

2.15. This flood risk assessment has been prepared with due consideration to the above local and national policy.

5 https://www.gov.uk/guidance/flood-risk-and-coastal-change#table2

3. Sources of Information

Documents and Online Mapping

3.1. Local Governments and Lead Local Flood Authorities provide documents which contain data and policies on flood risk and new development in their areas. These documents are introduced and briefly summarised below. For the purposes of this FRA, these documents have been reviewed for relevant information and any relevant data is discussed within the appropriate sub heading of this report.

3.2. The following sources of information have been reviewed for this assessment:

- Flood Map for Planning on the Environment Agency website *https://flood-map-for-planning.service.gov.uk/*
- Long Term Flood Risk Information on the Environment Agency website *https://www.gov.uk/check-long-term-flood-risk*
- National Planning Policy Framework (NPPF) (Department for Levelling Up, Housing and Communities, 2021)
- Planning Practice Guidance - Flood Risk and Coastal Change (Department for Levelling Up, Housing and Communities, 2022)
- Geoindex Onshore (British Geological Survey, 2022)
- Local Plan[6] (Richmond Council, 2018)
- Preliminary Flood Risk Assessment (Richmond Council, 2011)
- Level 1 Strategic Flood Risk Assessment (Richmond Council, 2021)

Preliminary Flood Risk Assessment (PFRA)

3.3. The PFRA, published in 2011, is a high-level appraisal of flood risk across Lead Local Flood Authority Richmond Council. The flood risk from all sources, including fluvial, surface water,

[6] **https://www.richmond.gov.uk/services/planning/planning_policy/local_plan/local_plan_review**

groundwater and surcharged sewers is evaluated. It is the basis upon which the Local Flood Risk Management Strategy (described below) is produced.

3.4. The PFRA summarises historical flood incidents in Richmond Council. The site is not recorded as having been affected by any flood event.

Strategic Flood Risk Assessment (SFRA)

3.5. The SFRA, published in 2021, provides the evidence base for the Local Planning Authority Richmond Council Local Plan and guidance for consideration when determining planning applications. The SFRA seeks to place new development into areas of lower flood risk taking into account current flood risk, future flood risk, and the effect a proposed development would have on the risk of flooding.

3.6. The SFRA mapping provided by Richmond Council has been used throughout production of this report as a source of information, particularly pertaining to historical flood incidents.

4. Sources of Flood Risk

Fluvial and Tidal Flood Risk

4.1. Flooding from watercourses arises when flows exceed the capacity of the channel, or where a restrictive structure is encountered, resulting in water overtopping the banks into the floodplain.

Main Rivers and Ordinary Watercourses

4.2. The nearest watercourse to the site is the River Thames (EA Main River), located approximately 170m east of the site. There are no other watercourses in the vicinity of the site.

EA Flood Map for Planning

4.3. The EA Flood Map for Planning (Figure 3) indicates that the site is in Flood Zone 1 (low risk of tidal and fluvial flooding) with a less than 1 in 1000 chance of annual fluvial or tidal flooding in any year.

Figure 3: EA Flood Map for Planning

Modelled Flood Data

4.4. The EA have previously provided Product 6 outputs from their Lower Thames (2019) fluvial model, and Upriver Defence Breach (2017) tidal breach modelling study.

4.5. These outputs indicate that the site would remain unaffected in the modelled 1:100 year +CC (25%) fluvial event on the Thames (Figure 4 and the modelled 2100 epoch tidal defence breach event (Figure 5).

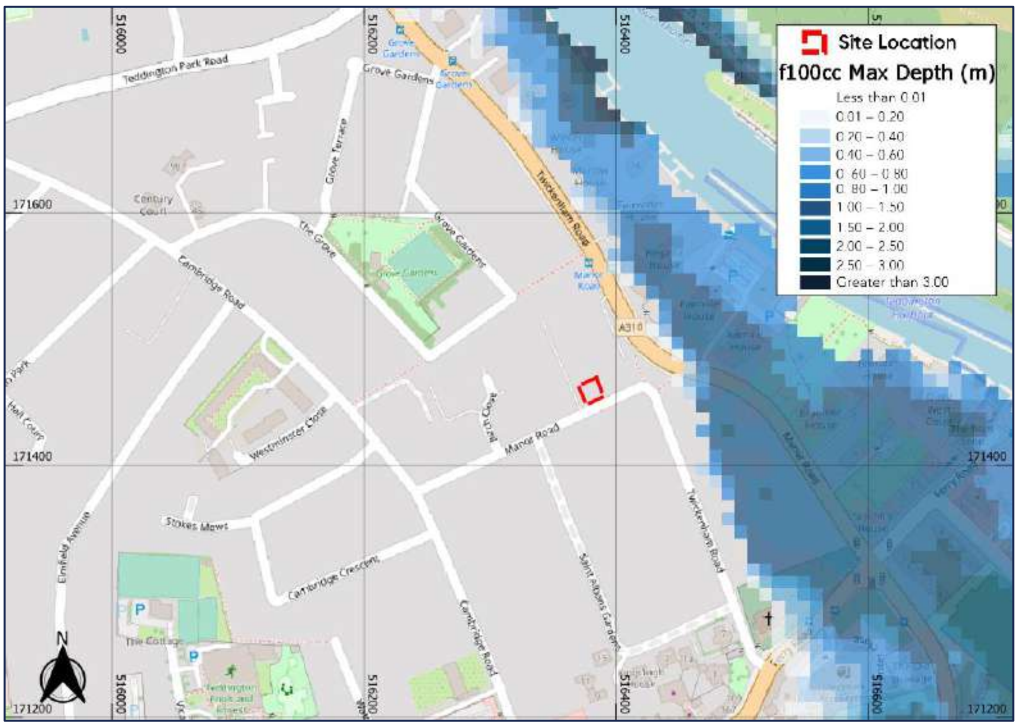

Figure 4: EA Modelled 1:100 year +CC (25%) Fluvial Depths (Sources: © Environment Agency copyright and/or database right 2015. All rights reserved. Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.)

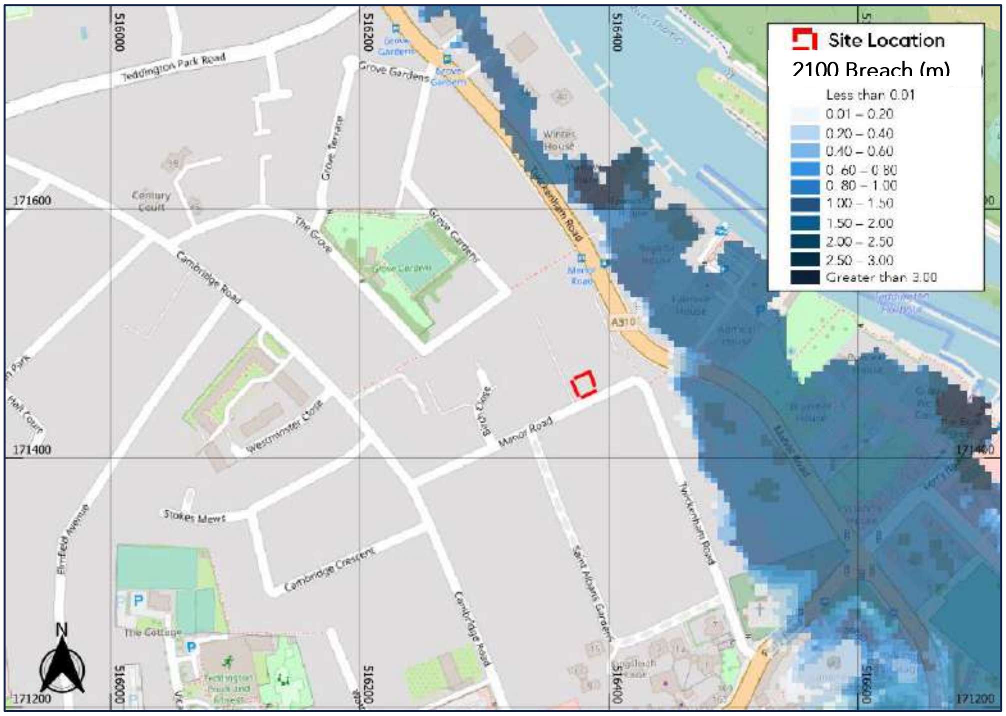

Figure 5: EA Modelled 2100 Tidal Defence Breach Depths (Sources: © Environment Agency copyright and/or database right 2015. All rights reserved. Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.)

Historical Flooding

4.6. The site is not within the recorded flood outlines for any historical tidal or fluvial events held by the EA (Figure 6).

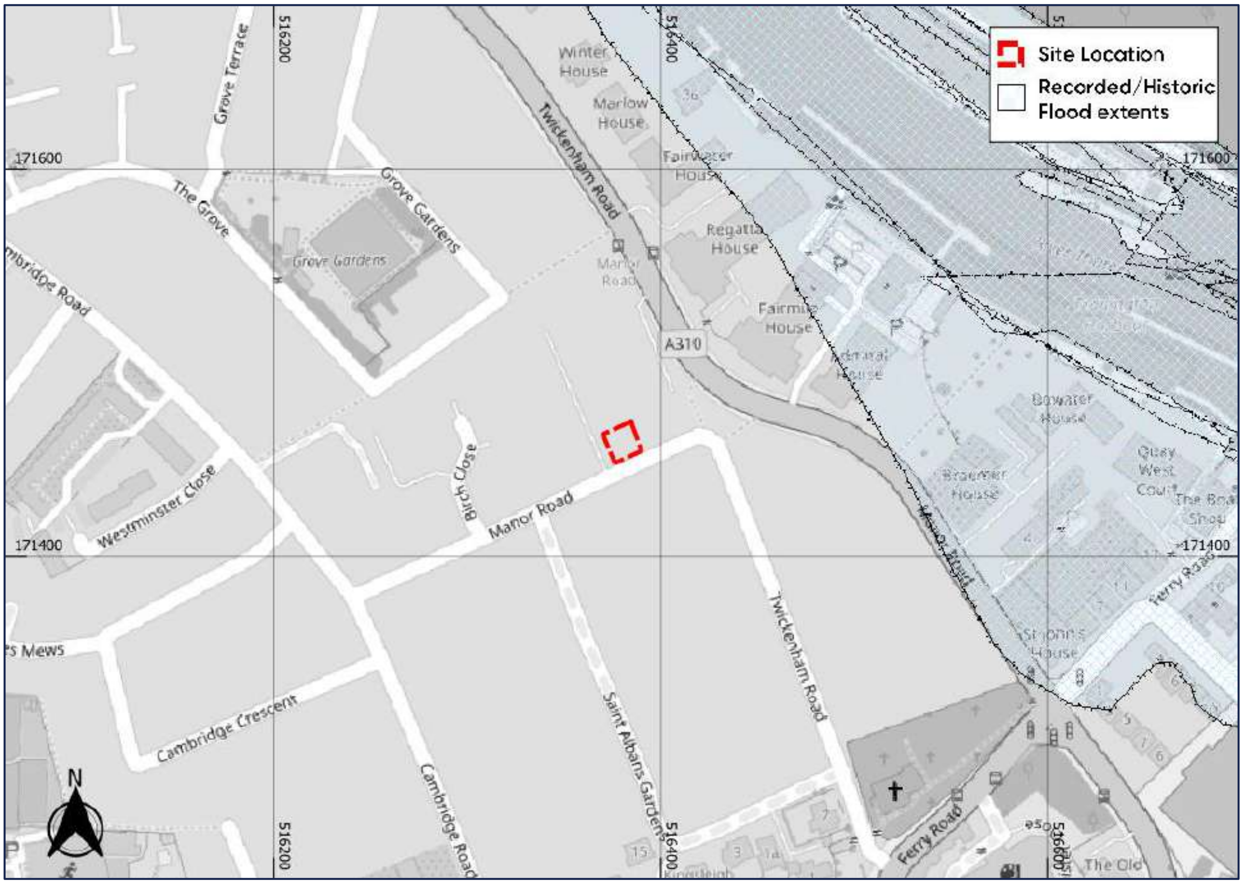

Figure 6: EA Recorded Flood Outlines (Sources: © Environment Agency copyright and/or database right 2015. All rights reserved. Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.)

Summary

4.7. As such, the risk of flooding from fluvial/ tidal sources is considered low.

Canals

4.8. The Canal and River Trust (CRT) generally maintains canal levels using reservoirs, feeders, and boreholes and manages water levels by transferring it within the canal system.

4.9. Water in a canal is typically maintained at predetermined levels by control weirs. When rainfall or other water enters the canal, the water level rises and flows out over the weir. If the level continues rising it will reach the level of the storm weirs. The control weirs and storm weirs are normally designed to take the water that legally enters the canal under normal conditions. However, it is possible for unexpected water to enter the canal or for the weirs to become obstructed. In such instances the increased water levels could result in water overtopping the towpath and flowing onto the surrounding land.

4.10. Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.

4.11. There are no canals within 1km of the site and thus the risk of flooding from this source is considered low.

Pluvial Flood Risk

4.12. Pluvial flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes.

4.13. Examination of EA's Flood Risk from Surface Water mapping for the modelled 3.3% (high risk), 1% (medium risk) and 0.1% (low risk) AEP flood events shows the site is at risk of flooding in 'Very Low' surface water flood events (Figure 7).

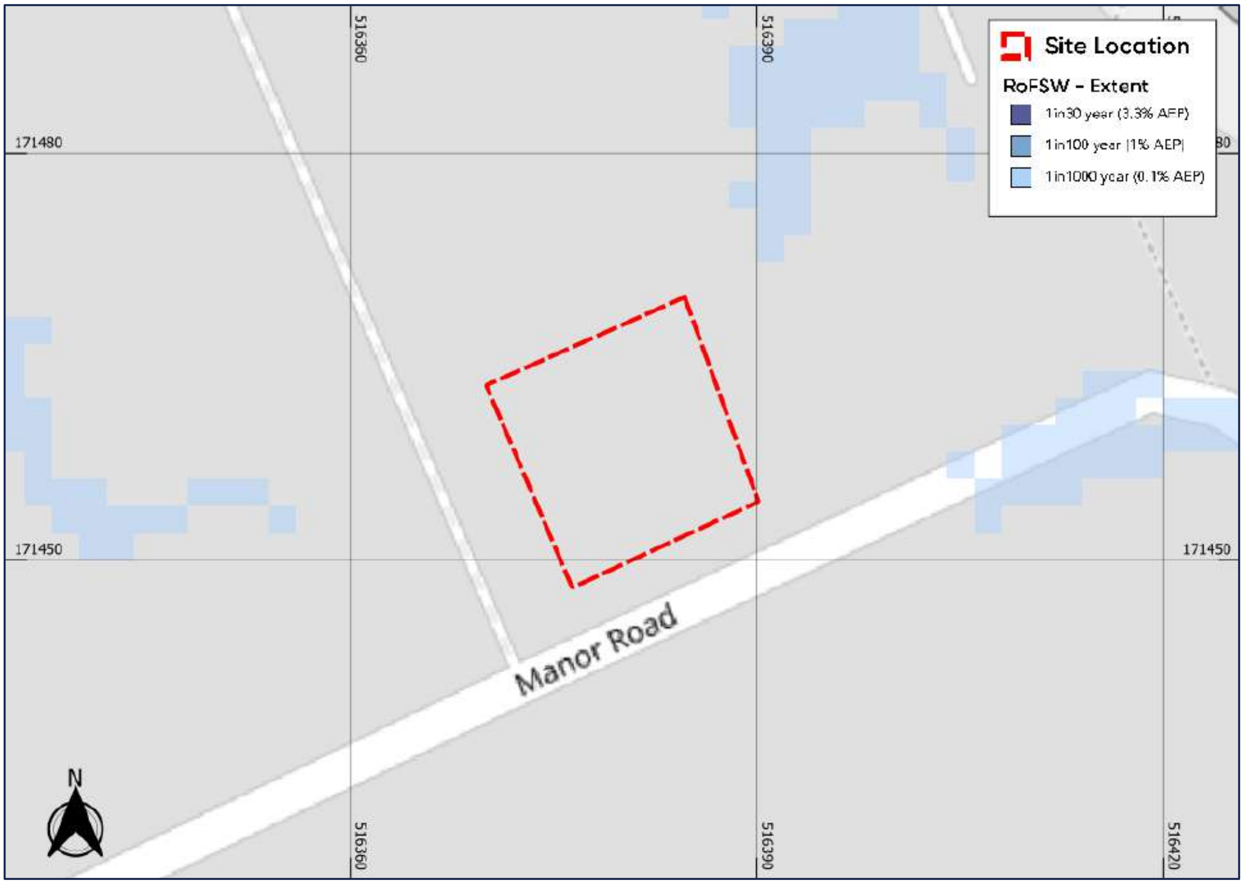

Figure 7: EA Surface Water Flood Risk Mapping (Sources: EA RoFSW, © Environment Agency copyright and/or database right 2015. All rights reserved. Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.)

4.14. As such, the risk of flooding from pluvial sources is considered low.

Reservoirs

4.15. Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.

4.16. According to the EA's Flood Risk from Reservoirs mapping the site is at risk of flooding in the event of a breach at multiple reservoirs. The worst reservoir failure model is a 'wet day' scenario meaning that a flood event would have to occur for there to be enough water to reach the site (Figure 8).

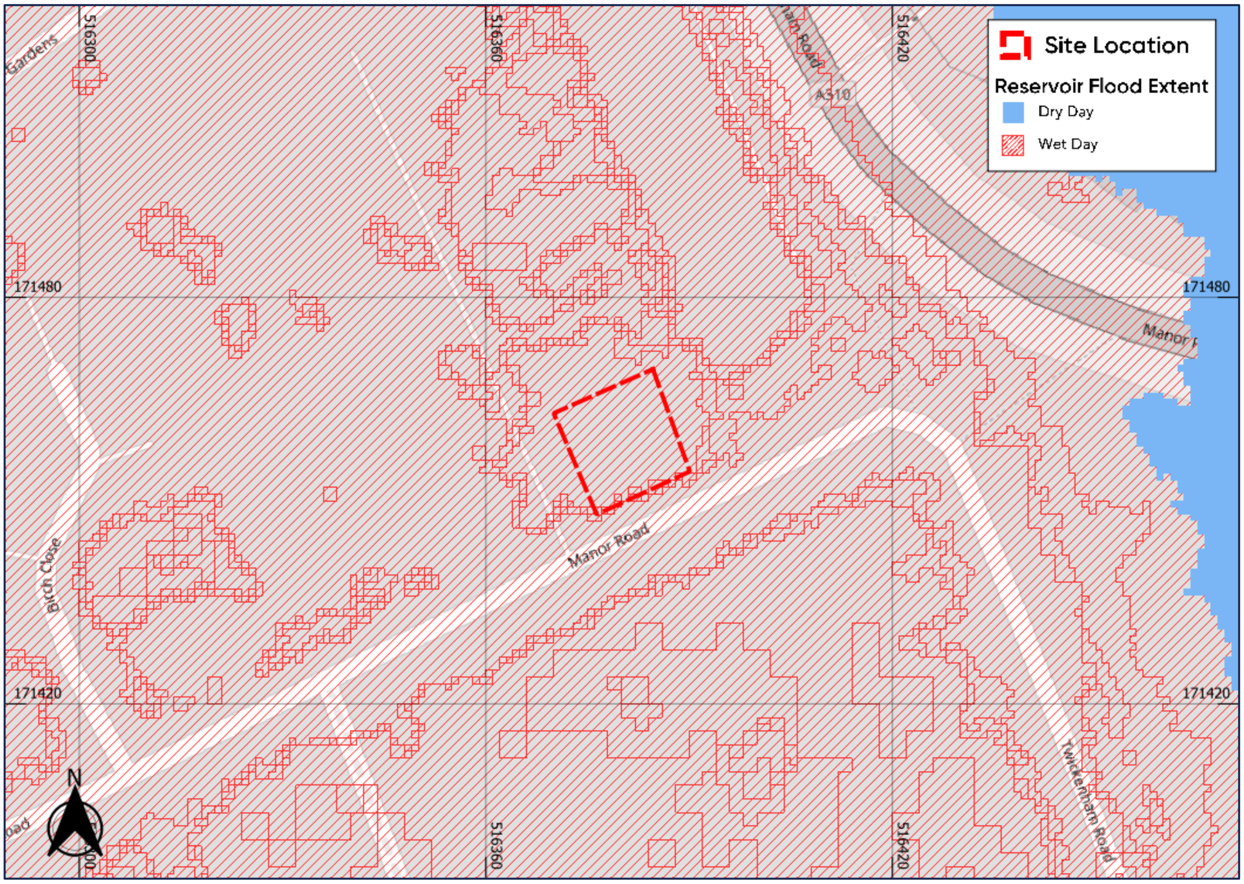

Figure 8: EA Reservoir Flood Risk Mapping (Sources: © Environment Agency copyright and/or database right 2015. All rights reserved. Base map and data from OpenStreetMap and OpenStreetMap Foundation (CC-BY-SA). © https://www.openstreetmap.org and contributors.)

4.17. As reservoirs are highly managed the maximum flood extent provided in the EA Risk of Flooding from Reservoir mapping is considered a worst case scenario. Therefore, given these criteria the site is deemed at a low risk of flooding from this source. Although to be precautionary flood resilient design and building practices could be implemented to further reduce risk.

Groundwater

4.18. Groundwater flooding occurs in areas where underlying geology is permeable and water can rise within the strata sufficiently to breach the surface.

4.19. The British Geological Survey's (BGS) mapping shows superficial deposits of Kempton Park Gravel Member comprising sand and gravel underlying the site. The bedrock underlying the area is mapped as London Clay comprising clay and silt.

4.20. A Groundwater Flooding Risk Assessment (GFRA) has been produced by Stephen Buss Environmental Consulting Ltd (SBEC) – Ref 2022-089-003-001 (18/11/2022). The full report can be found in Appendix B of this report.

4.21. The SBEC report produced a conceptual site model based on the mapped geological conditions. The SBEC report states:

> *There is a groundwater body within the gravels beneath the site. A local borehole log indicates that the water table was at about 4.0 m AOD in May 1988 (Section 2.3). This was probably not the highest seasonal level: by comparison with typical groundwater level ranges for London gravels in CIRIA (1993)6, the peak groundwater level might be expected to be perhaps 0.2 to 0.3 m higher at its peak.*
>
> *The seasonal peak groundwater level is therefore expected to be about 4.3 m AOD. But the floor level of the lower ground floor is to be about 1.05 m below pavement level (8.5 m AOD), i.e. about 7.45 m AOD. Therefore it is anticipated that there will always be at least 3.15 m between the water table and the base of the lower ground floor.*
>
> *Groundwater flooding that occurs upon low permeability bedrock tends to be related to the transmission of high river levels into adjacent permeable superficial deposits (i.e. sands and gravels). Groundwater flooding in this geological environment occurs separately from river flooding because the groundwater emerges into hollows behind the river banks (i.e. water does not reach the receptor via an overland flow route).*
>
> *Gravel deposits are present beneath Teddington, and specifically beneath the Twickenham Road site. Peak river levels downstream of Teddington Weir are not known but peak levels upstream, during the extremely high flood flows of early 2014, stayed below 5.2 m AOD (Figure 2.3). Even if this upstream level was to propagate through the gravel aquifer to beneath 35 Twickenham Road, there would still be 2.25 m between the water table and the lower ground floor...*
>
> *… Groundwater levels are expected to never reach the bottom of the structure. It is expected that there will always be at least 2.75 m clearance between the water table and the lower ground floor.*

4.22. As such, based on the analysis and conclusions of the SBEC report, the risk of groundwater flooding to the development is considered low.

Sewer Flooding

4.23. Sewers can be a cause of flooding where the drainage network has become overwhelmed, either by blockage or due to local development beyond the designed capabilities of the drainage system.

4.24. The Richmond SFRA web mapping indicates that the site is within an area that has experienced 0 to 10 incidents of sewer flooding based on Thames Water records.

4.25. As such, the risk of flooding from sewers is considered low.

4.26. Any new sewer connection from the site should be agreed with Thames Water and fitted with non-return valves.

5. Flood Risk Mitigation

Fluvial, Tidal and Canals

5.1. Based on the analysis within this report, the risk of flooding from fluvial and tidal sources is considered low and no specific mitigation measures are recommended for this source of flooding.

Pluvial

5.2. Based on the analysis within this report, the risk of flooding from pluvial sources is considered low and no specific mitigation measures are recommended for this source of flooding.

Reservoirs, Groundwater and Sewers

5.3. Flood risk from other sources is considered to be low, therefore mitigation is not required.

5.4. However, given that the proposal seek to create a lower ground floor level it is recommended that the lower ground floor level is constructed from solid (i.e waterproof) materials and is adequately tanked to limit the potential for groundwater ingress.

Increase to Flood Risk Elsewhere

5.5. The proposed development is in Flood Zone 1 and outside the modelled 1:1000 year pluvial extent.

5.6. Based on the SBEC GFRA:

> *Groundwater levels are expected to never reach the bottom of the structure. It is expected that there will always be at least 2.75 m clearance between the water table and the lower ground floor.*

5.7. The proposed development should therefore not result in significant increase in flood risk elsewhere.

6. Surface Water Drainage Strategy

Surrounding Water Environment & Existing Drainage

Geology

6.1. The British Geological Survey's (BGS) mapping shows superficial deposits of Kempton Park Gravel Member comprising sand and gravel underlying the site. The bedrock underlying the area is mapped as London Clay comprising clay and silt.

6.2. No infiltration testing has been carried out at the time of writing.

6.3. The proposed footprint will occupy the majority of the site boundary. As there is a general 5m exclusion zone from building footprints for soakaways, there may not be adequate space on site for soakaway infiltration.

6.4. As such, given the spatial limitations of the site and expected geology/ infiltration rates, soakaway infiltration has been discounted as a method of draining the site for the purposes of this report.

Watercourses

6.5. As identified in Section 4, the nearest main river is the River Thames which is approximately 170m east of the site. An outfall to this watercourse is not considered feasible.

Sewers

6.6. An asset plan has been obtained from Thames Water (Appendix B). An extract is provided in Figure 9 below.

6.7. It can be seen from Figure 9 that there is a 300mm diameter public surface water sewer flowing southwest to northeast below Manor Road/ High Wigsell to a manhole near the junction with Twickenham Road (MH Ref 4410). MH 4410 has a cover level of 8.36m AOD and an invert level of 4.85m AOD (so is 3.51m deep). Upstream of the site, at the junction with Birch Close, there is another manhole however the label is not provided so the cover and invert levels are unknown. Adopting a conservative approach, the proposed drainage strategy has been designed based on the invert level of the downstream manhole 4410, with the invert level of 4.85m AOD.

6.8. A topographic survey should be carried out on site to confirm existing levels (and thus the proposed lower ground floor level should be confirmed). A CCTV survey should also be carried out to determine if there are any outfalls from the site into the Thames Water sewer upstream of MH 4410, and whether these could be reused to avoid the need for a new connection.

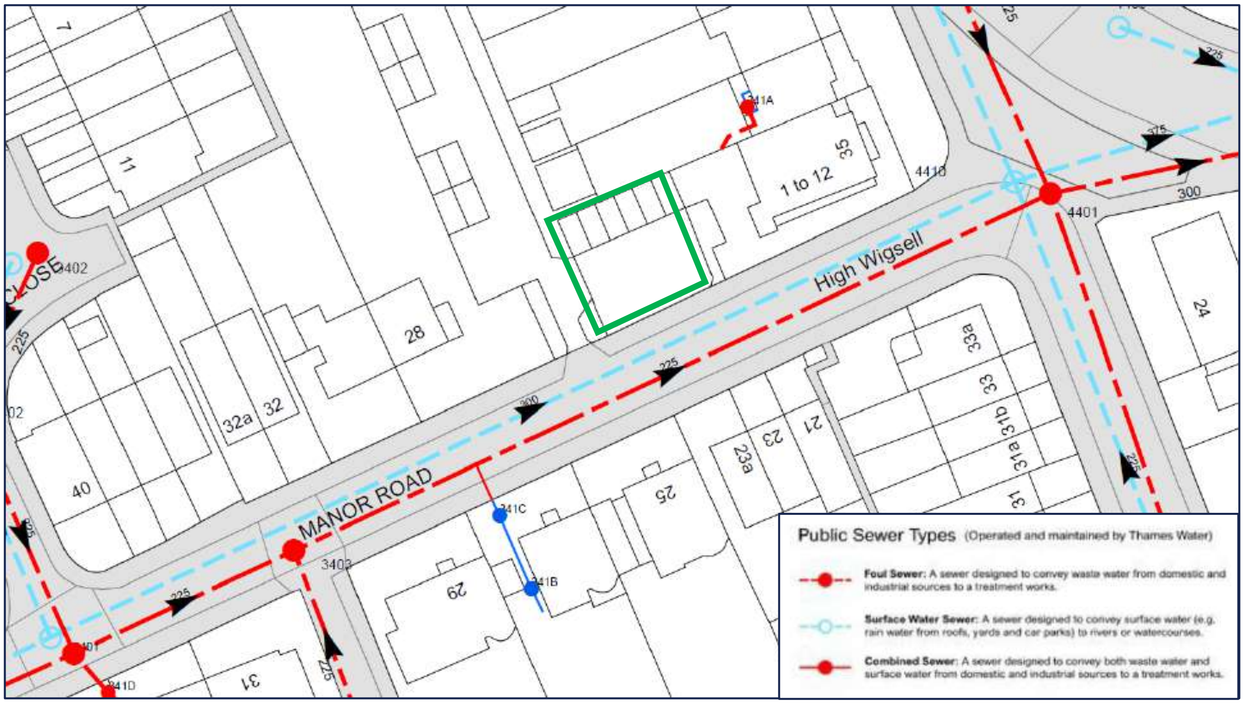

Figure 9: Thames Water Asset Plan

Greenfield Runoff Rates

6.9. Policy SI13 of the 2021 London Plan states:

> *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.*

6.10. As such, it is necessary for runoff rates from the proposed impermeable areas to be restricted to as close to greenfield rates as possible.

6.11. The impermeable areas total approximately 0.021 ha (210m^2) which consists of approximately 0.013 ha roof area and approximately 0.008 ha external paved areas.

6.12. Therefore, greenfield rates have been calculated for the area of 0.021 ha.

6.13. The greenfield runoff rate for the total proposed hardstanding areas has been calculated for each scenario using the IH124 method (via the ICP SuDS variation) within InfoDrainage Software v2023.0.

6.14. The IH124 method was developed as part of the original Flood Studies Report (FSR) in 1975 and was devised to calculate runoff from small catchments by estimating the mean annual flood flow (Qbar) using the following equation:

$$Qbar_{rural} = 0.00108(0.1 \times AREA)0.89 \times SAAR1.17 \times SPR2.17\ m^3/s$$

Where:

$Qbar_{rural}$ is the mean annual flood flow from a rural catchment (approximately 2.3 year return period).

AREA is the area of the hardstanding surfaces in ha.

SAAR is the Standard Average Annual Rainfall for the period 1941 to 1970 in mm

SPR is Standard Percentage Runoff coefficient for the SOIL category. The SOIL category is extracted from UK Winter Rainfall Acceptance Potential (WRAP) map.

6.15. The ICP SuDS variation is a scaled-down version of the IH124 runoff method for estimating peak flow rates from both undeveloped and partly urbanised catchments that are smaller than 50 ha in size, which is appropriate in this instance.

6.16. The parameters used for estimating the greenfield runoff rates for each proposed drainage sub-catchment are presented in Table 3.

Table 3: IH124 Input Parameters

Greenfield runoff rates from the site – simulation criteria	
Rainfall Data	FSR
SAAR	600.0
Area (ha)	0.021
SOIL	0.3
Region	Region 6
Urban %	0

6.17. Table 4 displays the estimated greenfield runoff rates for the proposed impermeable area.

Table 4: Greenfield Runoff Rates

Storm Event	Runoff Rate (l/s)
1:1 Year	0.0
Q_{BAR}	0.0
1:30 Year	0.1
1:100 Year	0.1

6.18. Due to risk of blockage, a 1.0l/s peak discharge has been selected which is as close to greenfield rates as possible.

Surface Water Drainage Strategy

6.19. In accordance with the SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in detail for the development.

6.20. The management of surface water has been considered in respect to the SuDS hierarchy in Table 5 below, as detailed in the CIRIA 753 "The SuDS Manual" (section 3.2.3).

Table 5: SuDS Drainage Hierarchy

SUDS DRAINAGE HIERARCHY			
		Suitability	Comment
1.	Store rainwater for later use	✓	Rainwater harvesting for the proposed development should be considered by a specialist at the detailed design stage. There are opportunities for rainwater harvesting measures to be included in the scheme. Adopting a conservative approach, any storage volume offered by rainwater harvesting has been excluded from the calculations.
2.	Use infiltration techniques, such as porous surfaces in non-clay areas	✓	No infiltration testing has been carried out at the time of writing. Given the mapped underlying geology at the site and the limited space for soakaways, infiltration has been discounted as the primary method of surface water management.
3.	Attenuate rainwater in ponds or open water features for gradual release	x	Limited space on site for above ground SuDS.
4.	Attenuate rainwater by storing in tanks or sealed water features for gradual release	✓	Attenuation can be provided in below ground geocellular crate systems in the proposed garden areas prior to discharging at 1 l/s to the surface water sewer network.
5.	Discharge rainwater direct to a watercourse	x	No watercourses within feasible distance of the site.
6.	Discharge rainwater to a surface water sewer/drain	✓	There is an existing Thames Water surface water sewer adjacent to the site. A new connection may be required from the site subject to Thames Water approval. A CCTV survey should also be carried out to determine if there are any outfalls from the site into the Thames Water sewer upstream of MH 4410, and whether these could be reused to avoid the need for a new connection.
7.	Discharge rainwater to Combined Sewer	x	Public sewers in area are separate surface water and foul, not combined.

6.21. The proposed outline surface water drainage layout for the proposed development can be found in Appendix E of this report.

6.22. It is proposed to attenuate runoff in geocellular crate systems within the garden of each dwelling. Runoff will be restricted via a Hydrobrake to 1.0 l/s, prior to discharging into the Thames Water surface water sewer subject to Thames Water approval.

6.23. A new connection may be required given the nearest manhole is located approximately 50m east of the site. A CCTV survey should also be carried out to determine if there are any outfalls from the site into the Thames Water sewer upstream of MH 4410, and whether these could be reused to avoid the need for a new connection.

6.24. Rainwater harvesting for the proposed development, and SuDS features such as tree pits should be considered by a specialist at the detailed design stage.

InfoDrainage Modelling

6.25. A simplified model has been produced in InfoDrainage software (v 2023.0) whereby inflow catchments representing the proposed roof and hardstanding areas are applied as inflows throughout the network.

6.26. The model comprises;

- 5no. contributing catchment areas across the proposed development area representing roof areas and hardstanding. A 10% allowance for urban creep has been included in the calculations.
- 2no. rainwater geocellular crate systems with 95% porosity.
- 5no. surface water manholes including 1no. Hydro-Brake flow control limited to 1 l/s.

6.27. The Environment Agency Peak Rainfall Climate Change Allowance guidance was reviewed and subsequently the Defra Peak Rainfall Allowances Map was assessed to determine appropriate climate change allowances to inform the surface water drainage strategy. The upper end allowances for the London Management Catchment have been used for both the 1% and 3.3% annual exceedance probability events for the 2070s epoch (40% and 35% respectively for the 1% and 3.3% events).

6.28. The simulation criteria for the InfoDrainage model is set out in Table 6.

Table 6: Simulation Criteria

Catchment Area Simulation Parameters	
Rainfall Data	FSR
M5-60	20.0mm
Total Area (inc 10% UC allowance)	0.023 ha
Ratio R	0.406
Return Periods	1, 30, 30+35% for climate change, 100, 100 +40% for Climate Change. Summer and Winter
Storm Durations	15, 30, 60, 120, 240, 360, 480, 960, 1440 minute
Volumetric Runoff Coefficient	0.900 (summer and winter storms)
Percentage Impervious	100%
Time of Concentration	5 minutes

InfoDrainage Modelling Results

6.29. The full calculation outputs can be found in Appendix D of this report.

6.30. The calculations indicate that in the 1:100 year +CC (40%) critical storm (120 min winter), the maximum resident volumes in both Dwelling 1 and Dwelling 2 Cellular Storage units would be 1.444m^3 per feature. Each tank is sized to provide 1.859m^3 of storage in the InfoDrainage model as per the calculations in Appendix D. Further attenuation is provided within the modelled pipe and chamber networks. No flooding is observed in the 1:100 year +CC (40%) event based on the InfoDrainage model.

6.31. As such, these results indicate that the runoff from the proposed development could be accommodated within a drainage system of the approximate size modelled, with surface water runoff restricted to 1 l/s. Full InfoDrainage results for all return periods and durations can be found in Appendix C.

Maintenance

6.32. Table 7 presents details regarding the maintenance requirements for the proposed SuDS included as part of the development, taken from the CIRIA C753 'The SuDS Manual'. Each manufacturer will have bespoke requirements however the below should be used as a guide. The final manufacturer will also have specific requirements.

Table 7: Maintenance Requirements for Geocellular Systems

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any area 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

Designing for Exceedance

6.33. Periods of exceedance occur when the rate of surface water runoff exceeds the drainage system capacity. Conveyance beneath ground cannot, generally, be economically or sustainably constructed to the scale required for the most extreme rainfall events. This may result, on occasion, in the surface water runoff exceeding the capacity of the drainage network, with excess water (exceedance flow) being conveyed above ground.

6.34. For situations where extreme rainfall intensity exceeds inlet capacities, or for extreme storm events exceeding the design flood event considered for drainage design, surface water would likely drain towards the northeast of the site.

6.35. Exceedance events could result in flooding the lower ground floor external/garden areas. Thresholds should be set 150mm above external levels to mitigate against overland flows in exceedance events.

Water Quality

6.36. In order to protect the downstream receiving water body, a key element of SuDS is that they have the potential to improve the quality of surface water discharged from a site. To assess this, the "Pollution hazard indices for different land use classifications", provided in the CIRIA SuDS Manual (C753) as table 26.2, has been reviewed. The indices use four different methods of assessing pollution potential based on the hazard level, total suspended solids (TSS), Metals, and Hydrocarbons.

6.37. The Pollution Hazard Indices are summarised in Table 8 below (with reference to table 26.3 in the CIRIA SuDS manual). The pollution hazard indices for "residential roofs" have been used.

Table 8: Pollutant Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2	0.2	0.05

6.38. Runoff from residential roofs is generally considered very low contamination risk and does not usually warrant any significant treatment. All downpipes should be fitted with silt traps to reduce the amount of sediment entering the subsurface piped network.

6.39. Gulleys in the car parking spaces should be fitted with oil interceptors to provide treatment of runoff in the trafficked areas.

7. Conclusions

7.1. This report has been undertaken with reference to the requirements of NPPF and Planning Practice Guidance with respect to the development at High Wigsell, 35 Twickenham Road, Teddington, TW11 8AH. It has been written to support a planning application and has been prepared with due consideration to the nature of the proposed development to provide the appropriate level of detail.

7.2. The FRA supports the planning application and demonstrates that there is an acceptable level of flood risk to the site if the mitigation strategies recommended are implemented in the scheme. The development does not increase flood risk off site or to the wider area.

Source of Flooding	Flood Risk Summary
Fluvial, Tidal and Canals	Based on the analysis within this report, the risk of flooding from fluvial and tidal sources is considered low and no specific mitigation measures are recommended for this source of flooding.
Pluvial	Based on the analysis within this report, the risk of flooding from pluvial sources is considered low and no specific mitigation measures are recommended for this source of flooding.
Reservoirs Groundwater Sewers	Flood risk from other sources is considered to be low, therefore mitigation is not required. However, given that the proposal seek to create a lower ground floor level it is recommended that the lower ground floor level is constructed from solid (i.e waterproof) materials and is adequately tanked to limit the potential for groundwater ingress.

7.3. The proposed outline surface water drainage layout for the proposed development can be found in Appendix D of this report.

7.4. It is proposed to attenuate runoff in geocellular crate systems within the garden of each dwelling. Runoff will be restricted via a Hydrobrake to 1.0 l/s, prior to discharging into the Thames Water surface water sewer subject to Thames Water approval.

7.5. A new connection may be required given the nearest manhole is located approximately 50m east of the site. A CCTV survey should also be carried out to determine if there are any outfalls from the site into the Thames Water sewer upstream of MH 4410, and whether these could be reused to avoid the need for a new connection.

7.6. Rainwater harvesting for the proposed development, and SuDS features such as tree pits should be considered by a specialist at the detailed design stage.

7.7. This report should be submitted as part of the planning application to satisfy the requirements under NPPF.

Appendix A - Development Proposals

General Notes

Do not scale from this drawing. Drawings are for the purpose of the stage stated at the base of the drawing and therefore not for construction unless specifically stated. All dimensions to be verified on site prior to construction.

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All structure to Structural Engineer's design.
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Drawings to be read in conjunction with full drawing package issued by Architect and other consultants information.

N

Revision	Date	Description
/	28.09.22	Client Issue
A	14.10.22	Planning Issue

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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RIBA

Project 35 Twickenham Road, TW11 8AH

Title Existing Location Plan

Number 287_33_00

Status Planning **Scale** 1:1250 A3/1:625 A1

0 6.25m 12.5m 25m 62.5m

General Notes

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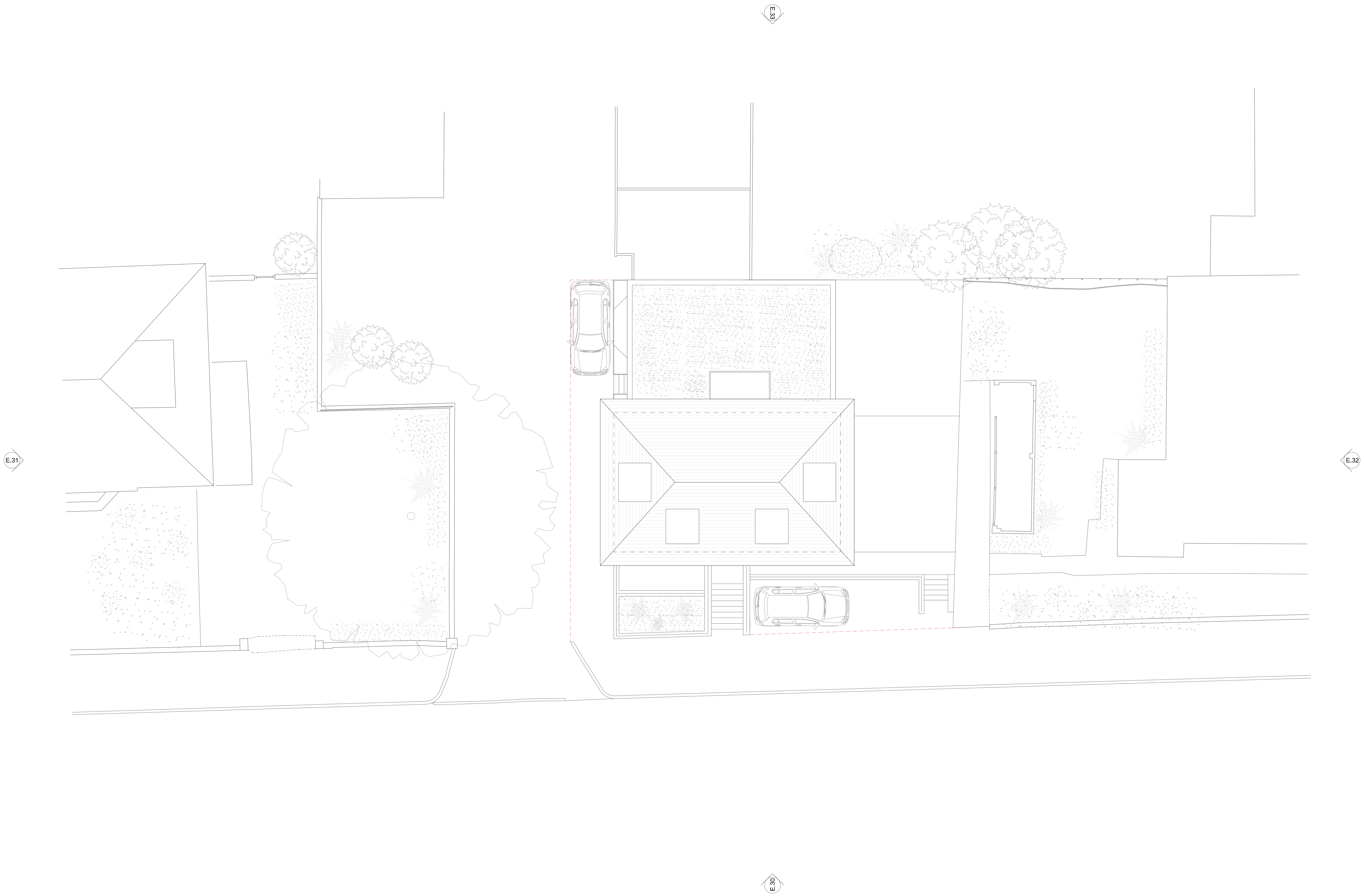

N

Neighbouring Site Boundary

Revision	Date	Description
/	28.09.22	Client Issue
A	14.10.22	Planning Issue

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CHARTERED PRACTICE

Project 35 Twickenham Road, TW11 8AH

Title Proposed Site Plan

Number 287_33_01

Status Planning **Scale** 1:200 A3/1:100 A1

0 1m 2m 4m 10m

General Notes

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A	14.10.22	Planning Issue

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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Project 35 Twickenham Road, TW11 8AH

Title Proposed Lower Ground Floor Plan

Number 287_33_09

Status Planning **Scale** 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

General Notes

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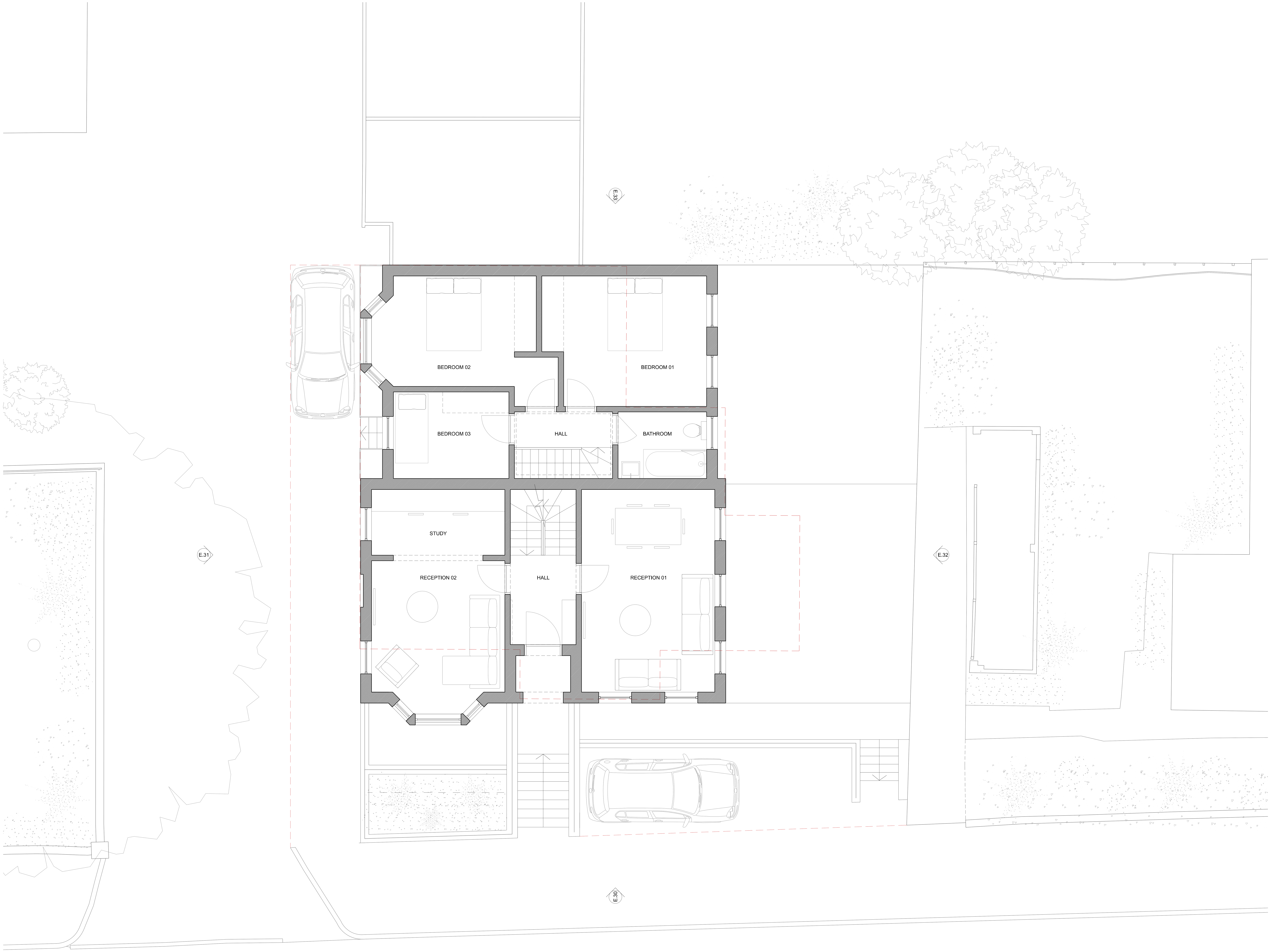

Neighbouring Site Boundary

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Project 35 Twickenham Road, TW11 8AH

Title Proposed Ground Floor Plan

Number 287_33_10

Status Planning **Scale** 1:100 A3/1:50 A1

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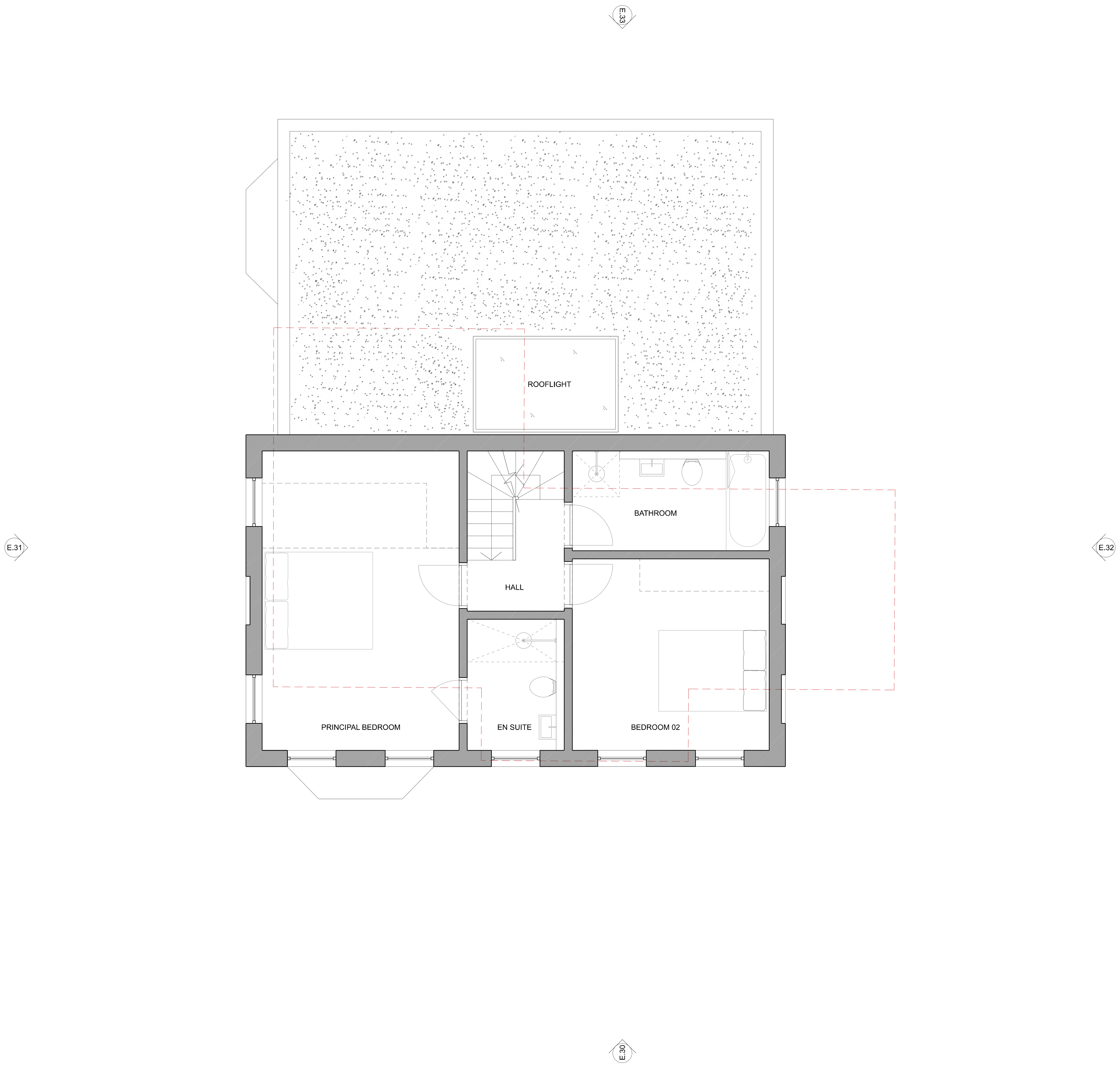

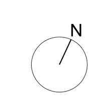

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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Project 35 Twickenham Road, TW11 8AH

Title Proposed First Floor Plan

Number 287_33_11

Status Planning **Scale** 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

General Notes

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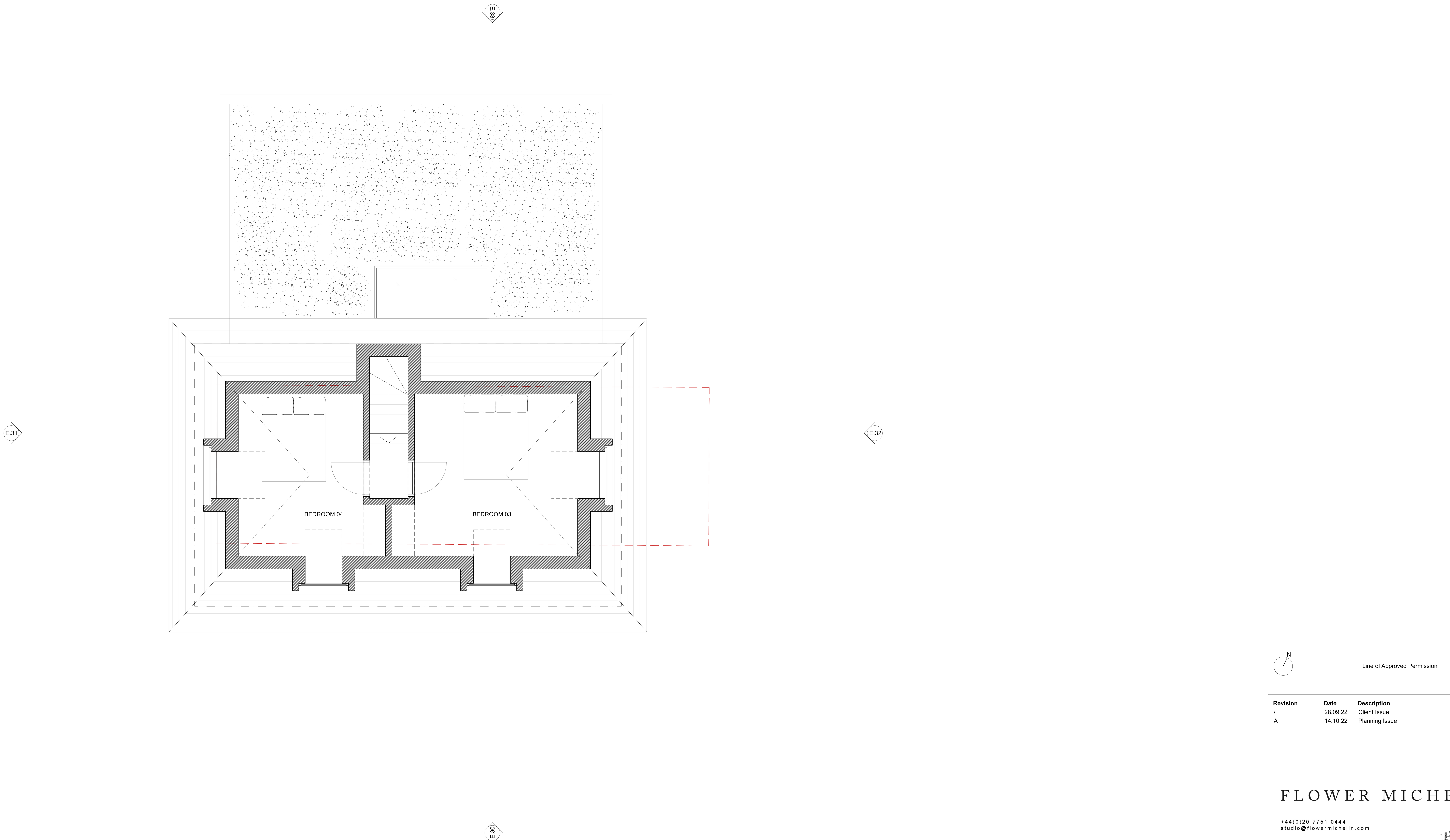

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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Project 35 Twickenham Road, TW11 8AH

Title Proposed Second Floor Plan

Number 287_33_12

Status Planning **Scale** 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

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Project 35 Twickenham Road, TW11 8AH

Title Proposed Roof Plan

Number 287_33_13

Status Planning **Scale** 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

General Notes

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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Project	35 Twickenham Road, TW11 8AH
Title	Proposed Front Elevation
Number	287_33_30
Status	Planning
Scale	1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

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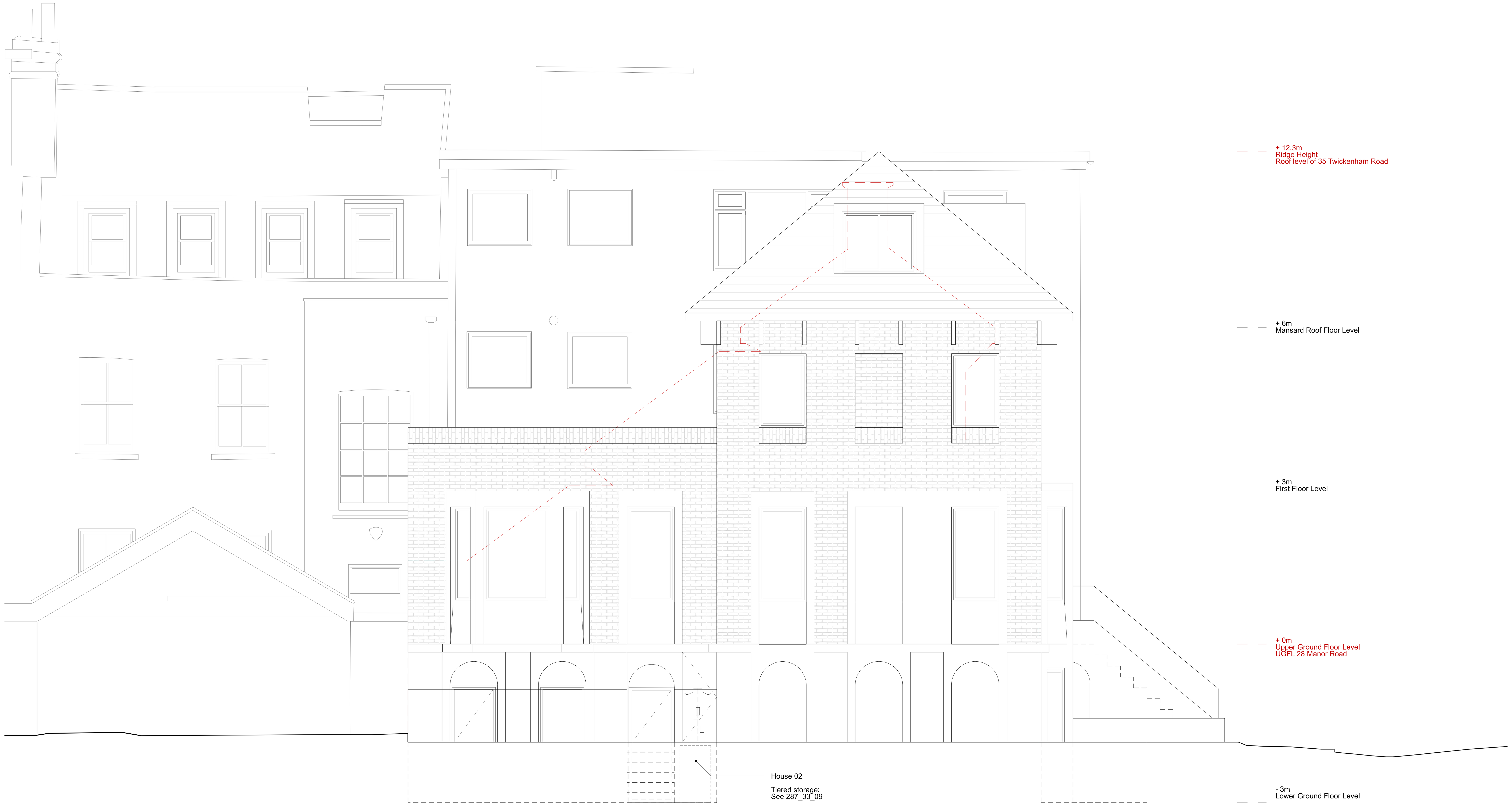

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Unit 7-8,27 Ackmar Road,London,SW6 4UR
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RIBA Chartered Practice

Project 35 Twickenham Road, TW11 8AH

Title Proposed Side Elevation

Number 287_33_31

Status Planning **Scale** 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

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RIBA Chartered Practice

Project 35 Twickenham Road, TW11 8AH

Title Proposed Side Elevation

Number 287_33_32

Status Planning

Scale 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

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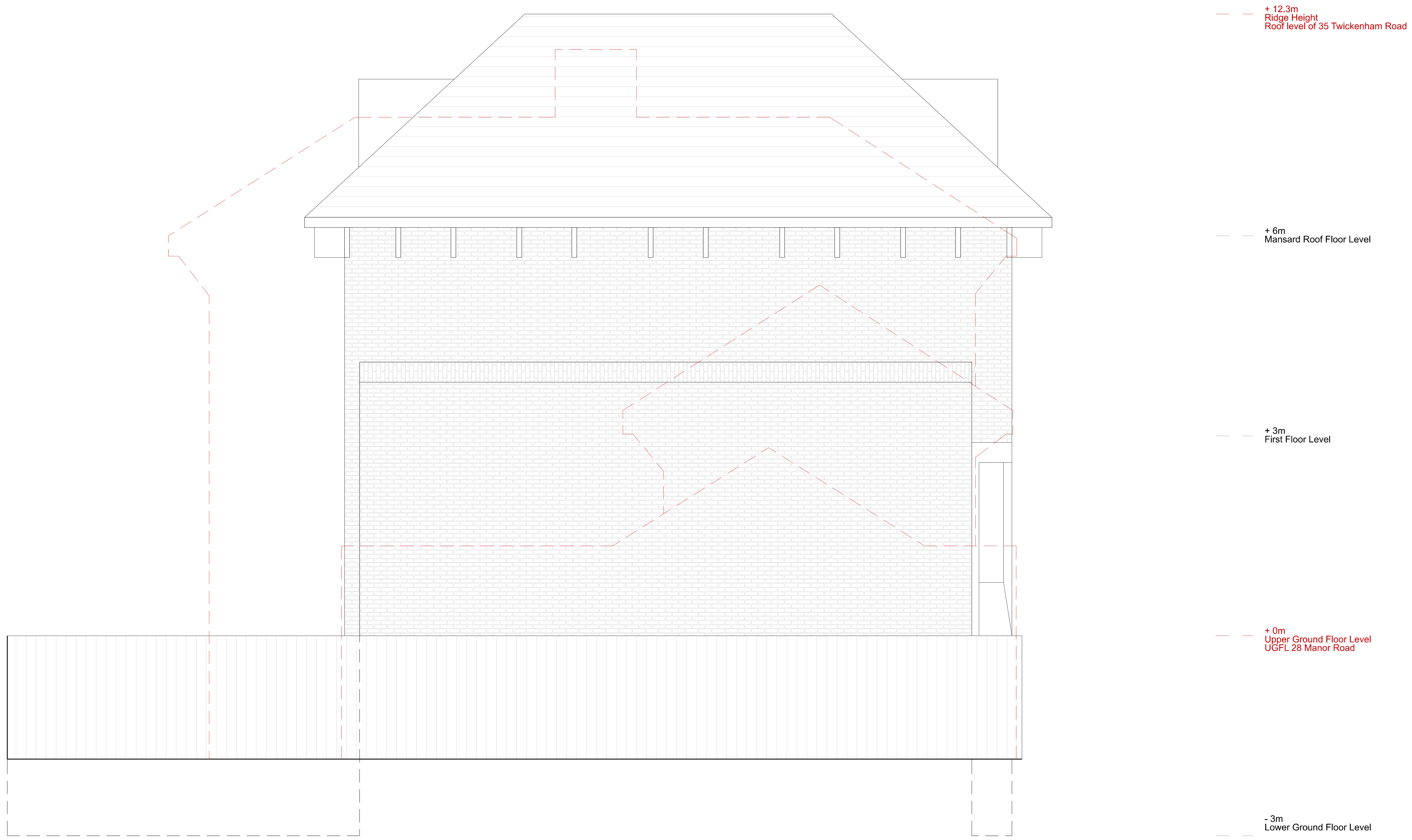

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Project 35 Twickenham Road, TW11 8AH

Title Proposed Rear Elevation

Number 287_33_33

Status Planning

Scale 1:100 A3/1:50 A1

0 0.5m 1m 2m 5m

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Revision	Date	Description
/	28.09.22	Client Issue
A	14.10.22	Planning Issue

FLOWER MICHELIN

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RIBA

Project	35 Twickenham Road, TW11 8AH
Title	Proposed Street Elevation
Number	287_33_34
Status	Planning
Scale	1:200 A3/1:100 A1

0 1m 2m 4m 10m

Appendix B - Groundwater Flooding Risk Assessment

Stephen Buss
Environmental Consulting Ltd

Rear of 35 Twickenham Road, Teddington: groundwater flooding risk assessment

Version control log

Document number	Date	Issued by	Issued to	Comments
2022-089-003-001	18/11/22	Steve Buss	Aegaea	First draft

Client: Aegaea

Dated: November 2022

www.hydro-geology.co.uk

32 Port Hill Road, Shrewsbury SY3 8SA

Registered in England and Wales number 08595273

DISCLAIMER

This report has been prepared by Stephen Buss Environmental Consulting Ltd (SBEC) in its professional capacity as hydrogeologist, in a manner consistent with the level of care and skill ordinarily exercised by members of the geological and engineering professions practising at this time, within the agreed scope and terms of contract, and taking account of the manpower and resources devoted to it by agreement with its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole. As with any environmental appraisal or investigation, the conclusions and observations are based on limited data. The risk of undiscovered environmental impairment of the property cannot be ruled out. SBEC cannot therefore warrant the actual conditions at the site and advice given is limited to those conditions for which information is held by SBEC at the time. The findings are based on the information made available to SBEC at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time.

This report is provided to the client addressed above. Should the client wish to release this report to any other third party for that party's reliance, SBEC accepts no responsibility to any third party to whom this report or any part thereof is made known. SBEC accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against SBEC except as expressly agreed with SBEC in writing.

The findings do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

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Figures

1. Introduction

1.1 Background

This report presents an assessment of the likely risk of groundwater flooding at the proposed development to the rear of 35 Twickenham Road, Teddington TW11 8AH (Figure 1.1). The planning authority is Richmond upon Thames London Borough.

According to the Richmond Strategic Flood Risk Assessment (SFRA), the site is in an area with a between 50% and 75% risk of groundwater flooding. The SFRA advises that:

> *Where a development site intersects with an area with >= 25% susceptibility to groundwater flooding, the applicant should assess this risk by answering the following questions:*
>
> - *Will the proposed development impact the flow profile of groundwater related flow or surface water to downstream areas?*
> - *Will the proposed development increase groundwater related flood risk to neighbouring properties?*
>
> *If the answer to either, or both, of these questions is 'yes', then the applicant should assess the potential impacts and level of risk posed by the development. Such an assessment may identify that the proposed development requires mitigation actions. All of this must be detailed as part of the applicant's submission. As a guide, the assessment could align with the approach as set out in the Basement Assessment User Guide.*
>
> *Where the development includes a basement a Basement Screening Assessment should be carried out. Examples of information that is expected as part of the Screening Assessment include, but is not limited to:*
>
> - *Description of the proposed basement, cellar or subsurface structure development.*
> - *Construction methods proposed.*
> - *Characteristics of the site, including geological information (bedrock, superficial deposits, and aquifer confirmation) and topographical information.*
> - *Site borehole information with water levels. If historical borehole data is used, the borehole location must be within 100m of the site and have been conducted within the last 20 years to best capture the current local conditions. However, singular borehole measurements may not provide information on what subterranean conditions might look like at a different time in the year. Groundwater flow and throughflow may be subjected to seasonal influences. Therefore, it will be necessary to monitor subterranean water levels over a period of time in areas that may be more susceptible to groundwater and throughflow.*
> - *Characteristics of potential impacts (including the impact on soils, land use, water quality and hydrology).*
> - *Details of mitigation measures (where appropriate).*

This report was commissioned to provide analysis and interpretation of geological and groundwater conditions at the Twickenham Road site, with the aim of providing such a screening assessment and clarifying the risk of groundwater flooding on site.

1.2 The Development

The site is to the rear (west) of number 35 Twickenham Road, it is roughly square, and is bounded by Manor Road to the south. It was previously occupied by garages but these have been demolished.

The proposed development is construct a four-storey house. The lower ground floor is to be sunk below current ground level, but not to the depth of a full basement (). The lower ground floor will be at a level circa 1.05 m below pavement level.

1.3 This Report

Stephen Buss Environmental Consulting Ltd (SBEC) was instructed by Aegaea in November 2022 to complete this report.

In June 2016 SBEC undertook a detailed groundwater modelling study for the redevelopment of Teddington Studios, which was about 400 m east of 35 Twickenham Road. Monitoring data for the site and modelling results are referred to in this current report. Hence some of the data used is from September to November 2015, the period of site investigation at Teddington Studios.

This report has been prepared by Dr Stephen Buss MA MSc CGeol. Dr Buss is a UK-based independent hydrogeologist with more than 20 years' consulting experience in solving groundwater issues for regulators, private sector organisations, and developers. **Dr Buss is a Chartered Geologist with the Geological Society of London.**

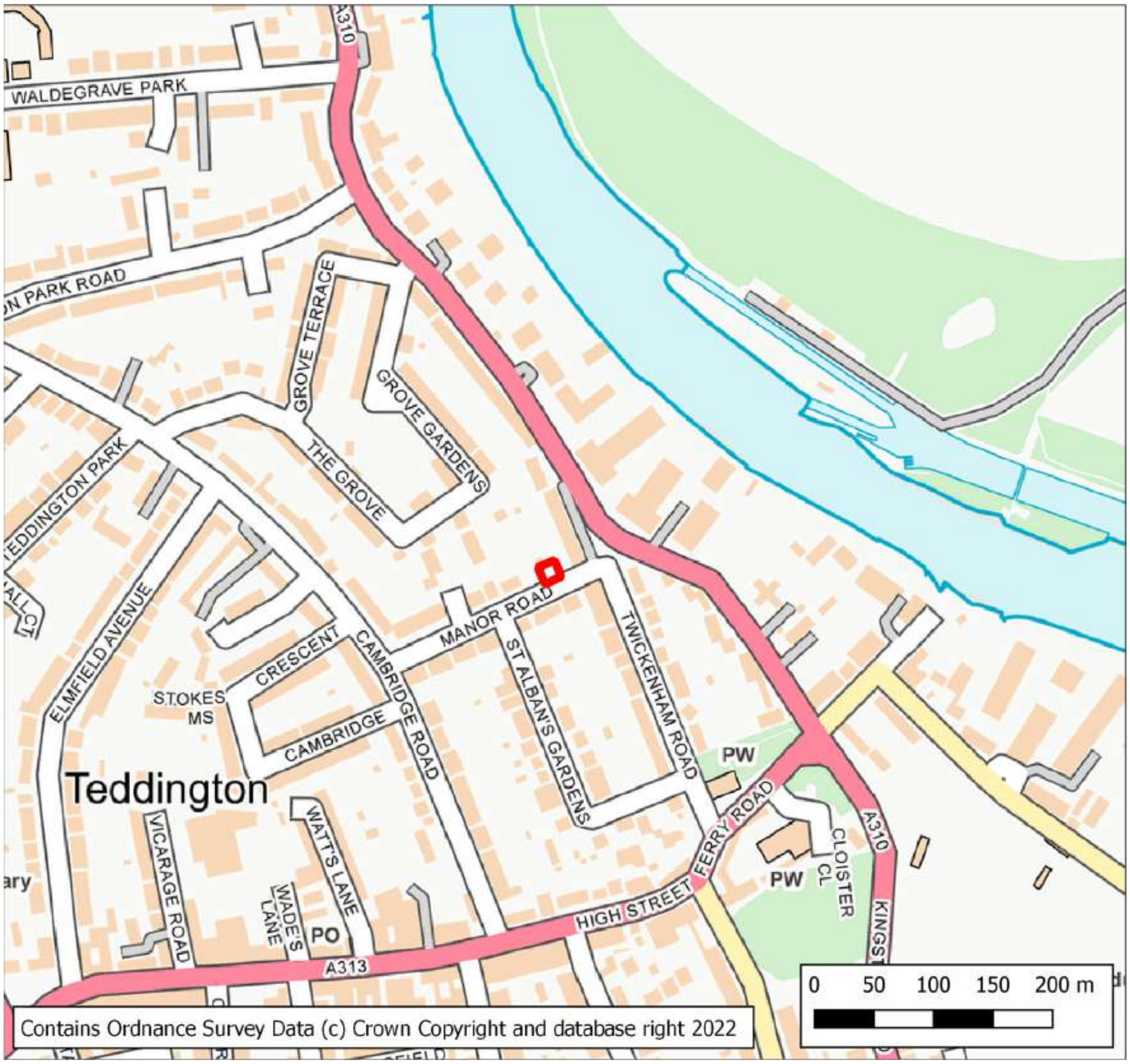

Figure 1.1 Boundary of the proposed development (outlined in red)

Figure 1.2: Front elevation of the proposed development.

(After Flower Michelin drawing number 287_33_30)

2. Physical Setting

2.1 Drainage and Topography

Ground level of the pavement adjacent to the site is about 8.5 m above Ordnance Datum (AOD) (Figure 2.1). The site lies on a terrace, at an elevation of about 8.5 m, adjacent to the flood plain of the River Thames. Ground level drops down east of Twickenham Road, to an elevation of about 5.0 to 6.0 m AOD.

The closest surface water body is the tidal River Thames about 170 m to the north east of the site. The riverside wall is constructed of sheet piles. About 500 m upstream of the site is Teddington Lock, which is the upper limit of the tidal river. Diurnal high tides reach Teddington Lock, and spring high tides can back up over the lock and may influence levels as far upstream as Hampton Court.

Water level in the tidal River Thames adjacent to Teddington Studios, downstream of the Teddington Lock, was monitored from 2 September 2015 to 4 November 2015. Also, an Environment Agency level gauge upstream of the lock was in operation and levels for the whole monitoring period, and for a few days over the spring tides at the end of September 2015, are shown in Figure 2.2.

A longer period of upstream levels for Teddington Lock is shown in Figure 2.3 and this shows that the period of monitoring (2 September to 4 November 2015) saw typical stages, with quite modest peaks. Peak levels upstream approached 5.2 m AOD in early 2014, which was indeed a very wet period with flooding upstream on the Thames (especially at Wraysbury and Datchet).

2.2 Geology

Bedrock geology[1] beneath the site comprises the London Clay. This is a dark grey clay with partings of silt and fine sand and is considered to be almost impermeable, therefore it isolates the underlying chalk aquifer from activities at the surface. The base of the London Clay is below 45 m depth at Teddington Wier[2], and isolates the deeper Chalk aquifer from the surface.

Mapped superficial geology comprises sand and gravel of the Kempton Park Gravel Member. From on the May 2018 site investigation report[3] (Albury S.I. Ltd., 2018) these strata may be described as follows.

Made ground is typically between up to 0.7 m in thickness. It generally comprises a top layer of concrete, with local fill of flint / gravel fragments. Below the concrete, made ground comprises dark brown sandy clay to silty sand with brick fragments and gravel. Below the made ground a layer of disturbed ground water identified to about 1.1 m depth.

A cohesive layer of unanticipated **Brickearth** (very sandy or silty clay with occasional gravel) was identified beneath the made ground / disturbed ground.

[1] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[2] http://scans.bgs.ac.uk/sobi_scans/boreholes/581551
[3] Albury S.I. Ltd., 2018. Phase 1 Desk Study and Phase 2 Site Investigation Report, Land Rear of 35 Twickenham Road, Teddington, Middlesex TW11 8AH

Kempton Park Gravel Member is present beneath the whole of the site and was confirmed to depths of between 2.1 and 4.1 m. This deposit comprised brown silty sand with gravel, grading to sand with gravel at depth. London Clay was not proved in the site investigation.

At a deeper borehole[4], TQ17/SE156, is about 150 m to the north west of 35 Twickenham Road, the base of the Kempton Park Gravels was proved at 4.4 m depth (c. 2.8 m AOD).

2.3 Hydrogeology

Groundwater was not identified in the site investigation boreholes. The deepest borehole was 4.1 m deep.

In borehole TQ17/SE156 water was struck at 3.5 m depth and rose to 3.2 m depth (c. 4.0 m AOD) in May 1988.

Water table elevations at Teddington Studios, adjacent to the tidal Thames, varied in time and across the site but there was a small range over September 2015 to November 2015: between a minimum of 2.94 m AOD and a maximum of 3.32 m AOD (Figure 2.4).

2.4 Groundwater Flooding

Figure 2.5 shows the mapped extent of groundwater flood susceptibility according to the BGS dataset (which is shown in the Richmond SFRA, which was used to screen in the potential for risk of groundwater flooding on the site). There is considered to be a 50 to 75% risk of groundwater flooding to occur at surface.

Figure 2.6 also shows the 'Increased potential for elevated groundwater' dataset from Drain London. The site is indicated to not have increased potential for elevated groundwater.

Further comment on the value of the groundwater flooding susceptibility datasets, for making site-specific decisions, is made in Section 3.1.

[4] http://scans.bgs.ac.uk/sobi_scans/boreholes/581593

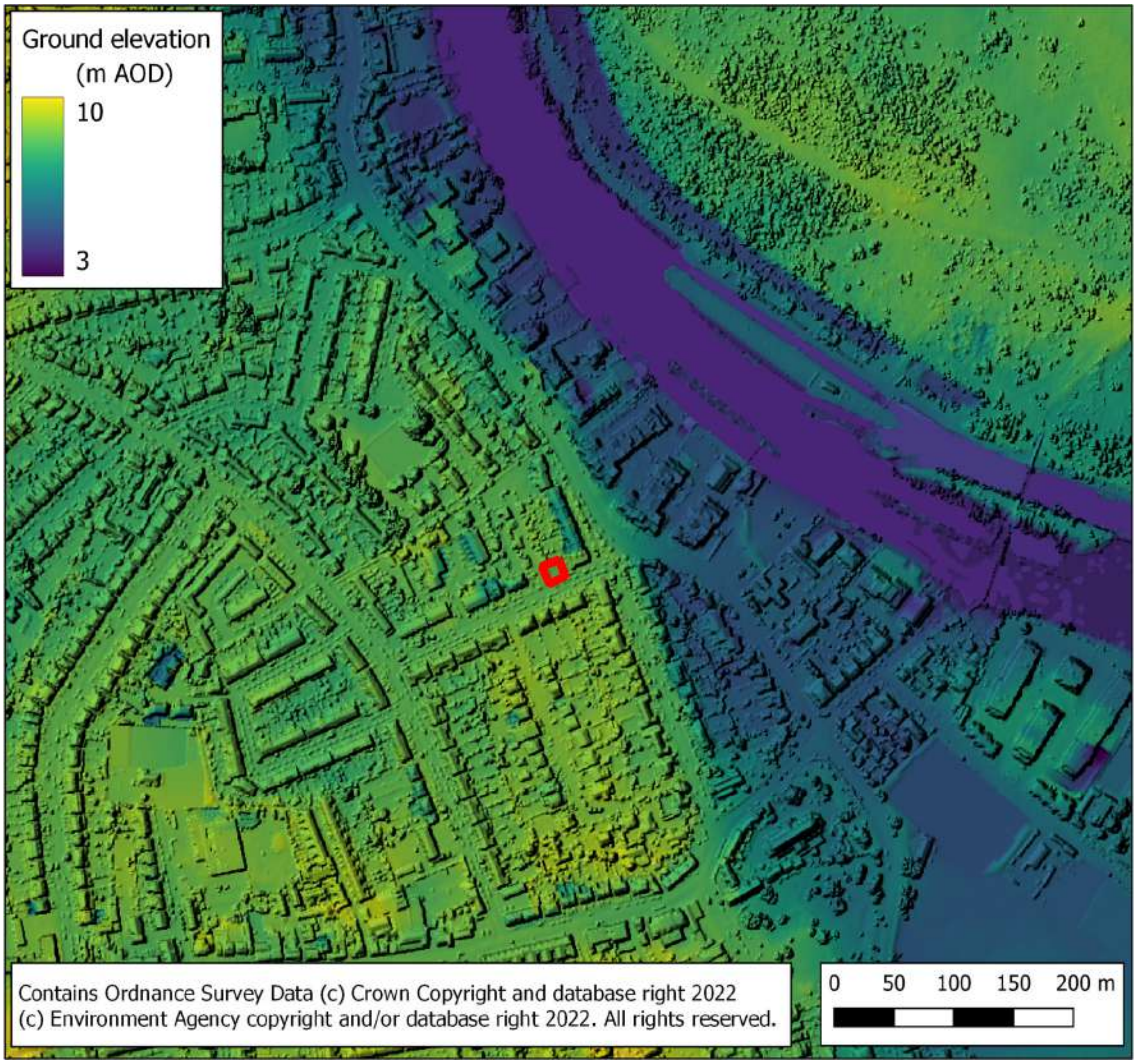

Figure 2.1 Elevation from Environment Agency LIDAR data

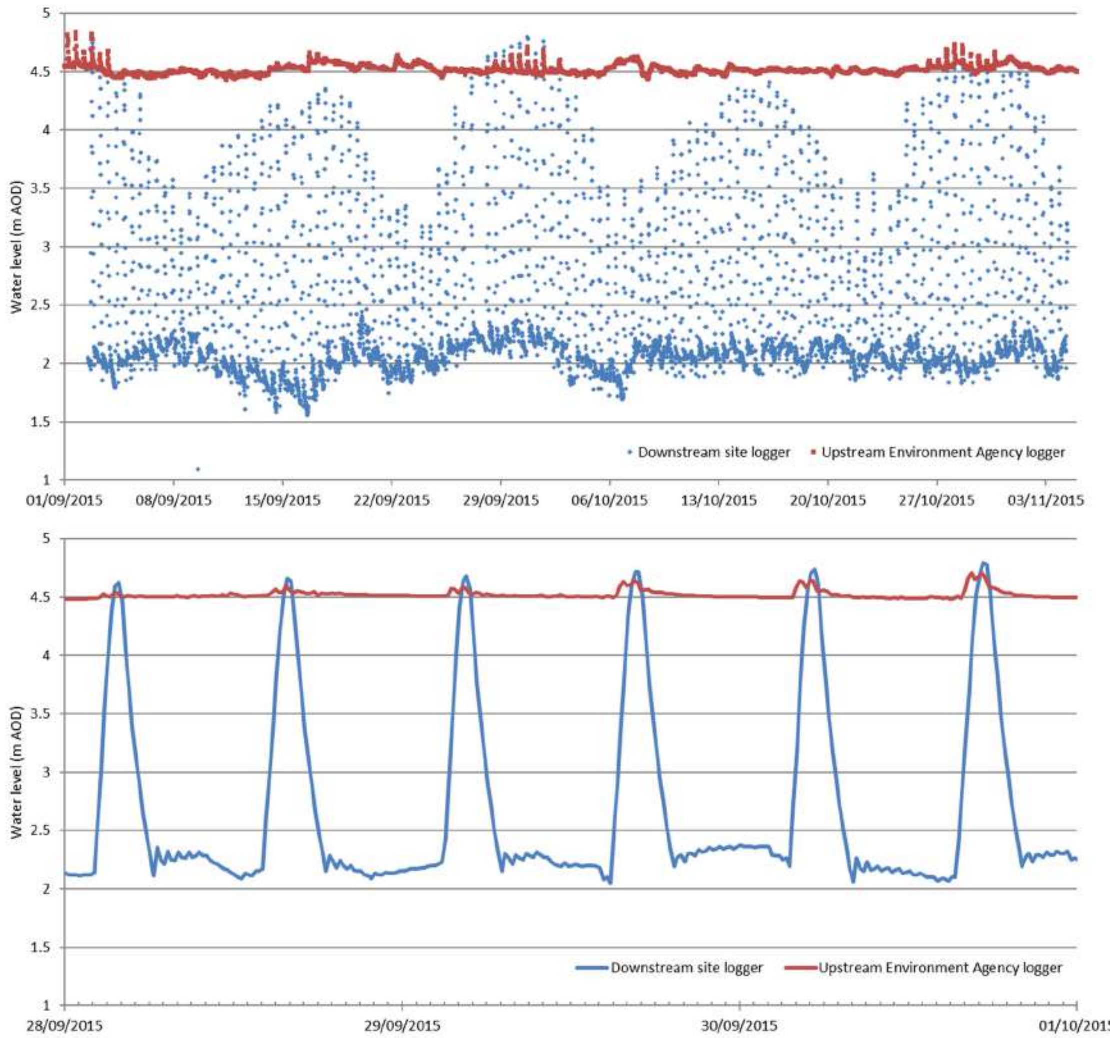

Figure 2.2 Water level upstream (red) and downstream (blue) of Teddington Lock

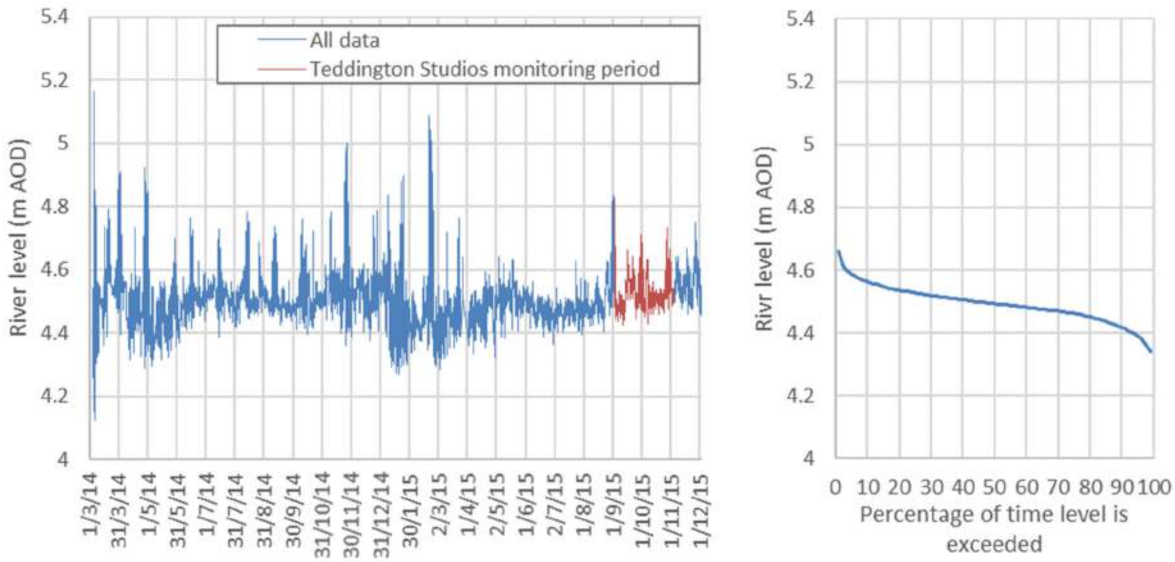

Figure 2.3 Stage data upstream of Teddington Lock, 2014-15

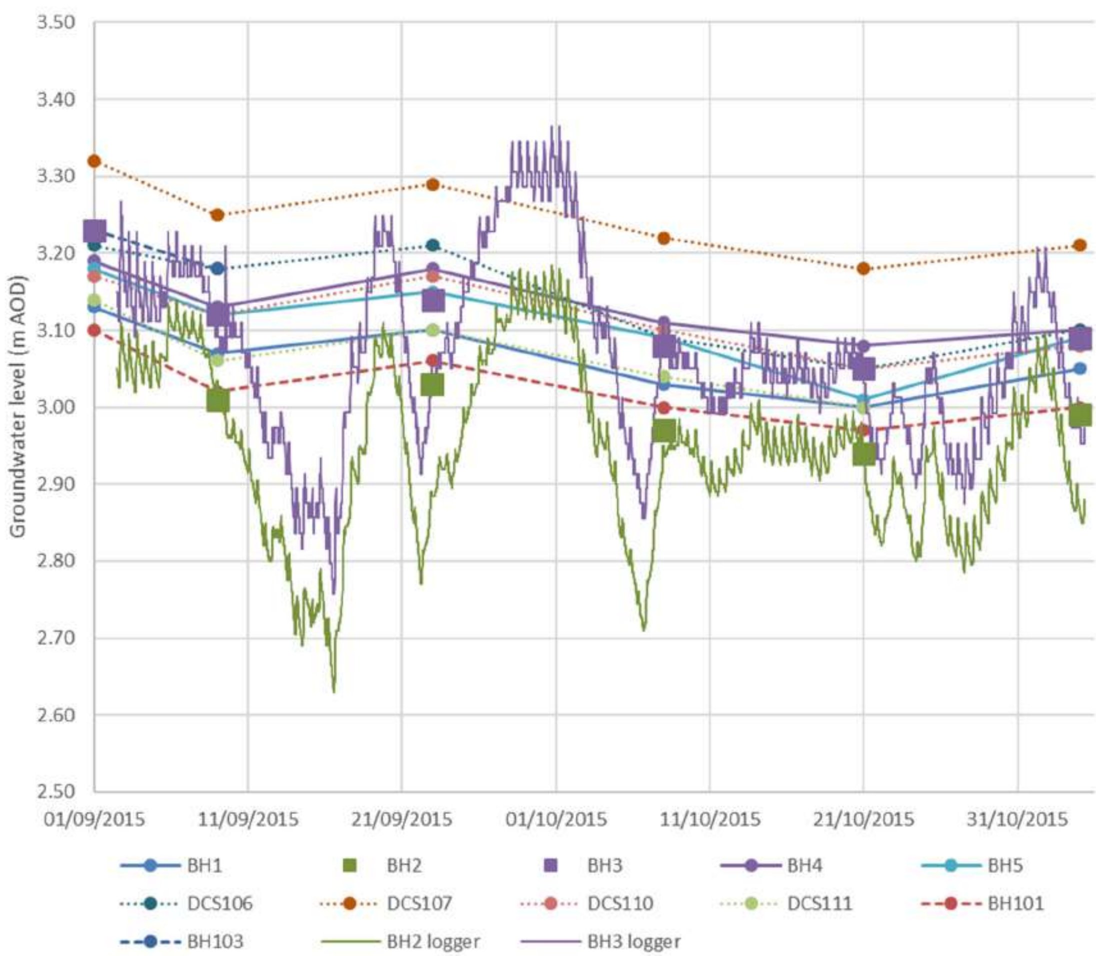

Figure 2.4 Groundwater level monitoring data, Teddington Studios

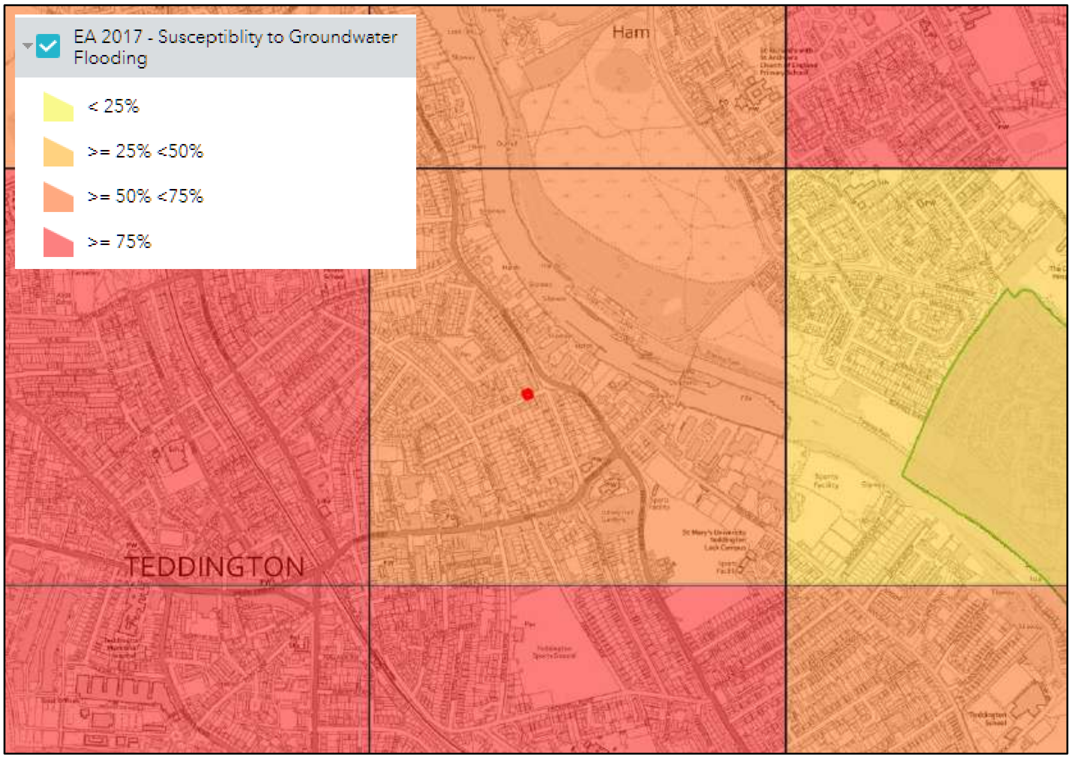

Figure 2.5 Mapped groundwater flood susceptibility

Figure 2.6 Increased potential for groundwater flooding

3. Interpretation

3.1 Comment on Groundwater Flood Susceptibility Mapping

The BGS groundwater flood susceptibility dataset is a tool for highlighting regional areas that are potentially at risk of groundwater flooding, but at a site scale the dataset is not reliable. The following section summarises the assumptions behind the dataset[5].

The dataset represents two types of groundwater flooding: 'clearwater' and 'PSD' (permeable superficial deposits). Clearwater flooding is mapped to the outcrop areas of permeable bedrock, such as the Chalk. London Clay is not considered to be permeable bedrock so the modelled groundwater flooding around Teddington is PSD flooding.

PSD flooding arises when a river level (or the sea level for coastal sites) rises within its banks, but there are areas behind the banks that are lower than the crest of the bank. Groundwater may then flow through the permeable sub-surface to emerge in these hollows that are not connected to the river by an overland flow path. This is a common phenomenon on the gravels next to the River Thames, with PSD flooding occurring in south Oxford and in Datchet, Wraysbury and Slough areas.

In creating the PSD flooding dataset the BGS did not use modelled flood levels (e.g. Environment Agency modelled levels) but developed a bespoke national model at a 50 m resolution. Topography data that was used to compare ground level with the flood level was also at 50 m resolution. This resolution is suitable for regional studies but not site-specific studies.

To create the Areas Susceptible to Groundwater Flooding (AStGwF) dataset used in the Richmond SFRA the Environment Agency down-sampled the 50 m dataset to 1 km resolution. The percentage result in the AStGwF dataset refers to the proportion of that square kilometre where the original dataset indicated some level of risk. A square kilometre with a lot of area at low susceptibility to groundwater flooding would have a much higher AStGwF score than a square kilometre with a narrow band at very high susceptibility.

The disclaimer for the AStGwF dataset (written by the Environment Agency) is as follows (emphasis is by SBEC):

> *The Areas Susceptible to Groundwater Flooding (AStGWF) is a strategic scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for Preliminary Flood Risk Assessment studies and allow the Lead Local Flood Authorities to determine whether there may be a risk of flooding from groundwater.*
>
> *This data shows the proportion of each 1km grid square where geological and hydrogeological condition show that groundwater might emerge.* ***It does <u>not</u> show the likelihood of groundwater flooding occurring.*** *It does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and* ***only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.***
>
> *The AStGWF data should be used only in combination with other information, for example local data or historic data. It should not be used as sole evidence for any specific flood risk management, land use planning*

[5] https://www.bgs.ac.uk/research/groundwater/datainfo/GFSD_methodology.html

or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

3.2 Conceptual Site Model

The 35 Twickenham Road site is underlain by a layer of sandy gravel overlying clays of the London Clay (Section 2.2). The base of the gravel unit / top of the London Clay is probably around 2.8 m AOD in elevation.

There is a groundwater body within the gravels beneath the site. A local borehole log indicates that the water table was at about 4.0 m AOD in May 1988 (Section 2.3). This was probably not the highest seasonal level: by comparison with typical groundwater level ranges for London gravels in CIRIA (1993)[6], the peak groundwater level might be expected to be perhaps 0.2 to 0.3 m higher at its peak.

The seasonal peak groundwater level is therefore expected to be about 4.3 m AOD. But the floor level of the lower ground floor is to be about 1.05 m below pavement level (8.5 m AOD), i.e. about 7.45 m AOD. Therefore it is anticipated that there will always be at least 3.15 m between the water table and the base of the lower ground floor.

Groundwater flooding that occurs upon low permeability bedrock tends to be related to the transmission of high river levels into adjacent permeable superficial deposits (i.e. sands and gravels). Groundwater flooding in this geological environment occurs separately from river flooding because the groundwater emerges into hollows behind the river banks (i.e. water does not reach the receptor via an overland flow route).

Gravel deposits are present beneath Teddington, and specifically beneath the Twickenham Road site. Peak river levels downstream of Teddington Weir are not known but peak levels upstream, during the extremely high flood flows of early 2014, stayed below 5.2 m AOD (Figure 2.3). Even if this upstream level was to propagate through the gravel aquifer to beneath 35 Twickenham Road, there would still be 2.25 m between the water table and the lower ground floor.

3.3 Impact Assessment

With regard to the questions related to groundwater flood screening posed in Section 1.1:

- *Will the proposed development impact the flow profile of groundwater related flow or surface water to downstream areas?*

  NO. Groundwater levels are expected to never reach the bottom of the structure. It is expected that there will always be at least 2.75 m clearance between the water table and the lower ground floor.

- *Will the proposed development increase groundwater related flood risk to neighbouring properties?*

  NO. Like the site at 35 Twickenham Road, neighbouring properties are not at risk of groundwater flooding as the water table will not rise to lower ground floor level. None of the neighbouring properties have full basements but 28 Marsh Road (west of the development site) does have a lower ground floor.

With regard to the basement-specific requirements listed in Section 1.1:

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[6] CIRIA, 1993. A Study of the Impact of Urbanisation on the Thames Gravels Aquifer. CIRIA report 129

- *Description of the proposed basement, cellar or subsurface structure development.*

The development comprises a house with a lower ground floor, approximately 1.05 m below surrounding ground level. See Section 1.2 and Figure 1.2.

- *Construction methods proposed.*

See information accompanying the planning application.

- *Characteristics of the site, including geological information (bedrock, superficial deposits, and aquifer confirmation) and topographical information.*

Geology comprises Kempton Park Gravel Member to c. 2.8 m AOD with London Clay below (Section 2.2). There is a groundwater body in the sand and gravel deposits ().

- *Site borehole information with water levels. If historical borehole data is used, the borehole location must be within 100m of the site and have been conducted within the last 20 years to best capture the current local conditions. However, singular borehole measurements may not provide information on what subterranean conditions might look like at a different time in the year. Groundwater flow and throughflow may be subjected to seasonal influences. Therefore, it will be necessary to monitor subterranean water levels over a period of time in areas that may be more susceptible to groundwater and throughflow.*

Recent (May 2018) site boreholes were dry at 4.1 m depth (4.4 m AOD). Recent (Sept-Nov 2015) boreholes at Teddington Studios measured groundwater levels at between 2.94 and 3.32 m AOD. A nearby but not recent (May 1988) borehole measured groundwater level at 4.0 m AOD and the conceptual site model uses this to be conservative.

The seasonal range in groundwater levels is likely to be about 0.3 m so the lower ground floor is expected to be always at least 3.15 m above the water table.

The (unlikely) extreme case of river flood levels at c. 5.2 m AOD in the Thames propagating through the gravels still leaves 2.25 m between the lower ground floor and the water table.

- *Characteristics of potential impacts (including the impact on soils, land use, water quality and hydrology).*

There are considered to be no impacts of development of the lower ground floor as it is far above the highest feasible water table elevation.

- *Details of mitigation measures (where appropriate).*

There is considered to be no need for mitigation as the lower ground floor is far above the highest feasible water table elevation.

Appendix C - Thames Water Information

Asset location search

Property Searches

Aegaea
66 Swaledale Road
WARMINSTER
BA12 8FJ

Search address supplied Flat 1
High Wigsell
35
Twickenham Road
Teddington
TW11 8AH

Your reference 0786_TW11_Teddington_07

Our reference ALS/ALS Standard/2022_4746912

Search date 8 November 2022

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

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

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

0800 009 4540

Asset location search

Thames Water Property Searches

Search address supplied: Flat 1, High Wigsell, 35, Twickenham Road, Teddington, TW11 8AH

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

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

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

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

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

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

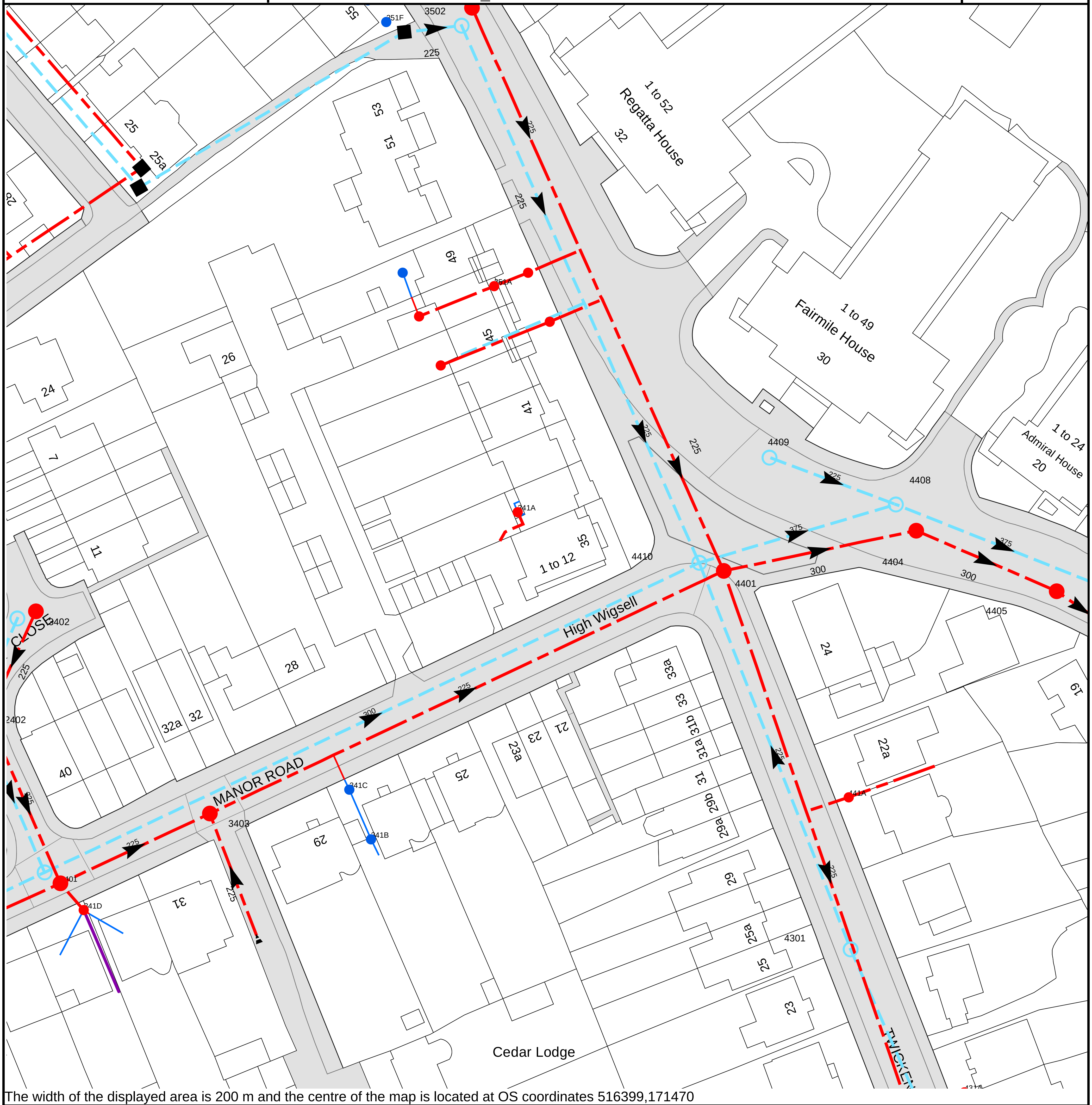
Clean Water queries

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

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

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

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4746912



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 516399,171470

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
341C	n/a	n/a
4405	5.7	2.77
4401	8.45	2.96
4410	8.36	4.85
4404	6.06	2.81
341A	n/a	n/a
4408	n/a	n/a
35ZT	n/a	n/a
35ZN	n/a	n/a
35ZX	n/a	n/a
351A	n/a	n/a
35ZV	n/a	n/a
35ZW	n/a	n/a
3502	n/a	n/a
351F	n/a	n/a
3501	n/a	n/a
351E	n/a	n/a
341D	n/a	n/a
3404	n/a	n/a
3405	n/a	n/a
3402	n/a	n/a
4301	n/a	n/a
341B	n/a	n/a
3401	n/a	n/a
3403	8.54	3.7
441A	n/a	n/a
4409	n/a	n/a

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

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

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

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

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

Sewer Fittings

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

- Air Valve
- Meter
- Dam Chase
- Vent
- Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- Weir

End Items

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

- Inlet
- Outfall
- Undefined End

Other Symbols

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

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

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

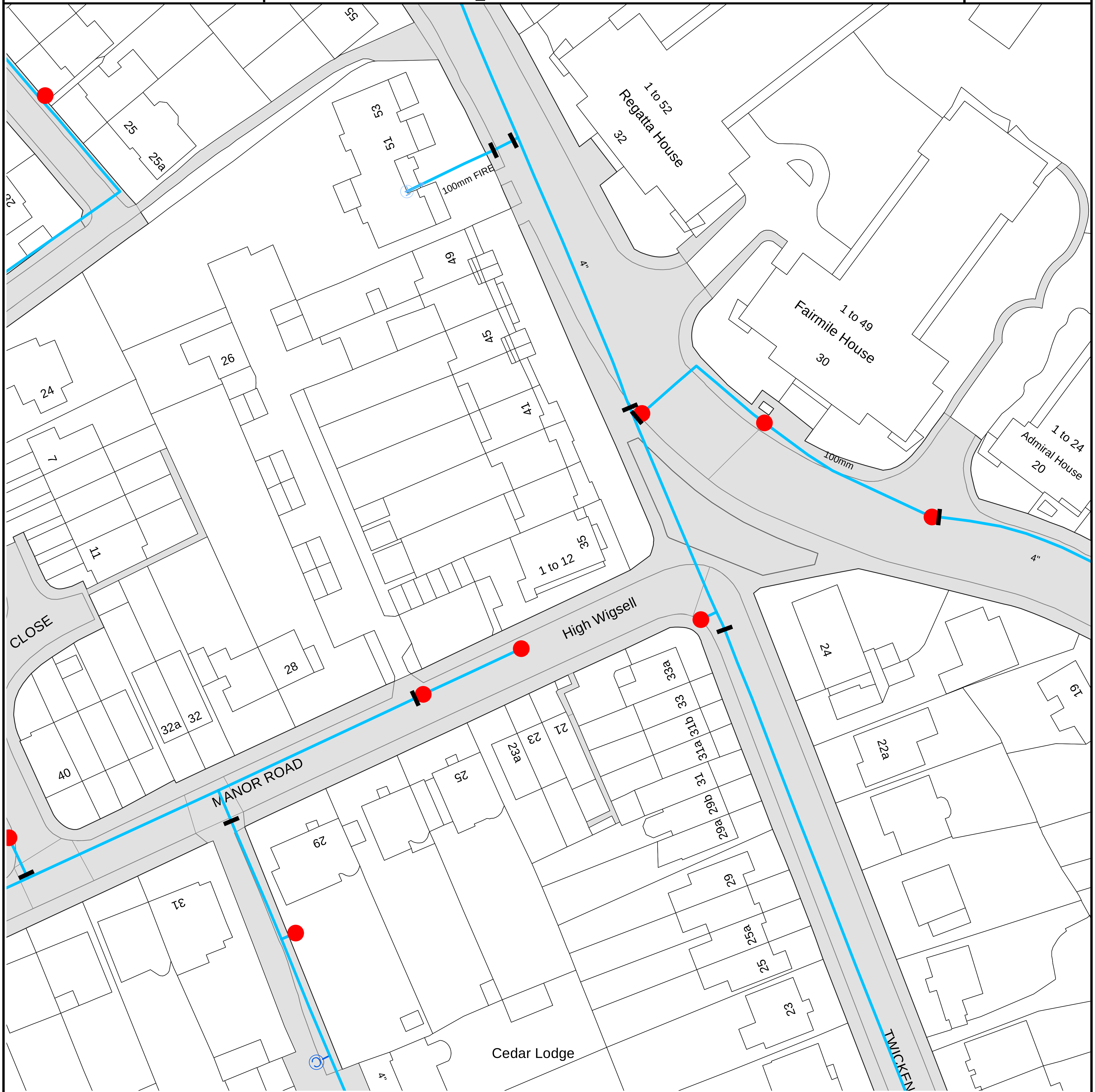
- Casement
- Conduit Bridge
- Subway
- Tunnel

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

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.

Asset Location Search Water Map - ALS/ALS Standard/2022_4746912



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 516399, 171470.

Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

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

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.

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

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

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.

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')

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

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

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.

Terms and Conditions

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

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

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

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

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

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

Ways to pay your bill

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

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

Appendix D - InfoDrainage Calculations

Dwelling 1 Roof Area Type : Catchment Area

Area (ha)	0.005

Preliminary Sizing

Volumetric Runoff Coefficient	0.900
Percentage Impervious (%)	100
Time of Concentration (mins)	5

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.900
Winter Volumetric Runoff	0.900
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Dwelling 1 Parking Area Type : Catchment Area

Area (ha)	0.001

Preliminary Sizing

Volumetric Runoff Coefficient	0.900
Percentage Impervious (%)	100
Time of Concentration (mins)	5

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.900
Winter Volumetric Runoff	0.900
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Dwelling 1 Paving Area Type : Catchment Area

Area (ha)	0.002

Preliminary Sizing

Volumetric Runoff Coefficient	0.900
Percentage Impervious (%)	100
Time of Concentration (mins)	5

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.900
Winter Volumetric Runoff	0.900
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Dwelling 2 Roof Area

Type : Catchment Area

Area (ha)	0.008

Preliminary Sizing

Volumetric Runoff Coefficient	0.900
Percentage Impervious (%)	100
Time of Concentration (mins)	5

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.900
Winter Volumetric Runoff	0.900
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Dwelling 2 Parking Area

Type : Catchment Area

Area (ha)	0.005

Preliminary Sizing

Volumetric Runoff Coefficient	0.900
Percentage Impervious (%)	100
Time of Concentration (mins)	5

Dynamic Sizing

Runoff Method	Time of Concentration
Summer Volumetric Runoff	0.900
Winter Volumetric Runoff	0.900
Time of Concentration (mins)	5
Percentage Impervious (%)	100

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Junctions Storm Phase: Phase	Aegaea Limited:		

Name	Junction Type	Easting (m)	Northing (m)	Cover Level (m)	Depth (m)
MH3	Manhole	408.720	275.621	8.000	3.000
MH5	Manhole	395.279	276.383	8.000	2.900
MH4	Manhole	395.065	285.303	8.000	2.800
MH1	Manhole	411.248	284.437	6.500	1.350
MH2	Manhole	411.008	278.370	6.500	1.400

Name	Invert Level (m)	Chamber Shape	Diameter (m)	Manhole Locked
MH3	5.000	Circular	0.450	☐
MH5	5.100	Circular	0.450	☐
MH4	5.200	Circular	0.450	☐
MH1	5.150	Circular	0.450	☐
MH2	5.100	Circular	0.450	☐

Inlets

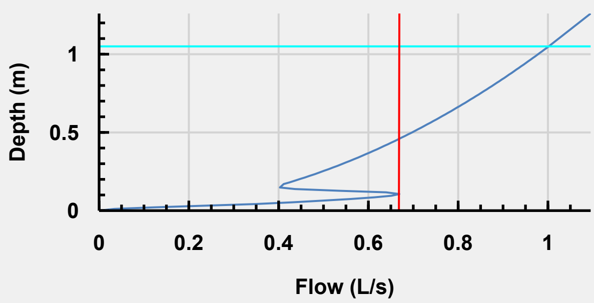
Junction	Inlet Name	Incoming Item(s)	Bypass Destination	Capacity Type
MH3	Inlet	Dwelling 2 Parking Area 3.001 1.002	(None)	No Restriction
MH5	Inlet	Dwelling 1 Paving Area	(None)	No Restriction
	Inlet (1)	3.000	(None)	No Restriction
MH4	Inlet	Dwelling 1 Parking Area	(None)	No Restriction
MH1	Inlet	1.000	(None)	No Restriction
MH2	Inlet	1.001 2.000	(None)	No Restriction

Outlets

Junction	Outlet Name	Outgoing Connection	Outlet Type
MH3	Outlet	(None)	Hydro-Brake®
MH5	Outlet	3.001	Free Discharge
MH4	Outlet	3.000	Free Discharge
MH1	Outlet	1.001	Free Discharge
MH2	Outlet	1.002	Free Discharge

MH3 Outlet details:

Invert Level (m)	5.000
Design Depth (m)	1.050
Design Flow (L/s)	1.0
Objective	Minimise Upstream Storage Requirements
Application	Surface Water Only
Sump Available	☐
Unit Reference	CHE-0045-1000-1050-1000



Dwelling 1 Cellular Storage

Type : Cellular Storage

Dimensions

Exceedence Level (m)	6.500
Depth (m)	0.800
Base Level (m)	5.300
Number of Crates Long	1
Number of Crates Wide	1
Number of Crates High	1
Porosity (%)	95
Crate Length (m)	1.2
Crate Width (m)	1.6
Crate Height (m)	0.8
Total Volume (m^3)	1.859

Inlets

Inlet

Inlet Type	Point Inflow
Incoming Item(s)	Dwelling 1 Roof Area
Bypass Destination	(None)
Capacity Type	No Restriction

Outlets

Outlet

Outgoing Connection	1.000
Outlet Type	Free Discharge

Dwelling 2 Cellular Storage

Type : Cellular Storage

Dimensions

Exceedence Level (m)	6.500
Depth (m)	0.800
Base Level (m)	5.300
Number of Crates Long	1
Number of Crates Wide	1
Number of Crates High	1
Porosity (%)	95
Crate Length (m)	1.2
Crate Width (m)	1.6
Crate Height (m)	0.8
Total Volume (m³)	1.859

Inlets

Inlet

Inlet Type	Point Inflow
Incoming Item(s)	Dwelling 2 Roof Area
Bypass Destination	(None)
Capacity Type	No Restriction

Outlets

Outlet

Outgoing Connection	2.000
Outlet Type	Free Discharge

Name	Length (m)	Connection Type	Slope (1:x)	Manning's n	Colebrook-White Roughness (mm)	Diameter / Base Width (mm)	Upstream Cover Level (m)	Upstream Invert Level (m)
3.000	8.923	Pipe	89.230		0.6	225	8.000	5.200
3.001	13.462	Pipe	134.616		0.6	225	8.000	5.100
1.001	6.072	Pipe	121.445		0.6	225	6.500	5.150
1.002	3.576	Pipe	35.762		0.6	225	6.500	5.100
1.000	4.685	Pipe	31.231		0.6	225	6.500	5.300
2.000	2.705	Pipe	13.527		0.6	225	6.500	5.300

Name	Downstream Cover Level (m)	Downstream Invert Level (m)
3.000	8.000	5.100
3.001	8.000	5.000
1.001	6.500	5.100
1.002	8.000	5.000
1.000	6.500	5.150
2.000	6.500	5.100

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Inflow Summary Storm Phase: Phase	Aegaea Limited:		

Inflow Label	Connected To	Flow (L/s)	Runoff Method	Area (ha)	Percentage Impervious (%)	Urban Creep (%)	Adjusted Percentage Impervious (%)	Area Analysed (ha)
Dwelling 1 Paving Area	MH5		Time of Concentration	0.002	100	10	110	0.002
Dwelling 1 Parking Area	MH4		Time of Concentration	0.001	100	10	110	0.001
Dwelling 1 Roof Area	Dwelling 1 Cellular Storage		Time of Concentration	0.005	100	10	110	0.006
Dwelling 2 Parking Area	MH3		Time of Concentration	0.005	100	10	110	0.005
Dwelling 2 Roof Area	Dwelling 2 Cellular Storage		Time of Concentration	0.008	100	10	110	0.009
TOTAL		**0.0**		**0.021**				**0.023**

ICP SUDS / IH 124

Details

Method	ICP SUDS
Area (ha)	0.021
SAAR (mm)	600.0
Soil	0.3
Region	Region 6
Urban	0
Return Period (years)	0

Results

Region	QBAR Rural (L/s)	QBAR Urban (L/s)	Q 1 (years) (L/s)	Q 30 (years) (L/s)	Q 100 (years) (L/s)
Region 6	0.0	0.0	0.0	0.1	0.1

FSR: 1 years: Increase Rainfall (%): +0: Critical Storm Per Item

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow (m³)
Dwelling 1 Roof Area	FSR: 1 years: +0 %: 15 mins: Summer	0.01	0.9	0.393
Dwelling 1 Parking Area	FSR: 1 years: +0 %: 15 mins: Summer	0.00	0.2	0.078
Dwelling 1 Paving Area	FSR: 1 years: +0 %: 15 mins: Summer	0.00	0.3	0.120
Dwelling 2 Roof Area	FSR: 1 years: +0 %: 15 mins: Summer	0.01	1.5	0.636
Dwelling 2 Parking Area	FSR: 1 years: +0 %: 15 mins: Summer	0.00	0.8	0.366

FSR: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow (m³)
Dwelling 1 Roof Area	FSR: 30 years: +0 %: 15 mins: Summer	0.01	2.2	0.972
Dwelling 1 Parking Area	FSR: 30 years: +0 %: 15 mins: Summer	0.00	0.4	0.192
Dwelling 1 Paving Area	FSR: 30 years: +0 %: 15 mins: Summer	0.00	0.7	0.297
Dwelling 2 Roof Area	FSR: 30 years: +0 %: 15 mins: Summer	0.01	3.6	1.557
Dwelling 2 Parking Area	FSR: 30 years: +0 %: 15 mins: Summer	0.00	2.1	0.897

FSR: 30 years: Increase Rainfall (%): +35: Critical Storm Per Item

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow (m³)
Dwelling 1 Roof Area	FSR: 30 years: +35 %: 15 mins: Summer	0.01	3.0	1.308
Dwelling 1 Parking Area	FSR: 30 years: +35 %: 15 mins: Summer	0.00	0.6	0.255
Dwelling 1 Paving Area	FSR: 30 years: +35 %: 15 mins: Summer	0.00	0.9	0.408
Dwelling 2 Roof Area	FSR: 30 years: +35 %: 15 mins: Summer	0.01	4.8	2.103
Dwelling 2 Parking Area	FSR: 30 years: +35 %: 15 mins: Summer	0.00	2.8	1.212

FSR: 100 years: Increase Rainfall (%): +0: Critical Storm Per Item

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow (m³)
Dwelling 1 Roof Area	FSR: 100 years: +0 %: 15 mins: Summer	0.01	2.9	1.254
Dwelling 1 Parking Area	FSR: 100 years: +0 %: 15 mins: Summer	0.00	0.6	0.249
Dwelling 1 Paving Area	FSR: 100 years: +0 %: 15 mins: Summer	0.00	0.9	0.390
Dwelling 2 Roof Area	FSR: 100 years: +0 %: 15 mins: Summer	0.01	4.7	2.025
Dwelling 2 Parking Area	FSR: 100 years: +0 %: 15 mins: Summer	0.00	2.7	1.167

FSR: 100 years: Increase Rainfall (%): +40: Critical Storm Per Item

Inflow	Storm Event	Inflow Area (ha)	Max. Inflow (L/s)	Total Inflow (m³)
Dwelling 1 Roof Area	FSR: 100 years: +40 %: 15 mins: Summer	0.01	4.0	1.758
Dwelling 1 Parking Area	FSR: 100 years: +40 %: 15 mins: Summer	0.00	0.8	0.345
Dwelling 1 Paving Area	FSR: 100 years: +40 %: 15 mins: Summer	0.00	1.3	0.546
Dwelling 2 Roof Area	FSR: 100 years: +40 %: 15 mins: Summer	0.01	6.5	2.829
Dwelling 2 Parking Area	FSR: 100 years: +40 %: 15 mins: Summer	0.00	3.8	1.635

FSR: 1 years: Increase Rainfall (%): +0: Critical Storm Per Item

Junction	Storm Event	Cover Level (m)	Invert Level (m)	Max. Level (m)	Max. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
MH3	FSR: 1 years: +0 %: 30 mins: Summer	8.000	5.000	5.273	0.273	1.7	0.043	0.000	0.5	1.816	OK
MH5	FSR: 1 years: +0 %: 30 mins: Summer	8.000	5.100	5.273	0.173	0.9	0.027	0.000	0.2	0.444	OK
MH4	FSR: 1 years: +0 %: 30 mins: Summer	8.000	5.200	5.273	0.073	0.2	0.012	0.000	0.1	0.145	OK
MH1	FSR: 1 years: +0 %: 30 mins: Summer	6.500	5.150	5.273	0.123	0.6	0.020	0.000	0.5	0.486	OK
MH2	FSR: 1 years: +0 %: 30 mins: Summer	6.500	5.100	5.273	0.173	1.5	0.027	0.000	1.1	1.229	OK

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Junctions Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item

Junction	Storm Event	Cover Level (m)	Invert Level (m)	Max. Level (m)	Max. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
MH3	FSR: 30 years: +0 %: 60 mins: Winter	8.000	5.000	5.589	0.589	1.7	0.094	0.000	0.8	5.024	OK
MH5	FSR: 30 years: +0 %: 60 mins: Winter	8.000	5.100	5.589	0.489	1.1	0.078	0.000	0.2	0.962	Surcharged
MH4	FSR: 30 years: +0 %: 60 mins: Winter	8.000	5.200	5.589	0.389	0.5	0.062	0.000	0.1	0.377	Surcharged
MH1	FSR: 30 years: +0 %: 60 mins: Winter	6.500	5.150	5.589	0.439	0.7	0.070	0.000	0.4	1.320	Surcharged
MH2	FSR: 30 years: +0 %: 60 mins: Winter	6.500	5.100	5.589	0.489	1.4	0.078	0.000	1.0	3.443	Surcharged

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
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Report Details: Type: Junctions Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 30 years: Increase Rainfall (%): +35: Critical Storm Per Item

Junction	Storm Event	Cover Level (m)	Invert Level (m)	Max. Level (m)	Max. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
MH3	FSR: 30 years: +35 %: 60 mins: Winter	8.000	5.000	5.795	0.795	2.1	0.126	0.000	0.9	5.868	OK
MH5	FSR: 30 years: +35 %: 60 mins: Winter	8.000	5.100	5.795	0.695	1.3	0.111	0.000	0.2	1.164	Surcharged
MH4	FSR: 30 years: +35 %: 60 mins: Winter	8.000	5.200	5.795	0.595	0.8	0.095	0.000	0.1	0.422	Surcharged
MH1	FSR: 30 years: +35 %: 60 mins: Winter	6.500	5.150	5.795	0.645	0.9	0.103	0.000	0.3	1.425	Surcharged
MH2	FSR: 30 years: +35 %: 60 mins: Winter	6.500	5.100	5.795	0.695	1.8	0.111	0.000	1.3	3.935	Surcharged

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Junctions Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 100 years: Increase Rainfall (%): +0: Critical Storm Per Item

Junction	Storm Event	Cover Level (m)	Invert Level (m)	Max. Level (m)	Max. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
MH3	FSR: 100 years: +0 %: 60 mins: Winter	8.000	5.000	5.774	0.774	1.9	0.123	0.000	0.9	5.778	OK
MH5	FSR: 100 years: +0 %: 60 mins: Winter	8.000	5.100	5.774	0.674	1.1	0.107	0.000	0.2	1.145	Surcharged
MH4	FSR: 100 years: +0 %: 60 mins: Winter	8.000	5.200	5.774	0.574	0.5	0.091	0.000	0.1	0.421	Surcharged
MH1	FSR: 100 years: +0 %: 60 mins: Winter	6.500	5.150	5.774	0.624	0.9	0.099	0.000	0.3	1.413	Surcharged
MH2	FSR: 100 years: +0 %: 60 mins: Winter	6.500	5.100	5.774	0.674	1.6	0.107	0.000	1.1	3.887	Surcharged

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Junctions Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 100 years: Increase Rainfall (%): +40: Critical Storm Per Item

Junction	Storm Event	Cover Level (m)	Invert Level (m)	Max. Level (m)	Max. Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Status
MH3	FSR: 100 years: +40 %: 120 mins: Winter	8.000	5.000	6.092	1.092	1.7	0.174	0.000	1.0	12.168	OK
MH5	FSR: 100 years: +40 %: 120 mins: Winter	8.000	5.100	6.092	0.992	0.8	0.158	0.000	0.2	2.324	Surcharged
MH4	FSR: 100 years: +40 %: 120 mins: Winter	8.000	5.200	6.092	0.892	0.5	0.142	0.000	0.1	0.917	Surcharged
MH1	FSR: 100 years: +40 %: 120 mins: Winter	6.500	5.150	6.092	0.942	0.5	0.150	0.000	0.3	2.960	Surcharged
MH2	FSR: 100 years: +40 %: 120 mins: Winter	6.500	5.100	6.092	0.992	1.1	0.158	0.000	0.7	7.859	Surcharged

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 1 years: Increase Rainfall (%): +0: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Dwelling 1 Cellular Storage	FSR: 1 years: +0 %: 15 mins: Summer	5.315	5.315	0.015	0.015	0.9	0.028	0.000	0.000	0.9	0.390	0	98	OK
Dwelling 2 Cellular Storage	FSR: 1 years: +0 %: 15 mins: Summer	5.315	5.315	0.015	0.015	1.5	0.027	0.000	0.000	1.4	0.634	0	99	OK

FSR: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Dwelling 1 Cellular Storage	FSR: 30 years: +0 %: 60 mins: Winter	5.589	5.589	0.289	0.289	1.0	0.528	0.000	0.000	0.7	1.487	9	72	OK
Dwelling 2 Cellular Storage	FSR: 30 years: +0 %: 60 mins: Winter	5.589	5.589	0.289	0.289	1.6	0.528	0.000	0.000	1.1	2.435	4	72	OK

FSR: 30 years: Increase Rainfall (%): +35: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Dwelling 1 Cellular Storage	FSR: 30 years: +35 %: 60 mins: Winter	5.795	5.795	0.495	0.495	1.4	0.904	0.000	0.000	0.9	1.738	15	51	OK
Dwelling 2 Cellular Storage	FSR: 30 years: +35 %: 60 mins: Winter	5.795	5.795	0.495	0.495	2.2	0.904	0.000	0.000	1.5	3.015	8	51	OK

Project AEG0786: 35 Twickenham Road Teddington TW11 8AH	Date: 25/11/2022		
	Designed by: NDD	Checked by:	Approved By:
Report Details: Type: Stormwater Controls Summary Storm Phase: Phase	Aegaea Limited:		

FSR: 100 years: Increase Rainfall (%): +0: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Dwelling 1 Cellular Storage	FSR: 100 years: +0 %: 60 mins: Winter	5.774	5.774	0.474	0.474	1.3	0.864	0.000	0.000	0.9	1.710	17	54	OK
Dwelling 2 Cellular Storage	FSR: 100 years: +0 %: 60 mins: Winter	5.774	5.774	0.474	0.474	2.1	0.864	0.000	0.000	1.4	2.958	8	54	OK

FSR: 100 years: Increase Rainfall (%): +40: Critical Storm Per Item

Stormwater Control	Storm Event	Max. US Level (m)	Max. DS Level (m)	Max. US Depth (m)	Max. DS Depth (m)	Max. Inflow (L/s)	Max. Resident Volume (m³)	Max. Flooded Volume (m³)	Total Lost Volume (m³)	Max. Outflow (L/s)	Total Discharge Volume (m³)	Half Drain Down Time (mins)	Percentage Available (%)	Status
Dwelling 1 Cellular Storage	FSR: 100 years: +40 %: 120 mins: Winter	6.092	6.092	0.792	0.792	1.2	1.444	0.000	0.000	0.5	3.211	32	22	OK
Dwelling 2 Cellular Storage	FSR: 100 years: +40 %: 120 mins: Winter	6.092	6.092	0.792	0.792	1.9	1.444	0.000	0.000	1.1	5.323	12	22	OK

FSR: 1 years: Increase Rainfall (%): +0: Critical Storm Per Item

Connection	Storm Event	Connection Type	From	To	Upstream Cover Level (m)	Max. US Water Level (m)	Max. Flow Depth (m)	Discharge Volume (m³)	Max. Velocity (m/s)	Flow / Capacity	Max. Flow (L/s)	Status
3.000	FSR: 1 years: +0 %: 15 mins: Summer	Pipe	MH4	MH5	8.0	5.249	0.099	0.064	0.1	0	0.2	OK
3.001	FSR: 1 years: +0 %: 15 mins: Winter	Pipe	MH5	MH3	8.0	5.248	0.198	0.006	0.0	0.01	0.3	OK
1.001	FSR: 1 years: +0 %: 15 mins: Summer	Pipe	MH1	MH2	6.5	5.250	0.125	0.317	0.2	0.01	0.6	OK
1.002	FSR: 1 years: +0 %: 15 mins: Summer	Pipe	MH2	MH3	6.5	5.250	0.200	0.803	0.2	0.01	1.3	OK
1.000	FSR: 1 years: +0 %: 15 mins: Summer	Pipe	Dwelling 1 Cellular Storage	MH1	6.5	5.315	0.054	0.390	0.6	0.01	0.9	OK
2.000	FSR: 1 years: +0 %: 15 mins: Summer	Pipe	Dwelling 2 Cellular Storage	MH2	6.5	5.315	0.079	0.634	0.6	0.01	1.4	OK

FSR: 30 years: Increase Rainfall (%): +0: Critical Storm Per Item

Connection	Storm Event	Connection Type	From	To	Upstream Cover Level (m)	Max. US Water Level (m)	Max. Flow Depth (m)	Discharge Volume (m³)	Max. Velocity (m/s)	Flow / Capacity	Max. Flow (L/s)	Status
3.000	FSR: 30 years: +0 %: 15 mins: Summer	Pipe	MH4	MH5	8.0	5.490	0.225	0.008	0.2	0	0.1	Surcharged
3.001	FSR: 30 years: +0 %: 15 mins: Summer	Pipe	MH5	MH3	8.0	5.491	0.225	0.018	0.0	0.01	0.3	Surcharged
1.001	FSR: 30 years: +0 %: 15 mins: Summer	Pipe	MH1	MH2	6.5	5.492	0.225	0.337	0.3	0.02	0.7	Surcharged
1.002	FSR: 30 years: +0 %: 30 mins: Winter	Pipe	MH2	MH3	6.5	5.564	0.225	1.943	0.2	0.02	1.8	Surcharged
1.000	FSR: 30 years: +0 %: 15 mins: Summer	Pipe	Dwelling 1 Cellular Storage	MH1	6.5	5.492	0.225	0.700	0.5	0.02	1.4	OK
2.000	FSR: 30 years: +0 %: 30 mins: Summer	Pipe	Dwelling 2 Cellular Storage	MH2	6.5	5.563	0.225	1.755	0.6	0.02	2.3	Surcharged

FSR: 30 years: Increase Rainfall (%): +35: Critical Storm Per Item

Connection	Storm Event	Connection Type	From	To	Upstream Cover Level (m)	Max. US Water Level (m)	Max. Flow Depth (m)	Discharge Volume (m³)	Max. Velocity (m/s)	Flow / Capacity	Max. Flow (L/s)	Status
3.000	FSR: 30 years: +35 %: 15 mins: Summer	Pipe	MH4	MH5	8.0	5.628	0.225	0.011	0.1	0	0.1	Surcharged
3.001	FSR: 30 years: +35 %: 15 mins: Summer	Pipe	MH5	MH3	8.0	5.628	0.225	0.022	0.0	0.01	0.3	Surcharged
1.001	FSR: 30 years: +35 %: 15 mins: Winter	Pipe	MH1	MH2	6.5	5.629	0.225	0.275	0.3	0.01	0.7	Surcharged
1.002	FSR: 30 years: +35 %: 15 mins: Summer	Pipe	MH2	MH3	6.5	5.630	0.225	1.272	0.1	0.02	2.0	Surcharged
1.000	FSR: 30 years: +35 %: 15 mins: Summer	Pipe	Dwelling 1 Cellular Storage	MH1	6.5	5.630	0.225	0.795	0.5	0.01	1.4	Surcharged
2.000	FSR: 30 years: +35 %: 15 mins: Summer	Pipe	Dwelling 2 Cellular Storage	MH2	6.5	5.630	0.225	1.591	0.7	0.02	2.8	Surcharged

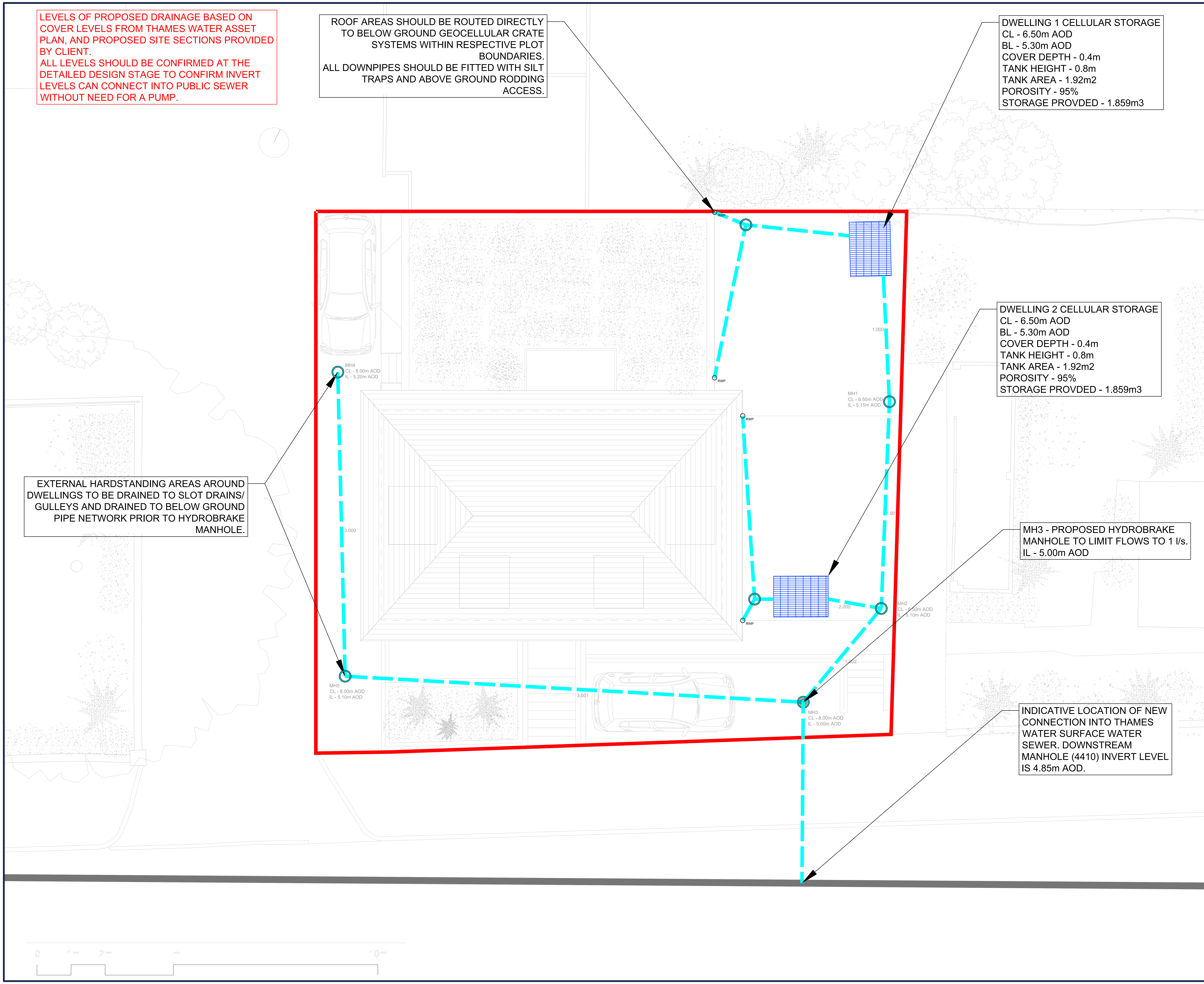
FSR: 100 years: Increase Rainfall (%): +0: Critical Storm Per Item

Connection	Storm Event	Connection Type	From	To	Upstream Cover Level (m)	Max. US Water Level (m)	Max. Flow Depth (m)	Discharge Volume (m³)	Max. Velocity (m/s)	Flow / Capacity	Max. Flow (L/s)	Status
3.000	FSR: 100 years: +0 %: 15 mins: Summer	Pipe	MH4	MH5	8.0	5.608	0.225	0.011	0.2	0	0.2	Surcharged
3.001	FSR: 100 years: +0 %: 15 mins: Summer	Pipe	MH5	MH3	8.0	5.608	0.225	0.024	0.0	0.01	0.3	Surcharged
1.001	FSR: 100 years: +0 %: 15 mins: Winter	Pipe	MH1	MH2	6.5	5.609	0.225	0.285	0.3	0.01	0.7	Surcharged
1.002	FSR: 100 years: +0 %: 15 mins: Summer	Pipe	MH2	MH3	6.5	5.609	0.225	1.257	0.1	0.02	2.0	Surcharged
1.000	FSR: 100 years: +0 %: 15 mins: Summer	Pipe	Dwelling 1 Cellular Storage	MH1	6.5	5.610	0.225	0.777	0.5	0.02	1.8	Surcharged
2.000	FSR: 100 years: +0 %: 15 mins: Summer	Pipe	Dwelling 2 Cellular Storage	MH2	6.5	5.609	0.225	1.548	0.7	0.02	2.7	Surcharged

FSR: 100 years: Increase Rainfall (%): +40: Critical Storm Per Item

Connection	Storm Event	Connection Type	From	To	Upstream Cover Level (m)	Max. US Water Level (m)	Max. Flow Depth (m)	Discharge Volume (m³)	Max. Velocity (m/s)	Flow / Capacity	Max. Flow (L/s)	Status
3.000	FSR: 100 years: +40 %: 15 mins: Winter	Pipe	MH4	MH5	8.0	5.813	0.225	0.019	0.1	0	0.2	Surcharged
3.001	FSR: 100 years: +40 %: 15 mins: Summer	Pipe	MH5	MH3	8.0	5.813	0.225	0.000	0.0	0.01	0.3	Surcharged
1.001	FSR: 100 years: +40 %: 15 mins: Winter	Pipe	MH1	MH2	6.5	5.814	0.225	0.200	0.2	0.02	0.9	Surcharged
1.002	FSR: 100 years: +40 %: 15 mins: Summer	Pipe	MH2	MH3	6.5	5.814	0.225	1.383	0.1	0.02	1.7	Surcharged
1.000	FSR: 100 years: +40 %: 15 mins: Winter	Pipe	Dwelling 1 Cellular Storage	MH1	6.5	5.814	0.225	0.925	0.6	0.02	1.6	Surcharged
2.000	FSR: 100 years: +40 %: 15 mins: Summer	Pipe	Dwelling 2 Cellular Storage	MH2	6.5	5.814	0.225	1.992	0.5	0.03	3.7	Surcharged

Appendix E - Surface Water Drainage Layout



NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT REPORTS, PLANS AND ARCHITECTURAL DRAWINGS
2. THIS DRAWING SHOULD NOT BE SCALED. THERE SHOULD BE NO RELIANCE ON THIS DRAWING WITH REGARDS TO DIMENSIONS. ALL DIMENSIONS SHOULD BE CONFIRMED ON SITE.
3. ANY DISCREPANCY ON THIS DRAWING SHOULD BE REPORTED TO AEGAEA IMMEDIATELY FOR CLARIFICATION.
4. THE CONTRACTOR IS RESPONSIBLE FOR ALL WORKS AND FOR THE STABILITY, INSTALLATION AND HEALTH AND SAFETY OF THE WORKS.
5. AEGAEA HAVE PRODUCED THIS DRAWING BASED ON THE DRAWINGS AND INFORMATION PROVIDED BY THE CLIENT AVAILABLE AT THE TIME OF PRODUCTION. WE CANNOT ACCEPT RESPONSIBILITY FOR DISCREPANCIES RESULTING FROM NEW PLANS/ INFORMATION BEING ISSUED POST-ISSUE OF THIS DRAWING. THE CONTRACTOR SHOULD REVIEW THIS DRAWING IN LIGHT OF WIDER SITE INFORMATION SUCH AS CONTAMINATION, UTILITIES SURVEYS AND SITE INVESTIGATIONS
6. IT IS THE RESPONSIBILITY OF THE PRINCIPLE CONTRACTOR TO MAKE THE DESIGNER AND CLIENT AWARE OF SITE-SPECIFIC RISKS AND HAZARDS THAT MAY AFFECT THE DRAWING AND SPECIFICATION

LEGEND

- PUBLIC SURFACE WATER SEWER
- RAINWATER PIPE
- PROPOSED SURFACE WATER DRAIN
- HYDROBRAKE MANHOLE
- SURFACE WATER MANHOLE
- ATTENUATION

CLIENT: FOSTER KENNY DEVELOPMENTS LTD

SITE: 35 TWICKENHAM ROAD, TEDDINGTON, TW11 8AH

DRAWING: OUTLINE SURFACE WATER DRAINAGE STRATEGY

DRAWING NUMBER: AEG0786-DR01

DATE: 25/11/2022 | **REV: -**

DRAWN BY: NDD

DRAWING SCALE: SEE DRAWING FOR SCALE BAR

PRELIMINARY DRAWING FOR PLANNING ONLY - NOT FOR CONSTRUCTION

aegaea

Flood risk, water and environment