Basement Impact Assessment

for

Proposed Development:
Silver Jetty P4 scheme

at

The Boathouse, Ranelagh Drive, Twickenham, London, TW1 1QZ

Date: 28th June 2023

Revision: B

CONTENTS

1.0 Introduction

Pringuer-James Consulting Engineers (PJCE) were appointed by The Twickenham Boathouse Ltd. (c/o Silver Jetty) as the structural engineers for the proposed development at The Boathouse, Ranelagh Drive, Twickenham, London TW1 1QZ.

As part of the project brief, PJCE are required to provide assistance on the structural engineering aspects of the proposed development, including the preparation of a Basement Impact Assessment (BIA) and outline Construction Method Statement (CMS) to be submitted as part of a planning application package.

The BIA and the CMS has been prepared in accordance with the current format set out by the London Borough of Richmond upon Thames (LBRT) Planning Department in the document: Panning Note - Good Practice Guide on Basement Developments (May 2015). This guidance document is based on the specially commissioned study carried out by Peter Brett & Associates Ltd.

The report is also based on the Level 1 Strategic Flood Risk Assessment with the Further Groundwater Investigations (both prepared by Metis Consultants Ltd. specially for LBRT), and The Surface Water Management Plan (prepared by Capita Symonds Ltd. specially for LBRT). The latter document is a detailed study of the geotechnical, hydrogeological and hydrological characteristics of soil strata found in the London borough of Richmond upon Thames. The report is also based on the site specific Flood Risk Assessment and Surface Water Drainage Strategy (FRA/SuDS) produced by SLR Ltd. ref. 425.064470.0001 Ver. 01 dated September 2022.

There are three critical criteria identified in this study which must be considered and dealt with for a proposed basement development. The defining criteria are as follows:

I) Subterranean Flow
II) Land Stability
III) Surface Flow & Flooding

This BIA and CMS document is set out in four stages accordingly. Stage One, the initial screening process which leads to Stage Two, the scoping process, whereby relevant impacts are identified for the site. Stage Three of the process involves gathering site specific data by means of a desk study and geotechnical site investigation. From this, the relevant information is obtained to enable an accurate assessment of the potential impacts of issues identified in the first two stages.

Following this, Stage Four of the BIA involves an analysis of the information gathered and a site specific assessment of the potential impact of the proposed development. If the potential impacts identified are found to have an adverse risk to the existing site, the surrounding properties and/or the extended area, then a series of measures to mitigate against any negative impact are outlined.

This report presents an outline structural scheme for the construction of the new subterranean structure and proposed superstructures. Above ground floor superstructure falls outside this report, but a summary is included to assist with the understanding of the complete structural scheme.

The report is based on the current design and discussions with the Architect and other consultants mentioned in the report. It should be read in conjunction with the information submitted at this stage by all other consultants, for information purposes.

The report has been compiled for The Twickenham Boathouse Ltd. (c/o Silver Jetty) and shall be for the private and confidential use of the client and should not be reproduced in whole or in part or relied upon by third parties for any use without express written authority from PJCE.

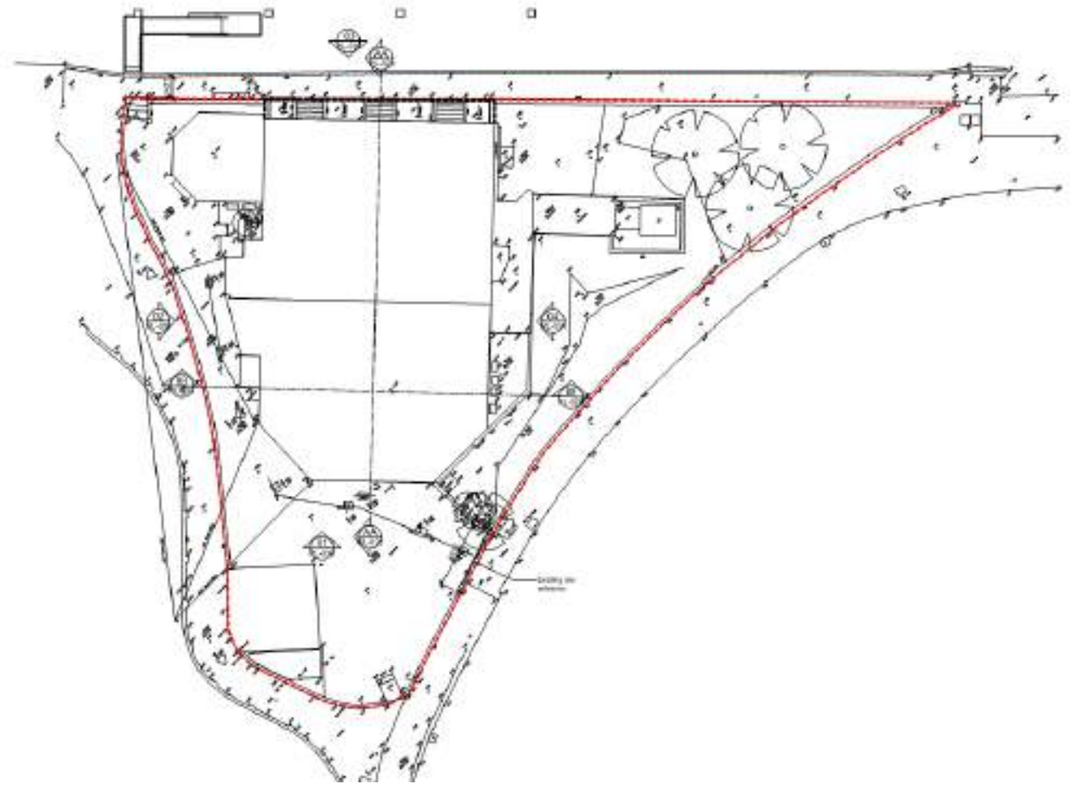

Figure 1 – Existing Site Location Map

2.0 Stage 1 – Screening

2.1 Location of the Project

The site is located in LB Richmond on Ranelagh Drive, Twickenham, approximately 100m North of Richmond Lock and Weir, along the Isleworth Promenade/River Thames and approx. 800m North of St. Margaret's Underground Station. The site is irregular in shape centred on NGR TQ 16875 75063, measures approximately 42m x 58m at it's longest ends and slopes approximately 1.5 metres from front to back. The site provides direct routes to A3004, connected to A316.

The existing property is a large two storey house, formerly a recording studio and boat house, measuring approximately 25m x 22m and built of traditional loadbearing masonry walls, timber joisted floor plates and a traditional cut timber roof.

The property is bounded on one side by the River Thames and by private residential properties on the other sides.

The surrounding area consists of similar residential properties, comprising two, three and four-storey detached houses also built of traditional loadbearing masonry construction, with associated gardens and public highways.

2.2 Characteristics of the Project

The existing property is a two-storey detached building located on relatively flat land with partly grassed and paved front and rear gardens and several shrubs present. Historically the building has been used for boating purposes and recently as a recording studio.

The structure of the building consists of loadbearing brickwork walls with timber floor plates, supported on walls and by a series of steel and timber beams. The entire building is covered by a pitched timber roof, supported on existing walls.

It is proposed to demolish the structures completely and form a new three-storey structure for residential purposes, with a full-height basement, partially under the new footprint. The basement will be formed as a reinforced concrete water resistant structure, built RC sequential underpinned walls or sheet piled with RC lining walls, Ground floor slab and raft foundation.

The new ground floor slab will be entirely formed of RC and will provide a prop at the top of the walls. New openings will be formed to allow for access via staircases. The walls will be designed as propped cantilevers to retain the surround earth and water pressures on full height of the walls.

The new superstructures fall outside the scope of this report, but a summary is included to assist with the understanding of the complete structural scheme. The superstructure will be built with a suspended ground floor slab in the areas where there is no basement. The external and internal walls will be built with RC walls and columns to support the loads from the floors and the roof. The floors and the roof will be formed with RC flat slabs or PC panels, bearing on the walls & columns. Stability will be achieved via the floors forming horizontal diaphragms to transfer the wind loads to the vertical stability systems formed by the shear wall action of the RC walls.

Preliminary structural details are attached as part of the appendices which outline the proposed construction details to facilitate installation of the new basement structure.

2.3 Mitigation Measures Being Considered

As with any construction involving of subterranean works, the proposed construction methods and sequencing of the works must give consideration to the inherent risks associated with excavation adjacent to existing buildings and their foundations.

Given the close proximity of neighbouring properties on all boundaries and the River Thames, the proposed works have been designed to limit the risk of adverse impact to the buildings. This has been achieved by proposing the use of sequentially underpinned walls or sheet piles with RC lining wall along the length of the proposed basement (TBC). These walls will be designed to act as retaining walls in both temporary and permanent conditions.

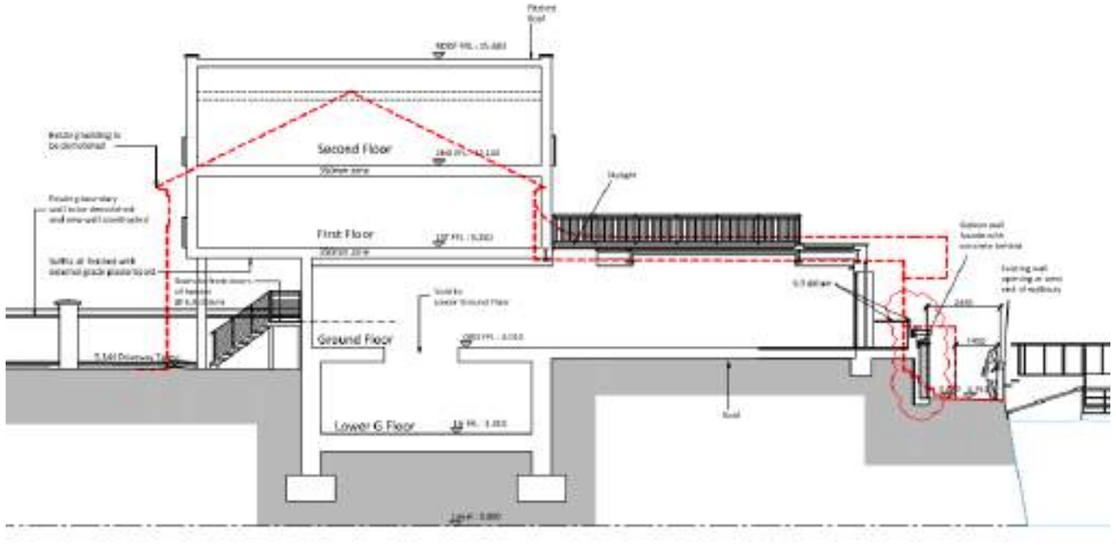

Figure 2 - Proposed Section

2.4 Characteristics of Potential Impacts

2.4.1 Subterranean (Groundwater Flow)

The BGS Solid and Drift Geological Map for the South London Area (Sheet Number 270) revealed that the site was underlain by the superficial Kempton Park Gravel Member deposits, underlain by the London Clay Formation bedrock deposits. No superficial deposits, outcrops of other bedrock deposits or areas of Made/Worked Ground were noted.

The DEFRA online maps indicated that the site was located on superficial deposits of the Kempton Park Gravel Member, classified as a Secondary A Aquifer, underlain by bedrock deposits of the London Clay Formation, classified as Unproductive Strata. From analysis of hydrogeological and topographical maps the groundwater table was anticipated to be encountered at shallow to moderate depth within the Kempton Park Gravel Member capping the impermeable London Clay Formation. Perched water was also likely to be found within the Made Ground, especially after periods of intense or prolonged rainfall. It was considered that the groundwater was flowing eastwards, towards the River Thames and in alignment with local topography.

In these areas of permeable material, it is common to come across a raised groundwater table due to the presence of a perched aquifer or historic river channel. The attributes of groundwater in these areas varies, sometimes found to be static if not connected to additional groundwater features.

Where a high groundwater table is found the possible effects of excavating for a basement structure include altering the water table level and/or diverting the existing groundwater flow paths. The effect of these changes needs to be taken into consideration in the early planning stages of a development and designed out of the proposed development.

These adverse effects may include:

- Forming alternative flow paths for the groundwater which may conflict with existing basements that have not been adequately protected against moisture.
- Altering existing groundwater levels locally and, as a result, altering the soil properties of the local area. The altered soil properties may influence existing slope stability, soil bearing capacity etc.

2.4.2 Slope Stability

Generally, slope stability is affected by a number of contributory factors ranging from soil properties, land use, topography, landscape and human activities (e.g. mining, drainage etc.). The excavation and construction of a basement structure can affect the slope stability of a site and the adjoining land or properties in several ways including:

- Altering soil properties such as, moisture content, pore water pressure, consolidation and compaction levels, shear strength and bearing capacity of the soil.
- Requiring an element of pumping or dewatering of the site which can lead to removal of “fines” in the existing soil, thus affecting soil properties through interaction of the soil particles.
- Requiring the removal of existing vegetation, plants and/or trees from site which are part of groundwater extraction systems. This in turn may alter groundwater levels, affecting soil properties.
- Altering the natural state of the landscape or possibly involving works to previously disturbed or “worked” soil which could have a historic element of instability.

Beyond the confines of the site, possible effects of any subterranean construction works must consider adjoining structures and their existing foundations, and any infrastructure in the area. The scale of proposed works will dictate the potential zone of influence of any works to be undertaken below ground.

During the construction stage of a project, the local bearing capacity of soil in the zone of influence for the works can be temporarily reduced. This is due to the removal of existing overburden pressures. Any project must allow for this reduction in pressure and undertake proper planning, design and execution of the excavation and any temporary works which would be required.

Additional effects which must be considered in the planning and design of a project are ground movements. With any excavation there is a degree of ground movement which must be allowed for. This is generally done by specifying agreed design parameters for any soil retaining element of the works and incorporating in the construction sequence a suitable scheme for temporary works.

Once the construction stage of a project is complete, possible effects which should be considered include increased stiffness of new foundations and a possible increase in the loads transmitted to the bearing strata.

As part of the project, any existing foundations within a site or adjoining site may require upgrading to support the new building. Upgrading foundations along party wall lines can give rise to a variation in stiffness between old and new foundations which should be considered as part of the planning and design process.

In addition to variation in stiffness of foundations, a new or redeveloped building can lead to increased or redirected pressures on soil bearing strata. The effects of this should be accommodated for in any design, with particular attention to areas where the primary soil is clay. This is due to the susceptibility of clay to experience swelling and contraction as moisture content varies. The issue of swelling and contraction can be minimized by excavating below upper layers of soil which would be more sensitive to weather and moisture conditions.

2.4.3 Surface Flow & Flooding

Potential impacts on surface flow and flooding characteristics in an area because of excavation for a basement can vary dependent on site location and existing drainage infrastructure which is required for any site runoff.

Excavating for a basement directly affects the volume of soil below ground and, depending on the type of material, can affect the natural groundwater storage capacity of the soil. If this is reduced significantly, it can cause an increase in the proportion of surface water runoff which needs to be carried by the local drainage network.

Following on from the point above, with an increase in the volume of surface water runoff, there is an increased risk of overwhelming the local drainage network which may not have sufficient capacity to deal with the increased volumes. This in turn could raise the risk of flooding properties downhill of site. As part of the planning and design process, careful consideration should be given to any runoff generated by the development and how it is managed within the confines of site, with any excess flow making its way into the drainage network in a controlled manner.

If a project causes an increase in runoff produced, and the increased volumes are not accommodated, the possibility and frequency of flooding is increased. In areas which are already prone to flooding, the effects of this must be examined and further analysis may need to be undertaken.

2.5 Screening Process

2.5.1 Subterranean Flow

Q1a: Is the site located directly above an aquifer? ***→ NO***

Figure 3.5.1 of the SWMP study indicates that the site is not located over an aquifer. This means permeable layers capable of supporting water supplies at local scale are not found in the area.

Q1b: Will the proposed basement extend beneath the water table surface? ***→ YES***

The proposed basement depth is expected to be a maximum of 4.0m below ground level. Water monitoring on the site confirmed that the water table is approx. 2.00m below ground level.

Q2: Is the site within 100m of a watercourse, well (used/disused), or potential spring line? ***→ YES***

The site is located directly adjacent to the River Thames.

Q3: Is the site within the catchment of any pond chains? ***→ YES***

The site is located directly adjacent to the River Thames and there are small ponds within the near vicinity.

Q4: Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas? ***→ NO***

At present the existing site has paved areas around the existing building. It is proposed that these are removed and replaced with new permeable paving and new garden areas.

Q5: As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)? ***→ NO***

The existing drainage system for site is assumed to drain freely into the local authority drainage network. It is proposed to re-use the same connection and to provide attenuation tanks to limit the flow into existing infrastructures, in line with the London Plan.

Q6: Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line? ***→ YES***

The site is located directly adjacent to the River Thames.

Q7: Are infiltration methods proposed as part of the site’s drainage strategy? ***→ NO***

Fig. 4.3.1 of the SWMP indicates that the site will not be suitable for SUDS. Therefore, an attenuation tank is proposed which will not allow infiltrations into the existing areas.

2.5.2 Slope Stability

Q1: Does the existing site include slopes, natural or manmade, greater than 7 degrees (approximately 1 in 8)? ***→ NO***

Topographical data available from existing site surveys suggest that the site is relatively flat across the plan area with no significant gradient or falls. Over the extended region, the site is located in an area which is not noted as vulnerable to landslides or significant soil movements.

Q2: Will the proposed re-profiling of landscaping at site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8)? ***→ NO***

The site is not anticipated to require any re-profiling of current landscaping to steeper than 7 degrees.

Q3: Does the development neighbour land including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8)? ***→ NO***

Initial site inspection does not suggest the presence of any railway cuttings or a slope in excess of 7 degrees in the vicinity.

Q4: Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8)? ***→ NO***

The site is set in a region with a gentle slope however this does not exceed 7 degrees.

Q5: Is the London clay the shallowest strata at the site? ***→NO***

The window samples carried out within the site boundary showed that the underlying London clay was found to be overlain by approx. 7.20m of made ground/alluvium.

Q6: Will any trees be felled as part of the proposed development and/or any works proposed within any tree protection zones where trees are to be retained? ***→YES***

There is a single semi-mature tree and some shrubs present within the boundaries of the site. These are proposed to be removed and the garden area re-landscaped

Q7: Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site? ***→ UNKNOWN***

With the limited information available (no precondition survey has been carried out to date on the existing buildings either within or adjacent to site) and no obvious signs of damage to the outside of the existing building, the effects of seasonal shrink-swell subsidence cannot be accurately established, however due to the deep nature of the London Clay, it is not considered that the effects of seasonal shrink-swell or subsidence will effect the proposed development.

Q8: Is the site within 100m of a watercourse or a potential spring line? ***→ YES***

Refer to Q2 of section 2.5.1 Subterranean Flow.

Q9: Is the site within an area of previously worked ground? ***→ NO***

The current data suggests that there is no indication that the site is within an area of previously worked ground.

Q10: Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction? ***→ NO***

Refer to Q1 of section 2.5.1 Subterranean Flow.

Q11: Is the site within 50m of any ponds different from watercourses? ***→YES***

The site is located directly adjacent to the River Thames and some local ponds.

Q12: Is the site within 5m of a highway or pedestrian right of way? ***→ YES***

The nearest of the site is approximately 1.6 metres from the nearest highway and pedestrian right of way, which is Ranelagh Drive, the footpath nearby and the path along the River Thames. These will remain usable during all works.

Q13: Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties? ***→ YES***

Along the boundaries with adjacent properties, it is anticipated that the differential depth of foundations will be approximately 2.5–3.0m, assuming no basement/cellar is found below the neighbouring properties, as a worst case scenario, however the nearest part of the neighbouring buildings is approx. 17.0m away from the proposed development. Therefore, the proposed development will not influence the neighbouring buildings.

Q14: Is the site over (or within) the exclusion zone of any tunnels, e.g. railway lines? ***→ NO***

The site is located more than 450m from the nearest section of the Railway Line. It is not expected that the site is over or within any exclusion zones for rail or underground infrastructure.

2.5.3 Surface Flow & Flooding

Q1: Is the site within the catchment of the pond chains? ***→ NO***

Refer to Q3 of section 2.5.1 Subterranean Flow.

Q2: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route? ***→ NO***

The site will retain its permeable elements and these will be increased by removing the current impermeable surfaces with new permeable surfaces. The use of any existing local authority drainage systems will be maintained and so the proposed development will not materially change the surface water flows.

Q3: Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas? ***→ NO***

It is proposed to remove the existing hard surfaces and to replace them with new permeable ones. therefore, it is not anticipated that the proposed basement will result in a change in surface water generated.

Q4: Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses? ***→ NO***

The existing site is serviced by a series of drainage sewers and channels which restrict the flow of surface water from site to adjacent properties. This also ensures that all surface water generated is directed into gravity fed drainage systems locally. The proposed basement is not expected to generate any additional surface water and so is not expected to change the profile of inflows of surface water to adjacent properties or downstream watercourses.

Q5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses? ***→ NO***

As per Q4, the proposed basement will not have any effect on surface water generated and so will not affect the quality of surface water received by adjacent properties or downstream watercourses.

Q6: Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature? ***→ YES***

Based on SuDS report, the site falls within Flood Zone 3a.

2.6 Summary

2.6.1 Subterranean (Groundwater) Flow

The screening process has identified two issues which are of initial concern as part of the planning process and should be examined further as part of the scoping process:

1. The site is directly adjacent to the River Thames.
2. The site is near the catchment areas of nearby ponds.
3. The underside of the basement is below the water table.

2.6.2 Slope Stability

The screening process has identified three issues which are of initial concern as part of the planning process and should be examined further as part of the scoping process:

1. Trees to be felled as part of the proposed development.
2. History of seasonal shrink-swell subsidence in the local area.

2.6.3 Surface Flow & Flooding

The screening process has identified one issue which is of initial concern as part of the planning process and should be examined further as part of the scoping process.

1. Flood Zone 3a Hazard area.

3.0 Stage 2 – Scoping

3.1 Potential Impacts of the Proposed Scheme

3.1.1 Subterranean Flow

3.1.1.1 Site directly adjacent to the River Thames and near the catchment area of nearby ponds

The site is directly adjacent to the river Thames making it sensitive to the tidal level variations and sudden increase of the water levels during construction.

The foundations are proposed to be piled, which will have slurry pumped into the drilled holes, keeping the pressures equalised and keeping the water filling the holes, preventing the sides of the excavation to collapse and leading to the piles being constructed using the Tremie method i.e. a Tremie pipe with its upper end connected to a hopper and the lower end continuously submerged in fresh concrete, is used to place concrete at the exact location from a hopper at the surface.

3.1.1.2 Underside of basement is below the water table

It was identified that the new basement will be below the expected water table. Furthermore, the water table is also liable to fluctuate with the tidal fluctuations of the adjacent river Thames.

The construction of the basement will need to be carried out by first injecting an inert material between the contiguous piles from ground level, which protrudes deep into the surrounding areas behind the piles and form a waterproof barrier. Once achieved, the area to the front of the piles will be dug out and kept dry without the need for pumps, which might affect the alluvium layer behind the piles.

3.1.2 Slope Stability

3.1.2.1 Trees to be felled as part of the proposed development

A single tree is proposed to be removed as part of the works. This has been identified in the arboriculturist report and are either recommended to be removed as they are poor specimens, diseased/defective, or required to be removed to facilitate the development. In the latter case, tree removal can be easily compensated for by new planting and management of existing retained trees.

Tree removal is unlikely to present any risk to the new or existing structure as new foundations (namely contiguous embedded pile retaining wall and single piles) will extend deeper than the likely desiccation level present on site.

3.1.2.2 Seasonal Shrink-Swell Subsidence

The history of seasonal shrink-swell ground movements in the local area is not readily known, although the clay-based nature of underlying soil suggests the need to consider the cause and effects of shrink-swell movement on proposed structural design.

There are a number of methods for dealing with possible ground movements which occur in clay soils. For areas of deep underground excavation, these include the use of tension piles to counteract anticipated hydrostatic pressures and/or the use of compressible material (e.g. Cordek) to reduce build-up of hydrostatic pressure acting on the slab. In situations where a raft slab is used, it is necessary to design the slab to resist anticipated hydrostatic uplift pressures.

In piled foundation systems, the depth of these will extend below the likely desiccation level present on site, thus minimizing its susceptibility to the problems associated with the more frequent shrink-swell movement of clay soils due to freezing.

The form of the foundations underlying the existing buildings adjacent to the excavation perimeter (typically stepped brickwork corbels) allows us to presume that the problems inherent with shrink/swell of clay soils in shallow foundations are not applicable to existing buildings on site. Leading to the assumption that shrink-swell movements in the local area are not currently causing any undue deterioration in the buildings or boundaries.

3.1.3 Surface Flow & Flooding

3.1.3.1 Flood Zone 3a Hazard Area

Flood Zone 3a is defined as land which could be at risk of flooding with an annual probability of occurrence greater than 1% (1:100 year) from fluvial sources and greater than 0.5% (1:200 year) from tidal sources i.e considered to be at ‘high probability’ of flooding.

As a result, the new basement area will only be used for housing of storage and plant equipment to comply with Policy LP21. The architectural proposals show this type of use.

Refer to Flood Risk Assessment in Appendix D for further details.

3.2 Summary

The potential impacts of the basement excavation and construction have been assessed in relation to the three screening flowcharts. The scoping process has examined the particular areas which pose the highest risk for potential impact to the existing property or adjacent properties in detail. These have subsequently been designed out/mitigated against in the final construction scheme.

4.0 Stage 3 – Site Investigation & Study

A geotechnical site investigation has been carried out by Paddock Geo Engineering Ltd. This has been used to interpret the soil conditions found in the proposed development site. The window sample details are attached in Appendix C of this document.

The findings of the geotechnical investigation confirm the assumptions made in relation to clay-based subsoil in the vicinity and serve to back up the points made as part of this BIA.

A brief summary of the findings from the site investigation reveals that the proposed excavation will be carried out in an area of soil containing predominantly made Ground/Alluvium.

5.0 Stage 4 – Outline Construction Method Statement

5.1 Proposed Substructure and Basement

The proposals for the basement structure are described on the structural drawings included in Appendix A of this report. They have been developed by PJCE in conjunction with the Architectural drawings to address the specific site requirements and constraints including:

- Ground conditions
- Permanent support of the new structure above
- Stability of the neighbouring structures
- Health and safety

5.1.1 Basement

A contiguous piled wall will be constructed around the perimeter of the extended area to provide the lateral resistance to the soil, surcharges, predicted live loads and anticipated line loads from neighboring properties. After completion, ground injection will be carried out to keep any water seeping through between the piles and to allow for a dry excavation. Internally, a 200-250 mm thick RC lining wall will be constructed to resist the hydrostatic component of the lateral forces formed against the piled walls. The construction of the RC lining walls will be cast in one, the piled wall and new RC basement slab providing the temporary support.

5.1.2 Basement Slab

The basement slab will be ground bearing and tied into the wall reinforcement to create a continuous structure, and an effective RC box. The complete RC structure will be designed to a crack width of 0.2mm during detailed design to ensure adequate water tightness.

A conservative water table at ground level has been assumed, leading to a total hydrostatic head of circa 4.0m applied to the deepest section of basement slab. The maximum uplift after consideration of the load condition above and after deduction of the slab dead load is found to be approximately 40 KN/m^2.

A minimum ground bearing slab depth of 300 mm will be constructed to the deepest section of basement slab with tension piles in key locations.

5.1.3 Ground floor

Above the proposed basement level, the superstructure will be constructed at approx. 500mm above the ground level. The new ground floor will primarily be constructed of 275 mm RC in-situ slab spanning between the contiguous piled walls and internal RC in-situ load bearing walls.

The floor structure will also act as a prop to the basement RC walls. Around stair voids, the basement RC slabs are modelled as 2 way spanning mechanisms, transferring the lateral loads across the voids.

5.2 Temporary Works Proposals

The following section provides details on the preferred methods for construction of the new basement by PJCE. The Contractor may propose solutions to suit an alternative method of working and the project's programme. No structural works shall commence until a detailed temporary works design, drawings and calculation package have been reviewed and commented upon by PJCE, this includes all necessary construction method statements.

5.2.1 Cantilevered contiguous piled walls

To ensure the stability of the excavation and safe construction of the basement, PJCE have proposed the contiguous piled walls to be designed and detailed as cantilevered in both permanent and temporary conditions to take the active earth pressure and surcharge loads applied.

5.3 Construction Sequence

Below is summary of the proposed steps for the contractor to follow:

Contiguous piled wall

- Contiguous piled wall installed using Tremie method.
- Inject soil behind piles with inert material to form waterproof barrier.

Basement slab

- Excavation down to formation level.
- Install rebar and pour concrete within basement slab.
- Install rebar and pour concrete in RC lining walls.

Ground floor

- Installation of formwork and rebar.
- Pouring of concrete and formation of slab.

6.0 Stage 5 – Impact Assessment & Conclusion

6.1 Site Attributes & Features Affected

6.1.1 Subterranean Flow

An analysis of site specific geotechnical data obtained from site investigation indicates that the presence of groundwater on site is high and thus the potential impacts to the groundwater as a result of the development would safely be considered negligible by the use of specially considered construction techniques.

6.1.2 Slope Stability

The scope of the proposed works and the extent of existing foundations in the area facilitate the construction for the proposed basement with a relatively low level of risk to the slope stability of the adjacent properties.

6.1.3 Surface Flow & Flooding

Construction of the basement is not anticipated to materially change the amount of permeable surface area currently on site and therefore is not anticipated to have a negligible effect on the volume and quality of surface water generated by the redeveloped site.

6.2 Conclusion

The basement impact assessment for The Boathouse on Ranelagh Drive has been carried out in accordance with current guidelines provided by London Borough of Richmond Upon Thames Planning Department.

The three principle criteria identified by the department which must be dealt with in each assessment include, subterranean (groundwater) flow, slope stability, and surface runoff and flooding.

At each stage of this assessment these three criteria have been considered and any requirements for each category have been incorporated into the proposed development scheme.

As a result of this assessment, it is reasonable to conclude that the proposed basement will not be detrimental to the region in terms of groundwater, slope stability or surface flow/flooding.

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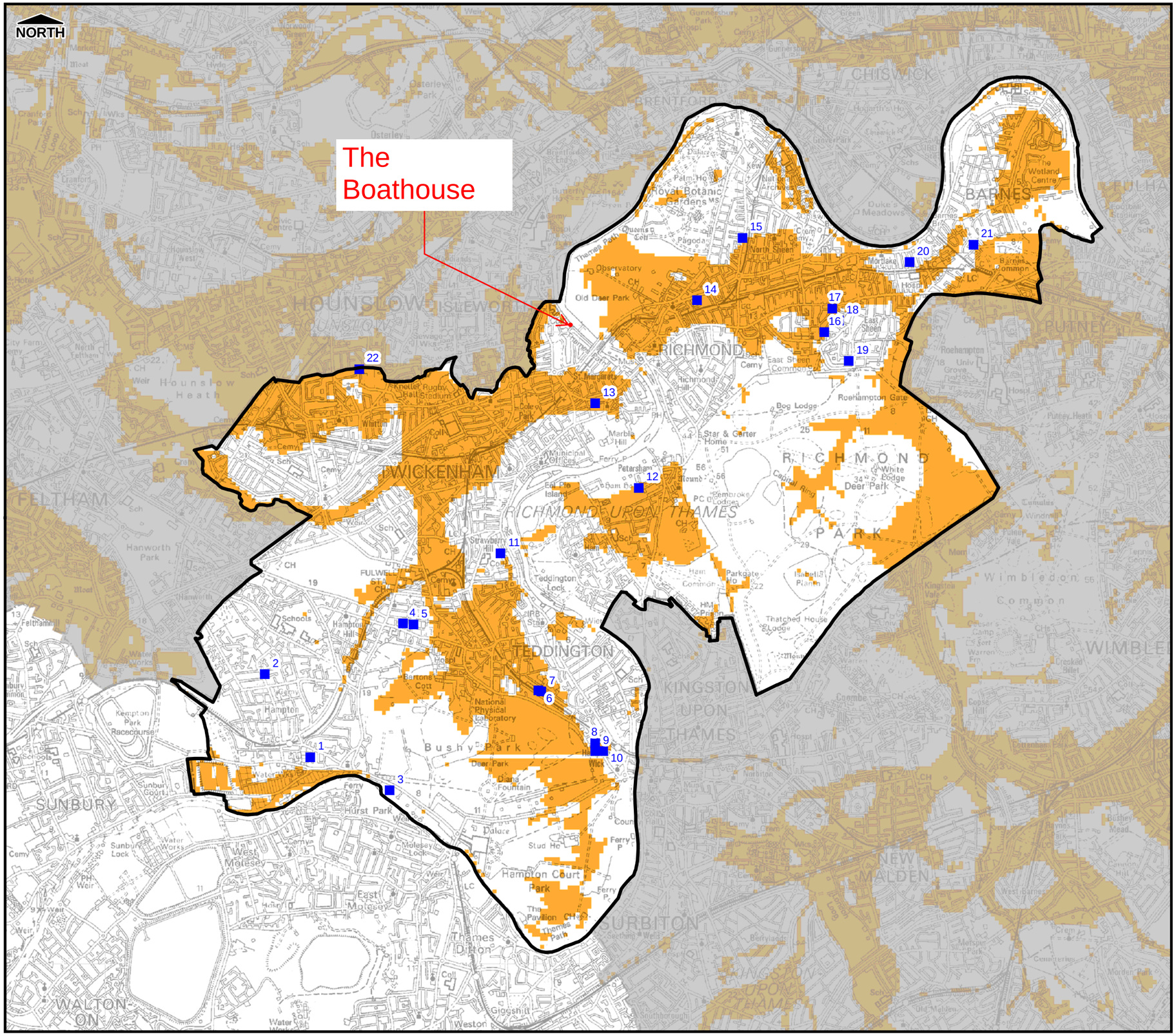
Appendix A

Mapping Data



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Richmond Borough Council
- Groundwater Flood Incident (EA Records)

Increased Potential for Elevated Groundwater in

- Permeable Superficial Deposits
- Consolidated Aquifers

Notes

1.The increased Potential for Elevated Groundwater map shows those areas within the London Boroughs where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the groundsurface. Such groundwater rise could lead to the following:

-Flooding of basements of buildings below ground level;
-Flooding of buried services or other assets below ground level;
-Inundation of farmland, roads, commercial, residental and amenity areas;
-Flooding of ground floors of buildings above ground level; and Overflowing of sewers and drains

2.Incident records shown are generally unconfirmed and may include issues such as water main bursts or non-groundwater related problems.
3.Areas not shown to have increased potential for elevated groundwater should be considered to have a low potential for elevated groundwater - Lack of information does not imply 'no potential' of elevated groundwater in that area.
4.Includes groundwater flood mapping provided by JBA consulting, Copyright. Jeremy Benn Associates Limited 2008-2011, partially derived from data supplied by the Environment Agency.

London Borough Richmond

LONDON BOROUGH OF RICHMOND UPON THAMES

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:50,000	22/03/2011	C.Woolhouse	S.Cox

Increased Potential For Elevated Groundwater

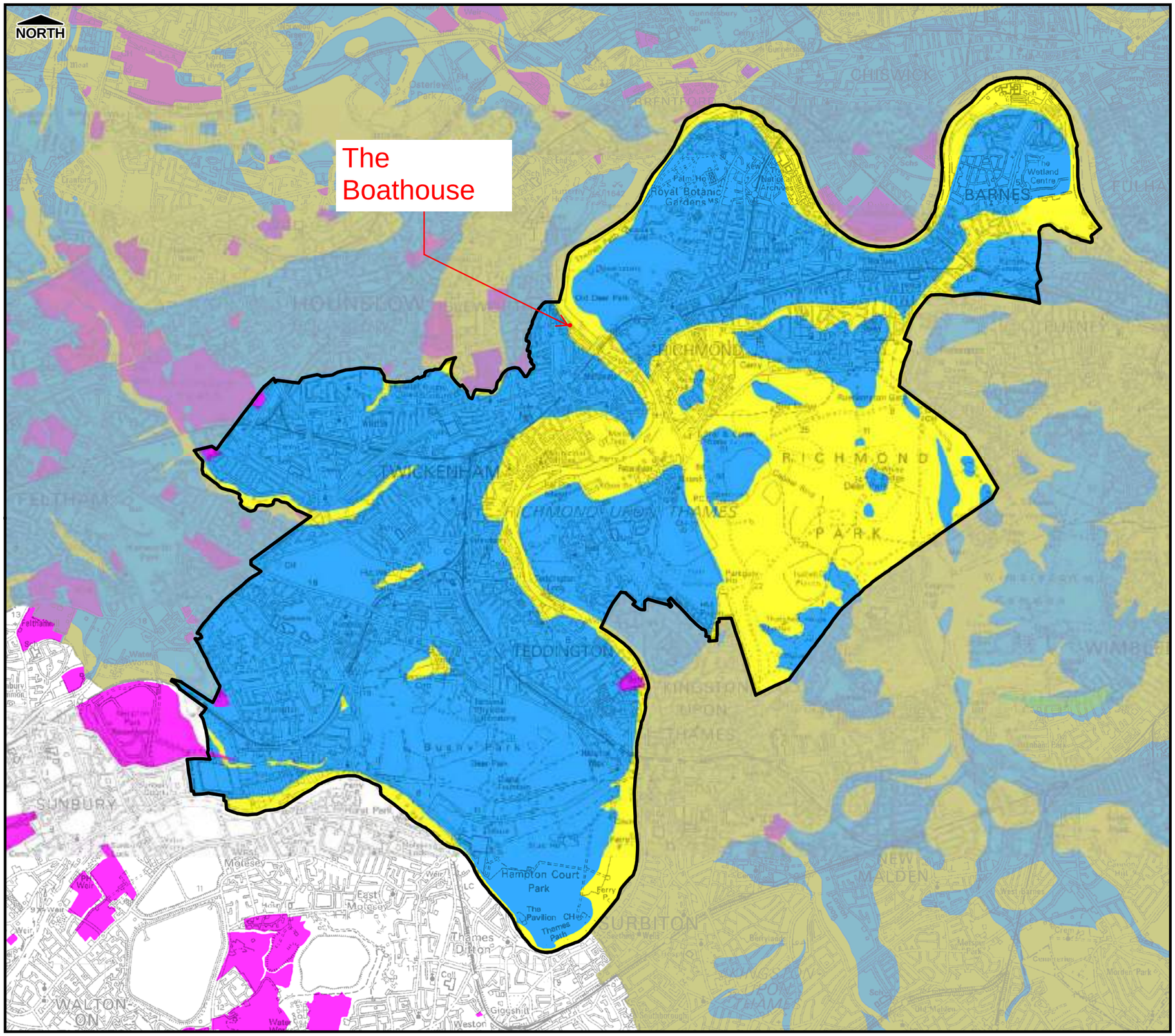
Consultants
CAPITA SYMONDS Flood Risk Management
Scott Wilson
URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

Drain London Programme Board Members

Environment Agency · Thames Water · LONDON COUNCILS · GREATER LONDON AUTHORITY

FIGURE 3.5.1

Filepath: D:\34786 Drain London_Tier 2_Group 8\700 Technical\711 GIS\01 Layout\Richmond\Increased Potential for Elevated GW.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

Legend

- Richmond Borough Council

EA Groundwater Source Protection Zone

- Inner Zone
- Outer Zone
- Historic Landfill Site

Infiltration SUDS Suitability

- Infiltration SUDS potentially suitable
- Infiltration SUDS potentially unsuitable
- Infiltration SUDS Suitability Uncertain -Site investigation required

Notes

London Borough Richmond

LONDON BOROUGH OF RICHMOND UPON THAMES

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:50,000	22/03/2011	C.Woolhouse	S.Cox

Infiltration SUDS Suitability Map

Consultants

CAPITA SYMONDS Scott Wilson
Flood Risk Management

URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

Drain London Programme Board Members

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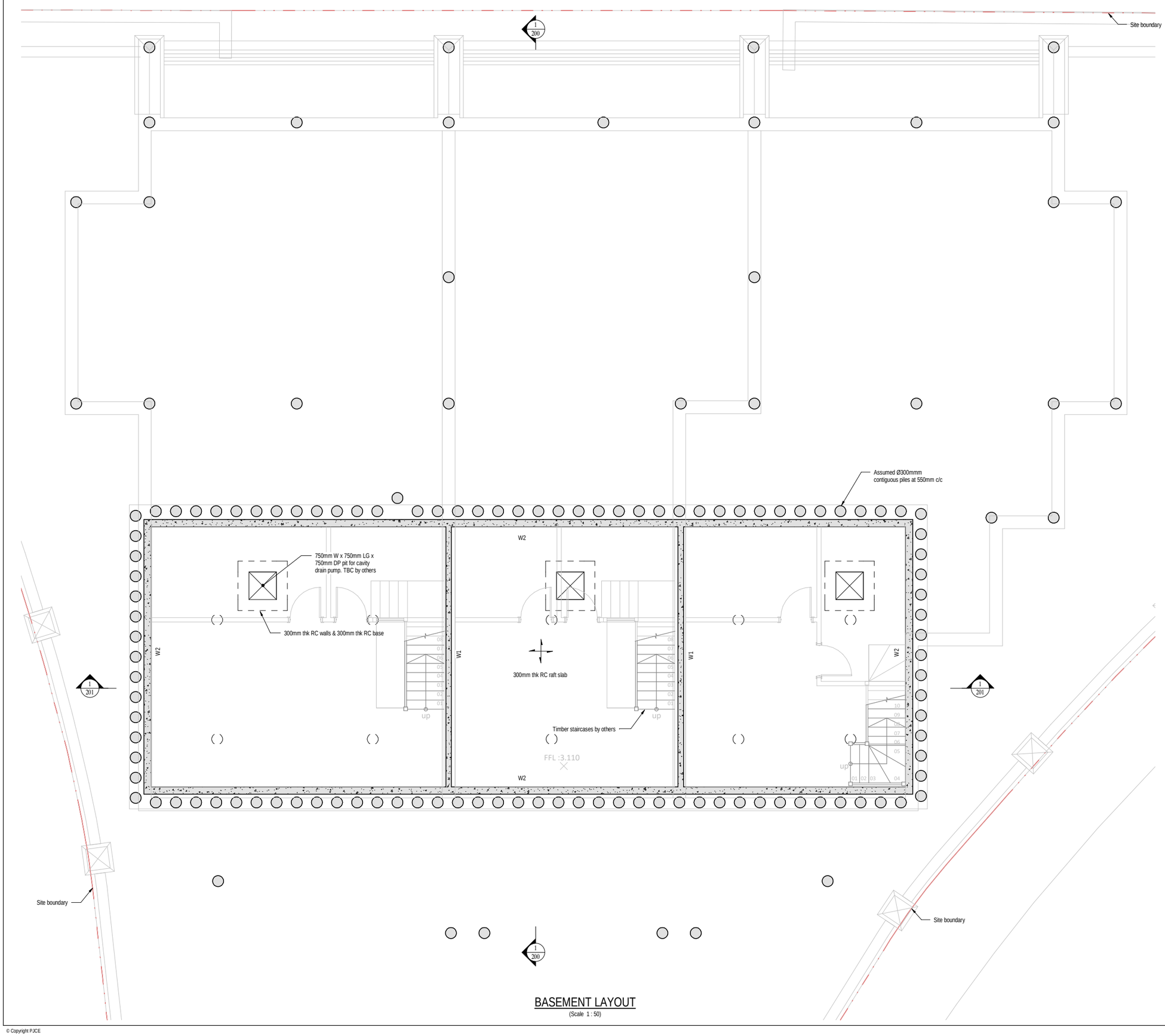
FIGURE 4.3.1

Filepath: D:\34786 Drain London_Tier 2_Group 8\700 Technical\711 GIS\01 Layout\Richmond\Infiltration SUDS Suitability Map.mxd

Appendix B

Preliminary Structural Drawings



BASEMENT LAYOUT
(Scale 1 : 50)

Wall Schedule

Ref	Type
W1	150 thk R.C wall
W2	200 thk R.C lining wall

For General Notes refer to PJCE drawing L11234-22-215

All Structural Engineering drawings are to be read with the specification and with all relevant Architects drawings and specifications.

Do not scale from any Structural Engineers drawing. All dimensions are in millimetres and levels in metres.

Any discrepancies noted on site are to be reported to the engineer immediately.

All waterproofing (DPM & DPC) works to Architects details.

All fire protection works to Architects details unless specifically noted otherwise.

Note:
Facade wall not shown for clarity by others

Rev	Date	Drawn	Chk	Amendment
01	06.03.23	CY	JB	Updated Client's details
-	24.01.23	CY	JB	Issued For Information

PJCE
Pringuer-James Consulting Engineers
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Phone:+44 (020) 8940 4159 Email:mail@pjce.com Website:www.pjce.com

THE TWICKENHAM BOATHOUSE LTD

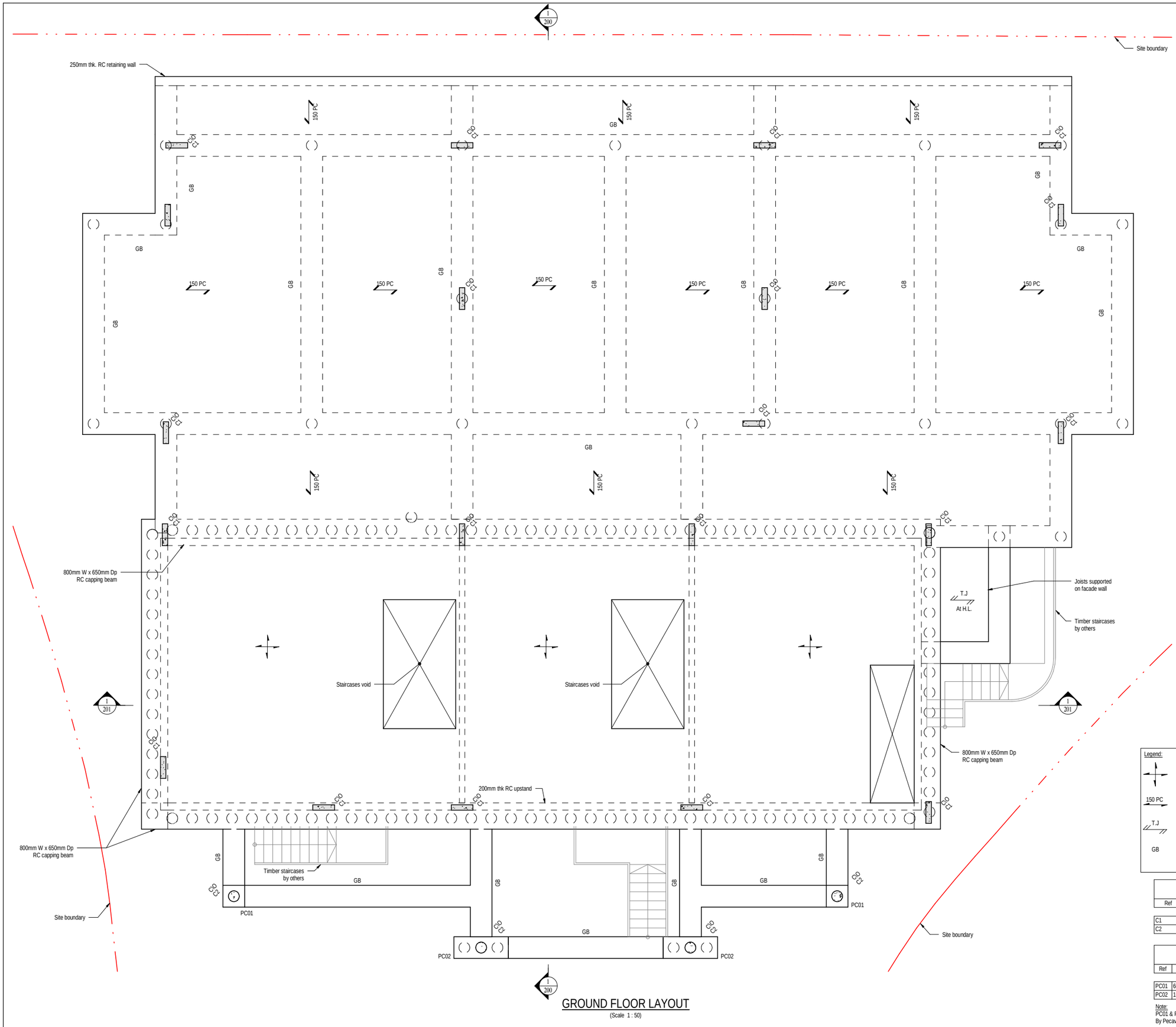
The Boathouse

GENERAL ARRANGEMENT OF BASEMENT

Status: **IMFORMATION**

Scale: 1 : 50@ A1		Date: JAN 2023
Drawn: CY	Engineer: TF	Checked: JB

Drawing No: **L2754-PJC-XX-B1-DR-S-090** Revision: **-**



GROUND FLOOR LAYOUT

(Scale 1 : 50)

For General Notes refer to PJCE drawing L11234-22-215

All Structural Engineering drawings are to be read with the specification and with all relevant Architects drawings and specifications.

Do not scale from any Structural Engineers drawing. All dimensions are in millimetres and levels in metres.

Any discrepancies noted on site are to be reported to the engineer immediately.

All waterproofing (DPM & DPC) works to Architects details.

All fire protection works to Architects details unless specifically noted otherwise.

Note:
Facade wall not shown for clarity by others

Legend:

	275mm thk RC flat slab
150 PC	150mm thk PC planks with 50mm structural RC topping
T.J	47x150mm dp timber joists (C24) at 400mm c/c with 18mm thk. ply screwed on top
GB	600mm W x 600mm dp RC ground beam on anti-heave boards. By Pecavoid & Clayfill side protection boards

Column Schedule

Ref	Type
C1	150mm W x 600mm LG RC column
C2	300Dia RC column

Pile Cap Schedule

Ref	Type
PC01	600 (W) x 600 (L) x 600mm (DP) RC Pile Cap
PC02	1500 (W) x 600 (L) x 700mm (DP) RC Pile Cap

Note:
PC01 & PC02 on anti-heave boards.
By Pecavoid & Clayfill side protection boards

Rev	Date	Drawn	Chk	Amendment
01	06.03.23	CY	JB	Updated Client's details
-	24.01.23	CY	JB	Issued For Information

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THE TWICKENHAM BOATHOUSE LTD

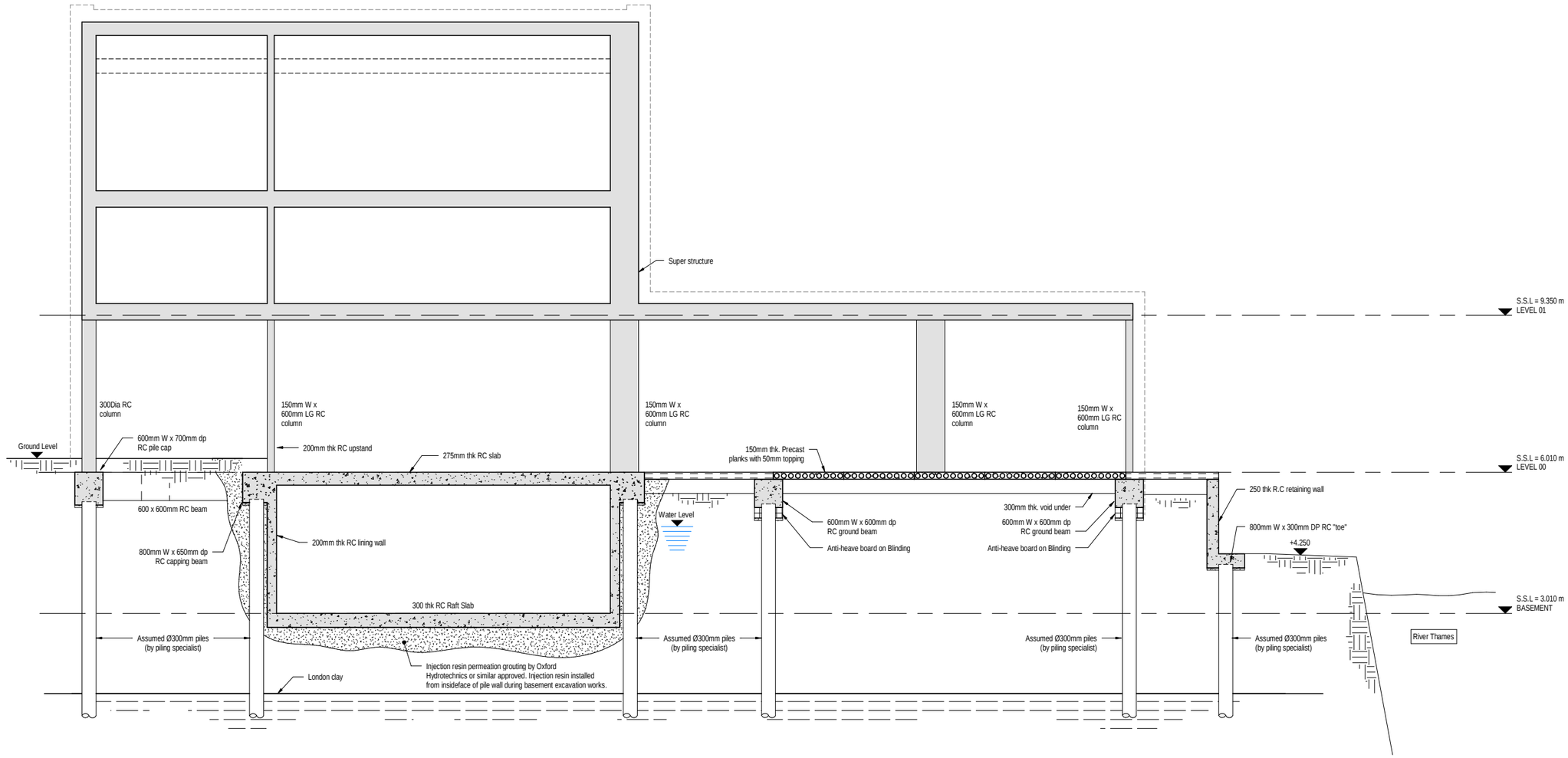
The Boathouse

GENERAL ARRANGEMENT OF GROUND FLOOR

Status: **IMFORMATION**

Scale: 1 : 50@ A1		Date: JAN 2023	
Drawn: CY	Engineer: TF	Checked: JB	

Drawing No: **L2754-PJC-XX-00-DR-S-100** Revision: **-**



Section 1 - 1

(Scale 1 : 50)

For General Notes refer to PJCE drawing L11234-22-215

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Rev	Date	Drawn	Chk	Amendment
01	06.03.23	CY	JB	Updated Client's details
-	24.01.23	CY	JB	Issued For Information

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THE TWICKENHAM BOATHOUSE LTD

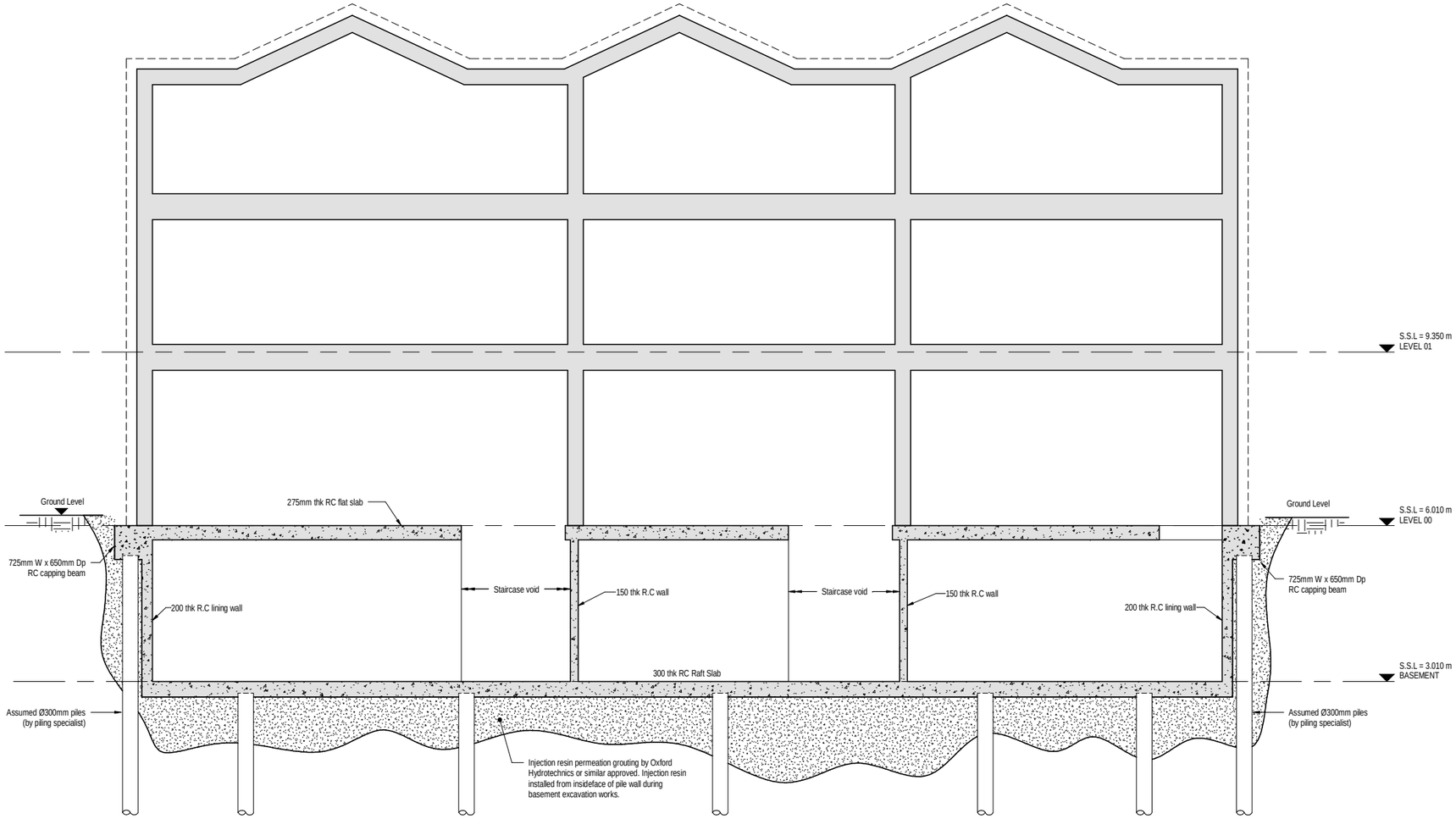
The Boathouse

SECTION

Status: **IMFORMATION**

Scale: 1 : 50@ A1		Date: JAN 2023
Drawn: CY	Engineer: TF	Checked: JB

Drawing No: **L2754-PJC-XX-XX-DR-S-200** Revision: **01**



Section 1 - 1

(Scale 1 : 50)

For General Notes refer to PJCE drawing L11234-22-215

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Rev	Date	Drawn	Chk	Amendment
-	06.03.23	CY	JB	Issued For Information

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THE TWICKENHAM BOATHOUSE LTD

The Boathouse

SECTION

Status: **IMFORMATION**

Scale: 1 : 50@ A1 | Date: FEB 2023

Drawn: Author | Engineer: TF | Checked: JB

Drawing No: **L2754-PJC-XX-XX-DR-S-201** Revision: **-**

Appendix C

Paddock Geo Engineering Ltd
Geotechnical Site Investigation Report

PADDOCK GEO ENGINEERING

The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ

Ground Investigation

The Twickenham Boathouse Ltd

Co / Silver Jetty

February 2023

P22-425gi_v2

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W: www.paddockgeoengineering.co.uk

Company Number: 8613165
VAT Number: GB 166 8087 72

CONTENTS

APPENDICES

A **Maps and Plans**

- Site Location Plans
- Proposed Development Plans

B **Ground Investigation Data**

- Exploratory Point Location Plan
- Borehole Logs
- Sitework Photographs

C **Geotechnical Assessment Data**

- Geotechnical Laboratory Testing Results
- Geochemical Laboratory Testing Results
- Geotechnical Data Summaries

ISSUE	DATE	Written By	Comments
1	20/02/2023	Iain Turkington MSc FGS CGeol	-
		Checked by	
		Matt Paddock MSc FGS	
2	02/03/2023	Iain Turkington MSc FGS CGeol	Client's name updated
		Checked by	
		Matt Paddock MSc FGS	
For and on behalf of Paddock Geo Engineering Limited			

1.0 INTRODUCTION

Paddock Geo Engineering (PGE) were instructed by The Twickenham Boathouse Ltd, Co / Silver Jetty; the Client, to undertake a Ground Investigation at the above site comprising the forming of 5 no. exploratory boreholes at The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ.

1.1 Terms of Reference

- BS 5930:2015 Site Investigation Code of Practice
- BS EN 1997-2, Eurocode 7. Geotechnical design. Ground investigation and Testing
- BS EN ISO 22475 Series (1-3), Geotechnical investigation and testing. Sampling methods and groundwater measurements.
- NHBC Standards Chapter 4.2 2006, Building Near Trees
- TRL Laboratory Report 1132:1984 – The Structure of Bituminous Road, Appendix C Table C1
- BS 5930:1999+A2:2010 Site Investigation Code of Practice
- BS EN 1997-2, Eurocode 7. Geotechnical design. Ground investigation and testing
- BS EN ISO 22475 Series (1-3), Geotechnical investigation and testing. Sampling methods and groundwater measurements.
- NHBC Standards Chapter 4.2 2006, Building Near Trees
- BRE412 1996 Desiccation in Clay Soils
- BRE240 1993 Low Rise Buildings on Shrinkable Clay Soils: Part 1
- BRE241 1990 Low Rise Buildings on Shrinkable Clay Soils: Part 2

1.2 Objectives

The objectives of the Ground Investigation for the site comprised the following elements:

- An Intrusive Investigation
- A Geotechnical Appraisal

The scope of work was discussed and agreed with the Client prior to commencement. The investigation was carried out in order to provide data on the sub-soil characteristics of the site, the groundwater regime and also to recover samples for geotechnical laboratory testing. This data was employed to derive a ground model for the site and a geotechnical appraisal including foundation design criteria.

2.0 THE SITE

2.1 Site Description

The subject site is located in an urban area in Richmond on the bank of the river Thames, approximately 13km southwest of central London.

The site comprises a roughly triangular plot of land which is currently occupied by a two storey detached building comprising several units. The building appears to have been of mixed use in the past with an air conditioning or refrigeration system external to the east of the building.

A terrace and large conservatory are situated to the rear (north) of the building and a garage and concrete hardstanding is located to the south with an entrance gate to Ranelagh Drive. A paved path leads from the parking area at the front along the western boundary of the building and the eastern area is covered in overgrown dense vegetation and occasional trees.

The site is bounded by brick walls and iron railings to the north, east and south and by a tall brick wall to the west. The river Thames is located directly north of the site with a promenade continuing to the east. Further residential dwellings are located to the west and Ranelagh Drive is situated to the south and east.

Site location plans are presented in Appendix A.

2.2 Proposed Development

The proposals are understood to comprise the redevelopment of the site into a new residential dwelling comprising three units over four storeys including partial lower ground floor/basement utility and plant rooms to the southwest of the structures.

Proposed development plans and sections as provided by the client are presented within Appendix A.

2.3 Tree Locations

No arboricultural reports or plans have been provided for the site at the time of writing this report to determine the species and height of trees in the vicinity of the site. Based upon site observations, overgrown vegetation is present within the eastern area of the site with a number of small trees also present. Further trees of various species and height are present on adjacent land to the west of the site.

3.0 GEOTECHNICAL DESK STUDY SUMMARY

A full Preliminary Geotechnical Desk Study and Risk Assessment was outside the scope of this report, however salient geological and historical data for the site has been sourced from freely available sources and this data is summarised in the following sections.

3.1 Geology and Hydrogeology

Information on the underlying geology at the site has been obtained from the British Geological Survey (BGS) relevant map sheet and the BGS Geology Viewer.

The BGS Geology Viewer indicates that the underlying bedrock is the London Clay Formation, a sedimentary mudstone formed between 56 and 47.8 million years ago during the Palaeogene Period.

Superficial deposits of Alluvium are recorded under the site.

The underlying London Clay Formation bedrock is categorised as non-productive strata.

4.0 INTRUSIVE INVESTIGATION FIELDWORKS

The original sitework was carried out on the 9th January 2023 and comprised the forming of 3 no. boreholes (WS1, WS3 & WS4) using percussion liner sampling. The forming of the final percussion liner sampler borehole; WS2, was abandoned towards the end of day due to actions required to rescue the Site Operative's vehicles from flooding occurring around the site.

A subsequent ground investigation was carried out on the 19th January comprising 2no. Rotary Auger boreholes.

Boreholes WS1, WS3 & WS4 were formed using percussion liner sampling techniques to a depth of 5.00m below ground level (bgl).

Boreholes WS2 and WS5 were formed using rotary auger boring techniques to a depth of 10.00m bgl.

The boreholes were positioned in open accessible areas and were clear of buried services following a Cable Avoidance Tool (CAT) and signal generator survey and consultation of buried services plans where available.

Soil strength testing was undertaken in the field employing Standard Penetration Tests (SPT) carried out at 1.0m intervals within the percussion liner sampler boreholes. The small auger drill rig employed for the secondary deeper boreholes to assess the depth of the London Clay Formation soils cannot carry out SPT testing.

Hand vane soil strength testing was carried out on the encountered fine-grained soil arisings in the percussion liner boreholes only as the arisings from the auger boreholes were considered too disturbed.

Monitoring wells were installed within boreholes WS3 and WS4 at depths of 3.40m bgl and 4.50m bgl respectively. The remaining boreholes were backfilled upon completion with arisings.

The depth of the boreholes, sample details, strata descriptions and comments on the groundwater conditions are detailed on the Logs which is presented in Appendix B along with an Exploratory Point Location Plan.

Disturbed samples were recovered from the percussion liner sampler borehole arisings at regular intervals and at changes in strata.

The drilling works were supervised by a PGE Engineer.

The details, locations and rationale of the exploratory point placement is summarised below.

Exploratory Location Details and Rationale

Exploratory Location (Depth)	Location Details
WS1 (5.00m)	General site coverage, near the northeast corner of the site.
WS2 (10.00m)	General site coverage, to the east of the existing building. Undertaken by rotary auger boring in order to penetrate the London Clay at depth.
WS3 (5.00m)	General site coverage, near the northwest corner of the site.
WS4 (5.00m)	General site coverage, to the south of the existing building within the parking area next to the garage.
WS5 (10.00m)	General site coverage, to the southwest of the existing building. Undertaken by rotary auger boring in order to penetrate the London Clay at depth.

A series of photographs taken during the fieldworks are presented in Appendix B.

4.1 Encountered Strata

The exploratory point arisings were logged by a Geotechnical Engineer generally in accordance with BS5930:2015. A log of the exploratory holes and Exploratory Point Location Plan showing the positions investigated are presented in Appendices B and C.

SURFACING – CONCRETE and PAVING SLABS

Reinforced concrete was encountered as the surface material at exploratory locations WS4 and WS5, located to the front of the dwelling within the car park area. Paving slabs were encountered at surface at WS3. Both the concrete and paving slabs were 200mm or less in thickness.

MADE GROUND

Made Ground was encountered in all exploratory hole locations and was highly variable, both in thickness and composition.

Made Ground Sub-base material was encountered underlying the concrete in exploratory hole WS4 to a depth of 0.45m and comprised a clayey silty GRAVEL overlying a gravelly fine to coarse SAND. A gravelly clayey SAND was also encountered below the paving slab within WS3. No Sub-base material was identified within WS5.

More general Made Ground was encountered in all exploratory holes to a maximum depth of 4.60m bgl (WS2) and can generally be described as a soft to firm grey to dark grey and brown, variably sandy, variably gravelly, locally cobbly CLAY with organic material and rare roots. Gravel is flint brick concrete tile and rare coal and shell fragments.

The Made Ground was generally thicker in the exploratory holes closer to the river (WS1, WS2 & WS3) and was thickest in exploratory hole WS2.

The base of the Made Ground was obscured locally within some borehole due to suspected intermixing with the soft Alluvial soils below.

ALLUVIUM

Alluvium was encountered below the Made Ground in all exploratory holes to a maximum depth of 7.20m bgl (WS2 & WS5) and can generally be described as either a soft to firm grey to dark grey, locally light brown slightly sandy to sandy gravelly CLAY with rare roots and organic material or, a medium dense to dense light brown grey brown and orange brown variably sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint.

LONDON CLAY FORMATION

Soils of the London Clay Formation were encountered directly below the Alluvium in the secondary deeper exploratory holes WS2 and WS5 at a depth of 7.20m bgl. These exploratory holes were advanced by rotary auger boring techniques. The London Clay can generally be described as a firm to stiff, dark blue grey, silty CLAY.

4.2 Groundwater Conditions

Groundwater was encountered during the investigation in all exploratory holes. The groundwater was initially struck at depths of between 2.00m and 5.00m depth rising to between 1.50m and 2.50m depth after 10 to 20 minutes.

Subsequent monitoring of the groundwater level has been carried out within the monitoring wells installed within the boreholes on 2no. occasion, the results of which are summarised below.

Groundwater Monitoring Levels

Exploratory Point	Groundwater Level (m bgl) and Monitoring Data	
	26/01/23	09/02/23
WS3	2.01	2.24
WS4	3.02	3.14

It should be noted that groundwater levels may vary seasonally and with other factors. The reviewer should satisfy themselves with the groundwater levels at the time of any construction works.

4.3 Sampling Strategy

Disturbed samples of the strata encountered were recovered at regular intervals within all of the exploratory points to the full depth of the investigation for geotechnical laboratory testing.

These were used to gather soil data to allow classification of the soils encountered in relation to the derivation of foundation design criteria.

5.0 FOUNDATION DESIGN CRITERIA

5.1 Geotechnical Laboratory Testing

A number of representative samples were sent to an external laboratory following visual assessment and logging of the borehole arisings. The testing programme was designed to classify the properties of the encountered soils and to determine the chemistry of the soil in relation to the design of buried concrete.

5.1.1 Atterberg Limits

A total of 8no. Atterberg Limit determinations were carried out on samples of soils identified as fine-grained material during the ground investigation work. The laboratory results are presented in Appendix C.

The soils tested have been assessed for their volume change potential (VCP) in accordance with NHBC Standards Chapter 4.2 and are detailed in the table below.

Atterberg Limit Testing

Exploratory Point	Strata	Depth (m)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing 0.425mm	NHBC Modified Plasticity Index	NHBC Volume Change Potential
WS1	ALL	3.30	48	73	29	44	97	43	High
WS2	LC	7.50	29	70	26	44	100	44	High
WS2	LC	9.00	30	64	26	38	100	38	Medium
WS3	ALL	3.40	63	94	40	54	98	53	High
WS4	ALL	1.70	21	36	16	20	100	20	Medium
WS4	ALL	2.90	21	32	17	15	100	15	Low
WS5	LC	8.00	31	64	27	37	100	37	Medium
WS5	LC	9.00	30	66	26	40	100	40	High

Note:

ALL Alluvium
LC London Clay Formation

The 8no. samples of fine-grained Alluvium and London Clay Formation soils have Modified Plasticity Indices (MPI) of between 15% and 53% and can be classified as **Low to High** Volume Change Potential employing the NHBC classification scheme. On this basis the soils across the site should be categorised as **High** VCP as a worst-case scenario for design purposes.

5.1.2 Natural Moisture Content

Testing was performed to determine the natural moisture content (NMC) of the fine-grained soil subjected to Atterberg Limit and Particle Size Distribution testing. The results are presented in Appendix C.

5.1.3 Particle Size Distribution

Particle Size Distribution (PSD) testing was carried out on a combined sample (WS1 – 4.90m & WS3 – 4.70m bgl) of the coarse grained Alluvial material encountered. The results of the PSD test indicate a fines content of 4%.

Soils with a fines content of less than 35% can be considered as non-plastic and hence non-shrinkable without a volume change potential as outlined in NHBC and LABC guidance. However, this material was only encountered at depths in excess of 4.00m bgl and therefore, below the general depths at which the VCP of the soils due to tree root action would be deemed significant.

5.1.4 pH and SOx

The level of pH, sulphate and other determinands within the BRE SD1 Suite have been determined for selected samples for a range of depths within the natural Gault Formation soils from above to below the proposed likely foundation invert level to assess the appropriate Design Sulphate Class for buried concrete in accordance with BRE Special Digest 1 Table 2. The results of the analysis are presented in Appendix C.

The table below summarises the reported pH values, Total Sulphate and 2:1 Water Soluble Sulphate concentrations.

Design Sulphate Class for Site

Exploratory Point (Strata)	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4	WS5	WS5
Depth	1.80	3.80	7.50	9.00	0.80	3.90	1.20	2.40	8.00	9.00
pH	8.0	7.6	8.3	8.3	7.9	7.7	7.4	7.4	8.2	8.5
Total Sulphate (%)	0.043	0.088	0.045	0.041	0.058	0.096	0.069	0.029	0.052	0.057
Water Soluble Sulphate (2:1 Water Extract) (mg/l)	17	25	180	170	25	117	96	57	230	190
Appropriate Design Sulphate Class	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**	**DS-1**

The above assessment assumes that all of the Total Sulphate (%) is in a suitable form that following ground disturbance could oxidise.

The Design Sulphate Class for the site was consistent across the site, with a worst-case classification of **DS-1** for both Made Ground and natural soils.

A worst case Aggressive Chemical Environment for Concrete (ACEC) site classification is **AC-1s** for both Made Ground and the natural Alluvium and London clay Formation soils.

5.2 In-Situ Testing

In-situ hand shear vane (HSV) testing was undertaken within the Made Ground and natural fine-grained Alluvium soils, encountered. The results indicated undrained shear strength values of between 13kPa (WS3) and 31kPa (WS4), indicating very low to low strength material.

HSV testing was attempted on arisings from the rotary auger boreholes (WS2 & WS5) however, due to the highly disturbed nature of the soil, the test results were considered to be unreliable.

SPT tests were carried out in the fine-grained Alluvial deposits. The SPT 'N' values ranged between 1 and 17. Based on the laboratory testing results and that Plasticity Index values are generally greater than 40%, this gives an estimated undrained shear strength of between 4.5kPa and 76.5kPa using the correlation by Stroud and Butler, 1975.

SPT tests carried out within the coarse-grained Alluvium gave an SPT 'N' value of 31 indicating a dense soil.

6.0 ENGINEERING EVALUATION

6.1 Introduction

The proposals are understood to comprise the redevelopment of the site into a new residential dwelling comprising three units over four storeys including partial lower ground floor/basement utility and plant rooms to the southwest of the structures.

Proposed development plans and sections as provided by the client are presented within Appendix A.

6.2 Foundation Design Considerations

The exploratory point arisings were logged by a Geotechnical Engineer generally in accordance with BS5930:2015. A log of the exploratory holes and Exploratory Point Location Plan showing the positions

Reinforced concrete or paving slabs were encountered as the surface material at all exploratory locations.

Made Ground was encountered in all exploratory hole locations and was highly variable, both in thickness and composition.

Made Ground Sub-base material was encountered underlying the concrete in exploratory hole WS4 to a depth of 0.45m and comprised a clayey silty GRAVEL overlying a gravelly fine to coarse SAND. A gravelly clayey SAND was also encountered below the paving slab within WS3. No Sub-base material was identified within WS5.

More general Made Ground was encountered in all exploratory holes to a maximum depth of 4.60m bgl (WS2) and can generally be described as a soft to firm grey to dark grey and brown, variably sandy, variably gravelly, locally cobbly CLAY with organic material and rare roots. Gravel is flint brick concrete tile and rare coal and shell fragments.

The Made Ground was generally thicker in the exploratory holes closer to the river (WS1, WS2 & WS3) and was thickest in exploratory hole WS2.

The base of the Made Ground was obscured locally within some borehole due to suspected intermixing with the soft Alluvial soils below.

Alluvium was encountered below the Made Ground in all exploratory holes to a maximum depth of 7.20m bgl (WS2 & WS5) and can generally be described as either a soft to firm grey to dark grey, locally light brown slightly sandy to sandy gravelly CLAY with rare roots and organic material or, a medium dense to dense light brown grey brown and orange brown variably sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint.

Soils of the London Clay Formation were encountered directly below the Alluvium in the secondary deeper exploratory holes WS2 and WS5 at a depth of 7.20m bgl. These exploratory holes were advanced by rotary auger boring techniques. The London Clay can generally be described as a firm to stiff, dark blue grey, silty CLAY.

Groundwater was encountered during the investigation in all exploratory holes. The groundwater was initially struck at depths of between 2.00m and 5.00m depth rising to between 1.50m and 2.50m depth after 10 to 20 minutes.

Subsequent monitoring of the groundwater level has been carried out within the monitoring wells installed within the boreholes WS3 and WS4 on 2no. occasion, this indicated water levels of between 2.01m and 3.14m bgl.

It should be noted that groundwater levels may vary seasonally and with other factors. The reviewer should satisfy themselves with the groundwater levels at the time of any construction works.

Atterberg Limit testing undertaken from samples of the fine grained Alluvium and London Clay Formation soils indicated Modified Plasticity Indices (MPI) of between 15% and 53% and therefore can be classified as worst case **High** Volume Change Potential employing the NHBC classification scheme.

In-situ hand shear vane (HSV) testing was undertaken within the Made Ground and natural fine-grained Alluvium soils, encountered. The results indicated undrained shear strength values of between 13kPa (WS3) and 31kPa (WS4), indicating very low to low strength material. HSV testing was attempted on arisings from the rotary auger boreholes (WS2 & WS5) however, due to the highly disturbed nature of the soil, the test results were considered to be unreliable.

SPT tests were carried out in the fine-grained Alluvial deposits. The SPT 'N' values ranged between 1 and 17. Based on the laboratory testing results and that Plasticity Index values are generally greater than 40%, this gives an estimated undrained shear strength of between 4.5kPa and 76.5kPa using the correlation by Stroud and Butler, 1975.

SPT tests carried out within the coarse-grained Alluvium gave an SPT 'N' value of 31 indicating a dense soil.

6.2.1 Soil Volume Change Assessment

No arboricultural reports or plans have been provided for the site at the time of writing this report to determine the species and height of trees in the vicinity of the site. Based upon site observations, overgrown vegetation and occasional trees are present within the east of the site that may be within influencing distance of the proposed structures.

Given the proposed development includes a partial basement and, that due to the soft and variable nature of the soils encountered to depths of c 4.80m bgl, any structures are likely to require deeper foundations and it is considered that a full building near trees assessment is unlikely to be required.

Should the use of shallow foundations be deemed acceptable for any potential ancillary structures and where such foundations lay outside the zone of influence of any trees the minimum foundation depth of 1.50m bgl is recommended to be considerate of restrictive new planting given the worst case High VCP soils encountered beneath the site.

6.2.2 Shallow Excavations

Excavations should be readily achieved within the near surface soils using conventional plant.

Groundwater was encountered within all exploratory points during the fieldworks between 2.00m and 5.00m depth, rising to between 1.50m and 2.50m depth, and was noted at level of between 2.01m and 3.14m in subsequent monitoring. It should be noted that due to the proximity of the river Thames, ground water is likely to be in hydraulic continuity with river levels and therefore subject to tidal and flooding fluctuations. During the original site works, the Thames flooded the road outside the site area, rising to within approximately 0.50m of the level of the boreholes.

Additionally, groundwater tables can fluctuate seasonally, therefore provision for dewatering control is considered essential to accommodate groundwater, floodwater and potential surface water run off conditions at the time of construction.

All boreholes remained stable during and after excavation.

Given the above, provision of shoring and dewatering is highly likely to be required for excavations which are to remain open for significant periods of time or during periods of inclement weather. Where excavations are open for a longer period of time or during inclement weather, this will result in increased risk of collapse of excavation sides.

At no time should any excavations be entered by personnel without correct shoring and only after an assessment of whether the task can be completed without entry to the excavation has been completed.

6.3 Ground Floor Slabs

Where Made Ground or fine-grained material is present below proposed floor slabs, then the use of ground bearing floors is not recommended for ground bearing movement sensitive structures as detailed in Section 5.1 of the NHBC Standards.

6.4 Foundation Options Discussion

Conventional foundations, such as spread and isolated pads, placed into Made Ground, variable or soft soils are generally subjected to increased risk of settlement, especially differential settlement. Therefore, it is not recommended that foundations be placed into the Made Ground or soft Alluvial soils encountered to a maximum depth of 4.80m bgl.

It is understood that the proposed development is to include a basement under the development, therefore, the main foundations for the basement are likely to be at least 3.50m into the Alluvial soils and it is possible that the dense gravel encountered below the soft to firm Alluvium may provide an adequate bearing stratum for a basal slab. However, it should be noted that this founding level is well below the observed ground water levels recorded during the ground investigation and subsequent monitoring and this would likely lead to significant construction difficulties due to water ingress and soil instability at the base of the excavation and subsequent loosening of the soil at foundation level.

Therefore, given the above assessment it is considered that conventional foundations are unlikely be suitable across the site and that a piled foundation solution is likely to be the most practical option, especially given the high groundwater and proximity to the river Thames.

The above foundation options and design approaches are subject to detailed Structural Engineer design and regulator agreement.

6.5 Bearing Capacity

It is considered that bearing capacities for the soft to firm Alluvium encountered to depths of between 3.90m and 4.80m bgl will not be adequate for the proposed development.

For a deep raft foundation or pad such as the basement floor slab bearing onto the dense, coarse grained Alluvial soils at depth below the site, a conservative allowable bearing capacity would be in the order of **90kPa.** This value includes an allowance for the high groundwater levels encountered during the ground investigation.

A similar bearing capacity could be employed for a pad foundation bearing onto the same dense coarse grained Alluvial soils at depth below the site.

These estimates further include a factor of safety of 3 against general shear failure and should keep settlements within tolerable limits.

Any excavations for a basal slab should be inspected by a suitably qualified person to assess the variability of the soils and groundwater conditions. If, following inspection, the soil conditions differ from those identified within this geotechnical appraisal the recommendations may require reassessment. Any roots, organic matter, and in particular any 'soft/loose' or otherwise unsuitable material encountered at the founding depth should be removed prior to pouring of any concrete.

6.6 Piled Foundations

Given the above foundation and bearing capacity assessments, it is considered that a piled foundation will be a likely economical and practical solution. Any basement excavation and construction will likely require some form of piling to provide an adequate cut-off wall to prevent water ingress and therefore, this can be incorporated into the required foundation solution.

Piled foundations are likely to provide a satisfactory foundation option for the proposed development with piles extending deeper into the underlying deeper London Clay Formation soils.

A deep borehole with attendant sampling, testing and supplementary ground investigation report will be required to provide a further range of geotechnical parameters and to assist the structural engineer and piling contractor with the piled foundation design. The advice of a specialist piling contractor should be sought who can provide an assessment of the suitability of their piles.

6.7 Retaining Structures Design Criteria

It is understood that the proposed development includes provision for a basement within the proposed dwelling footprint. It is considered that retaining structures will be required for the proposed works. For the design of retaining structures, the groundwater details in Section 4.2 should be noted.

Groundwater was encountered during the site investigation to depths of c. 1.50m to 2.50m bgl, however, during the initial ground investigation, flooding of the river was observed to within approximately 0.50m of the ground level at which the boreholes were drilled. Therefore, for design purposes it is recommended to use a worst-case design water table at existing ground level.

Site specific testing was not carried out for the derivation of retaining structure design coefficients. However, much geotechnical data is available for the strata encountered beneath the site from published sources, best practice and correlated data.

However, BS8004:2015 gives guidance on deriving these values based on the soil classification. Therefore, the most appropriate effective stress design coefficients have been derived and are summarised below. The design values may be taken as 'worst credible' following the guidance of CIRIA C580 Embedded retaining walls - guidance for economic design: 2003.

For deposits, such as some of those encountered on site, which vary between fine- and coarse-grained units, the worst-case values should be used for design.

Preliminary Retaining Structure Design Criteria

Strata	Bulk Density (Mgm^{-3})	Effective Cohesion (c') kNm^{-2}	Effective Friction Angle (φ') (degrees)
Made Ground	1.50	0	20^0
Fine grained Alluvium	1.90	0	22^0
Coarse grained Alluvium	1.80	0	30^0

6.8 Basement Excavation

Excavations should be readily achieved within the near surface soils using conventional plant to a depth of c.4.00m. Groundwater was encountered during drilling at depths of between c.1.50m and 2.50m bgl. In addition, the site is located directly adjacent to the River Thames. Therefore, it is considered highly likely that provision for dewatering and groundwater control, especially during inclement weather will be required.

In addition, ingress of such groundwater can result in instability of excavations and on this basis, some form of cut-off wall is considered essential for excavations beyond c.1.50m depth, especially during periods of inclement weather. Depending on the extent of the proposed basement excavation, in relation to the footprint of the new development, any foundation piling could be incorporated into the cut-off wall.

At no time should any excavations be entered by personnel without correct shoring and only after an assessment of whether the task can be completed without entry to the excavation has been completed.

6.10 Excavation Heave

The proposed basement excavation is considered to be approximately 3.50m depth below current ground levels, and this soil removal is likely to result in the unloading of the formation soils by some c.55kN/m^2. However, given the high groundwater levels encountered across the site, the effective overburden removal is likely to be less than 40kPa.

The material at this depth is likely to be soft to firm, fine grained Alluvium which, will not have undergone significant consolidation given the groundwater conditions. Therefore, significant heave pressures are unlikely to develop.

Whilst groundwater was recorded at a minimum depth of c.1.50m bgl during the site investigation, for design purposes it is recommended that theoretical flood conditions are modelled.

6.11 Sub-Surface Concrete

The Design Sulphate Class for the shallow soils across the site was similar across the site with a worst-case classification of DS-1.

There is a corresponding worst case Aggressive Chemical Environment for Concrete (ACEC) site classification of AC-1s.

6.12 Access Roadways and Parking Areas

No in-situ CBR determinations were carried out during the ground investigation. Given the thickness of the Made Ground encountered, any road or pavement construction will be within the variable Made Ground and a conservative design CBR value of **1.0%** is considered appropriate across the site assuming a formation depth of below 0.60m.

7.0 CERTIFICATION

This report is produced for the sole use of the Client, and no responsibility of any kind, whether for negligence or otherwise, can be accepted for any Third Party who may rely upon it.

The conclusions and recommendations given in this report are based on our understanding of the future plans for the site and based on a scope of works agreed by the Client and afforded by the agreed budget. No responsibility is accepted for conditions not encountered, which are between exploratory points or outside of the agreed scope of work, or if construction is commenced before regulatory approval of designs.

If the future plans for the site are changed, such as the site is developed for a more or less sensitive use, then a different interpretation might be appropriate.

The report has been prepared generally following the guidelines and principles established in the British Standards, BS5930:1999+A2:2010, BS 10175:2011, entitled 'Investigation of Potentially Contaminated Sites – Code of Practice' and the DEFRA/EA Contaminated Land Reports CLR7 and CLR8.

It necessarily relies on the co-operation of other organisations and the free availability of information and total access. No responsibility can, therefore, be accepted for conditions arising from information that was not available to the investigating team as a result of information being withheld or access being denied.

This report may suggest an opinion on a suspected configuration of strata or conditions between exploratory points and below the maximum depth of investigation. However, this is for guidance only and no liability can be accepted for its accuracy. Comments on the groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. It should be noted, however, that groundwater levels might vary due to seasonal or other effects.

It should be noted that this report is based solely on the samples collected in the borehole locations investigated. During the works and following general site clearance, should the sub-soil conditions in other areas of the site appear to be inconsistent with those found in the areas sampled then this geotechnical appraisal and site contamination assessment may need to be reviewed.

This report is prepared and written in the context of the proposals stated in the introduction to this report and it should not be used in a differing context. Furthermore, new information, improved practices and changes in legislation may require an alteration to the report in whole or in part after its submission. Therefore, with any changes in circumstances, or after one year from the date of the report, the report should be referred back to Paddock Geo Engineering Limited for re-assessment (and, if necessary, for an estimate for the cost of such).

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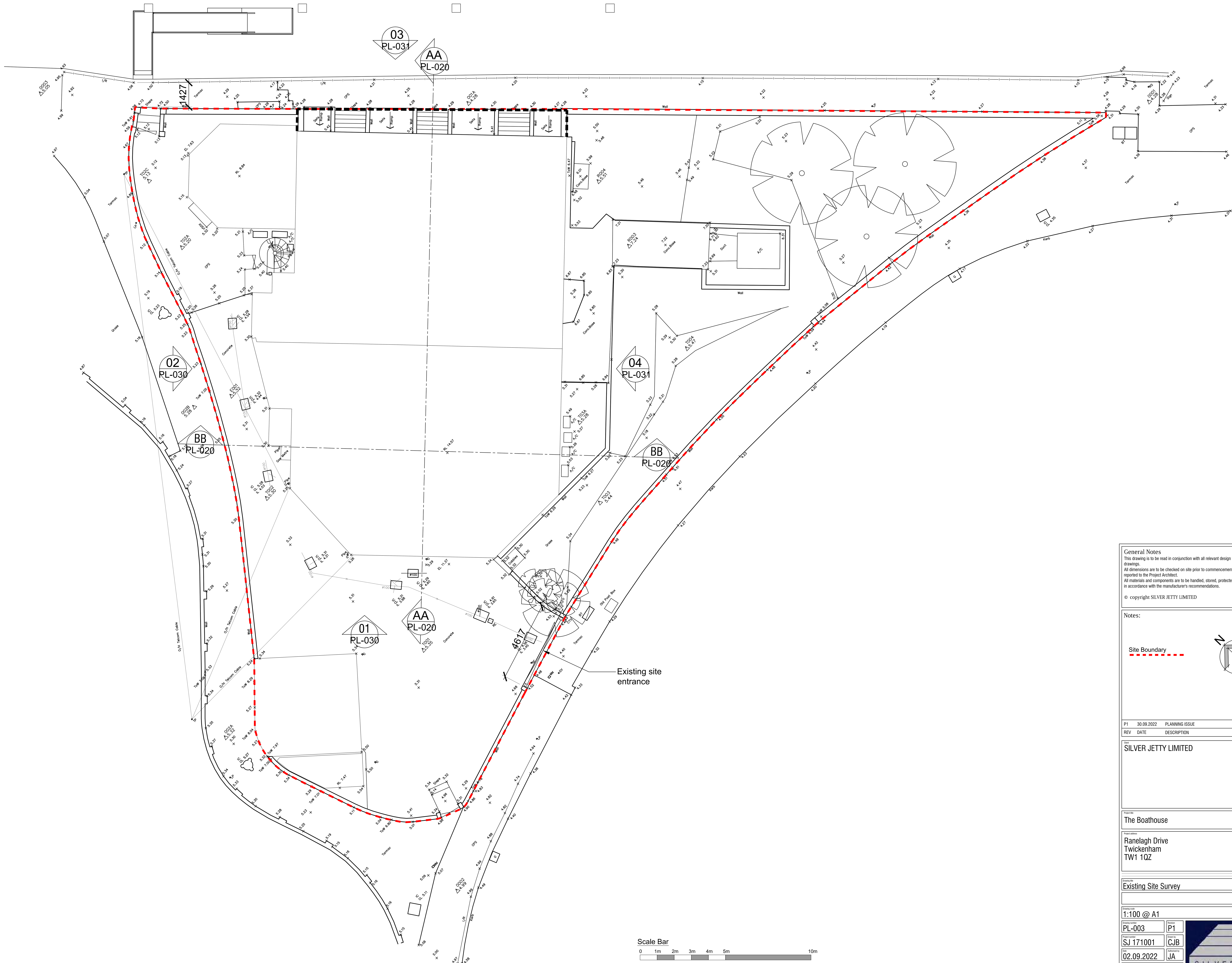
APPENDIX A – MAPS AND PLANS

Site Location Plans

Proposed Development Plans



Existing Site Survey Plan

Scale @ 1:100

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.

All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.

All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

Site Boundary

REV	DATE	DESCRIPTION	INITIALS
P1	30.09.2022	PLANNING ISSUE	CJB

Client
SILVER JETTY LIMITED

Project title
The Boathouse

Project address
Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title
Existing Site Survey

Drawing scale
1:100 @ A1

Drawing number: PL-003	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 02.09.2022	Authorised by: JA
Drawing status: PLANNING	

SILVER JETTY

River Thames

River wall access point opened up and increased from 1427mm to 2600mm

Existing

Proposed

River side walk

Line of Existing Boundary Wall

Existing trees retained

Line of Existing Boundary Wall

House 01

House 02

House 03

New permeable Path

New permeable Path

Existing wall rebuilt to existing wall height

FFL : 4.470

Car Park 05

Car Park 06

Open gantry steps up to each property door threshold @ 6.9 datum

Bin Store

Bins

Line of 1st floor / 2nd floor above

Car Park 04

Car Park 03

Pedestrian entrance

Bin Store

3000

FFL : 4.470

Bins

Cycle Store

Site entrance maintained
New sliding gate.
Entrance Kerb unaltered

Cycles Store

25166

Car Park 02

Car Park 01

Proposed Site Plan

Scale @ 1:100

Scale Bar

0 1m 2m 3m 4m 5m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

Site Boundary

N

REV	DATE	DESCRIPTION	INITIALS
P2	21.11.2022	Gabion wall and brick piers moved by 300mm to increase path width. External bench removed. Update to internal landscaping	CJB
P1	30.09.2022	PLANNING ISSUE	CJB

Client
SILVER JETTY LIMITED

Project title
The Boathouse

Project address
Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title
Proposed Site Plan Plan

Planning scale
1:100 @ A1

Drawing number	Revision
PL-040	P2
Project number	Drawn by
SJ 171001	CJB
Date	Authorised by
02.09.2022	JA

Drawing status
PLANNING

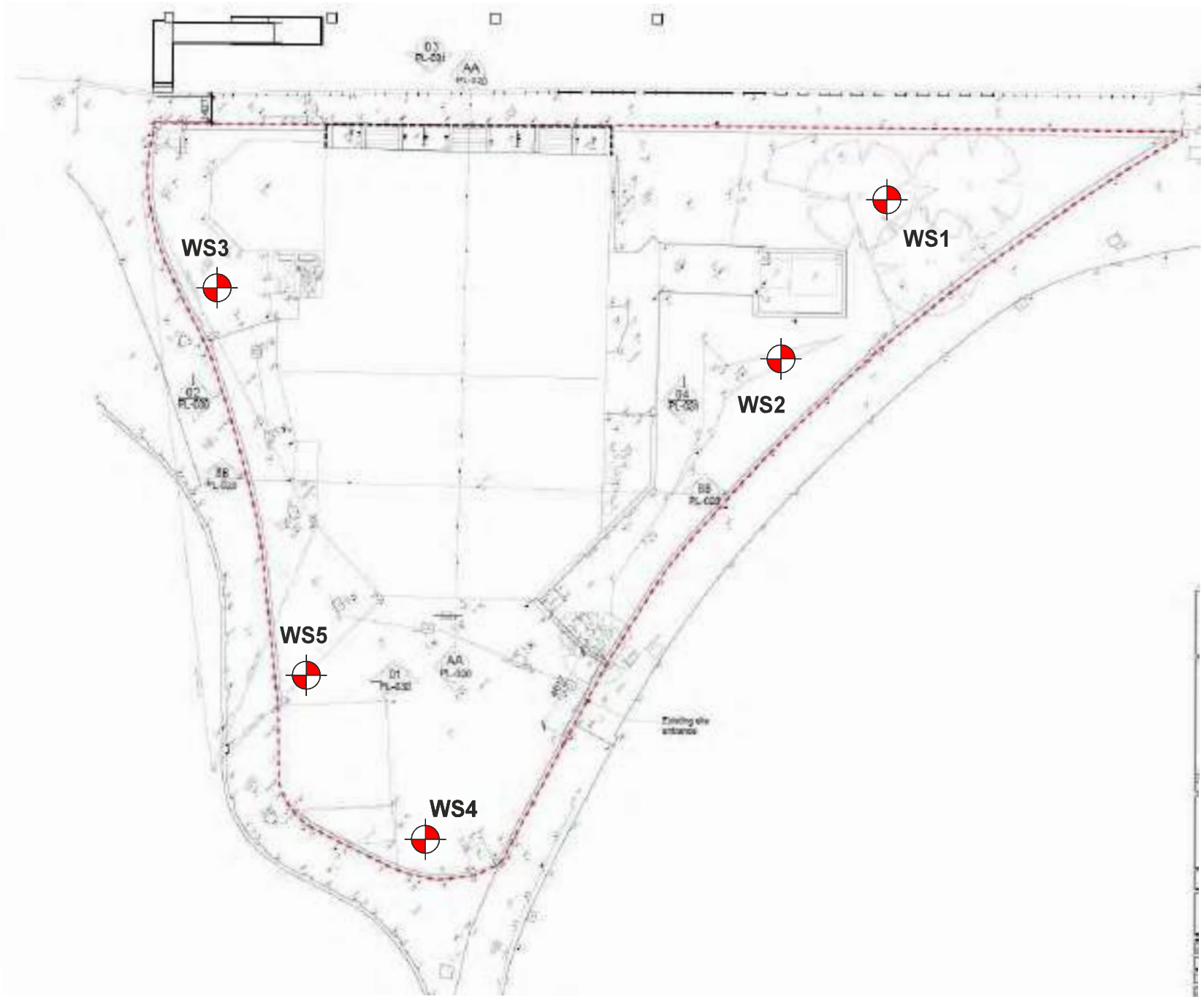
SILVER JETTY

APPENDIX B – GROUND INVESTIGATION DATA

Exploratory Point Location Plan

Borehole Logs

Sitework Photographs



PADDOCK GEO ENGINEERING

Exploratory Location Plan

The Boathouse
Ranelagh Drive
Richmond, TW1 1QZ

The Twickenham Boathouse Co / Silver Jetty.

February 2023

Window Sampling Locations

Not to scale.
All positions are approximate.
Based on plan provided by the client.

PADDOCK GEO ENGINEERING

Site	Number
The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	WS1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Windowless Sampler			The Twickenham Boathouse Ltd Co / Silver Jetty	P22-425
	Location	**Dates** 09/02/2023	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.15) 0.15	Vegetation onto dark brown slightly sandy slightly gravelly CLAY with frequent roots, rootlets and organic material. Gravel is flint and brick fragments. (MADE GROUND)		
0.10	C							
0.80	C					Soft to firm dark brown and light brown slightly sandy slightly gravelly to gravelly CLAY with occasional roots and rootlets. Gravel is flint brick concrete tile and rare coal fragments. (MADE GROUND)		
0.80	D							
1.00-1.45	SPT N=12		5,4/2,3,4,3					
					(2.65)			
1.80	D							
2.00-2.45	SPT N=2		0,0/0,0,1,1					1
2.60	D							
					2.80 (0.30)	Soft to firm grey to dark grey slightly sandy to sandy gravelly CLAY with rare roots and organic material. Gravel is brick, flint and occasional shell fragments. (MADE GROUND)		
3.00-3.45	SPT N=1		0,0/0,0,1,0		3.10			
3.30	D					Soft to firm grey to dark grey slightly sandy to sandy gravelly CLAY with rare roots and organic material. Gravel is flint and occasional shell fragments. (ALLUVIUM)		
3.40	HSV 23kPa							
3.80	D							
3.90	HSV 26kPa				(1.70)			
4.00-4.45	SPT N=1		0,0/0,0,0,1					
4.40	D							
4.50	HSV 19kPa							
					4.80 (0.20) 5.00	Grey to brown grey slightly sandy to sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint. (ALLUVIUM)		
4.90	D		Water strike(1) at 5.00m, rose to 2.40m in 20 mins.					1
						Complete at 5.00m		

Remarks
Borehole backfilled with arisings
Groundwater encountered at base of borehole rising to 2.40m bgl after 20 minutes
Borehole cased to 5.00m depth
Borehole termiated at 5.00m depth

Scale (approx)	Logged By
1:50	MC

Figure No. P22-425.WS1

PADDOCK GEO ENGINEERING

Site	Number
The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	WS2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Rotary Auger Bored			The Twickenham Boathouse Ltd Co / Silver Jetty	P22-425
	Location	**Dates** 19/02/2023	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	Vegetation onto dark brown slightly sandy slightly gravelly CLAY with frequent roots, rootlets and organic material. Gravel is flint and brick fragments. (MADE GROUND)		
					(0.90) 1.10	Dark brown and red brown sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint brick and concrete. (MADE GROUND)		
					(3.50) 4.60	Soft to firm grey to dark grey slightly sandy to sandy gravelly cobbly CLAY with rare roots and organic material. Gravel is brick, flint and occasional shell fragments. Cobbles are bricks (MADE GROUND)		1
			Water strike(1) at 4.60m, rose to 2.40m in 10 mins.		(2.60) 7.20	Grey to brown grey slightly sandy to sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint. (ALLUVIUM)		1
7.50	D				(2.80) 10.00	Firm to stiff dark blue grey silty CLAY (LONDON CLAY FORMATION)		
9.00	D							

Remarks
Borehole terminated at 10.00m depth
Groundwater encountered at 4.60m rising to 2.40m after 10 minutes
Borehole stable
Borehole backfilled with arisings

Scale (approx)	Logged By
1:50	IT

Figure No. P22-425.WS2

PADDOCK GEO ENGINEERING

Site	Number
The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	WS3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Windowless Sampler			The Twickenham Boathouse Ltd Co / Silver Jetty	P22-425
	Location	**Dates** 09/02/2023	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					0.06 (0.14) 0.20	Concrete PAVING SLAB			
0.30	C				(0.30)	Light brown to brown grey slightly gravelly slightly clayey SAND with rare rootlets. Gravel is flint and rare brick. (MADE GROUND)			
0.30	D				0.50				
0.80	C				(0.50)	Brown to dark grey brown slightly sandy slightly clayey GRAVEL. Gravel is flint brick concrete and tile fragments. (MADE GROUND)			
0.80	D				1.00				
1.00-1.45	SPT N=1		0,0/0,0,1,0			Soft brown grey to light brown grey slightly gravelly very sandy CLAY. Gravel is sub-angular fine to coarse flint with occasional brick and coal fragments. (MADE GROUND)			
1.40	HSV 13kPa				(1.20)				
1.50	D								
1.80	HSV 19kPa					Soft light brown slightly gravelly sandy CLAY. Gravel is sub-angular fine to medium flint and rare sandstone fragments. (MADE GROUND)			
			Water strike(1) at 2.00m, rose to 1.50m in 10 mins.		2.20				
2.00-2.45	SPT N=3		0,0/1,1,1,0			Grey to light brown grey clayey sandy GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint and occasional brick and sandstone fragments. (MADE GROUND)			
2.50	D				(1.00)				
3.00-3.45	SPT N=0		1,0/0,0,0,0		3.20				
3.40	D					Soft to firm grey to dark grey slightly gravelly sandy CLAY with organic debris. Gravel is sub-angular fine to coarse flint and shell fragments. (ALLUVIUM)			
3.60	HSV 15kPa				(1.20)				
4.00-4.45	SPT N=17		0,2/3,4,5,5		4.40				
						Medium dense light brown slightly clayey sandy GRAVEL. Gravel is sub-rounded fine to coarse flint. (ALLUVIUM)			
					(0.60)				
					5.00				
						Complete at 5.00m			

Remarks
Monitoring well installed to 4.50m depth.
Borehole cased to 5.00m depth
Groundwater encountered at 2.00m depth rising to 1.50m after 10 minutes.
Borehole terminated at 5.00m depth

Scale (approx)	Logged By
1:50	MC

Figure No. P22-425.WS3

PADDOCK GEO ENGINEERING

Site	Number
The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	WS4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Windowless Sampler			The Twickenham Boathouse Ltd Co / Silver Jetty	P22-425
	Location	**Dates** 09/02/2023	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					(0.13)	Grey to light brown grey reinforced CONCRETE			
0.20	C				0.13 (0.17)	Red grey clayey silty GRAVEL. Gravel is flint and concrete. (MADE GROUND - SUB-BASE)			
0.70	C				0.30 (0.15)	Light yellow brown gravelly fine to coarse SAND. Gravel is flint. (MADE GROUND - SUB-BASE)			
0.70	D				0.45 (0.95)	Dark grey to dark brown grey slightly gravelly clayey to very clayey fine to coarse SAND. Gravel is flint brick and ash. (MADE GROUND)			
1.00-1.45	SPT N=4		0,0/1,1,1,1						
1.20	D				1.40	Firm light brown slightly sandy slightly gravelly to gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint. (ALLUVIUM)		1	
1.70	D					...from 1.90m becoming light brown to yellow brown			
1.80	HSV 26kPa								
2.00-2.45	SPT N=6		1,1/1,2,2,1						
2.40	D				(2.50)				
2.50	HSV 31kPa								
2.90	D		Water strike(1) at 3.00m, rose to 1.50m in 10 mins.			...from 3.00m very sandy		1	
3.00-3.45	SPT N=5		2,1/2,1,1,1						
					3.90	Dense orange brown to light brown sandy GRAVEL. Gravel is sub-rounded fine to coarse flint. (ALLUVIUM) No recovery from 4.00m to 5.00m.			
4.00-4.45	SPT N=31		3,4/6,8,8,9		(1.10)				
					5.00	Complete at 5.00m			

Remarks
Monitoring well installed to 3.40m depth
Borehole cased to 4.00m depth
Groundwater encountered at 3.00m rising to 1.50m after 10 minutes
No recovery from 4.00m to 5.00m depth
Borehole terminated at 5.00m depth

Scale (approx)	Logged By
1:50	MC

Figure No. P22-425.WS4

PADDOCK GEO ENGINEERING

Site	Number
The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	WS5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Rotary Auger Bored			The Twickenham Boathouse Ltd Co / Silver Jetty	P22-425
	Location	**Dates** 19/02/2023	**Engineer**	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	Light yellow grey unreinforced CONCRETE		
					(1.30) 1.50	Soft to firm grey to dark grey slightly sandy to sandy gravelly cobbly CLAY with rare roots and organic material. Gravel is brick, flint and occasional shell fragments. Cobbles are brick. (MADE GROUND)		
					(2.40) 3.90	Soft to firm grey to dark grey slightly sandy to sandy gravelly CLAY with rare roots and organic material. Gravel is brick, flint and occasional shell fragments. (MADE GROUND)		1
			Water strike(1) at 4.00m, rose to 2.50m in 10 mins.		(3.30) 7.20	Grey to brown grey slightly sandy to sandy clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to coarse flint. (ALLUVIUM)		1
8.00	D				(2.80) 10.00	Firm to stiff dark blue grey silty CLAY (LONDON CLAY FORMATION)		
9.00	D							

Remarks
Borehole terminated at 10.00m depth
Groundwater encountered at 4.00m depth rising to 2.50m after 10 minutes
Borehole stable
Borehole backfilled with arisings

Scale (approx)	Logged By
1:50	IT

Figure No. P22-425.WS5

General Site View—Looking southwest

General Site View—looking southeast

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

General Site View - looking north from the car park

General Site View—Looking northeast towards the river

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

General Site View—south side of existing dwelling

General Site View—Extractor fan enclosure

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

Arisings WS1

Arisings WS2

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

Arisings WS3

Arisings WS4

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

Arisings WS5

PADDOCK GEO ENGINEERING

Client:	**The Twickenham Boathouse Ltd Co / Silver Jetty**
Project No:	**P22-425**
Project Title:	**The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ**
Date:	**January 2023**

APPENDIX C – GEOTECHNICAL DATA

Geotechnical Laboratory Testing Results

Geochemical Laboratory Testing Results

Potential Desiccation Plots

Geotechnical Data Summaries

Eurotest Ltd
The Studio
Benefield Road
Northants
NN14 3EZ
Tel +44 (0)1536 370140
www.eurotest.co.uk

Report for the Determination of Particle Size Distribution of Soil

Report Details

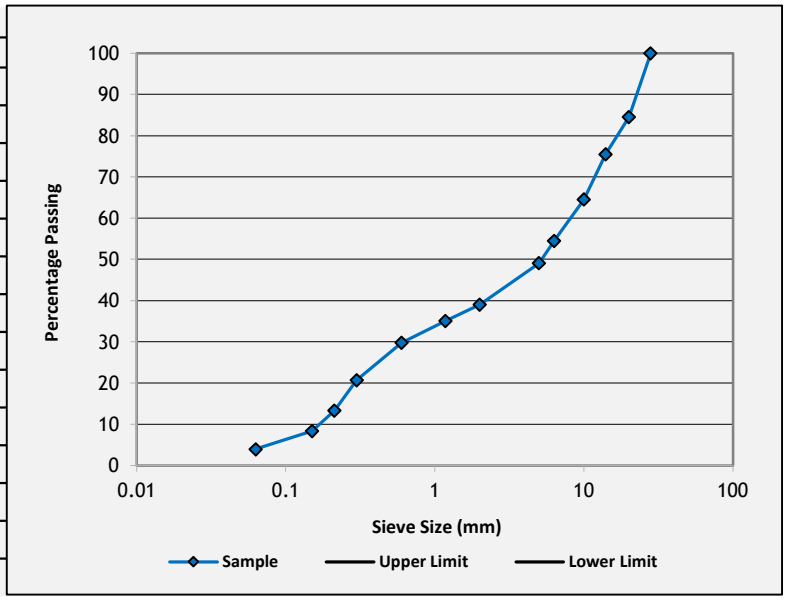
Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119-L1096**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20/01/2023**
Project Name	**The Boathouse,Richmond**	Date of Test	**17/01/2023**

Test Details

Sample Location	**PSD1 (WS1 4.9m, WS3 4.7m)**	Laboratory Sample Number	**L1096**
Sample Identification	**Dark Grey Clay + Light Brown Sand**	Date Sample Received	**12/01/2023**
Type of Sample	**D**	Moisture Content	**13%**
Soil Description	**Dark Grey Clay + Light Brown Sand**		

Test Results

Apperture size (mm)	Percentage passing	Specification (%) Min	Specification (%) Max
28	100		
20	85		
14	76		
10	65		
6.3	54		
5	49		
2	39		
1.18	35		
0.6	30		
0.3	21		
0.212	13		
0.15	8		
0.063	4		



Test Method	**BS 1377 Part 2 Clause 9.2:1990 - Determination of particle size distribution - wet seiving method**
Test Method	**BS 1377 Part 2 Clause 3.2:1990 - Determination of Moisture Content - Oven Drying Method**
Test variation	**None**

Name	Hamza Ghanchi
Position	Laboratory Manager

For and on behalf of Eurotest Ltd

Issued subject to our terms and conditions available at www.eurotest.co.uk

UKAS TESTING
2646

Eurotest Ltd
The Studio
Benefield Road
Northants
NN14 3ES
Tel +44 (0)1536 370140
www.eurotest.co.uk

Report on the Determination of the Plastic Limit and Plasticity Index of Soil to BS 1377 Part 2: 1990

Report Details

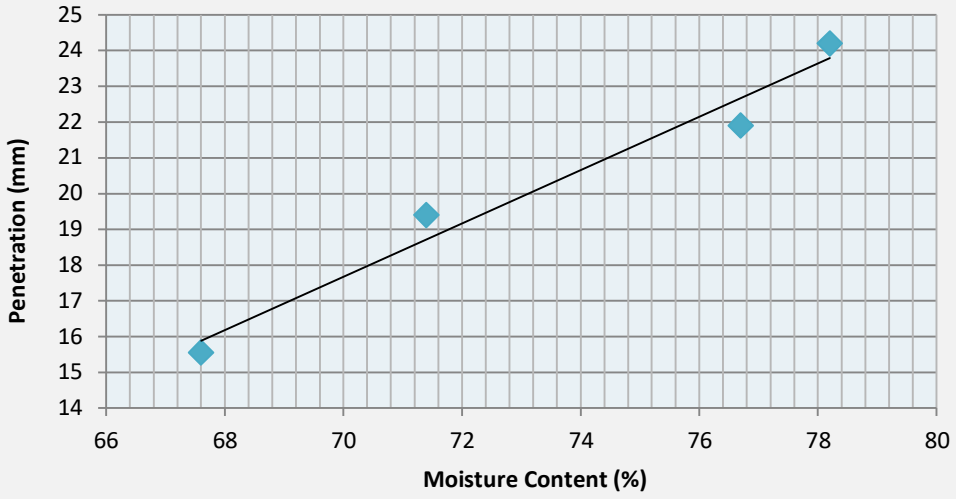
Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119-L1092**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20-Jan-23**
Project Name	**The Boathouse,Richmond**	Date of Test	**16-Jan-23**

Test Details

Sample Location	**WS1 3.3m**	Laboratory Sample Number	**L092**
Client Identification	**Dark Grey Clay**	Date Sample Received	**12-Jan-23**
Type of Sample	**D**	% Retained on 425µm Sieve	**3**
Soil Description	**Dark Grey Clay**		

Test Results

Liquid Limit (%)	**73**
Plastic Limit (%)	**29**
Plasticity Index (%)	**44**



Sample preparation	**BS 1377 Part 2 Clause 4.2.3 : 1990 - Specimen from natural soil**
Liquid limit	**BS 1377 Part 2 Clause 4.3 : 1990 - Determination of liquid limit - Cone penetrometer method**
Plastic limit	**BS 1377 Part 2 Clause 5.3 : 1990 - Determination of plastic limit**
Plasticity index	**BS 1377 Part 2 Clause 5.4 : 1990 - Derivation of plasticity index**
Test variations	**None**

Name Hamza Ghanchi
Position Laboratory Manager

For and on behalf of Eurotest Ltd

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The Studio
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Report on the Determination of the Plastic Limit and Plasticity Index of Soil to BS 1377 Part 2: 1990

Report Details

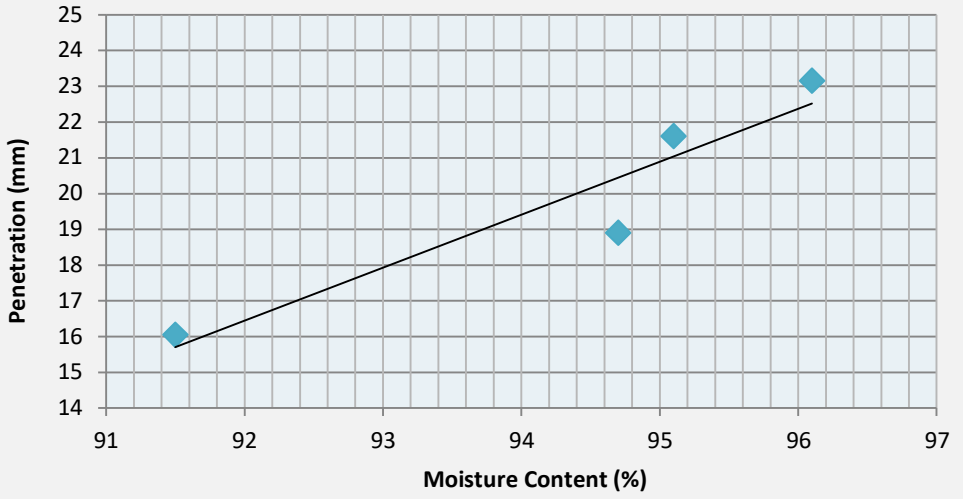
Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119-L1093**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20-Jan-23**
Project Name	**The Boathouse,Richmond**	Date of Test	**16-Jan-23**

Test Details

Sample Location	**WS3 3.4m**	Laboratory Sample Number	**L1093**
Client Identification	**Dark Brown Clay**	Date Sample Received	**12-Jan-23**
Type of Sample	**D**	% Retained on 425µm Sieve	**2**
Soil Description	**Dark Brown Clay**		

Test Results

Liquid Limit (%)	**94**
Plastic Limit (%)	**40**
Plasticity Index (%)	**54**



Sample preparation	**BS 1377 Part 2 Clause 4.2.3 : 1990 - Specimen from natural soil**
Liquid limit	**BS 1377 Part 2 Clause 4.3 : 1990 - Determination of liquid limit - Cone penetrometer method**
Plastic limit	**BS 1377 Part 2 Clause 5.3 : 1990 - Determination of plastic limit**
Plasticity index	**BS 1377 Part 2 Clause 5.4 : 1990 - Derivation of plasticity index**
Test variations	**None**

Name Hamza Ghanchi
Position Laboratory Manager

For and on behalf of Eurotest Ltd

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Report on the Determination of the Plastic Limit and Plasticity Index of Soil to BS 1377 Part 2: 1990

Report Details

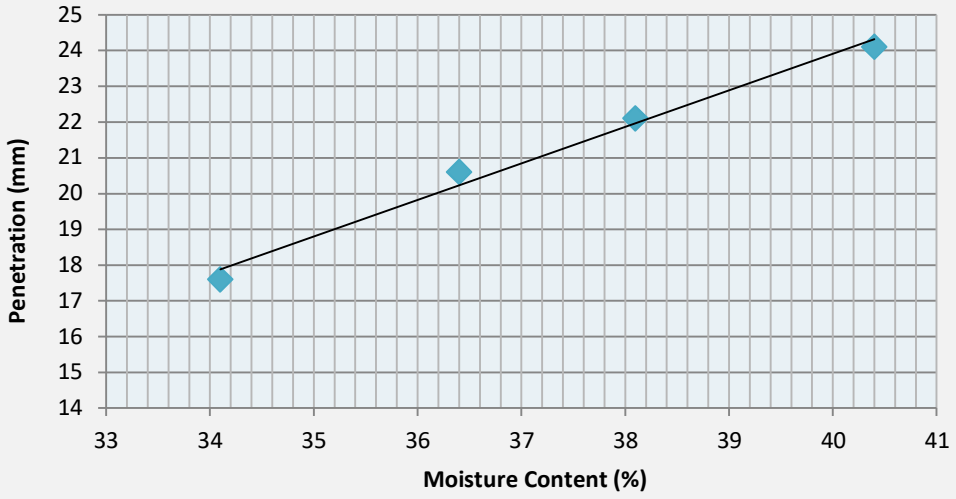
Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119-L1094**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20-Jan-23**
Project Name	**The Boathouse,Richmond**	Date of Test	**16-Jan-23**

Test Details

Sample Location	**WS4a 1.7m**	Laboratory Sample Number	**L1094**
Client Identification	**Dark Brown Clay**	Date Sample Received	**12-Jan-23**
Type of Sample	**D**	% Retained on 425µm Sieve	**0**
Soil Description	**Dark Brown Clay**		

Test Results

Liquid Limit (%)	**36**
Plastic Limit (%)	**16**
Plasticity Index (%)	**20**



Sample preparation	**BS 1377 Part 2 Clause 4.2.3 : 1990 - Specimen from natural soil**
Liquid limit	**BS 1377 Part 2 Clause 4.3 : 1990 - Determination of liquid limit - Cone penetrometer method**
Plastic limit	**BS 1377 Part 2 Clause 5.3 : 1990 - Determination of plastic limit**
Plasticity index	**BS 1377 Part 2 Clause 5.4 : 1990 - Derivation of plasticity index**
Test variations	**None**

Name Hamza Ghanchi
Position Laboratory Manager

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www.eurotest.co.uk

Report on the Determination of the Plastic Limit and Plasticity Index of Soil to BS 1377 Part 2: 1990

Report Details

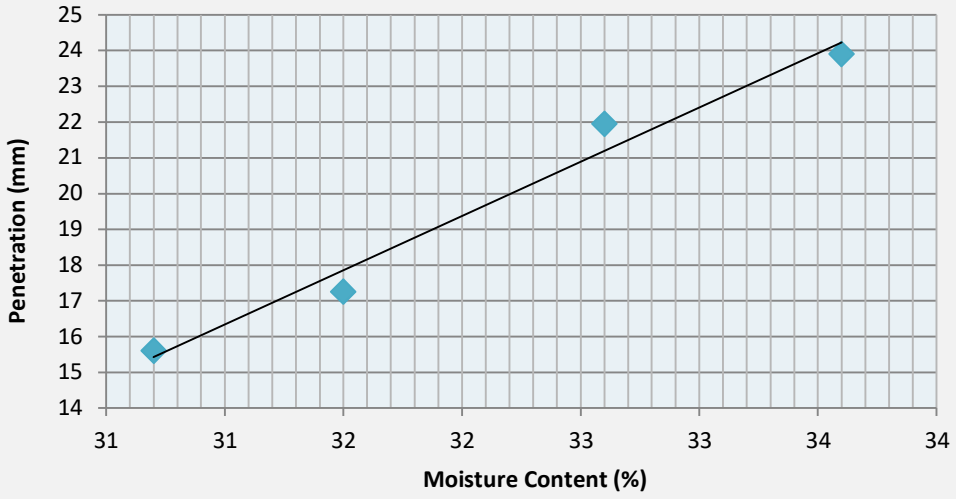
Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119-L1095**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20-Jan-23**
Project Name	**The Boathouse,Richmond**	Date of Test	**16-Jan-23**

Test Details

Sample Location	**WS4a 2.9m**	Laboratory Sample Number	**L1095**
Client Identification	**Light Brown Silty Clay**	Date Sample Received	**12-Jan-23**
Type of Sample	**D**	% Retained on 425µm Sieve	**0**
Soil Description	**Light Brown Silty Clay**		

Test Results

Liquid Limit (%)	**32**
Plastic Limit (%)	**17**
Plasticity Index (%)	**15**



Sample preparation	**BS 1377 Part 2 Clause 4.2.3 : 1990 - Specimen from natural soil**
Liquid limit	**BS 1377 Part 2 Clause 4.3 : 1990 - Determination of liquid limit - Cone penetrometer method**
Plastic limit	**BS 1377 Part 2 Clause 5.3 : 1990 - Determination of plastic limit**
Plasticity index	**BS 1377 Part 2 Clause 5.4 : 1990 - Derivation of plasticity index**
Test variations	**None**

Name Hamza Ghanchi
Position Laboratory Manager

For and on behalf of Eurotest Ltd

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Report on the Determination of the Moisture Content of Soil to BS 1377 Part 2: Clause 3.2: 1990

Report Details

Client	**Paddock Geo Engineering Ltd**	Report Number	**PJ119**
Address	**The Log Cabin, Newton Longville, MK**	Date of Report	**20-Jan-23**
Project Name	**The Boathouse,Richmond**	Date of Test	**12-Jan-23**

Test Details

Sample Location	**See Below**	Date Sample Received	**12-Jan-23**

Test Results

Laboratory Sample Number	L1092	L1093	L1094	L1095	L1096		
Client Identification	WS1 3.3m	WS3 3.4m	WS4a 1.7m	WS4a 2.9m	PSD 1		
Type of Sample	D	D	D	D	D		
Soil Description							
Moisture Content(%)	48%	63%	21%	21%	13%		
Laboratory Sample Number							
Client Identification							
Type of Sample							
Soil Description							
Moisture Content(%)							

Name **Hamza Ghanchi**

Position **Laboratory Manager**

For and on behalf of Eurotest Ltd

Where our involvement consists exclusively of testing samples, the results relate only to the samples tested.

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client:	Paddock Geo Engineering	Client Reference:	P22-425
Client Address:	The Log Cabin, Manor Farm, Whaddon Road, Newton Longville, Milton Keynes, MK17 0AU	Job Number:	23-14388-1
		Date Sampled:	19/01/2023
		Date Received:	25/01/2023
Contact:	Matt Paddock	Date Tested:	31/01/2023
Site Address:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	Sampled By:	Not Given

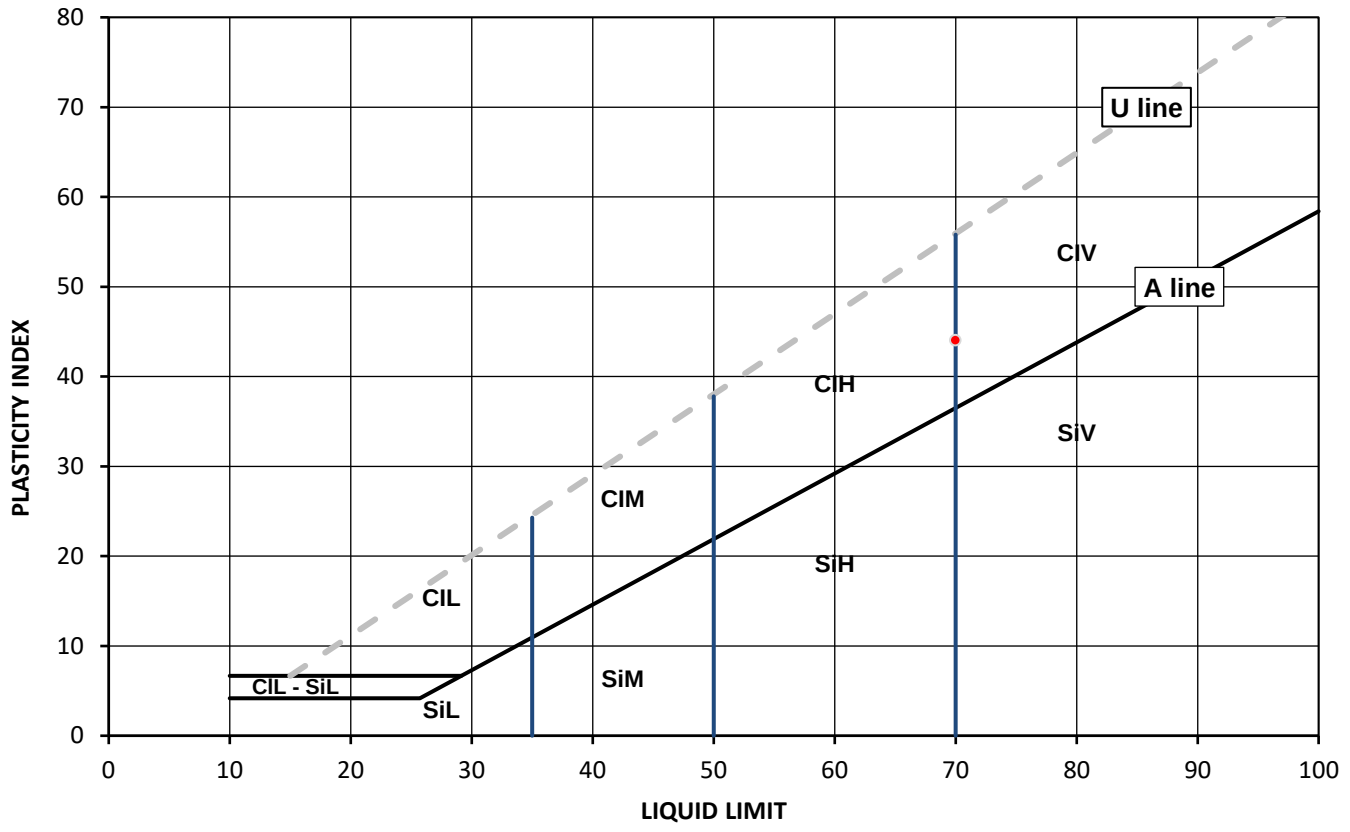
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2567446	Depth Top [m]:	7.50
Hole No.:	WS2	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	B
Sample Description:	Brown CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
29	70	26	44	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client:	Paddock Geo Engineering	Client Reference:	P22-425
Client Address:	The Log Cabin, Manor Farm, Whaddon Road, Newton Longville, Milton Keynes, MK17 0AU	Job Number:	23-14388-1
		Date Sampled:	19/01/2023
		Date Received:	25/01/2023
Contact:	Matt Paddock	Date Tested:	31/01/2023
Site Address:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	Sampled By:	Not Given

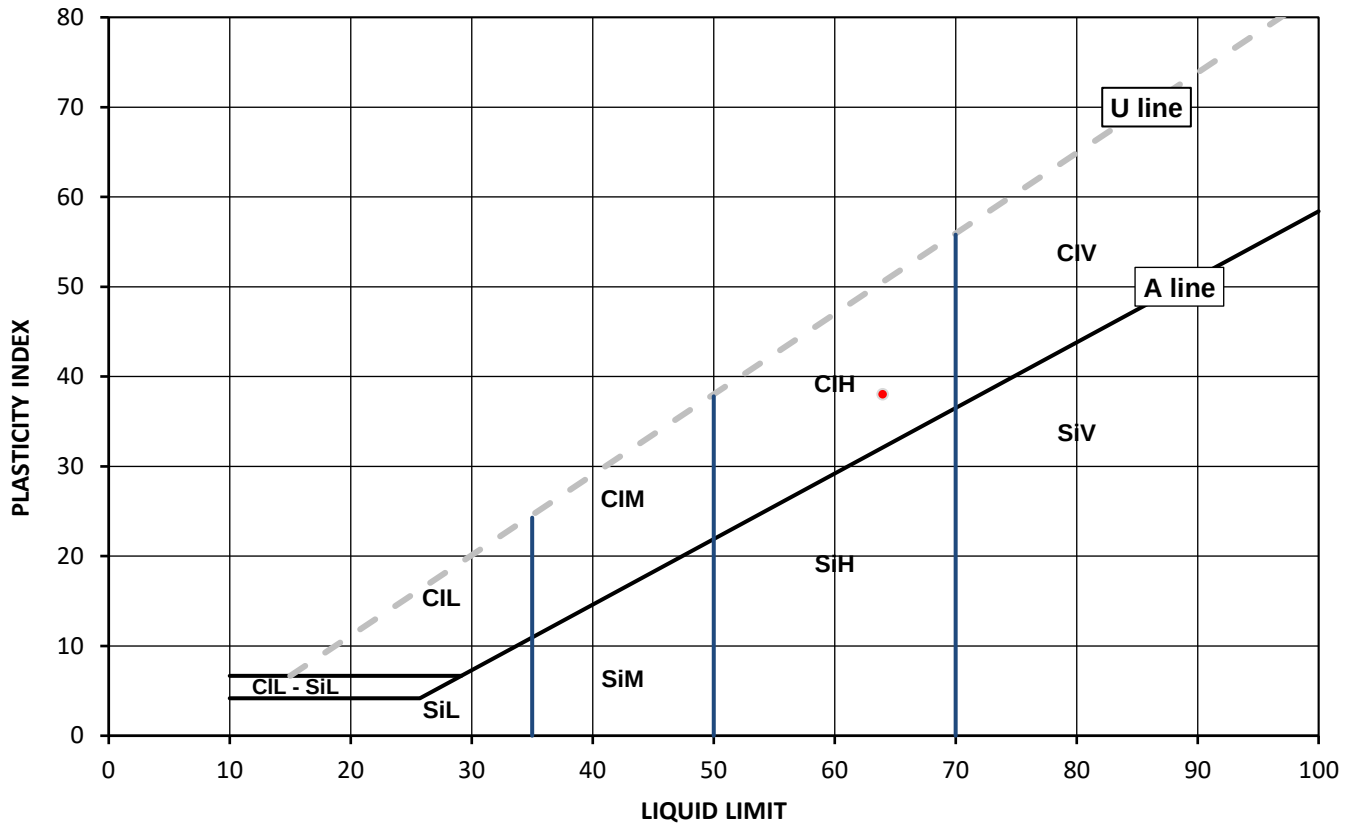
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2567447	Depth Top [m]:	9.00
Hole No.:	WS2	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	B
Sample Description:	Brown CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
30	64	26	38	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client:	Paddock Geo Engineering	Client Reference:	P22-425
Client Address:	The Log Cabin, Manor Farm, Whaddon Road, Newton Longville, Milton Keynes, MK17 0AU	Job Number:	23-14388-1
		Date Sampled:	19/01/2023
		Date Received:	25/01/2023
Contact:	Matt Paddock	Date Tested:	31/01/2023
Site Address:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	Sampled By:	Not Given

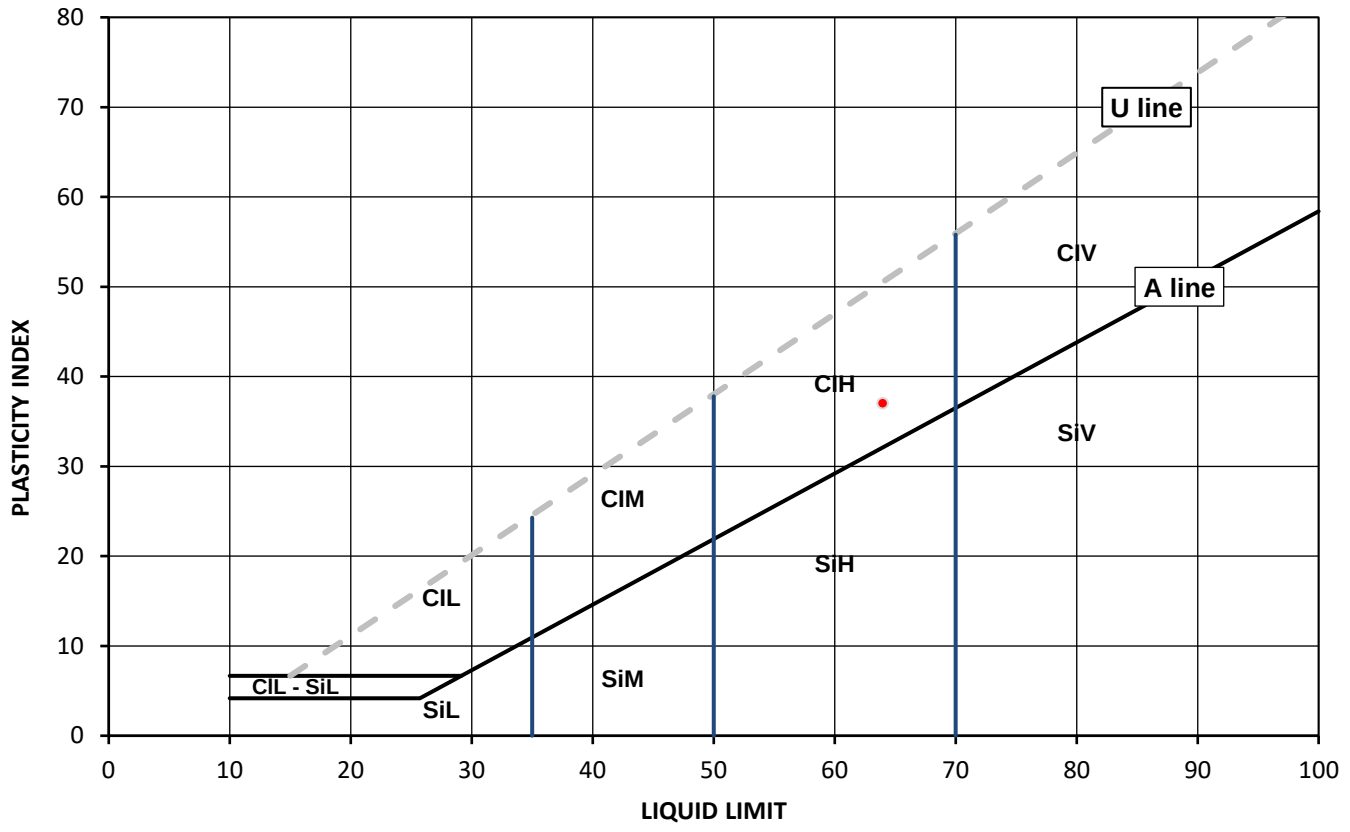
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2567448	Depth Top [m]:	8.00
Hole No.:	WS5	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	B
Sample Description:	Brown CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
31	64	27	37	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client:	Paddock Geo Engineering	Client Reference:	P22-425
Client Address:	The Log Cabin, Manor Farm, Whaddon Road, Newton Longville, Milton Keynes, MK17 0AU	Job Number:	23-14388-1
		Date Sampled:	19/01/2023
		Date Received:	25/01/2023
Contact:	Matt Paddock	Date Tested:	31/01/2023
Site Address:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	Sampled By:	Not Given

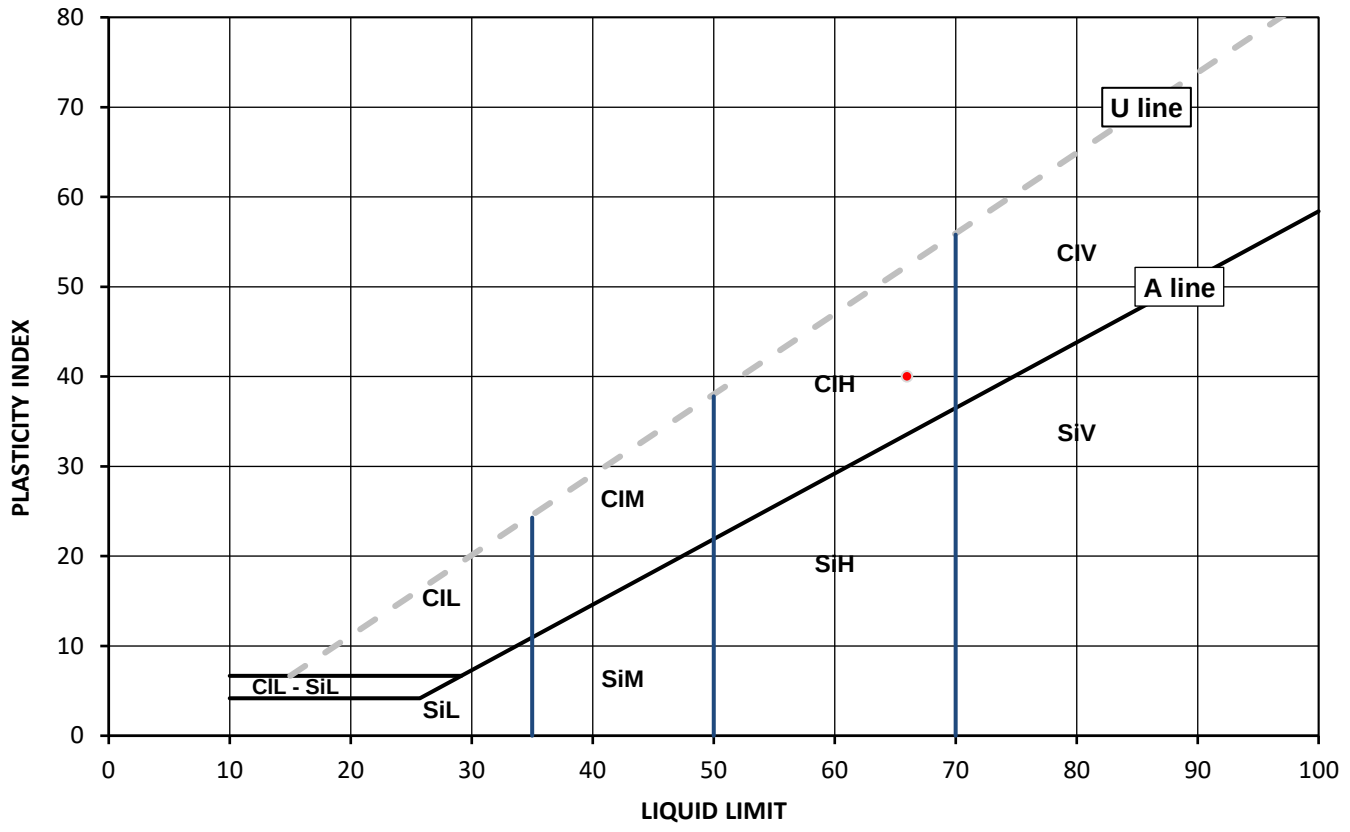
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2567449	Depth Top [m]:	9.00
Hole No.:	WS5	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	B
Sample Description:	Brown CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
30	66	26	40	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 232.12

SUMMARY REPORT

SUMMARY OF CLASSIFICATION TEST RESULTS

Tested in Accordance with:

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client: Paddock Geo Engineering

Client Address: The Log Cabin, Manor Farm, Whaddon Road, Newton Longville, Milton Keynes, MK17 0AU

Contact: Matt Paddock

Site Address: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ

Water Content by BS 1377-2:1990: Clause 3.2; Atterberg by BS 1377-2: 1990: Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5; PD by BS 1377-2: 1990: Clause 8.2

Client Reference: P22-425
Job Number: 23-14388-1
Date Sampled: 19/01/2023
Date Received: 25/01/2023
Date Tested: 31/01/2023
Sampled By: Not Given

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	Water Content BS 1377-2 [W]	Water Content BS EN ISO 17892-1 [W]	Atterberg				Density			Total Porosity#		
		Reference	Depth Top	Depth Base	Type					% Passing 425um	WL	Wp	Ip	bulk	dry	PD			
			m	m				%	%	%	%	%	%	Mg/m3	Mg/m3	Mg/m3	%		
2567446	WS2	Not Given	7.50	Not Given	B	Brown CLAY	Atterberg 1 Point	29		100	70	26	44						
2567447	WS2	Not Given	9.00	Not Given	B	Brown CLAY	Atterberg 1 Point	30		100	64	26	38						
2567448	WS5	Not Given	8.00	Not Given	B	Brown CLAY	Atterberg 1 Point	31		100	64	27	37						
2567449	WS5	Not Given	9.00	Not Given	B	Brown CLAY	Atterberg 1 Point	30		100	66	26	40						

Note: # Non accredited; NP - Non plastic

Comments:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 234.14

SUMMARY REPORT

DETERMINATION OF WATER CONTENT

Tested in Accordance with: BS 1377-2: 1990: Clause 3.2

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client: Paddock Geo Engineering

Client Address: The Log Cabin, Manor Farm,
Whaddon Road, Newton Longville,
Milton Keynes, MK17 0AU

Contact: Matt Paddock

Site Address: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ

Client Reference: P22-425
Job Number: 23-14388-1
Date Sampled: 19/01/2023
Date Received: 25/01/2023
Date Tested: 31/01/2023
Sampled By: Not Given

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	WC	Sample preparation / Oven temperature at the time of testing			
		Reference	Depth Top m	Depth Base m	Type			%				
2567446	WS2	Not Given	7.50	Not Given	B	Brown CLAY		29	Sample was quartered, oven dried at 106.2 °C			
2567447	WS2	Not Given	9.00	Not Given	B	Brown CLAY		30	Sample was quartered, oven dried at 106.2 °C			
2567448	WS5	Not Given	8.00	Not Given	B	Brown CLAY		31	Sample was quartered, oven dried at 106.2 °C			
2567449	WS5	Not Given	9.00	Not Given	B	Brown CLAY		30	Sample was quartered, oven dried at 106.2 °C			

Comments:

Signed:

Anna Dudzinska
PL Deputy Head of Reporting Team
for and on behalf of i2 Analytical Ltd

Date Reported: 10/02/2023

GF 099.16

Matt Paddock
Paddock Geo Engineering Ltd
The Log Cabin
Manor Farm
Whaddon Road
Newton Longville
MK17 0AU

Derwentside Environmental Testing Services Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 23-00415

Site Reference:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ
Project / Job Ref:	P22-425
Order No:	P22-425 GI
Sample Receipt Date:	13/01/2023
Sample Scheduled Date:	13/01/2023
Report Issue Number:	1
Reporting Date:	18/01/2023

Authorised by:

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate						
DETS Report No: 23-00415	Date Sampled	09/01/23	09/01/23	09/01/23	09/01/23	09/01/23
Paddock Geo Engineering Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	TP / BH No	WS1	WS1	WS3	WS3	WS4a
Project / Job Ref: P22-425	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: P22-425 GI	Depth (m)	1.80	3.80	0.80	3.90	1.20
Reporting Date: 18/01/2023	DETS Sample No	627808	627809	627810	627811	627812

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.0	7.6	7.9	7.7	7.4
Total Sulphate as SO_4	mg/kg	< 200	MCERTS	429	877	579	963	694
Total Sulphate as SO_4	%	< 0.02	MCERTS	0.04	0.09	0.06	0.10	0.07
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	17	25	25	117	96
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.02	0.03	0.02	0.12	0.10

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate						
DETS Report No: 23-00415	Date Sampled	09/01/23				
Paddock Geo Engineering Ltd	Time Sampled	None Supplied				
Site Reference: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	TP / BH No	WS4a				
Project / Job Ref: P22-425	Additional Refs	None Supplied				
Order No: P22-425 GI	Depth (m)	2.40				
Reporting Date: 18/01/2023	DETS Sample No	627813				

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.4				
Total Sulphate as SO_4	mg/kg	< 200	MCERTS	295				
Total Sulphate as SO_4	%	< 0.02	MCERTS	0.03				
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	57				
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.06				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - Sample Descriptions
DETS Report No: 23-00415
Paddock Geo Engineering Ltd
Site Reference: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ
Project / Job Ref: P22-425
Order No: P22-425 GI
Reporting Date: 18/01/2023

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
627808	WS1	None Supplied	1.80	16.2	Brown sandy clay with stones
627809	WS1	None Supplied	3.80	42.8	Grey clay
627810	WS3	None Supplied	0.80	15.7	Brown sandy clay with stones
627811	WS3	None Supplied	3.90	34.5	Grey sandy clay
627812	WS4a	None Supplied	1.20	13.3	Brown sandy clay
627813	WS4a	None Supplied	2.40	17.7	Light brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 23-00415
Paddock Geo Engineering Ltd
Site Reference: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ
Project / Job Ref: P22-425
Order No: P22-425 GI
Reporting Date: 18/01/2023

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Matt Paddock
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t: 01923 225404
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Analytical Report Number : 23-14390

Project / Site name:	The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ	**Samples received on:**	25/01/2023
Your job number:	P22-425	**Samples instructed on/ Analysis started on:**	25/01/2023
Your order number:	P22-425 GI	**Analysis completed by:**	02/02/2023
Report Issue Number:	1	**Report issued on:**	08/02/2023
Samples Analysed:	4 soil samples		

Signed:

Adam Fenwick
Technical Reviewer
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 23-14390
Project / Site name: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ
Your Order No: P22-425 GI

Lab Sample Number				2567455	2567456	2567457	2567458
Sample Reference				WS2	WS2	WS5	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				7.50	9.00	8.00	9.00
Date Sampled				19/01/2023	19/01/2023	19/01/2023	19/01/2023
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**				
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	20	22	22	20
Total mass of sample received	kg	0.001	NONE	0.1	0.1	0.1	0.1

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.3	8.3	8.2	8.5
Total Sulphate as SO4	mg/kg	50	MCERTS	450	410	520	570
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.18	0.17	0.23	0.19

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

Analytical Report Number : 23-14390
Project / Site name: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
2567455	WS2	None Supplied	7.5	Grey clay with gravel.
2567456	WS2	None Supplied	9	Grey clay with gravel.
2567457	WS5	None Supplied	8	Brown clay.
2567458	WS5	None Supplied	9	Brown clay and sand.

Analytical Report Number : 23-14390
Project / Site name: The Boathouse, Ranelagh Drive, Richmond, TW1 1QZ

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE

For method numbers ending in 'UK or A' analysis have been carried out in our laboratory in the United Kingdom (WATFORD).
For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).
For method numbers ending in 'PL or B' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC
Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Appendix D

Sustainable Drainage Strategy Report

THE BOATHOUSE, TWICKENHAM

Flood Risk Assessment and Surface Water Drainage Strategy

Prepared for: The Boathouse Twickenham Ltd

SLR Ref: 425.064470.00001
Version No: 01
September 2022

BASIS OF REPORT

This document has been prepared by SLR with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with The Boathouse Twickenham Ltd (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

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CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1.0 Introduction

1.1 Background

SLR Consulting Limited (SLR) has been appointed by The Boathouse Twickenham Ltd ("the client") to provide a Flood Risk Assessment and Surface Water Drainage Strategy to support a full planning application for the demolition of the existing building and the construction of a residential scheme comprising 3 properties with associated hardstanding and soft landscaping at The Boathouse, Ranelagh Drive, Twickenham, TW1 1QZ ("the site").

A plan of the development proposals is included in Appendix 01.

This Flood Risk Assessment (FRA) and Surface Water Drainage Strategy (SWDS) has been prepared under the direction of a Technical Director in Hydrology at SLR who specialises in flood risk and associated planning matters. Reporting has been completed in accordance with guidance presented within the National Planning Policy Framework[1] (NPPF) and its associated Planning Practice Guidance[2] (PPG), taking due account of current best practice documents relating to the assessment of flood risk published by the British Standards Institution BS8533[3] and local planning policies.

1.2 Site Location

The site is located along the River Thames between Isleworth and St Margarets in West London, centred on National Grid Reference (NGR) TQ 16875 75063. The site is accessed from Ranelagh Drive and St Margarets Drive to the south which lead onto the Thames Pathway along the river frontage. This forms the eastern boundary of the site. St Margarets Drive provides a direct access route to the A3004, connected to the A316.

A site location plan is provided below in Figure 1-1.

1 Revised National Planning Policy Framework: Communities and Local Government (July 2021)
2 Planning Practice Guidance, Flood Risk and Coastal Change: Communities and Local Government (March 2014)
3 BS8533:2017, Assessing and managing flood risk in development: Code of Practice (2nd Edition, December 2017)

Figure 1-1
Site Location Plan

1.3 Administrative Context

The site is under the planning jurisdiction of the London Borough of Richmond upon Thames, who are responsible for the determination of this application. They are also the Lead Local Flood Authority (LLFA) for the area, dealing with matters relating to localised flood risk and drainage.

2.0 Baseline Site Appraisal

The site currently comprises an existing building which was formerly used as a recording studio but is now in residential use (C3). The surrounding developed area is typically for residential use with small areas of urban greenspace.

The site is situated along the River Thames frontage however a small access path is provided along the eastern boundary (Thames Pathway) which separates the site from the immediate riverbank. St Margarets railway station is present c.780m south of the site with Isleworth railway station around 1.8km north west. Richmond Lock is present c.50m south east of the site.

Satellite Imagery of the site is provided below in Figure 2-1.

Figure 2-1
Satellite Imagery

2.1 Topography

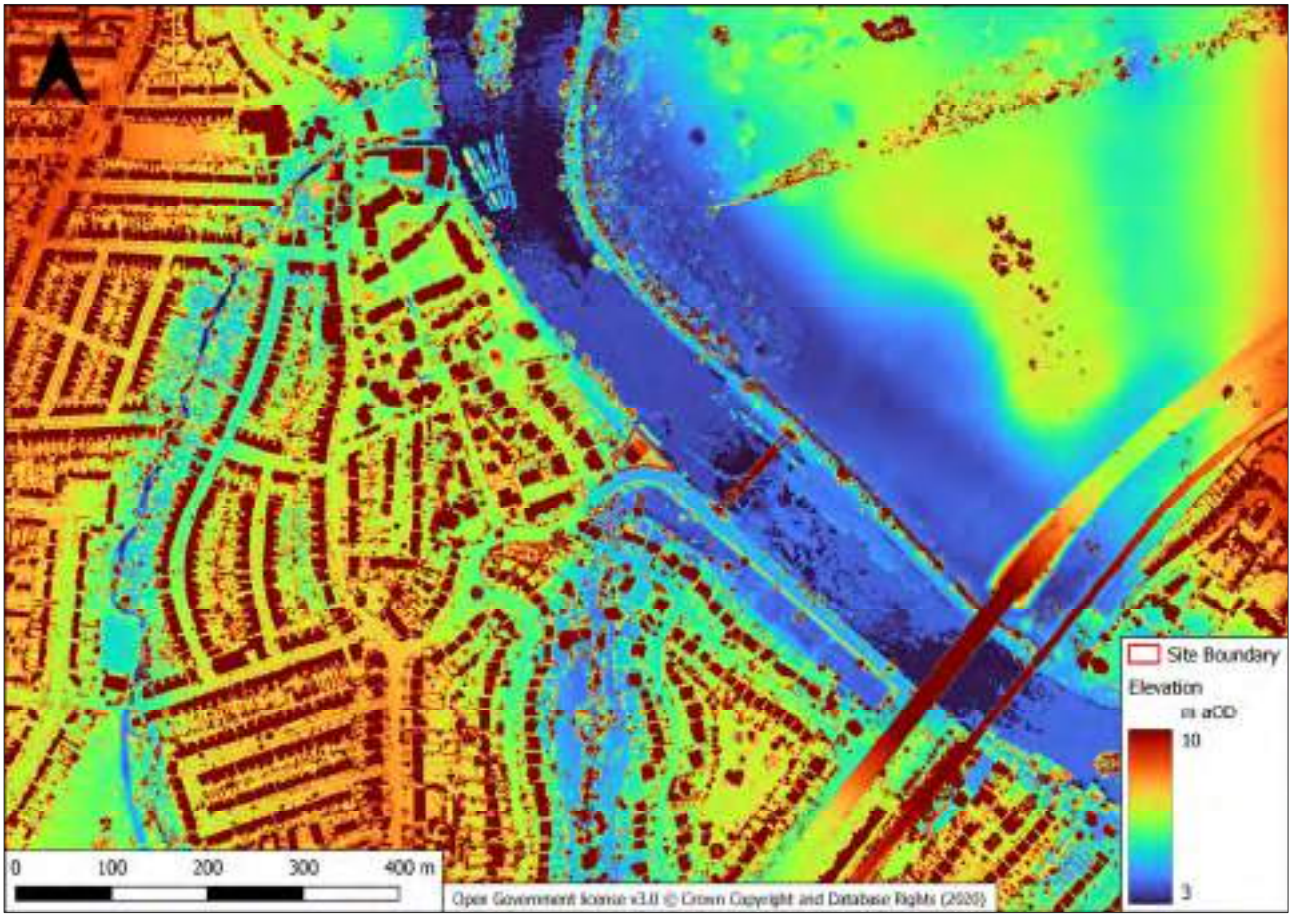
Topographic data from on and around the site, gathered using Light Detection and Ranging (LiDAR) aerial photogrammetric techniques, has been downloaded from the Environment Agency open data website[4]. The elevation data presented is a Digital Surface Model (DSM) which maps the first reflective surface and therefore

4 Environment Agency open data website http://environment.data.gov.uk

includes features such as built development and vegetation. LiDAR plots of the wider area and the site are presented in Figure 2-2 and Figure 2-3.

A topographic survey of the site is also included as Appendix 02 which corrolates well with the LiDAR data presented below.

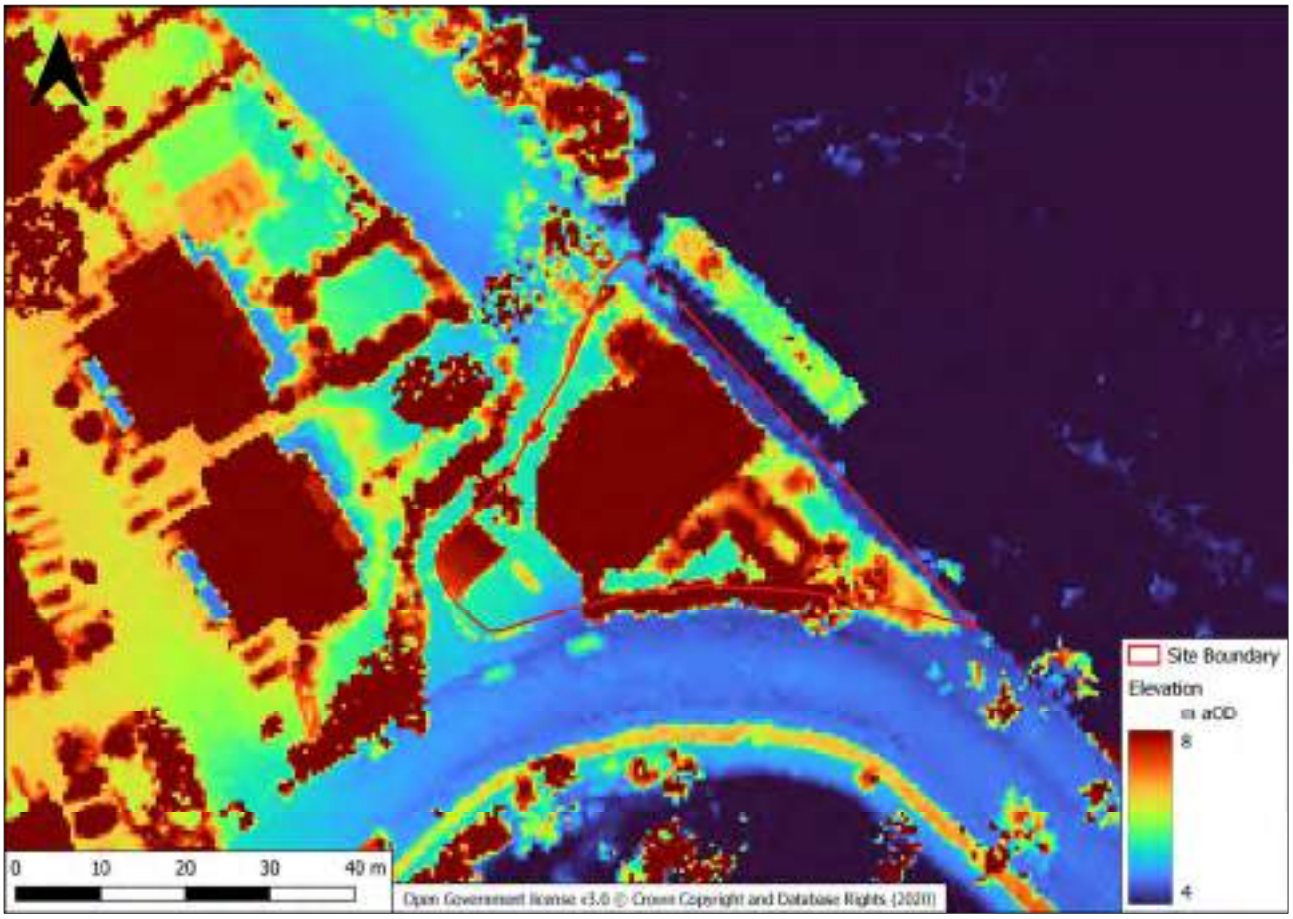
Figure 2-2
Regional Topography



Regional topography provided in Figure 2-2 is heavily dominated by the presence of the River Thames and its associated tributaries. The topography across the wider area therefore falls in variable directions but overall towards the River Thames. The banks of the River Thames have been raised out of the floodplain with protected land immediately behind the defences typically much lower.

Lower lying land is present to the south of the site which corresponds to a small unnamed water feature and woodland areas bounding Ranelagh Drive. These areas are elevated to around 3.5m above Ordnance Datum (aOD) and 3.7m aOD respectively. Ranelagh Drive is typically elevated below the site around c.4.4m aOD.

Figure 2-3
Site Topography



Ground levels on the site are generally flat but do fall slightly from 5.37m above Ordnance Datum (aOD) in the south west to 5.13m aOD to the north at the pedestrian access along the boundary with the River Thames. The ground also slopes down the ramped vehicle point onto Ranelagh Drive at around 4.46m aOD.

The Thames footpath is elevated at between 4.13-4.73m aOD however the finished floor levels to the front (east) of the existing building are raised significantly above this, at around 5.85m aOD. Finished floor levels in the existing property are slightly lower (200mm) at the south western entrance at around 5.65m aOD.

2.2 Hydrology

The site is located along the frontage of the River Thames which, at this location, is a tidally influenced watercourse designated by the Environment Agency as a Main River[5]. Water levels within the Thames therefore vary daily but are typically within the region of -0.96m – 3.79m aOD[6]. Past the site, the Thames flows in a north westerly direction but beyond heads east towards its estuary some 66km away. The interface between the fluvial and tidal Thames occurs at Teddington Lock only 3.6km south of the site.

The River Crane discharges into the River Thames at a confluence 370m north west of the site, draining a total upstream catchment area[7] of around 106km^2. This watercourse flows largely over mixed permeability geology

5 Main River Map, Environment Agency
6 Tide Times – Richmond Lock, https://www.tidetimes.org.uk/richmond-lock-tide-times
7 Flood Estimation Handbook Web Service, UK Centre for Ecology & Hydrology

and drains a predominantly urban catchment area (65%)[8]. Set back from the confluence with the Thames, the River Crane flows through a set of tidal gates and water levels drop across a weir into the Thames. Water levels upstream of the weir (where the channel is considered fluvial) are at around 4.7m aOD.

There is an additional unnamed water body (referred to as Boat Lake in this report) present 95m south of the site. From mapping this feature does not appear to have an obvious inlet and is therefore likely a groundwater fed system which also receives overland flows from a small urban catchment area. Based on mapping in the Strategic Flood Risk Assessment[9], the lake is fitted with a sluice gate which, during wet periods, likely discharges elevated water within the system into the Thames but similarly prevents water ingress during periods of high tide.

2.3 Geology

The National Soil Resources Institute[10] suggests that the soils at the site consist of "*Loamy and clayey floodplain soils with naturally high groundwater*". Due the existing built development and largely impermeable concrete hardstanding, it is unlikely that these natural soils are no longer present across much of the site and instead the shallow layers comprise of made ground.

British Geological Survey (BGS) mapping[11] indicates that the site is underlain by London Clay Bedrock which comprises of clay and silt. The clay is overlain by alluvium deposits across the full extent of the site which comprise clay, silt, sand and peat.

BGS Borehole TQ17SE107, located 90m south east of the site identified 1m of Made Ground underlain by 2.8m of alluvium. Gravel and brown silty sands were identified for an additional 1.6m before striking the London Clay.

2.4 Hydrogeology

The Clay bedrock is designated by the Environment Agency as an 'Unproductive'[12] aquifer, which are defined as layers of rock or drift deposits which have low permeability and negligible significance for water supply and baseflow.

The alluvium deposits are designated as a 'Secondary B (undifferentiated)[12]' aquifer which are predominantly low permeability layers but may store limited amounts of groundwater dependant on local lithological characteristics.

The site is not located within a Source Protection Zone (SPZ) typically associated with potable groundwater abstractions.

Given the geological conditions (i.e., made ground and alluvium of varying permeability underlain by impermeable clay), we would expect groundwater to be perched within the shallow layers above the clay strata at varying depths depending on local lithology.

Boat Lake, as discussed in Section 2.2, is assumed as largely a groundwater fed system that also receives overland flows from its small surface catchment area. Water levels in Boat Lake are typically around 3.7m aOD which we assume is an approximate standing winter groundwater level locally. It is understood that due to the nature of the geology depth to groundwater will vary.

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8 39094 – Crane at Marsh Farm, National River Flow Archive, https://nrfa.ceh.ac.uk/data/station/info/39094

9 Strategic Flood Risk Assessment- Level 1, London Borough of Richmond upon Thames, Metis Consultants Ltd, March 2021, https://www.richmond.gov.uk/services/planning/planning_policy/local_plan/local_plan_evidence/flooding_ground_water/flood_risk_assessment

10 Soilscapes map, http://www.landis.org.uk/soilscapes/

11 British Geological Survey, Geoindex, http://mapapps.bgs.ac.uk/geologyofbritain/home.html?

12 Magic Map Application, managed by Natural England, delivered by Landmark, https://magic.defra.gov.uk/MagicMap.aspx

2.5 Existing Site Drainage

Based on information provided on the topographic survey (Appendix 02) and wastewater asset plans provided by Thames Water (Appendix 03), surface water runoff from the existing site is intercepted by a number of drainage gullies and manholes located around the north and west of the building. These manholes appear to convey flows towards Ranelagh Drive and discharge into a Thames Water Surface Water sewer beneath the road. This sewer conveys all flows in a north eastward direction to outfall into the Thames.

During periods of high tide it is likely that the surface water sewer outfall becomes surcharged. This therefore means that during coincidental events of high tide and heavy rainfall, surface water is unable to discharge from the sewer. In such an event, surface water will surcharge from the drainage manholes/gullies on site and flow overland in line with local topography either to the east, discharging onto Ranelagh Drive, or northwards via the existing pedestrian access point onto the Thames footpath. Due to ground levels flows via either route will discharge into the Thames and away from the site.

3.0 Policy Status for Proposed Development

3.1 Development Proposals

This report supports an application for the demolition of the existing residential building and construction of 3, 4-storey residential houses with associated hardstanding and soft landscaping. These proposed properties have been developed following a pre-application submission (20/P0166/PREAPP) to the local authority. As part of this process the Environment Agency have been consulted and their advice has been incorporated into the scheme design to reduce flood risk over the lifetime of development.

The development is set to comprise of four levels, these are a lower ground, ground, first and second floors. The lower ground floor will be a combination of sub surface and surface development, with a finished floor level of 3.10m aOD. There will be no external entrances into the lower ground floor and this level of the properties will only be accessed via the upper levels of each building.

The ground floor levels will also be raised from the external areas, with an entrance level of 6.9m aOD which falls to an internal level of 6.01m aOD. Any vented areas below 6.90m aOD will be fitted with valves to inhibit water ingress.

The existing access points along the eastern site (Thames frontage), which currently comprise of a pedestrian walkway and doors into the building, will be removed and replaced with a new retaining wall elevated to 6.9m aOD.

Ground levels to the south of the property will be levelled to a finished platform level of 4.47m aOD. Parking will also be provided externally to the building to the south of the property at this equivalent level.

The perimeter wall which currently exists around the site will be demolished and replaced with a new wall of the same height, i.e., 6.9m aOD. Two new access points will be provided (for pedestrians and vehicles) along the south eastern site boundary onto Ranelagh Drive. New areas of vegetation planting area will be provided throughout the site.

The proposed development masterplan is provided as Appendix 01.

As outlined in the PPG[2], residential institutions are classified as '*More Vulnerable*' with respect to flood risk.

For the purpose of this assessment a 100-year lifetime of development has been assumed for this residential scheme.

3.2 Flood Zone Classification

The definition of Environment Agency flood zones is provided in PPG *Table 1: Flood Zones*:

- *Zone 1 - Low Probability* (Flood Zone 1) is defined as land which could be at risk of flooding from fluvial or tidal flood events with less than 0.1% annual probability of occurrence (1:1,000 year) i.e. considered to be at 'low probability' of flooding.
- *Zone 2 - Medium Probability* (Flood Zone 2) is defined as land which could be at risk of flooding with an annual probability of occurrence between 1% (1:100 year) and 0.1% (1:1,000 year) from fluvial sources and between 0.5% (1:200 year) and 0.1% (1:1,000 year) from tidal sources i.e. considered to be at 'medium probability' of flooding.
- *Zone 3a - High Probability* (Flood Zone 3a) is defined as land which could be at risk of flooding with an annual probability of occurrence greater than 1% (1:100 year) from fluvial sources and greater than 0.5% (1:200 year) from tidal sources i.e. considered to be at 'high probability' of flooding.
- *Zone 3b - the Functional Floodplain* (Flood Zone 3b) is defined as land where water has to flow or be stored in times of flood. Local Planning Authorities should identify in their Strategic Flood Risk

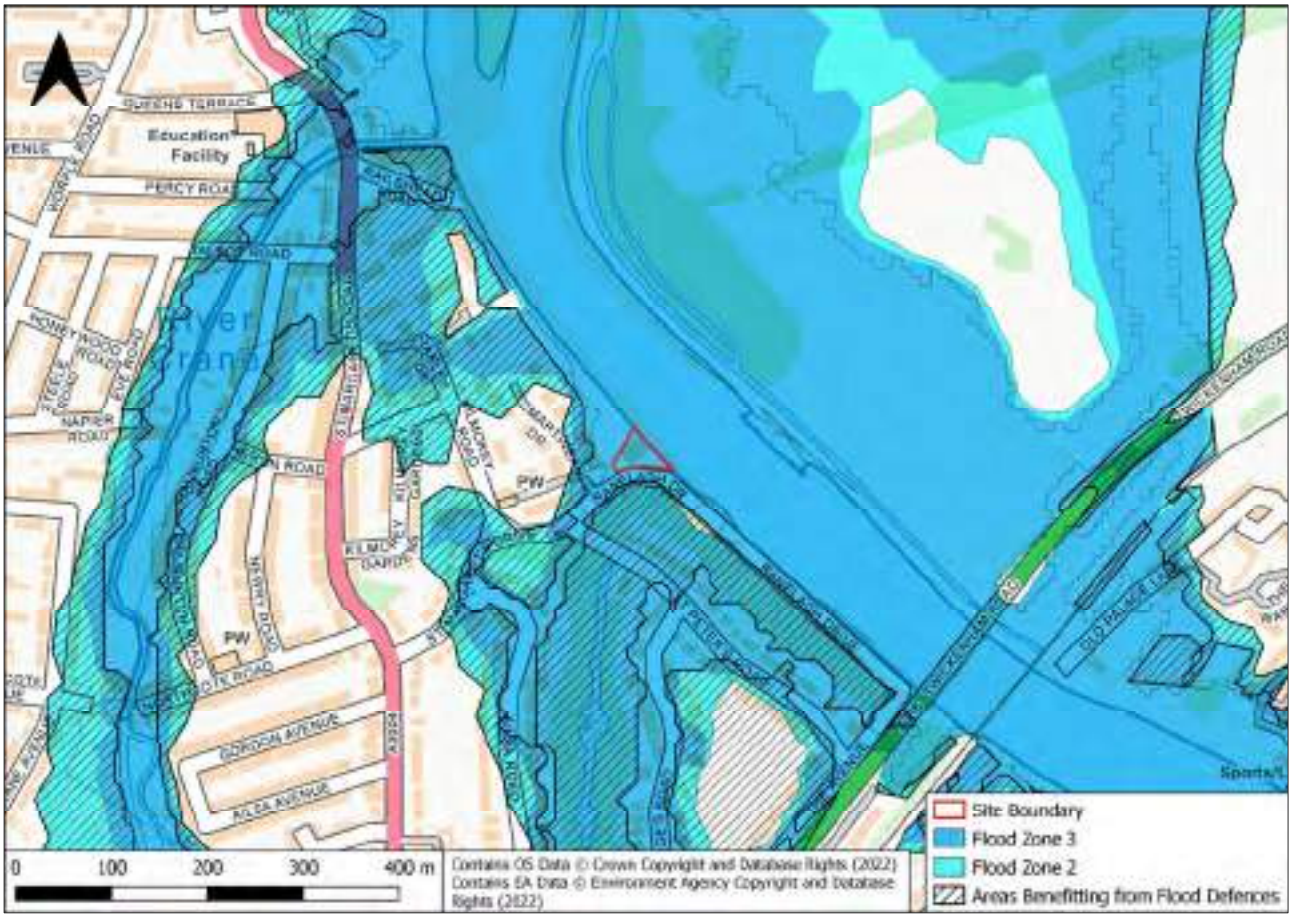
Assessments areas of functional floodplain in agreement with the Environment Agency. In the absence of definitive information, it is often defined as land that would flood with an annual probability of occurrence of 5% (1:20 year) or greater.

In assessing the boundary between Flood Zones 1, 2 and 3, the protection afforded by any flood defence structures, and other local circumstances, is not considered by the Environment Agency.

An extract of the Environment Agency (EA) Flood Map for Planning is included as Figure 3-1 which indicates the site lies within Flood Zone 3 and does not benefit from flood defences locally.

Mapping contained within the SFRA indicates that the site is designated as Flood Zone 3a and not 3b.

Figure 3-1
Environment Agency Flood Map for Planning



3.3 National Planning Policy

This FRA report has been completed in accordance with the guidance presented in the NPPF[1] and with reference to PPG[2].

3.3.1 Flood Risk Compatibility

The proposed residential scheme is classified as a '*More Vulnerable'* development with regards to flood risk.

As outlined in Table 3 of the PPG guidance[2] (reproduced as Table 3-1'), 'More Vulnerable' development types are permitted in Flood Zone 3a; however the exception test must be passed.

Table 3-1
Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification (PPG Table 2)		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (functional floodplain)	Exception Test Required	x	x	x	✓

Key: ✓ Development is appropriate x Development should not be permitted

3.3.2 Sequential Test

With reference to the NPPF, the Sequential Test gives preference to locating new development in areas that are at lowest risk of flooding (i.e. Flood Zone 1). The Environment Agency Flood Map for Planning (Figure 3-1) and SFRA are geared to providing the basis for applying this test.

The Sequential Test requires developers to:

> *".....demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed."*

The site is an existing residential property which seeks to be replaced by 3 residential properties. Ultimately the development will not change the flood vulnerability of the site or have a significant impact on the number of residents.

Development is needed in riverside areas. Given its economic and cultural value locally and there is no plan to discourage river frontage residential schemes where these are appropriately designed. This is supported by policy LP 34 of the Local Plan, whereby riverside housing development in both Richmond and Twickenham is required in order to meet the boroughs new housing target.

This FRA and SWDS will ensure that the proposed residential development is appropriately designed and safe throughout its lifetime of development. On this basis we assume that the sequential test is passed.

3.3.3 Exception Test

The exception test, as set out in paragraph 164 of NPPF, states that

> *"For the exception test to be passed it should be demonstrated that:*
>
> *(a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*
>
> *(b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

Both elements of the exception test should be satisfied for development for be allocated or permitted".

The development will provide additional sustainable housing within the borough in an amenity location set back from its existing location to expand and significantly improve the River Walk ecologically but also for public amenity. Wider consideration of how the scheme addresses sustainability through its design is included elsewhere within the application.

This report, a Flood Risk Assessment and Surface Water Drainage Strategy, sets out how the scheme to fulfils point b.

3.4 Local Planning Policy

The site falls within the planning jurisdiction of the London Borough of Richmond upon Thames, and therefore must satisfy the planning requirements set out in the Local Plan[13]. The Local Plan was adopted in July 2018 and sets out policies and guidance for development in the borough up to 2033. Policy LP21 relates directly to flood risk and drainage and is reproduced below.

Policy LP21 – Flood Risk and Drainage

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

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

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

Basements and Subterranean Developments

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

Flood Zone 3a (Fluvial / Tidal)	*In areas of Extreme, Significant and Moderate Breach Hazard (as set out in the Council's SFRA):*
	• *New basements:*
	  ○ *restricted to Less Vulnerable / Water Compatible use only.*
	  ○ *'More Vulnerable' uses will only be considered if a site-specific Flood Risk Assessment demonstrates that the risk to life can be managed. Bedrooms at basement levels will not be permitted.*
	  ○ *'Highly Vulnerable' such as self-contained basements/bedrooms uses will not be permitted.*
	• *Existing basements:*

13 Local Plan, London Borough of Richmond upon Thames, July 2018, https://www.richmond.gov.uk/media/15935/adopted_local_plan_interim.pdf

	○ *No basement extensions, conversions or additions for 'Highly Vulnerable' uses.* ○ *'More Vulnerable' uses will only be considered if a site-specific Flood Risk Assessment demonstrates that the risk to life can be managed.* • *In areas of Low or No Breach Hazard (as set out in the Council's SFRA):* • *New basements: if the Exception Test (where applicable) is passed, basements may be permitted for residential use where they are not self-contained or used for bedrooms.* • *Existing basements: basement extensions, conversions or additions may be permitted for existing developments where they are not self-contained or used for bedrooms.* *If a basement, basement extension or conversion is acceptable in principle in terms of its location, it must have internal access to a higher floor and flood resistant and resilient design techniques must be adopted.*

Sustainable Drainage

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

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

Flood Defences

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

1. *Retain the effectiveness, stability and integrity of flood defences, river banks and other formal and informal flood defence infrastructure.*
2. *Ensure the proposal does not prevent essential maintenance and upgrading to be carried out in the future.*
3. *Set back developments from river banks and existing flood defence infrastructure where possible (16 metres for the tidal Thames and 8 metres for other rivers).*
4. *Take into account the requirements of the Thames Estuary 2100 Plan and the River Thames Scheme, and demonstrate how the current and future requirements for flood defences have been incorporated into the development.*
5. *The removal of formal or informal flood defences is not acceptable unless this is part of an agreed flood risk management strategy by the Environment Agency.*

The London Plan[14] is the statutory development plan for the city and was updated in 2021. All London Boroughs should conform to the wider London Plan to ensure that the planning system for London reflects the overall strategy for how the city can develop in a sustainable manner. Relevant policy from the London Plan includes:

Policy SI 12 Flood risk management

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.*

14 The London Plan, The Spatial Development Strategy for Greater London, Mayor of London, March 2021, https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

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

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

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

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

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

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

Policy SI 13 Sustainable drainage

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.*

Paragraph 9.13.3 of the London Plan, which provides supplementary commentary to Policy SI 13 Sustainable Drainage, states:

> *In some cases, direct discharge into the watercourse is an appropriate approach, for example rainwater discharge into the tidal Thames or a dock. This should include suitable pollution prevention filtering measures, ideally by using soft engineering or green infrastructure. In addition, if direct discharge is to a watercourse where the outfall is likely to be affected by tide-locking, suitable storage should be designed into the system.*

3.5 Climate Change

In February 2016 the Environment Agency issued guidance on the impacts of climate change on flood risk in the UK to support the NPPF (last major update in May 2022[15]). This advice sets out that peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future as a result of climate change.

PPG recommends that considerations for future climate change are included in FRA's for proposed developments. The site is not located on open coast and therefore changes in relation to offshore wind speed and extreme wave heights are not applicable. The site is located along the tidal Thames frontage and therefore this assessment will consider the effects of sea level rise on tidal inflows but also fluvial flows progressing downstream. Uplifts in peak rainfall intensity on surface water flood risk will also be accounted for.

3.5.1 Sea Level Change

To take into account the effects of climate change over the lifetime of the proposed development (75-years), the most recent advice on climate change provided by the EA should be applied. An extract of this advice, *Table 3 sea level allowance for each epoch in mm per year (based on a 1981 to 2000 baseline) – the total sea level rise for each epoch is in brackets*, is reproduced as Table 3-2 for the south east area of England. Flood risk assessments should assess both the higher central and upper end allowances.

Table 3-2
Sea Level Allowance for each epoch in millimetres (mm) per year, with total sea level rise for each epoch in brackets (use 1981 to 2000 baseline) by River Basin District

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
South East	Higher Central	5.7 (200)	8.7 (261)	11.6 (348)	13.1 (393)	1.20
	Upper end	6.9 (242)	11.3 (339)	15.8 (474)	18.2 (546)	1.60

The anticipated sea level rise throughout the 100-year anticipated lifetime of development, up until 2122, is 1.16m using the higher central allowance and up to 1.55m using the upper end allowance.

In reality these uplifts relate to areas of open sea and the Thames adjacent to the site is estuarine. In such situations best practice is to apply the projected sea level rise at the downstream boundary of a tidal flood model and then use the model to assess how this impacts water levels extending up the tidal reaches. Where available the outputs of such modelling should be used in preference to simply uplifting current day estimate of extreme flood levels.

3.5.2 Peak Fluvial Flows

Peak River Flow Allowances provided by the Environment Agency show the anticipated changes to peak flows by management catchment. Guidance states that for *"more vulnerable"* development located in Flood Zone 3a the *"central"* allowance should be considered.

15 Environment Agency, Flood Risk Assessments: Climate change allowances, February 2016 (Updated May 2022)

For the London Management Catchment, this equates to a 17% increase in peak flow by the end of the anticipated lifetime of the development, as demonstrated in Table 3-4.

Table 3-3
Peak River Flow Allowances by Management Catchment (based on a 1981 to 2000 baseline)

Management Catchment	Allowance Category	Total potential change anticipated for 2015 to 2039	Total potential change anticipated for 2040 to 2069	Total potential change anticipated for 2070 to 2115
London	Central	10%	7%	17%

3.5.3 Peak Rainfall Intensity

The Environment Agency climate change guidance acknowledges that there is uncertainty with respect to the absolute level of change that is likely to occur with respect to rainfall, and that both the absolute level of change and the level uncertainty increase over time. As such, the document provides estimates of possible changes that reflect three different time horizons and two different emission scenarios. These recommended allowances for rainfall depths are set out in Table 3-4.

Guidance states that flood risk assessments should assess the 'Upper End' allowance to understand the range of impact for both the 1% and 3% AEP events for the 2070s epoch for a 100-year development lifetime (Table 3-4). The higher of the two allowances, which in this case corresponds to the 2070s epoch, should be accounted to assess the flood risk.

Table 3-4
Peak Rainfall Intensity Allowance in the London Management Catchment

Management Catchment	Annual Exceedance Rainfall Event	Allowance	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2070s' (2061 to 2125)
London	3.3%	Upper End	35%	35%
		Central	20%	35%
	1%	Upper End	40%	40%
		Central	20%	25%

4.0 Potential Sources of Flooding

4.1 Methodology and Best Practice

This Flood Risk Scoping Report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[16], and British Standard BS8533[3].

A screening study has been completed to identify whether there are any potential sources of flooding at the site which may warrant further consideration. If required, any potential significant flooding issues identified in the screening study are then considered in subsequent sections of this assessment.

4.2 Screening Study

Potential sources of flooding include:

- Flooding from the sea or tidal flooding;
- Flooding from rivers or fluvial flooding;
- Flooding from surface water and overland flow;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flooding from infrastructure failure.

The flood risk from each of these potential sources is discussed below and summarised in Section 4.3.

4.2.1 Flooding from the Sea or Tidal Flooding

Based on mapping provided by the Environment Agency and SRFA, the site falls within Flood Zone 3a adjacent to the River Thames in its tidal reaches.

Flooding from tidal sources is therefore possible at the site and is discussed in further detail in Section 5.4.

4.2.2 Flooding from Rivers or Fluvial Flooding

The site is situated downstream of Teddington Lock which is the interface between the tidal and fluvial influences on the Thames. Whilst it is considered the reach of the Thames past the site is largely tidal in nature, high tides coinciding with extreme fluvial flooding will affect the fluvial conveyance of the Thames resulting in potentially elevated water levels past the site resulting from fluvial sources. This eventuality is largely managed through use of the Thames Barrier to prevent the flood tide during period of peak fluvial flow and minimise the potential for backwater effects.

Similarly, backwater effects / closing of the tidal lock gates during extreme fluvial flooding along the River Crane paired with extreme high tide may result in out of bank flood waters preferentially discharging to areas of lower lying land.

While of lesser concern than tidal flooding both of these fluvial influences will be reflected in the flood modelling and is therefore assessed in detail in Section 5.3.

16 Report C753, The SuDS Manual; CIRIA (2015). Report C753, November 2015.

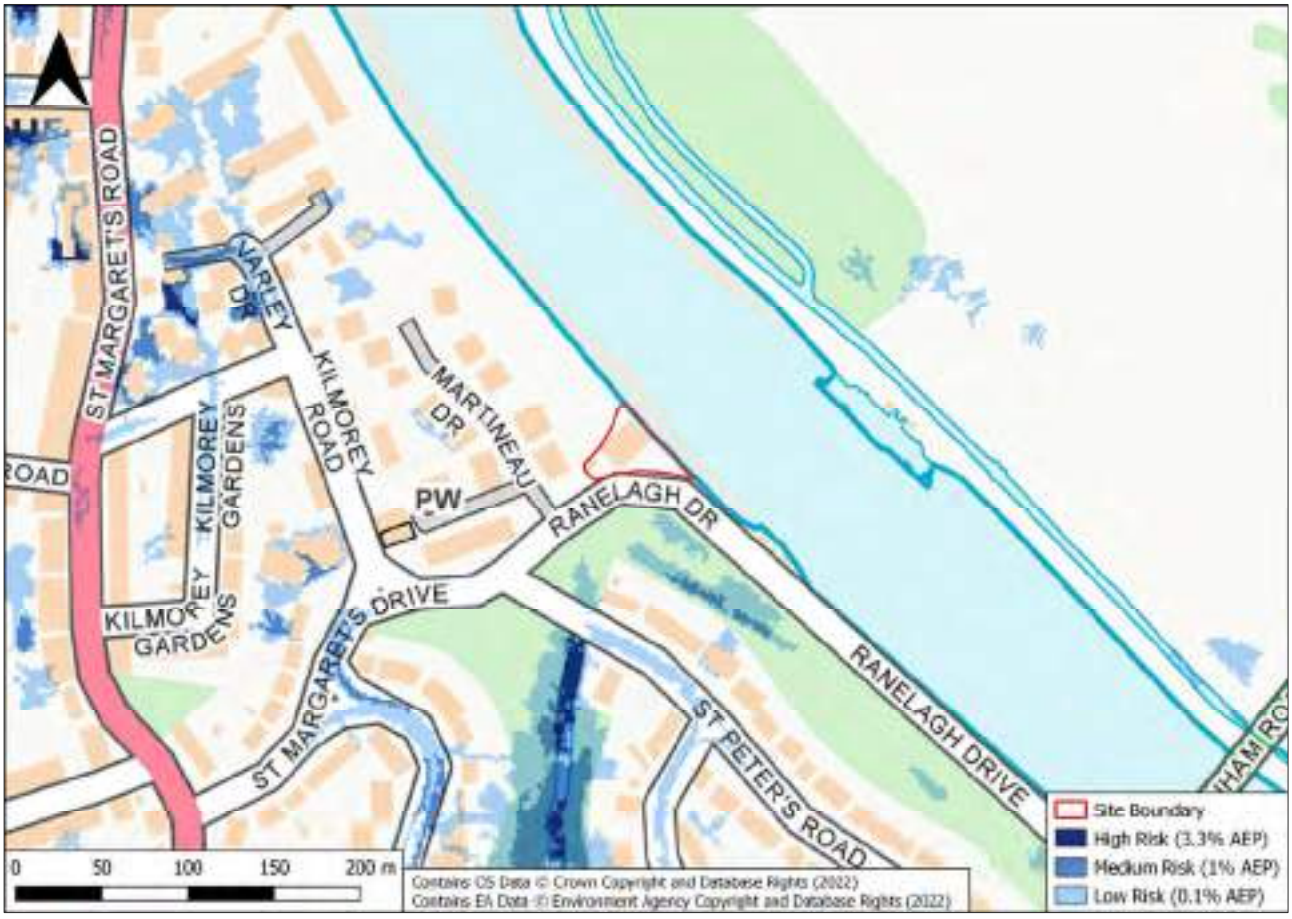
4.2.3 Flooding from Surface Water and Overland Flow

The site sits to the north of a small topographic crest resulting in a limited upgradient catchment area. Significant overland flows are therefore unlikely to propagate onto the site from this direction.

Whilst the topography of the wider area slopes north east towards the River Thames, areas to the south west are lower than the site and any overland flows would therefore pond in these depressions and not flow onto the site.

Long Term Flood Risk Information (LTFRI)[17] provided by the Environment Agency includes mapping of surface water flood risk. Surface water modelling has been undertaken by the Environment Agency in order to establish areas at risk of surface water flooding based upon latest hydrological techniques and surface terrain data. This is not representative of any surface water drainage (such as highways drainage) and therefore likely overestimates the flood risk.

Figure 4-1
Environment Agency Surface Water Flood Map



An extract of the map for the site and surrounding area is presented in Figure 4-1, where the Environment Agency define the surface water flood risk categories as:

- **Very Low:** less than 1 in 1,000 annual probability of flooding in any given year;

17 Environment Agency, Long Term Flood Risk Information Service: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

- **Low:** less than 1 in 100 annual probability but greater than or equal to 1 in 1,000 annual probability of flooding in any given year;
- **Medium**: between 1 in 100 annual probability and 1 in 30 annual probability of flooding in any given year; and
- **High:** greater than 1 in 30 annual probability of flooding in any given year.

The surface water flood mapping provided in Figure 4-1 supports the conceptual understanding that surface water flood risk to the site is very low, with elevated areas of risk in the local topographic depressions to the south and south west.

Whilst peak rainfall depths could increase by up to 40% over the projected development lifetime this will not significantly alter the risk posed to the site. Instead, it is likely that more severe rainfall would increase the frequency and severity of flooding to those areas where runoff would naturally drain to (i.e., not the site).

A surface water drainage strategy would be required from the site to ensure that runoff derived from the site is actively managed for the design 1% AEP plus 40% climate change.

The risk of flooding from surface water and overland flow is very low and not considered further.

4.2.4 Flooding from Groundwater

Groundwater flooding can be defined as flooding caused by the emergence of water originating from subsurface strata. Groundwater flooding can occur where sites are located on permeable ground. After a prolonged period of rainfall and groundwater recharge, a considerable rise in the water table can result in inundation for extended periods of time.

The site is situated on largely impermeable clay bedrock geology which would not typically give rise to groundwater flooding. More permeable alluvium and made ground deposits are present above the clay which results in perched groundwater within the shallow layers. This is supported by data from borehole records locally (Section 2.4), where groundwater strike was noted at variable depths of 2 – 3.8m bgl within the alluvium and made ground layers. During periods when river levels are high, groundwater levels are likely to approach the ground surface in areas surrounding the site. However, as the site is raised above adjacent areas, and is overlain by hardstanding, water would emerge from the lower ground to the south (open areas of vegetation) rather than result in groundwater flooding at the site surface.

Mapping contained within the SFRA indicates the site as being at risk of groundwater flooding for any subsurface development. Based on the geological conditions, we would agree with this mapping and expect shallow groundwater at the site perched above the London Clay. Actual depths to water would need to be determined post planning as part of the ground investigation works however the lower ground floor will require tanking regardless to prevent any potential groundwater ingress.

4.2.5 Flooding from Sewers and Water Mains

Thames Water Asset Plans are provided as Appendix 03 which indicate surface, foul and mains water sewers beneath Ranelagh Drive past the site.

In the event of failure or surcharge of sewerage infrastructure or burst of the water mains flood water would pond on Ranelagh Drive along the Thames frontage as this is the topographic low whereby there are no restrictions to flow. It is unlikely that the volume of flow following such an event would result in flood levels which would progress onto the site beyond the main ramped access point (depths of up to 1m required).

Flooding from sewers and water mains is low and therefore not considered further.

4.2.6 Flooding from Reservoirs, Canals and Other Artificial Sources

With reference to Environment Agency Reservoir Breach Mapping[17], the site is located partially in an area considered to be at risk of flooding from a total of 8 different reservoirs. In reality due to the raised nature of the proposed development, it is unlikely such an event would result in internal flooding of the property. However, this risk is significantly heightened, and could theoretically inundate the entire site, if a major reservoir failure occurred when there is also flooding from rivers.

Reservoirs are subject to stringent inspection and maintenance controls under the 1975 Reservoirs Act. The probability of flooding from this source is therefore near zero and integrating further mitigation works to prevent flooding in this scenario would be inappropriate. The associated flood risk is therefore not considered further in this assessment.

A review of Ordnance Survey mapping has not identified any canals or other artificial water bodies upgradient of the site. As such the risk of flooding proposed to the development from this source is assessed to be negligible and is not considered further.

4.2.7 Flooding from Infrastructure Failure

EA mapping (Figure 3-1) indicates that the site is not situated in an area that benefits from flood defences; however, the EA asset database indicates the presence of raised defences around the perimeter of the existing building. As detailed below in Section 5.2, there are gaps in this wall which therefore means that its effect in reducing flood risk to the existing site is negligible and the site would already be fully inundated should the solid wall be overtopped or fail.

Boat Lake is present to the south of the site. This receives inflows from a number of sources including surface water runoff, groundwater within the shallow gravel layers. At its northern extent, the lake is fitted with a sluice gate which is connected to the River Thames which prevents tidal water backing up into the lake. Should the sluice gate mechanism fail, tidal water would be able to back up into Boat Lake potentially resulting in flooding of the surrounding areas present behind the Thames Tidal wall. The site is however located on the riverward side of these defences and therefore this potential flood mechanism would not affect the site.

A review of the local context has not identified any other infrastructure, the failure of which could result in flooding at the site. The risk of flooding resulting from infrastructure failure is not considered further.

4.3 Summary of Flood Screening

A summary of the potential sources of flooding and the flood risk arising from them is presented in Table 4-1.

Table 4-1
Potential Risk Posed by Flooding Sources

Potential Source	Potential Flood Risk at Site?
Sea or Tidal Flooding	Yes
Rivers or Fluvial Flooding	Yes
Surface Water and Overland Flow	No
Groundwater	No
Sewers and Water Mains	No
Reservoirs, Canals and other Artificial Sources	No

Potential Source	Potential Flood Risk at Site?
Infrastructure Failure	No

5.0 Technical Assessment of Flood Risk

The screening assessment summarised in Table 4-1 identifies potential sources of flooding from:

- Fluvial sources associated with coincidental events of:
  - Astronomical high tide coinciding with extreme fluvial flows along the Thames restricting flood flow conveyance and resulting in elevated water levels past the site due to fluvial flows.
  - Closure of the lock gates on the River Crane due to astronomical high tide coinciding with extreme fluvial flows along the River Crane causing flood water to back up into the catchment.
- Tidal sources as the site is located adjacent to tidal reaches of the River Thames.

These potential flood risks to the site are therefore assessed in further detail below. A data request was submitted to the Environment Agency to support this Flood Risk Assessment and the resulting correspondence is provided in Appendix 04.

5.1 Historical Flooding

With reference to the Environment Agency Historical Flood Mapping[18], and as confirmed in the SFRA[9] and Appendix 04, there have been no recorded historical incidents of flooding at the site. However, based on internet research of published news articles, Ranelagh Drive, which is elevated below the site, regularly floods following high tide. This is most prominently recorded following the spring high tide in March 2013. The property itself has not recorded any internal flooding.

There are also two recorded incidents of out of bank flooding along the Crane past the site in November 1965 and January 1999. This is likely a result of elevated flows within the Crane unable to discharge into the Thames due to high tide (reduction in flood conveyance) resulting in flows backing up into the upgradient catchment (the mechanism described in Section 5.1). These flood events did not affect the site.

5.2 Flood Defences

5.2.1 Thames Barrier

Water levels within the Thames adjacent to the site are dominated by downstream tidal conditions and to a small degree by fluvial flows from the upstream catchment. During major storms water can surge up the estuary and could (if not controlled) result in significant flooding within central London.

The Thames Barrier, present on the lower Thames downstream of the site, is designed to manage water levels within central London. The barrier is shut;

a) at low tide in advance of fluvial flood flows reaching central London to ensure that there is sufficient capacity to receive fluvial flows without flooding occurring; and
b) in advance of high tide when major storm surges are predicted to impact the outer Thames Estuary.

The barrier has been designed, and is maintained, to a high standard and the probability of it being unable to manage water levels as designed is estimated to be less than 1 in 1000 in any given year.

The Environment Agency currently operate the Thames Barrier to ensure that peak water levels in the Thames adjacent to the site do not exceed 5.61m aOD. They indicate that this standard will be maintained through to 2065.

18 Environment Agency Historic Flood Map, Open Data, GOV.UK, https://www.data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

Beyond 2065 the Thames Barrier will still provide protection to a high standard. Changes in flood severity associated with climate change would however require increasingly frequent operation of the barrier to maintain the target water level. It is therefore envisaged that operating rules would be altered to permit higher water levels in central London and therefore provide sufficient time to maintain the system. By the end of the projected development lifetime the Project maximum water level permitted by the operations of the barrier would therefore increase to 6.30m aOD.

5.2.2 Local Defences

With reference to the Flood Defence Mapping contained in Appendix 04, the site is situated riverside to the main linear flood wall along the Thames which at present, is raised to a height of around 5.94m aOD.

A perimeter wall is also present around the site comprised of parts of the existing building (along the river front) and freestanding brick walls which, along the riverfront, have been infilled with solid ground to an equivalent level. Due to large gaps in this wall for the entrances to the property (see Figure 5-1) this structure would have no effect in managing flood risk to the existing property. Instead flood risk to the existing property is controlled by the raised floor level. Based on survey data and observations the current floor level is estimated to be at an elevation of between 5.65 and 5.85m aOD. This explains why the property has never been flooded.

Figure 5-1
Gaps in existing site perimeter wall

5.3 Flooding from Rivers and Fluvial Flooding

It is considered the site is potentially at risk of fluvial flooding from two potential flood mechanisms:

1) Astronomical high tide coinciding with extreme fluvial flows along the Thames restricting flood flow conveyance and resulting in elevated water levels past the site due to fluvial flows; and
2) Closure of the lock gates on the Crane due to astronomical high tide coinciding with extreme fluvial flows along the River Crane causing flood water to back up into the catchment.

With reference to point 1, this modelling has been included as part of the Lower Thames and Jubilee River Modelling Study which inputs a range of design fluvial flow conditions on a static downstream tidal boundary (the maximum tidal level before the Thames Barrier is closed). Flood model outputs and the associated assessment of fluvial flood risk is provided in Section 5.3.1.

With reference to point 2, the data request to the EA did not provide flood model outputs for the River Crane however, fluvial flood mapping has been incorporated into the SFRA using the River Crane SRFM Modelling and Mapping Study which will have included the effects of high tide / closure of the lock gates on flood conveyance in the lower reaches. This is discussed in Section 5.3.2.

5.3.1 Lower Thames, Jubilee River and River Ash Model

The Lower Thames, Jubilee River and River Ash Modelling Study was produced by JBA Consulting in July 2020. This study assessed flood risk along the River Thames and its main tributaries (including the Crane) between Hurley and Teddington. Output modelling data from this study was provided by the EA and provides a range of in channel flood levels past the site for both the defended and undefended scenarios across a range of return periods, including climate change uplifts on fluvial flows.

The Hammersmith reach of the model (the site) considers both fluvial flows and downstream tidal elevations with the upstream boundary scaled to represent the design flow condition on the Thames, and the downstream boundary condition using the highest tidal level in Southend whereby the Thames Barrier will not close. This model therefore explicitly analyses the effects of fluvial flows on the Thames using a static downstream tidal water level.

This modelling provides in-channel design flood levels for a range of different fluvial flood probabilities. Analysis of this data will conservatively use the defended scenario outputs for the neighbouring modelled nodes (Figure 5-2) as this represents the presence of the existing local Thames Tidal Defences behind the site. Flood model outputs for the upstream and downstream node are summarised in Table 5-1.

Figure 5-2
Model Node Locations past the site from Lower Thames, Jubilee River and River Ash Model

Table 5-1
Flood Model Outputs for the Lower Thames Model

Annual Exceedance Probability (%)	Modelled Node	
	061_00_2018_a2.7 (upstream)	061_00_2018_2.8 (downstream)
20% (1 in 5)	4.76	4.75
10% (1 in 10)	4.79	4.77
5% (1 in 20)	4.83	4.81
2% (1 in 50)	4.98	4.95
1.33% (1 in 75)	5.04	5.00
1% (1 in 100)	5.10	5.05
0.5% (1 in 200)	5.28	5.23
0.1% (1 in 1000)	5.71	5.62
1% (1 in 100) + 25% Climate Change	5.42	5.36
1% (1 in 100) + 35% Climate Change	5.67	5.57
1% (1 in 100) + 70% Climate Change	6.51	6.38

Based on the model outputs the low-lying land along Ranelagh Drive (elevation c.4.4m aOD) would be flooded frequently. This accords with anecdotal experience. During larger events water would approach and flood the ground on the site, but internal flooding of the existing property is not likely.

For fluvial flooding the 1 in 100 annual probability event, with an appropriate uplift in climate change, is the normal design standard for new development. Based on current guidance (see Section 3.5.2) for residential development it should be assumed that peak fluvial flows in this area will increase by up to 17% over the projected development lifetime. For the purposes of this assessment, we have therefore conservatively taken the 1 in 100 annual probability event plus 25% climate change allowance as the design event. Using the upstream model note (061_00_2018_a2.7), this equates to a design fluvial flood level of **5.42m aOD**.

5.3.2 River Crane

Modelled flood outlines along the River Crane included in the SFRA and derived as part of the Lower Thames Model confirm the site is not at risk of fluvial flooding from the River Crane for all events up to and including the 1 in 100 annual probability event plus 70% climate change.

5.4 Flooding from the Sea and Tidal Flooding

The flood risk screening has identified that the site is potentially at risk of flooding from tidal sources. The site is situated along the tidal Thames frontage in an area designated as Flood Zone 3a and is not afforded protection from flood defences locally.

5.4.1 Thames Estuary 2100 Model

The Thames Estuary 2100 (TE2100) model provides the maximum likely water level past the site under a defended scenario following closure of the Thames Barrier. These outputs are summarised below in Table 5-2 across a range of epochs. As discussed in Section 5.2, the operation of the Thames Barrier will change over time in response to climate change, resulting in a high maximum possible tidal water level at the site.

Table 5-2
Flood Model Outputs from TE2100 Model

Node	Present Day Water Level (m aOD)	Future 2065-2100 Water Level (m aOD)	Future 2100 Water Level (m aOD)
a2.7	5.61	5.85	6.30

Using the modelled data in Table 5-2, it is understood that, under a present day extreme tidal scenario, all internal areas would remain flood free however the yard area to the west and rear of the property would be inundated, with flood depths of up to 1.15m at the vehicle access point (4.46m aOD) along Ranelagh Drive.

The TE2100 modelling has considered changes to the maximum likely water level as a consequence of climate change. It is envisaged that by 2100, the maximum likely water level in the Thames past the site will be at around **6.3m aOD**. This is 0.88mm above the projected fluvial flood level and is therefore the adopted design flood level at the site.

5.5 Finished Floor Levels

As discussed in Section 5.4.1, the design flood level for the site is 6.3m aOD using the 2100 water level from the TE2100 tidal model. This is above the modelled 1 in 100 plus 25% (not allowance is only 17%) climate change fluvial flood level at 5.42m aOD.

Following pre-application discussions with the Environment Agency the proposed threshold level for the property is 6.90m aOD; 500mm above the design flood level in this assessment. The finished floor level of the building is however lower at 6.01m aOD. All aspects of the building below 6.90m aOD will be of flood resilient construction, with any vented areas fitted with valves to inhibit flood water ingress. As a result, the probability of internal flooding of the property is very low.

External ground levels on the site would be re-profiled to a base level of 4.47m aOD which would mean that the annual probability of flooding would be greater than 1 in 5 (i.e., a flood level of 4.76m aOD).

5.6 Flood Compensation

The site falls within the active Thames fluvial floodplain and therefore any raising of ground levels will result in a loss of flood storage which must be offset by providing compensation elsewhere.

The built footprint of the site will be reduced as part of the proposed development and ground levels to the rear of the property would be reprofiled to a lower level 4.47m aOD. The remaining areas of the site would remain as existing with planted vegetation. These measures clearly increase the flood storage available on the site.

Further analysis of flood compensation storage on the site is not considered necessary at this stage.

5.7 Access and Egress

As demonstrated in the scheme masterplan (Appendix 01), all access and egress from the site will be provided off Ranelagh Drive.

The proposed development will not alter the prevailing flood risk to Ranelagh Drive (no changes in road levels) or drop site levels below the height of the road (where flood flows would then preferentially pond). As such following redevelopment, the flood hazard along the access route will be no worse than it currently is.

Ground levels along Ranelagh Drive out of the access and egress point are at around 4.4m aOD and increase gradually towards the south west. Based on a design flood level of 6.3m aOD, this a maximum flood depth of 1.9m provided any attempt to egress the site is made following Ranelagh Drive to the south west. This would clearly not be safe to traverse.

5.8 Flood Resilience Measures

A number of flood resilience measures will be required in the scheme design to reduce flood risk. These measures will ensure all internal areas remain flood free throughout the proposed lifetime of development. The required measures are summarised below:

- External walls will comprise of flood proof materials to a level of 6.90m aOD to prevent lateral ingress of flood water;
- Vented areas of the building set below 6.90m aOD will be fitted with valves to prevent flood water ingress;
- The building and specifically the lower ground floor construction will need to accommodate the hydrostatic pressures caused by flood water around the building (including groundwater); and
- All subsurface development (lower ground floor) will need to be lined to prevent groundwater ingress.

5.9 Flood Response

While measures to minimise the flood risk posed to future residents are incorporated into the existing design of the site (i.e., raised finished floor levels), the site will become an island during any major fluvial or tidal flood event along the River Thames and access onto and egress from the site would be hazardous during all major flood events.

Given this, it is essential that the site prepares, maintains, and implements a robust Emergency Flood Response Plan (EFRP) that sets out actions to minimise the risk posed to residents and infrastructure. As the proposal is for less than 10 residential properties (see Section 3.4 and policy LP21) a draft of this plan has not been prepared for planning. This plan would however be prepared post planning and prior to occupation of the site. This would be secured by way of a planning condition.

The EFRP will include the following:

- details of roles and responsibility for maintaining, updating, and implementing the plan;
- overview of the local flood risk;
- details of the Environment Agency flood warming service locally;
- adaptation and requirements for the properties to ensure that they provide a safe point of refuge (should this be required);
- specific actions that will be undertaken in response to the issuing of a flood alert or flood warning;
- recommendation concerning evacuation of the site; and

- details of access and egress routes onto the site for periods in advance and during a flood event.

As noted above this plan would be prepared post planning and would be finalised and implemented prior to occupation of the site. Responsibility for the plan would rest with a site management company paid for through annual property service charges. Adherence to the plan would form part of the induvial property deeds for each residential unit.

6.0 Surface Water Drainage Strategy

This surface water drainage strategy sets out high level principles for managing storm water on the site in line with best practice and the requirements of the London Borough of Richmond upon Thames, the LLFA for the area.

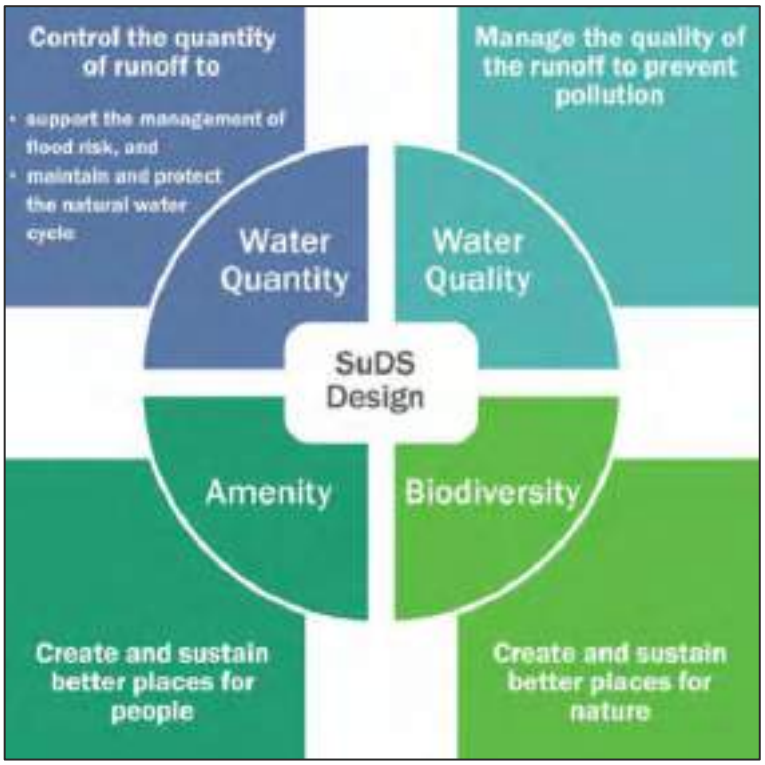
This strategy is intended to demonstrate that, given the nature and quantum of development proposed, it will be feasible to drain the site in line with planning requirements using one of the proposed methodologies.

The London Borough of Richmond upon Thames SuDS pro-forma is attached as Appendix 05 to support this SuDS application.

6.1 Key Principals of Surface Water Management

Current best practice guidance document; The Sustainable Drainage System (SuDS) Manual (CIRIA Report C753)[19], promotes sustainable water management through the use of SuDS. There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in Figure 6-1.

Figure 6-1
Four Pillars of SuDS (extract from CIRIA Report C753)



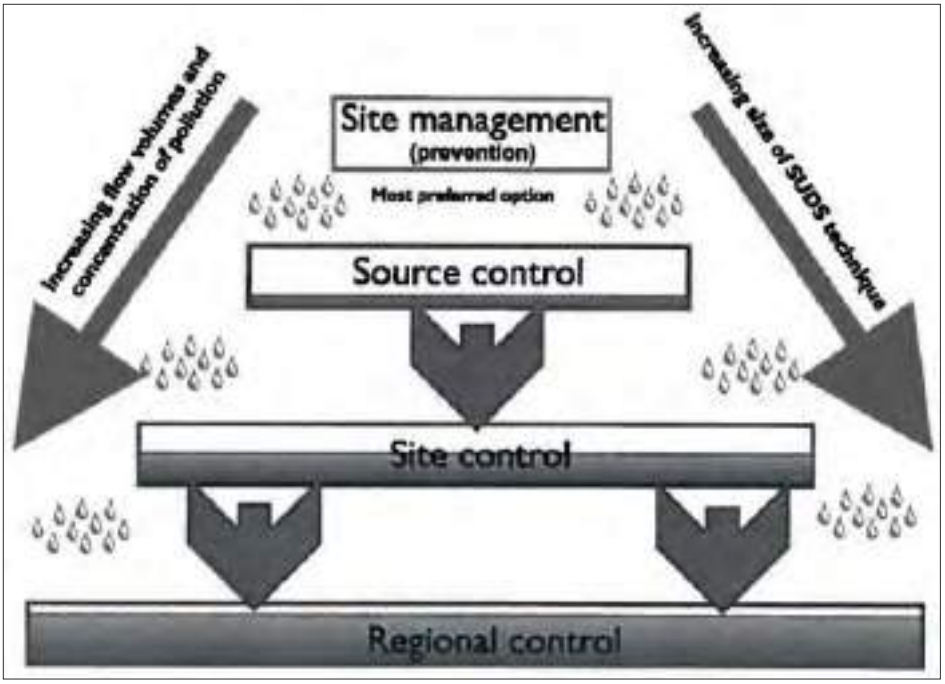
The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train'. The hierarchy of techniques is identified as:

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

19 Report C753, The SuDS Manual; CIRIA (2015). Report C753, November 2015.

- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

Figure 6-2
SuDS Management Train



It is generally accepted that the implementation of SuDS, as opposed to conventional drainage systems, provides a number of benefits by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- Reducing potable water demand through rainwater harvesting;
- Improving amenity through the provision of public open spaces and wildlife habitat; and replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

6.2 Existing Surface Water Drainage Regime

Based on information provided on the topographic survey (Appendix 02) and wastewater asset plans provided by Thames Water (Appendix 03), surface water runoff from the existing site is intercepted by a number of drainage gullies and manholes which convey flows towards a Thames Water Surface Water sewer beneath Ranelagh Drive. This sewer conveys all flows in a north eastward direction to outfall into the Thames.

During periods of high tide it is likely that the surface water sewer outfall becomes surcharged and therefore stormwater is unable to discharge from the sewer into the Thames. Under such circumstances, surface water will surcharge from the drainage manholes/gullies on site and flow overland in line with local topography to the east onto Ranelagh Drive, or northwards via the existing pedestrian access point onto the Thames footpath of which both would result in flows discharging into the Thames.

6.3 Constraints on the Use of SuDS

6.3.1 Hydrology and Flood Risk

External areas of the site are situated within Flood Zone 3 (finished level of 4.47m aOD) and whilst SuDS features should not typically be located in areas designated as Flood Zone 3 (as any SuDS would become overwhelmed by flood water), attenuation is not required as the site sits in a predominately tidal setting.

This however means that during periods of high tide stormwater from the site may be unable to discharge away via the sewer network as this has consequentially become backed up. In order to counter this, storage will only be provided on the site for the volume of rainfall which would be anticipated following a 4-hour surcharge (tidal) event. Should tidal flood water progress onto the external area of the site this would also be captured in the remaining storage and would then discharged away accordingly once river levels subside.

6.3.2 Geology and Hydrogeology

The site is underlain by a combination of made ground, alluvium and clay bedrock. As such we would expect shallow groundwater perched within the more permeable made ground and alluvium deposits which to some degree, will vary with the tide. Using the estimated groundwater level of 3.7m aOD (Boat Lake) it would not be possible to achieve a 1m differential between the maximum groundwater level and the base of any SuDS features considering all external areas on site are elevated to 4.47m aOD.

6.3.3 Spatial Constraints

There is no available open space within the proposed development masterplan which is not essential for the proposed residential use or biodiversity / amenity purposes. This means that surface SuDS features cannot be implemented and drainage infrastructure must be at or below the external ground level.

In line with the requirements of the London Plan[14], it is recommended that all new developments should, where possible, include blue or green roofs within the design. Blue roofs are typically used to provide attenuation storage which is not required at this site. Areas of flat roof within the proposed development masterplan will therefore be laid with a sedum / green roof which slowly conveys incidental rainfall towards the drainage outfall but primarily forms an amenity and biodiversity feature.

6.3.4 Rainwater Harvesting

Rainwater butts will be installed on downpipes to the rear of the building for ‘non-potable’ external uses such as irrigation of soft landscaping / vegetative planting etc. This will reduce mains water usage and also the net volume of storm water discharging from the site.

For the purposes of the surface water drainage strategy the precautionary principle has been adopted whereby no (beneficial) allowance for rainwater re-use has been factored into the calculations or design at this stage. This therefore represents a situation where the rainwater butts are full at the start of the storm event.

6.4 Proposed Discharge Arrangement

With reference to the SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is as follows:

1. Infiltration to Ground;
2. Discharge to Surface Waters; or
3. Discharge to Sewer.

Policy SI 13 Sustainable Drainage in the London Plan[14] extend this and specifies a more detailed drainage hierarchy that must be applied to all SuDS schemes within Greater London. This is reproduced below.

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

Table 6-1 summarises the applicability of the rainfall disposal methods at the site.

Table 6-1
Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
Reuse of Rainwater	Rainwater harvesting methods are applicable at the site for non-potable uses only. The development masterplan shows areas of flat roof which would be suitable for use as a green roof (attenuation not required as provided by a blue roof). Downflows from the roof will be stored within water butts for irrigation purposes.	Y
Infiltration	Due to elevated groundwater levels and made ground deposits, infiltration of surface water flows is unlikely. Infiltration testing is not possible at present as this would involve demolishing the formidable concrete plinth at the site.	N
Green Infrastructure	Areas of flat roof at the site are provided in the scheme design to allow for the	Y

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
	development of a green roof with gradual release of runoff to both water butts and the proposed drainage system.	
Surface Water Discharge	The site is located on the riverfront of the Thames however a new piped outflow connection would result in significant earthworks on the channel bank. There are other more preferable ways of discharging water into the Thames without considerable construction works.	N
Surface Water Sewer	Thames Water Asset plans (Appendix 03) identify a surface water sewer / box culvert beneath Ranelagh Drive which outfalls into the Thames. Existing on-site flows discharge into this feature, and the existing connection could be reutilised as part of the new development.	Y
Combined Sewer	There are no combined sewers in the vicinity of the site. There is however a foul sewer beneath Ranelagh which conveys flows south west away from the site.	N

6.5 Catchment Area Schedule

The development proposals which are provided in Appendix 01 indicate the scheme will construct a new perimeter wall. This means that all incidental rainfall onto the will discharge into the SuDS features rather than offsite and into the Thames. Runoff from the raised platform area and planting along the Thames frontage will be under drained (effectively impermeable) and conveyed towards the on-site drainage.

Development at the site is a combination of both hardstanding and soft landscaping areas and in order to accurately represent the effective impermeable areas drained, runoff coefficients have been applied to both permeable and impermeable areas. This therefore accounts for rainfall in exceedance of the soil saturation capacity of which the remainder of flows would discharge into the drainage system.

A runoff coefficient of 1.0 has conservatively been applied to all hardstanding areas and therefore does not account for potential losses through evaporation. Additionally, a coefficient of 0.45 has been applied which is considered to replicate the soil conditions based on the relatively impermeable geology / made ground locally (see Section 2.3).

An urban creep allowance of 10% has been applied to external hardstanding areas to account for small changes to the landscaping throughout the lifetime of development. The urban creep would effectively remove some of the soft landscaping areas as demonstrated in Table 6-2.

Table 6-2
Contributing Catchment Areas

Land Use	Area (ha)	Area + 10% Urban Creep (ha)[1]	Effective Impermeable Area (ha)
Roof Areas	0.0470	0.0470	0.0470
External Hardstanding	0.0470	0.0517	0.0517
Soft Landscaping	0.0235	0.0188	0.0085
Total	**0.1175**	**0.1175**	**0.1072**

1. Urban creep allowance is only applied to external hardstanding areas.

6.6 Conceptual Surface Water Drainage Strategy

All surface water runoff from the site will discharge into the tidal Thames at unrestricted rates via the very short length of Thames Water sewer beneath Ranelagh Drive. For purposes of this assessment, it is conservatively assumed that this sewer is in full hydraulic continuity with the Thames (i.e., no external or internal valves or tidal flaps to prevent the upsurge of water). This means that during periods of high tide, water within the Thames is able to back up into the sewer preventing discharge of stormwater for a maximum period of approximately 4 hours (one third of tidal cycle across high tide).

In line with paragraph 9.13.3 of the London Plan, attenuation is not required on the site as high discharge rates into a tidal waterbody have a negligible effect on the receiving water levels. However, during periods of high tide, the sewer outfall will become surcharged, and stormwater will be unable to freely discharge from the site. Storage will therefore be provided for the volume of runoff anticipated for the site during a 1 in 100 year plus 40% climate change rainfall event across a period of 4 hours.

This storage will be provided through the widespread use of permeable paving across the site and a below ground tank system. Both of these features would be lined to prevent groundwater ingress. In the event of on-site flooding, flood water would overwhelm the drainage system. The impact on site runoff on flooding locally under these conditions (i.e. when the area is already in flood) would be negligible.

A non-return valve will be installed on the outfall from the tank to prevent stormwater within the sewer backing up onto the site prior to surface flooding occurring.

Outflows from the green roof will discharge into rainwater butts for non-potable external uses however once full, stormwater will be overflow (formally) and drain into the subbase of the paving.

A conceptual surface water drainage strategy drawing is provided as Appendix 06.

6.7 SuDS Attenuation Storage

During coincidental high tide and extreme rainfall events, stormwater from the site would be unable to discharge into the receiving sewer and would instead back up into the permeable paving provided on site. It is envisaged that the maximum duration of sewer surcharge would be around 4-hours (one third of tidal cycle over high tide) and therefore the storage volume available must provide the equivalent volume of rainfall for the design, 1 in 100 year annual probability event plus 40% climate change event onto the site during this period.

The Simplified Rational Method has been used to estimate the volume of rainfall falling onto the site during the design 4-hour 1 in 100 year plus 40% climate change event. To be conservative a runoff coefficient of 1.0 has been applied for the drainage design.

The following equation has been used:

$$Q = ciA$$

Where Q is the runoff rate; c is the runoff coefficient[20], i is the rainfall intensity[21] and A is the impermeable area[22]. The results are then summarised in Table 6-3.

Table 6-3
Surface Water Drainage Volumetric Requirements

Rainfall Event	Duration (hours)	Rainfall Depth (mm)	Runoff Rate (l/s)	Attenuation Volume Required (m^3)
1 in 100 plus 40% climate change	4	96.4	7.2	103.4

As detailed in Table 6-3, a total volume of 100.8m^3 is required within the drainage system on site. Whilst this has not been explicitly modelled, the construction of the permeable paving is as follows:

- Cover Level 4.47m aOD
- Invert Level: 4.02m aOD
- Surface Area: 470m^2
- Membrane Depth: 150mm
- Depth of Gravels: 300mm
- Void Ratio: 0.3
- Volume Available: 42.3m^3

Typical construction of the attenuation tank is provided below:

- Cover Level: 4.47m aOD
- Soffit Level: 3.67m aOD
- Invert Level: 2.47m aOD
- Surface Area: 52m^2
- Volume Available: 62.4m^3
- Invert Level of Receiving Sewer: c.1.3m aOD (typical cover levels of this sewer based on manhole data is around 3m from invert level)

The combined use of permeable paving and a tank provides 104.7m^3 of storage which is sufficient for the 4-hour 1 in 100 year plus 40% climate change rainfall event.

20 Runoff coefficient 1.0 used for effective impermeable areas.

21 For a 4-hour storm duration using the flood estimation handbook web service, FEH 2013 DDF modelling.

22 Effective impermeable area of 0.1072ha.

6.8 Exceedance

In the event of exceedance of the surface water drainage strategy, albeit by flood water from the Thames or extreme rainfall in excess of the design event, water would discharge from the site via Ranelagh Drive to the east. From Ranelagh Drive, water would progress in an eastward direction along the road to discharge into the River Thames.

In some instances, such as flooding as a consequence of overtopping the Thames, flood water may pond on the site for longer durations however these flows would still dissipate from the site following the same exceedance route.

6.9 SuDS Assessment of Water Quality

SuDS can provide a number of water quality and amenity benefits. This surface water drainage strategy utilises a green roof and permeable pavement for treatment of surface water flows prior to discharge. Tanks do not offer any water quality treatment.

The simple index method as outlined within the SuDS Manual provides a way of quantifying the benefit to water quality of the SuDS Management Train. The pollution hazard from the land use and the mitigation from the SUDS component are each assigned an index. The total mitigation index must be greater than the pollution hazard index for adequate treatment to be delivered.

Total SuDS mitigation index ≥ pollution hazard index

(for each contaminant type) (for each containment type)

The total SuDS mitigation is the summation of the first components mitigation index and half the mitigation index of any subsequent component.

With reference to the SuDS Manual, post-development surface water runoff generated from residential roofs and low traffic roads is considered to have a 'very low' and 'low' *Pollution Hazard Level* respectively as presented Table 6-4.

Table 6-4
Pollution Hazard Potential for the Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Residential Roofs	Very Low	0.2	0.2	0.05
Car Park / Low Traffic Road	Low	0.5	0.4	0.4

The proposed drainage system is required to demonstrate sufficient treatment capability to manage the specified Pollution Hazard Indices. The SuDS mitigation indices for the Proposed Development is provided in Table 6-5.

Table 6-5
SuDS Mitigation Indices for the Proposed Development

SuDS Component	Mitigation Indices		
	Total Suspended Solids (TSS)	*Metals*	*Hydro-Carbons*
Green Roof[1]	0.6	0.5	0.6
Permeable Pavement	0.7	0.6	0.7

2. Dense vegetation underlain by soil with good contaminant potential.

Table 6-6 compares the SuDS Mitigation Indices, provided by the proposed 'Source Control', 'Conveyance' and 'Site Control' measures against the Pollution Hazard Indices.

Table 6-6
SuDS Performance: Water Quality Indices Assessment

Land Use	Pollution Hazard Level	*Pollution Hazard and SuDS Mitigation Indices Comparison*					
		Total Suspended Solids (TSS)		*Metals*		*Hydro-Carbons*	
		Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index	Pollution Index	SuDS Mitigation Index
Residential Roofs	Low	0.2	0.6	0.2	0.5	0.05	0.6
Low Traffic Access Roads	Low	0.5	0.7	0.4	0.6	0.4	0.7

As the SuDS Mitigation Index provided by the proposed SuDS measures are ≥ Pollution Hazard Index the water quality assessment criteria are satisfied for the site.

6.10 SuDS Operation and Maintenance

A full SuDS maintenance plan would be produced as part of the detailed drainage design post-development and the precise requirement would depend on manufacture specification of the final design. At this time, it is considered that the maintenance of the drainage network would be undertaken by a third-party management company funded by ground rent contributions from the property owners.

An outline of the typical maintenance requirements of the proposed SuDS features is provided below.

6.10.1 Green Roof

The anticipated maintenance and management for a green roof associated with the surface water drainage system is outlined in Table 6-7.

Table 6-7
Typical Green Roof Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular Maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (i.e., year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required- clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked, or moved, investigate and repair as appropriate	As required

6.10.2 Permeable Pavement

The anticipated maintenance and management for Permeable Pavement associated with the surface water drainage system is outlined in Table 6-8.

Table 6-8
Typical Permeable Paving Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weeds or management using glyphosphate applied directly into the weeds by an applicator rather than spraying.	As required – once per year on less frequently used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to uses, and replace lost joining material.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection.	Monthly for three months after installation
	Inspect for evidence of poor operation and/or wee growth – if required, take remedial action.	Three-monthly, 48h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually

Maintenance Schedule	Required Action	Minimum Frequency
	Monitor inspection chambers.	Annually

6.10.3 Tank

The anticipated maintenance and management for the tank associated with the surface water drainage system is outlined in Table 6-9.

Table 6-9
Typical Tank Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Inspect and identify areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae, or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and / or internal forebays	Annually, or as required
Remedial Actions	Repair 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 tank for sediment build up and remove is necessary	Five yearly, or as required

7.0 Conclusions

SLR Consulting Limited (SLR) has been appointed by The Boathouse Twickenham Ltd to provide a Flood Risk Assessment and Surface Water Drainage Strategy to support a full planning application for the demolition of the existing building and the construction of a residential scheme comprising 3 properties with associated hardstanding and soft landscaping at The Boathouse, Ranelagh Drive, Twickenham, TW1 1QZ.

7.1 Flood Risk

A screening was undertaken which evaluated the potential flood risk from a range of sources to the site. This identified flood risks from both fluvial and tidal sources associated with the River Thames.

Using hydraulic modelling provided by the Environment Agency of the Lower River Thames, the design fluvial flood level, 1 in 100 year plus 25% climate change event, is estimated at around 5.42m aOD. The TE2100 tidal flood model was also provided indicating in channel flood levels for the maximum likely water level past the site. This flood level is much greater at 6.3m aOD from 2100. The design flood level of 6.3m aOD has therefore been adopted at the site.

The scheme proposals have been developed following a pre-app with the Environment Agency and therefore flood resilience and mitigation measures have already been implemented into the scheme. The entrance level of the ground floor properties is raised to 6.9m aOD which is 600mm above the design flood level. All areas of the building below this level will be of formidable flood proof construction (from surface and groundwater sources). Any vented areas below 6.90m aOD will be fitted with valves to prevent flood water ingress. These measures ensure all internal areas of the property will remain flood free throughout the lifetime of development.

The built footprint has decreased as a result of development, and all external aeras have been lowered to a flat level of 4.47m aOD. This therefore ensures there is no decrease in flood compensation storage at the site.

There are no proposed changes to Ranelagh Drive and ground levels on the site, whilst lowered, are still raised with respect to this access and egress road. Consequently, the flood hazard associated with access and egress from the site remains the same as for the current property on the site.

Post planning, an Emergency Flood Response Plan will be prepared and implemented that sets out actions to minimise the risk posed to residents and infrastructure.

7.2 Surface Water Drainage

Surface water drainage has been developed at the site in line with the national and local policy requirements. The site is situated riverfront to a tidal waterbody and therefore there is no requirement for restricted discharge rates. All flows from the site will discharge into the tidal Thames via a short length of Thames Water Sewer beneath Ranelagh Drive.

During periods of extreme high tide, which should last less than 4 hours, the sewer will become surcharged, and stormwater flows from the site will not be able to freely discharge. Storage has therefore been provided within the scheme for all runoff which is shed from the effective impermeable areas during a 4-hour 1 in 100 year plus 40% climate change storm event. This equates to an approximate volume of 100.8m^3 which will be provided through the use of permeable paving across all external hardstanding areas, and a below ground tank. A pipe from the tank into the sewer will be fitted with a non-return valve to prevent flows from backing up into the site.

A green roof will also be provided on areas of flat roof of each property which discharges into rainwater butts for non-potable uses. Once the rainwater butts are at capacity, excess flows will be re-routed into the permeable paving.

The surface water drainage scheme successfully satisfies the requirements of the simplex index method through the use of green roofs and permeable paving. Residual events in exceedance of the drainage strategy have also

been considered with all flows discharging overland in line with topographic gradients along Ranelagh Drive to the east and then north into the Thames.

While the strategy implemented follows all required SuDS principles, in common with most drainage strategies put forward in support of planning applications, the scheme presented here will need to be subject to detailed design before construction commences.

APPENDICES

Appendix 01: Proposed Development Masterplan

River Thames

River side walk

River wall access point opened up and increased from 1427mm to 2600mm

Existing

Proposed

Line of Existing Boundary Wall

Existing trees retained

Line of Existing Boundary Wall

Permeable stone seating area

New permeable Path

New permeable Path

Existing wall rebuilt to existing wall height

FFL : 4.470

Open gantry steps up to each property door threshold @ 6.9 datum

Bin Store

Line of 1st floor / 2nd floor above

Pedestrian entrance

Bin Store

3000

FFL : 4.470

Cycle Store

Site entrance maintained New sliding gate

25166

N

Proposed Site Plan

Scale @ 1:200

Scale Bar

0 1m 2m 4m 6m 8m 10m 20m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

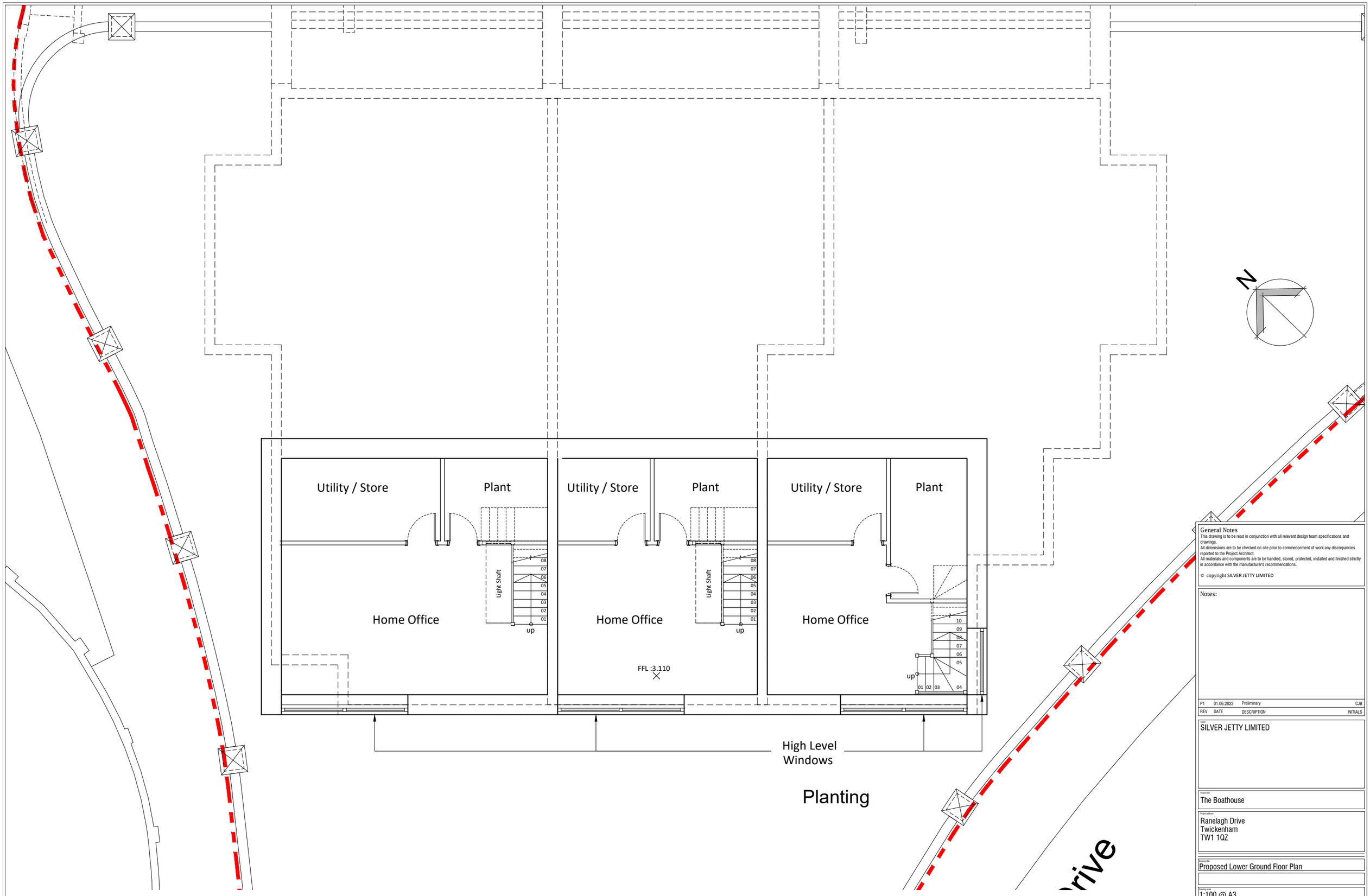
Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Schedule Of Accommodation

Drawing scale: 1:200 @ A3

Drawing number: PL-040	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 22.11.2021	Checked by: JA
Drawing status: PRELIMINARY	

SILVER JETTY



Proposed Lower Ground Floor Plan

Scale @ 1:100

Scale Bar

0 1m 2m 4m 6m 8m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Proposed Lower Ground Floor Plan

Drawing size: 1:100 @ A3

Drawing number: PL-050	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 22.11.2021	Authorised by: JA
Drawing status: PRELIMINARY	

Porcelain tiles
Brick
Timber
Brick
Porcelain tiles
Timber
Brick
Porcelain tiles
Timber
Brick
AA
P-060
Timber engineered
Floor 65m²
Line of Terrace above
Timber engineered
Floor 65m²
Timber engineered
Floor 65m²
Living room / Dining
Living room / Dining
Living room / Dining
Gravel path
Granite
Sets
6.9 datum
1200mm wall and
timber capping
Stair to
Terrace
up
1200mm wall and
timber capping
Stair to
Terrace
up
1200mm wall and
timber capping
Library shelves
Stair to
Terrace
up
Library shelves
Granite
Sets
6.9 datum
Mulch
and planting
Granite
Sets
Kitchen
Kitchen
Kitchen
Fire Place
Fire Place
Fixed window
Glass and handrail
down
Glass
300mm above
counter unit
300mm above
counter unit
300mm above
counter unit
6.9 datum
Hoist
Open sided steel
frame stairs / Hoist
and landing
Gravel path
Larder
WC /
Cloaks
down
to LG
Larder
WC
down
to LG
Larder
WC
down
to LG
up
cpd
New brick wall
and pillars
throughout
Fire rated
timber &
glass
screen
Void
Fire rated
timber &
glass
screen
Void
Study
Study
Study
Fire rated
timber &
glass
screen
Void
up
up
up
down
down
Gravel path
up
6.9 datum
Open sided steel
frame stairs / Hoist
and landing
6.9 datum
Gravel path
Open horizontal timber
slatted fence and gate
Mulch
and planting
Hoist
Hoist
AA
P-060
New brick wall
and pillars
throughout
Permeable brick
Permeable brick paving
to all areas
Open horizontal timber
slatted fence and gate
Bin Store
Scale Bar
0 1m 2m 4m 6m 8m 10m
N

Proposed Ground Floor Plan

Scale @ 1:100

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Proposed Ground Floor Plan

Drawing scale: 1:100 @ A3

Drawing number: PL-051	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 22.11.2021	Authorised by: JA
Purpose of issue: PRELIMINARY	

SILVER JETTY

AA
P-060

Sedum Roof

Sedum Roof

Sedum Roof

Sedum Roof

House 01

House 02

House 03

Retractable

Retractable

Line of Wall below

Retractable

Green Screen

Green Screen

down 15 14 13 12

down 15 14 13 12 11

07 06 05 04 03 02 01

up 01 02

Bedroom 01

Bedroom 01

Master Bedroom

En-Suite

En-Suite

Bathroom

En-Suite

Bathroom

Dresser

down 13 12 11 10 09 08 07 06 05

up 01 02 03 04 05 06

Bedroom 03

Bedroom 02

Bedroom 02

Bathroom

Bedroom 02

Bedroom 03

AA
P-060

N

Drive

Proposed First Floor Plan

Scale @ 1:100

Scale Bar

0 1m 2m 4m 6m 8m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

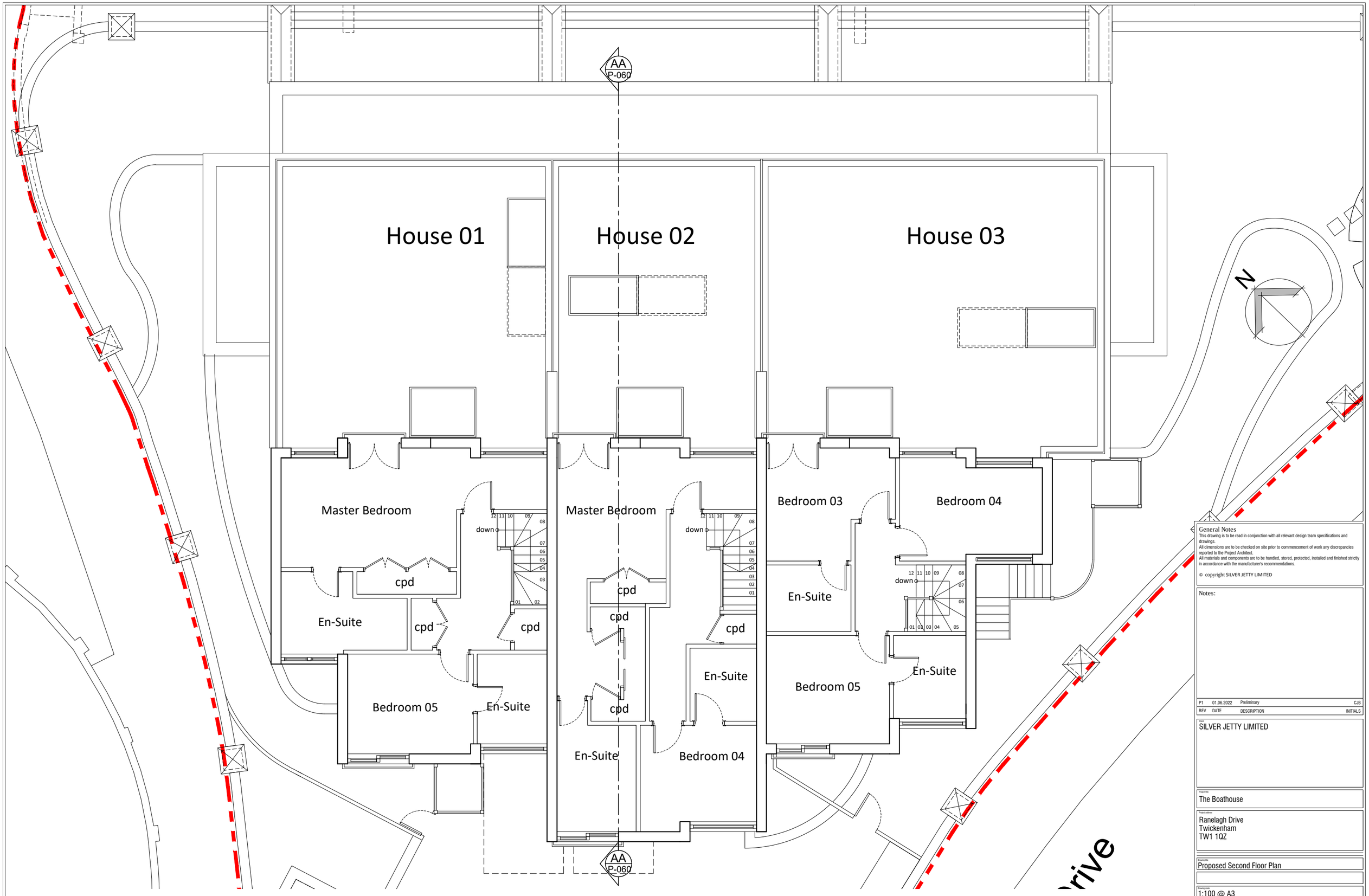
Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Proposed First Floor Plan

Drawing scale: 1:100 @ A3

Drawing number	Revision
PL-052	P1
Project number	Drawn by
SJ 171001	CJB
Date	Approved by
22.11.2021	JA
Drawing status	
PRELIMINARY	

SILVER JETTY



Proposed Second Floor Plan

Scale @ 1:100

Scale Bar

0 1m 2m 4m 6m 8m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

Project address: Ranelagh Drive, Twickenham, TW1 1QZ

Drawing title: Proposed Second Floor Plan

Drawing scale: 1:100 @ A3

Drawing number: PL-053	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 22.11.2021	Approved by: JA
Drawing status: PRELIMINARY	

SILVER JETTY

AA
P-060

House 01

House 02

House 03

Flat roof

Fall

Fall

Flat roof

Fall

Fall

Flat roof

Fall

Fall

Flat roof

Flat roof

AA
P-060

N

Proposed Roof Plan

Scale @ 1:100

Scale Bar

0 1m 2m 4m 6m 8m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

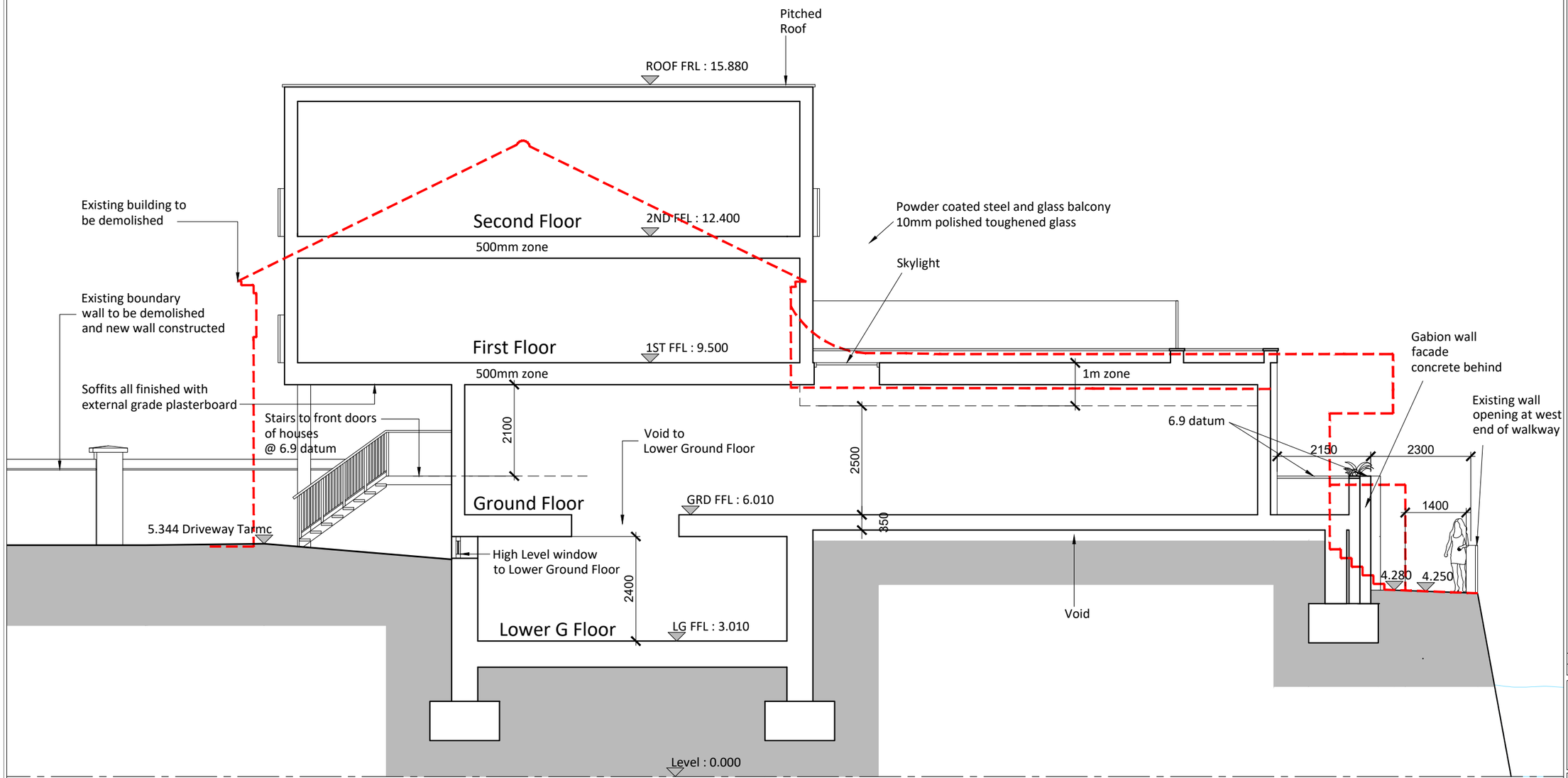
Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Proposed Roof Plan

Drawing size: 1:100 @ A3

Project number: PL-054	Status: P1
Project number: SJ 171001	Drawn by: CJB
Date: 22.11.2021	Approved by: JA
Drawing status: PRELIMINARY	

SILVER JETTY



Proposed Section AA

Scale @ 1:100

Scale Bar

0 1m 2m 4m 6m 8m 10m

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

Project address: Ranelagh Drive
Twickenham
TW1 1QZ

Drawing title: Proposed Section AA

Drawing scale: 1:100 @ A3

Drawing number	Revision
PL-060	P1
Project number	Drawn by
SJ 171001	CJB
Date	Authorised by
22.11.2021	JA

Drawing status: PRELIMINARY

SILVER JETTY

Appendix 02: Topographic Survey

Existing Site Survey Plan

Scale @ 1:200

General Notes

This drawing is to be read in conjunction with all relevant design team specifications and drawings.
All dimensions are to be checked on site prior to commencement of work any discrepancies reported to the Project Architect.
All materials and components are to be handled, stored, protected, installed and finished strictly in accordance with the manufacturer's recommendations.

Notes:

REV	DATE	DESCRIPTION	INITIALS
P1	01.06.2022	Preliminary	CJB

Client: SILVER JETTY LIMITED

Project title: The Boathouse

Project address: Ranelagh Drive, Twickenham, TW1 1QZ

Drawing title: Existing Site Survey Plan

Drawing scale: 1:200 @ A3

Drawing number: PL-003	Revision: P1
Project number: SJ 171001	Drawn by: CJB
Date: 13.12.2021	Approved by: JA
Drawing status: PRELIMINARY	

Appendix 03: Thames Water Asset Plans

Asset location search

Thames Water Property Searches

SLR Consulting Limited
Warnford Court
29 Throgmorton Street
LONDON
EC2N 2AT

Search address supplied Waites Boat House
Ranelagh Drive
Twickenham
TW1 1QZ

Your reference Boathouse

Our reference ALS/ALS Standard/2022_4674184

Search date 5 July 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: Waites Boat House, Ranelagh Drive, Twickenham, TW1 1QZ

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

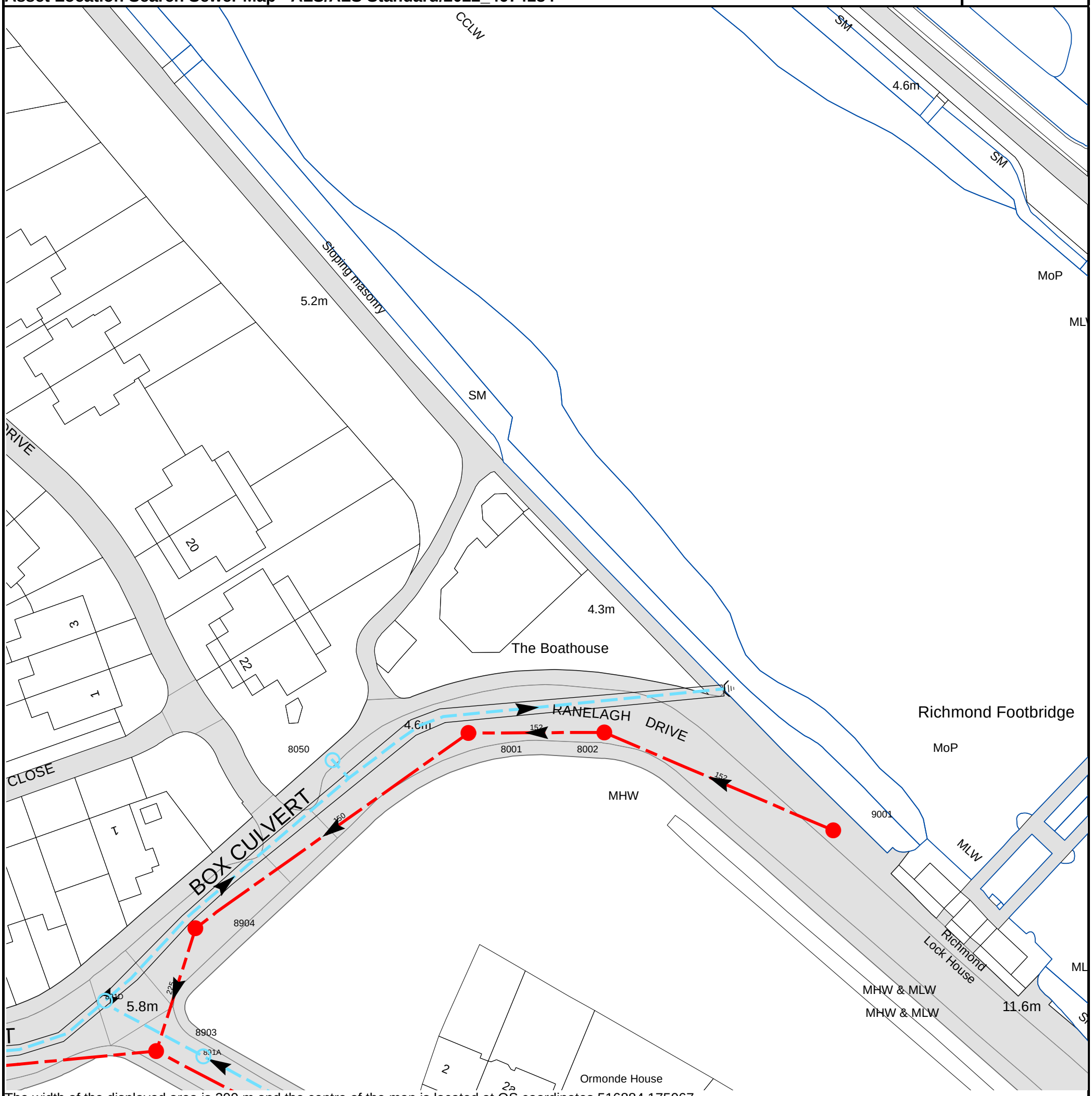
Clean Water queries

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_4674184



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 516884,175067

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
891A	n/a	n/a
8903	5.48	2.16
891D	n/a	n/a
8904	5.23	2.55
9001	n/a	n/a
8050	4.99	2.04
8001	4.52	2.91
8002	4.55	3.16

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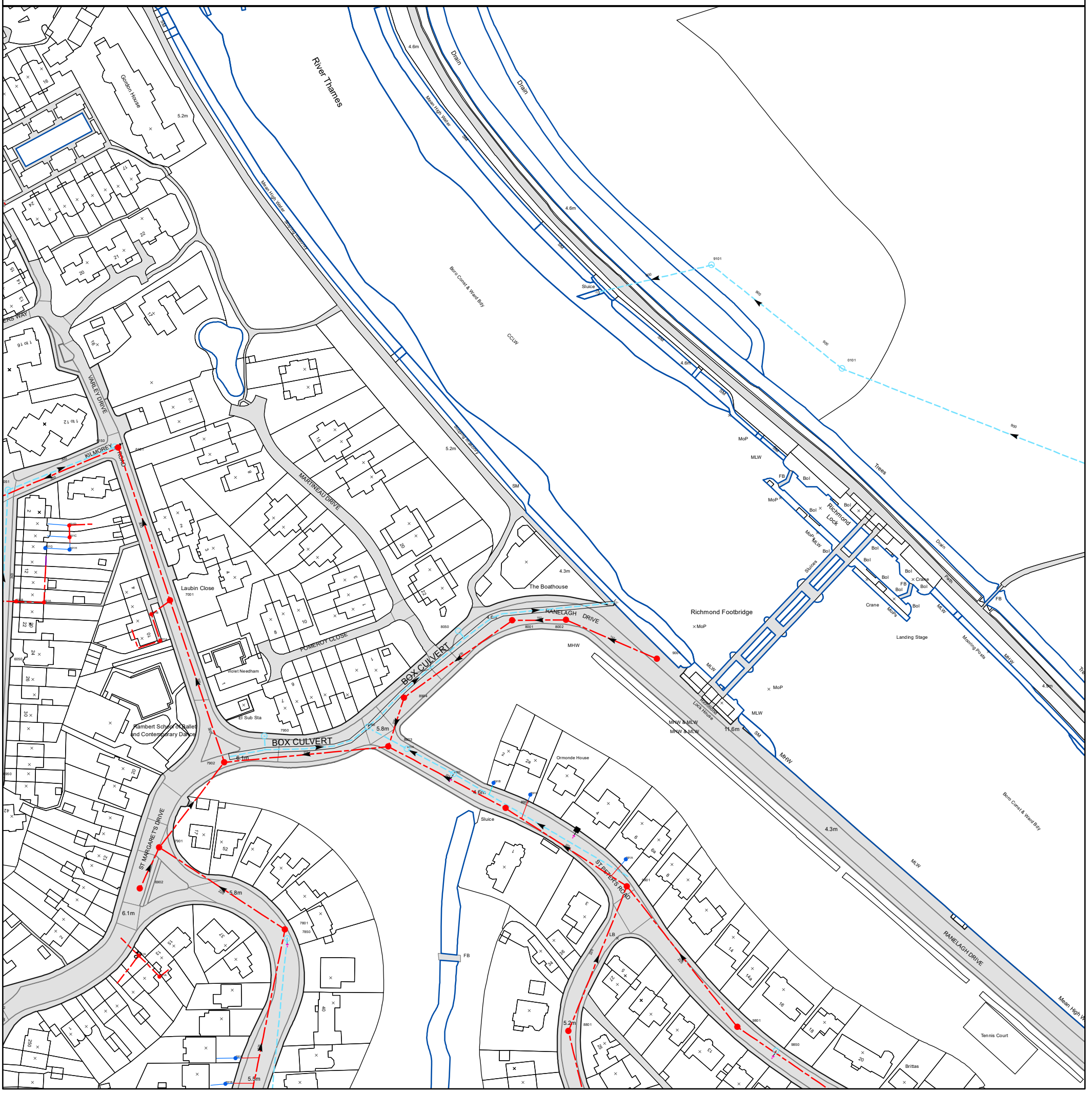
Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

ALS/ALS Standard/2022_4674184



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Scale:	1:1790
Width:	500m
Printed By:	G1KANAGA
Print Date:	05/07/2022
Map Centre:	516884,175066
Grid Reference:	TQ1675SE

Comments:

ALS/ALS Standard/2022_4674184

NB: Level quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no Survey information is available.

REFERENCE	COVER LEVEL	INVERT LEVEL
6902	5.98	4.04
8001	4.52	2.91
8002	4.55	3.16
8904	5.23	2.55
7001	6.5	1.55
7950	6.23	2.54
9850	5.93	4.26
6150	6.41	3.85
9901	5.19	2.48
7902	5.99	1.87
601C		
781C		
8901	4.56	2.29
601D		
601G		
701B		
681A		
8950	4.75	2.03
891A		
891B	4.55	3.58
891D		

REFERENCE	COVER LEVEL	INVERT LEVEL
0101		
7850	5.54	3.52
6051	6.34	3.79
7901	5.85	2.3
7801	5.59	2.64
9801	5.88	2.7
8050	4.99	2.04
8801	5.31	2.7
9101		
6101	6.39	1.33
781B		
781A		
601B		
601A		
601H		
701A		
991A		
9001		
8903	5.48	2.16
891C	4.6	2.6

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 divects 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

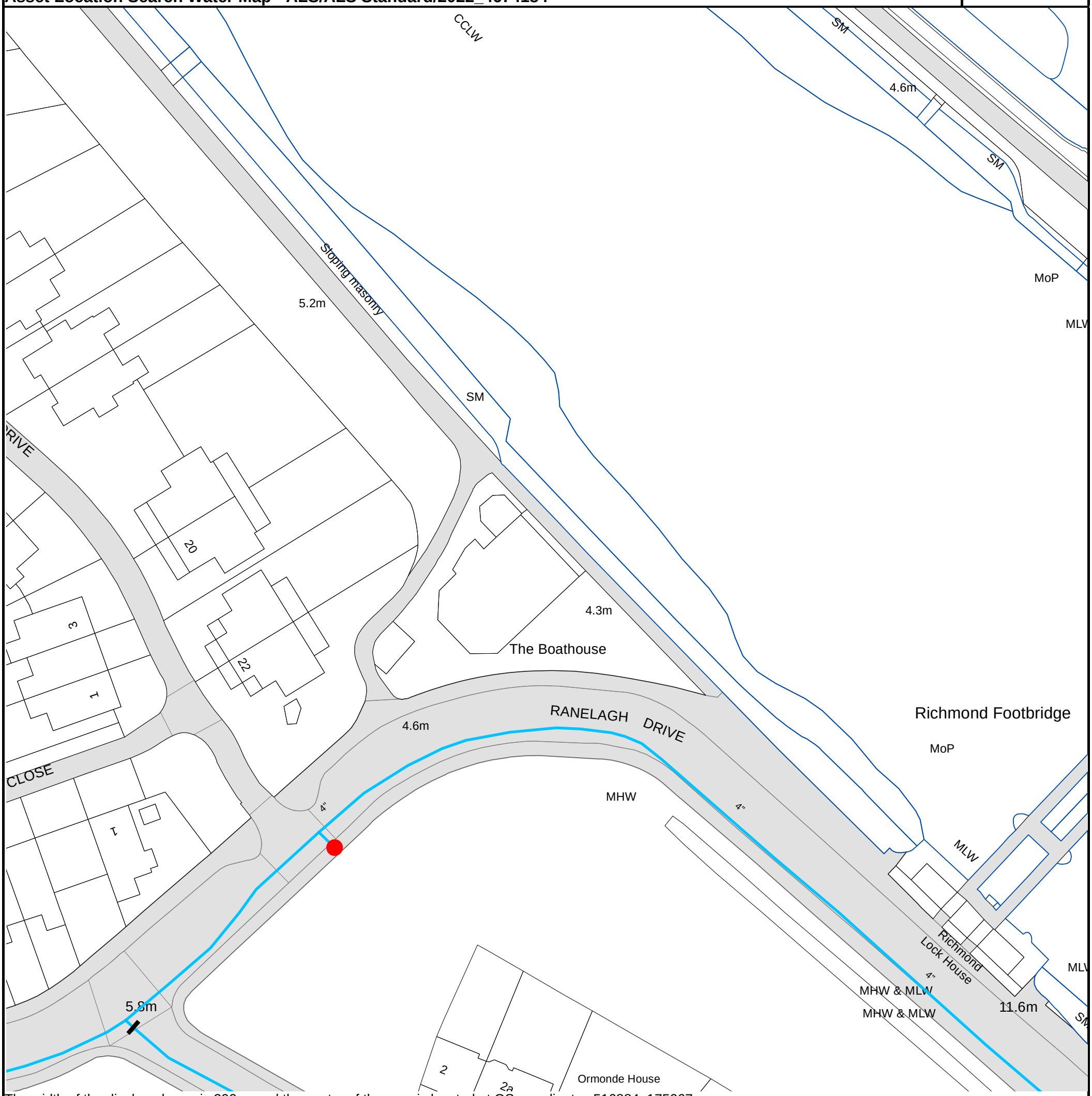
- Casement — Ducts may contain high voltage cables. Please check with Thames Water.
- Conduit Bridge
- Subway
- Tunnel

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_4674184



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Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

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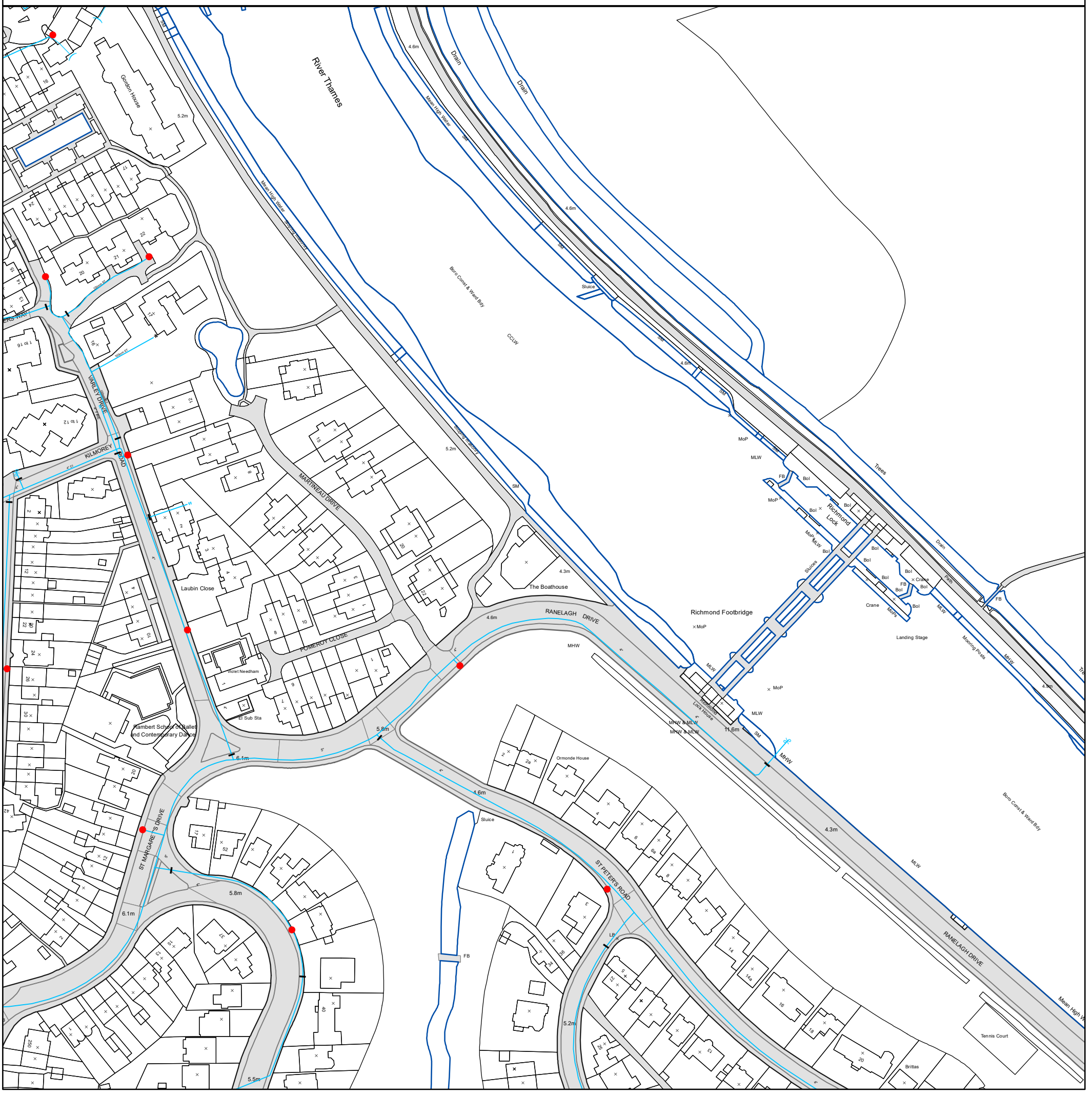

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Scale:	1:1790
Width:	500m
Printed By:	G1KANAGA
Print Date:	05/07/2022
Map Centre:	516884,175066
Grid Reference:	TQ1675SE

Comments:

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: Indicates 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 04: Environment Agency Flood Product 4

Product 4 (Detailed Flood Risk) for: **516878,175059**
Reference: **HNL 271714 JH**
Date: 20/07/2022

Contents

The information provided is based on the best data available as of the date of this letter.

You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements to the data for this location have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

Please refer to the Open Government Licence which explains the permitted use of this information.

Alchemy, Bessemer Road, Welwyn Garden City, Hertfordshire, AL7 1HE
Customer services line: 03708 506 506
Email: NETenquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Flood Map for Planning (Rivers and Sea)

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. In addition, the map also shows the location of some flood defences and the areas that benefit from them.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time and also take into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at https://www.gov.uk/check-flood-risk

At this Site:

The Flood Map shows that this site:

lies within Flood Zone 3 - with a 1% chance of flooding from rivers (fluvial flooding) and a 0.5% chance of flooding from the sea (tidal flooding) in any given year
Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed modelling of the tidal River Thames through the

- Thames Tidal Defences Study completed in 2006 by Halcrow Ltd.

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Thames Estuary 2100 (TE2100)

You have requested in-channel flood levels for the tidal river Thames. These have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled Thames node closest to your site is **2.8**; the locations of nearby nodes on the River Thames are also shown on the enclosed map.

Details about the TE2100 plan

The Plan sets out how the Environment Agency and our partners can work together to manage tidal flood risk, from now until the end of the century. It is an adaptive plan for managing the Thames Estuary, including the tidal defence system, until 2100 so that current standards of flood protection are maintained or improved taking into account climate change effects e.g. sea level rise. The Plan has 3 phases of activity:

- Until 2035 – maintain and improve current defences, safeguard areas required for future improvements, and monitor climate change indicators.
- 2035-2050 – raise existing walls, defences & smaller barriers whilst reshaping the riverside environment.
- 2050-2100 – determine and implement an option for the future of the Thames Barrier, and adapt other defences as required to work alongside this to protect the estuary.

The Thames Estuary 2100 Plan can be found at: https://www.gov.uk/government/publications/thames-estuary-2100-te2100

Details about the TE2100 in-channel levels

The TE2100 in-channel levels take into account operation of the **Thames** Barrier when considering future levels. The **Thames** Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels – for which the Barrier would normally shut for the 2008 epoch – will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upriver of the barrier will increase and the tidal walls will need to be heightened to match.

Why is there no return period for levels upriver of the barrier? -

The levels upriver of the barrier are the highest levels permitted by the operation of the Thames Barrier. If levels and flows are forecast to be any higher, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a low level. For this reason the probability of any given water level upriver of the Barrier is controlled and therefore any associated return period becomes irrelevant. The Thames Barrier and associated defence system has a 1 in 1000 year standard which means it ensures that flood risk is managed up to an event that has a 0.1% annual probability. The probability of water levels upriver is ultimately controlled by the staff at the Thames Barrier.

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TE2100 2008 levels:

Levels downriver of the Thames Barrier are 0.1% AEP (1 in 1000) and levels upriver are the highest levels permitted by the Thames Barrier, described as the Maximum Likely Water Levels (MLWLs). The defence levels (left defence, right defence) are the minimum levels to which the defences should be built.

Node	Easting	Northing	Extreme water level (m)	Present Day Statuatory Defence Level (Thames Left Bank) (m)	Allow for future 2100 defence raising to a level of... (Thames Left Bank)
2.8	516863	175134	5.59	5.94	6.70
2.81	516864	175180	5.59	5.94	6.70
2.9u	516742	175353	5.54	5.94	6.70
2.9d	516766	175416	5.54	5.94	6.70

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TE2100 climate change levels:

			2065 to 2100		2100	
Node	Easting	Northing	Design water level	Defence level (both banks)	Design water level	Defence level (both banks)
2.8	516863	175134	5.84	6.25	6.29	6.70
2.81	516864	175180	5.84	6.25	6.29	6.70
2.9u	516742	175353	5.83	6.25	6.28	6.70
2.9d	516766	175416	5.83	6.25	6.28	6.70

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TE2100 flood levels:

Upstream of the Thames Barrier, the levels provided are the highest levels permitted by the Barrier.
Downstream of the Thames Barrier they are the 1 in 1000 (0.1%) levels.

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

Location	Node	Easting	Northing	Present Day Water Level	Future 2065-2100 Water Level	Future 2100 Water Level
	2.6	517278	174807	5.64	5.87	6.32
	a2.6	517173	174880	5.63	5.86	6.31
Richmond	a2.7	517026	174968	5.61	5.85	6.3

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TE2100 defence levels:

The table below shows both the current defence level, and the TE2100 plan future defence levels. New development should either include future defence raising or demonstrate that future raising has been allowed for.

Note: The defence levels near Teddington may be lower than the water levels because they take into account high fluvial events. The defences are tidal only.

Location	Node	Easting	Northing	Current Defence Levels		Allow for future defence raising (both banks) to a level of...	
				Left	Right	2065-2100	2100
	2.6	517278	174807	5.94	5.94	6.45	6.90
	a2.6	517173	174880	5.94	5.94	6.45	6.90
Richmond	a2.7	517026	174968	5.94	5.94	6.45	6.90

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Thames Tidal Upriver Breach Inundation Modelling – 2017 Upstream

- The map attached displays site-specific modelled flood levels at your site. These have been taken from the Thames Tidal Upriver Breach Inundation Modelling Study 2017 completed by Atkins Ltd. in May 2017.

We have developed a modelling approach where all upriver breach locations along the Thames are equitably modelled, to ensure a consistent approach across London. This modelling simulates 5679 continuous tidal breaches along the entire extent of the Thames from Teddington to the Thames Barrier. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

For breaches upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. The levels used are referred to as Maximum Likely Water Levels (MLWLs). Therefore 2005 and 2100 epochs were modelled on that basis.

This modelling has two epochs to consider; the 2005 epoch is a representation of today's flood levels without climate change considerations taken into account, and the 2100 epoch which takes into account changes likely to be seen due to climate change.

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Defence Details

The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP; they are designed to defend London up to a 1 in 1000 year **tidal** flood event. The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure that they are maintained to a crest level of **6.02** mAODN (the Statutory Flood Defence Level in this reach of the Thames). We inspect them twice a year to ensure that they remain fit for purpose. For more information on your rights and responsibilities as a riparian owner, please see our document 'Living on the edge' found on our website at:

https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities

There are no planned improvements in this area. Please see the 'Thames Estuary 2100' document on our website for the short, medium and long term Flood Risk Management strategy for London:

https://www.gov.uk/government/publications/thames-estuary-2100-te2100

Areas Benefiting from Flood Defences

This site is within an area benefiting from flood defences, as shown on the enclosed extract of our Flood Map. Areas benefiting from flood defences are defined as those areas which benefit from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in 100) chance in any given year, or flooding from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there.

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Recorded Flood Events Data

a) We do not hold records of historic flood events from rivers and/or the sea affecting the area local to this site.
However, please be aware that this does not necessarily mean that flooding has not occurred here in the past, as our records are not comprehensive.

Due to the fact that our records are not comprehensive, we would advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:

- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding and drainage systems that have been overwhelmed.

Other Sources of Flood Risk

The Lead Local Flood Authority for your area are responsible for local flood risk (i.e. surface runoff, ground water and ordinary watercourse) and may hold further information .

You may also wish to consider contacting the appropriate relevant Local Planning Authority and/or water/sewerage undertaker for the area. They may be able to provide some knowledge on the risk of flooding from other sources.

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Additional Information

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In **England**, you should refer to the Environment Agency's Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

https://www.gov.uk/flood-risk-standing-advice-frsa-for-local-planning-authorities

https://www.gov.uk/government/publications/national-planning-policy-framework-technical-guidance

https://www.gov.uk/government/publications/development-and-flood-risk-practice-guide-planning-policy-statement-25

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

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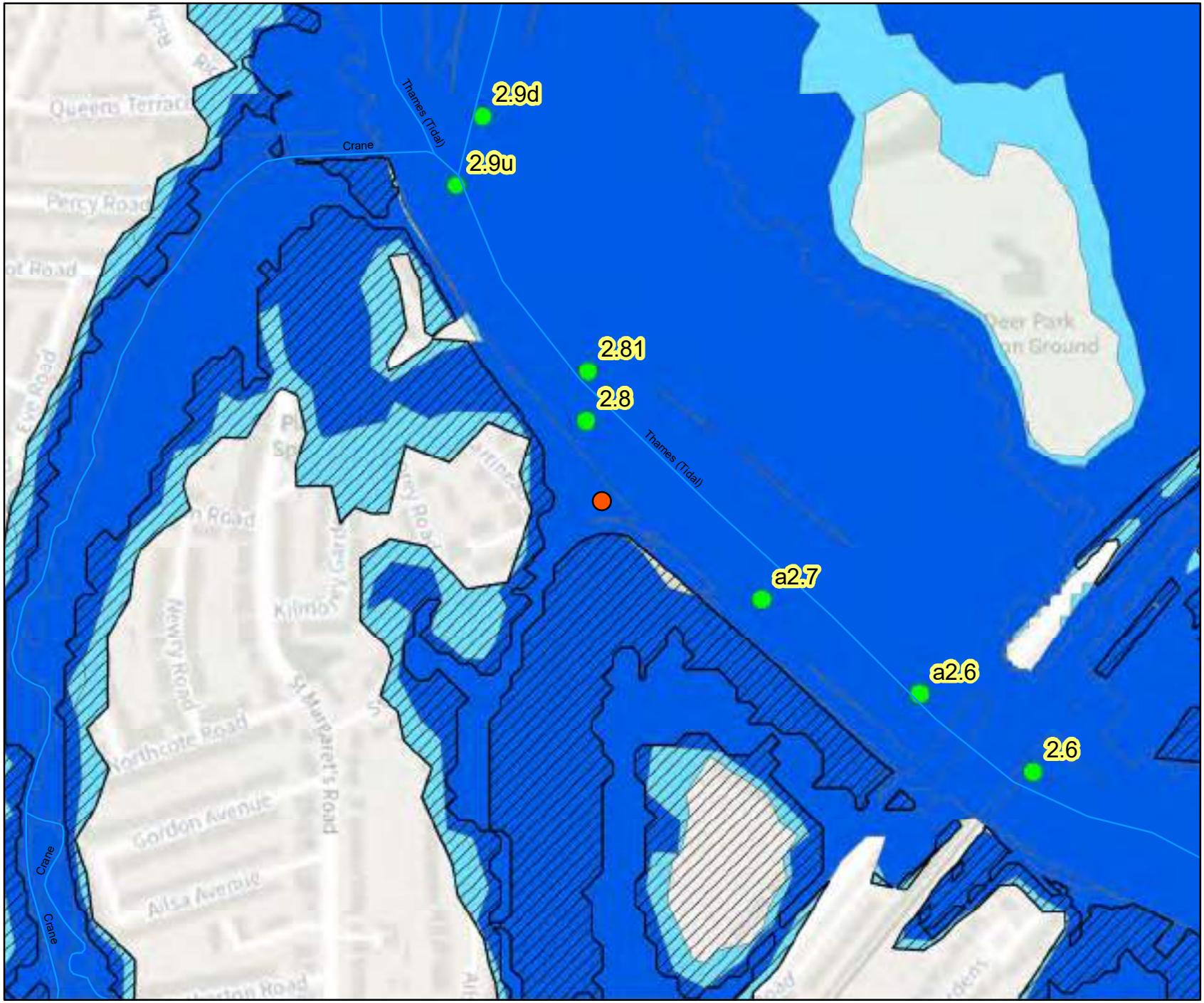
Website: www.environment-agency.gov.uk

Detailed FRA/FCA for: 516878,175059 - 19/07/2022 - HNL 271714 JH



Environment Agency
Alchemy,
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Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 75 150 300
Metres

Legend

- Main Rivers
- Site location
- TE2100Nodes
- 1707 Flood Outline
- 1928 Flood Outline
- 1953 Flood Outline
- Areas Benefiting from Flood Defences
- FZ3
- FZ2

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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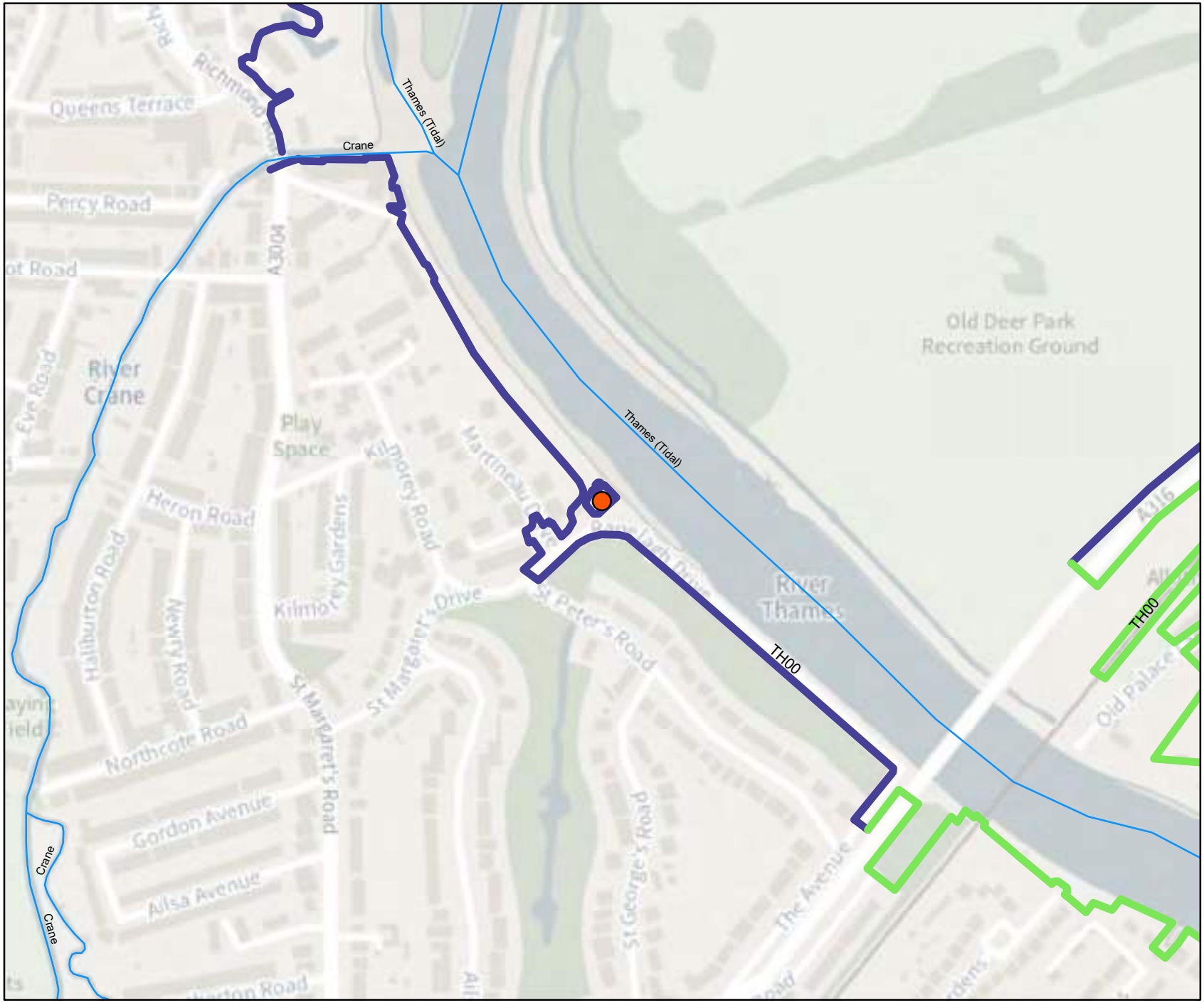
Detailed FRA/FCA for: 516878,175059 - 19/07/2022 - HNL 271714 JH



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N

0 75 150 300

Metres

Legend

- Main Rivers
- Site location

TTD Defences SDL (mAODN)

SDL

- 5.94
- 6.02

Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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Breach Modelling Map for: 516878,175059 - 19/07/2022 - HNL 271714 JH

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N

0 75 150 300

Metres

Legend

- Main Rivers
- Site location

Upstream Breach Outlines

Epoch

- 2005
- 2100

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

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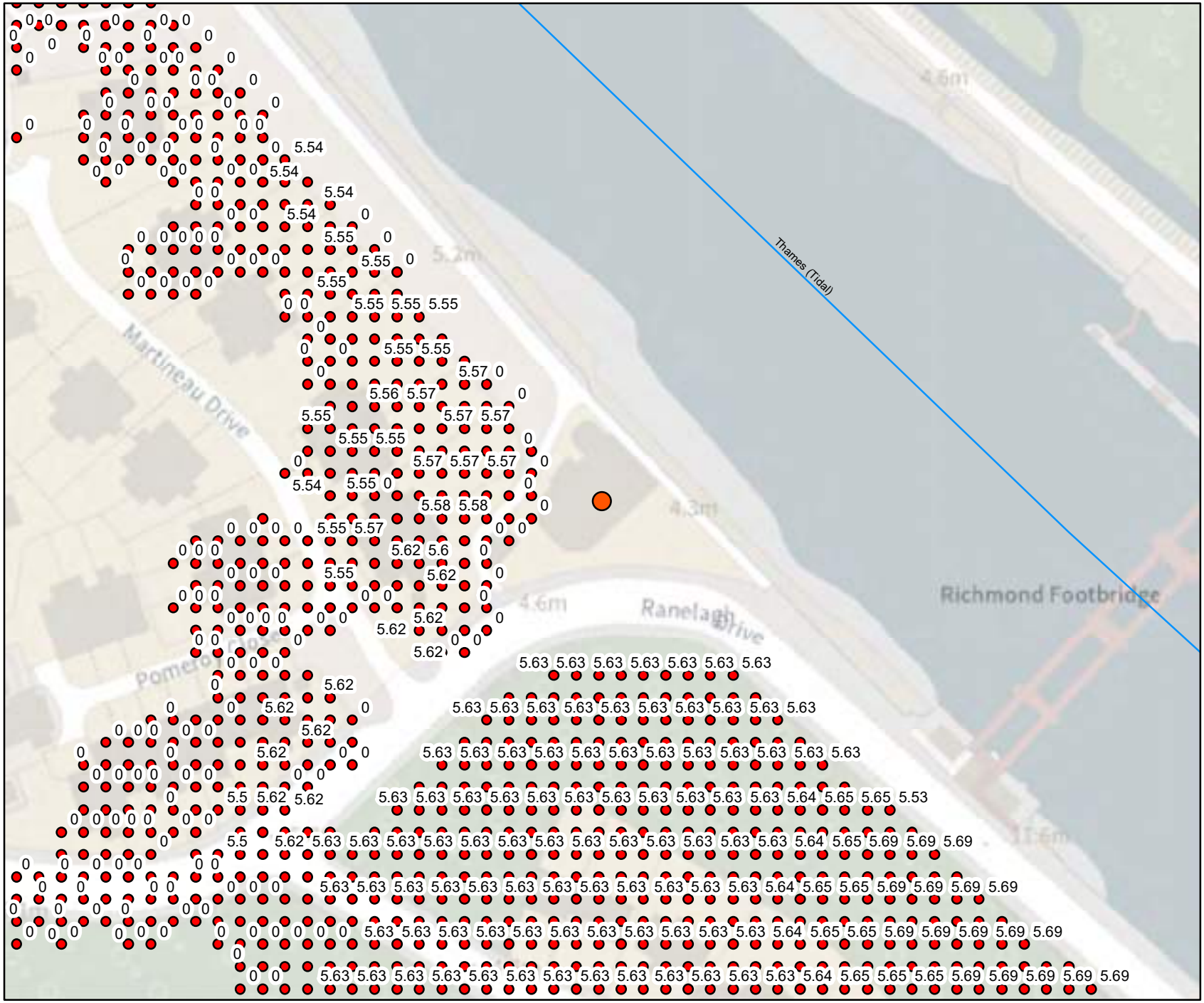
Modelled Flood Levels For: 516878,175059 - 19/07/2022 - HNL 271714 JH



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Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 15 30 60
Metres

Legend

- Main Rivers
- Site location

2D Node Results: Heights

- Tidal Breach Height (mAOD) 2005

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

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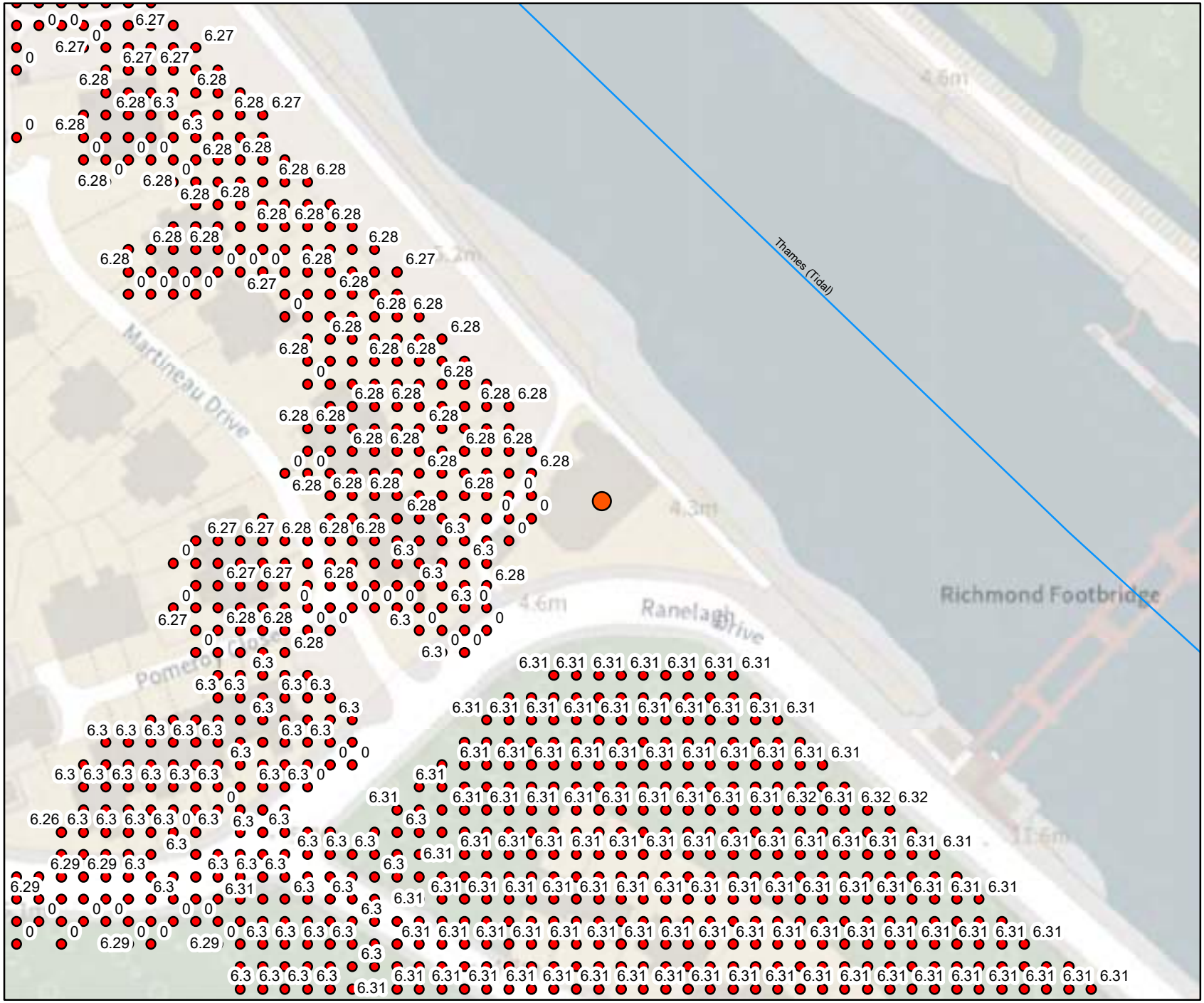
Modelled Flood Levels For: 516878,175059 - 19/07/2022 - HNL 271714 JH



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AL7 1HE

N

0 15 30 60
Metres

Legend

- Main Rivers
- Site location

2D Node Results: Heights

- Tidal Breach Height (mAOD) 2100

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

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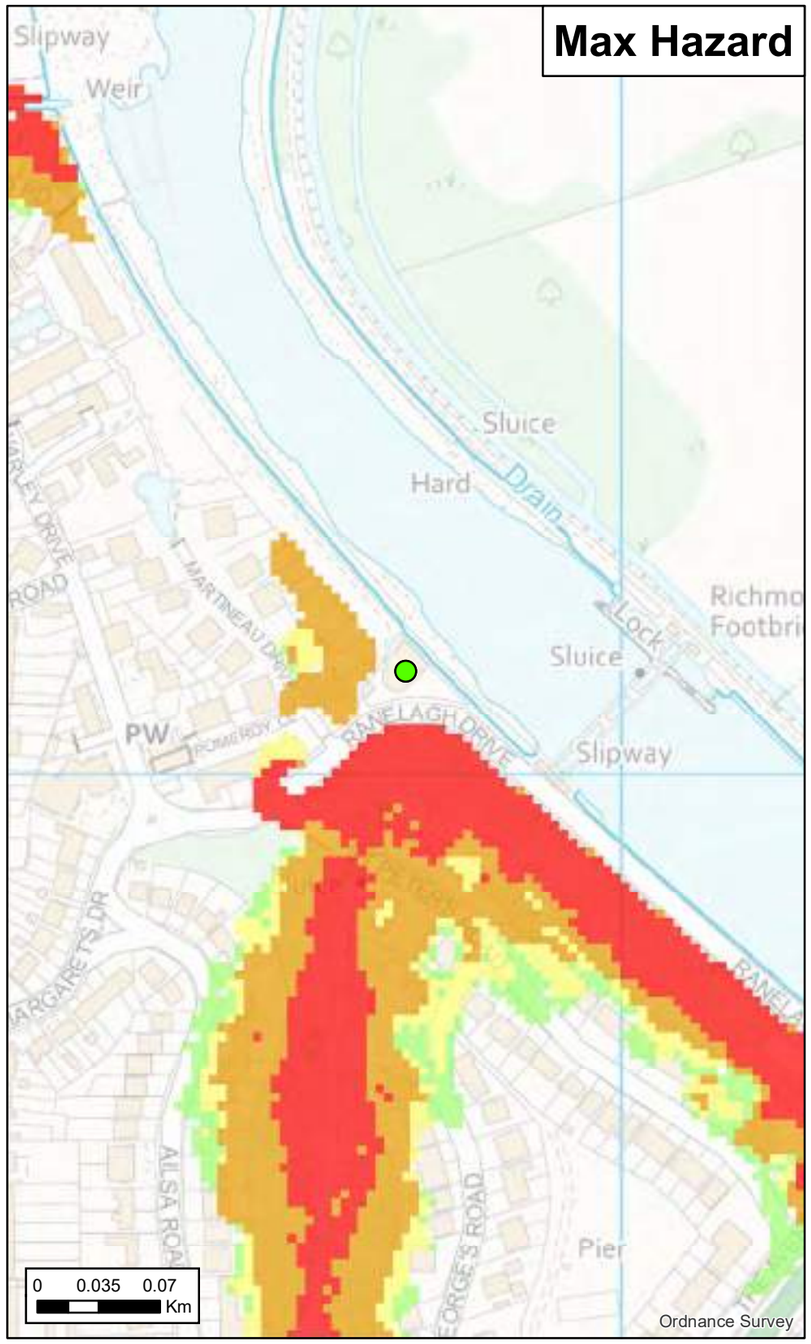
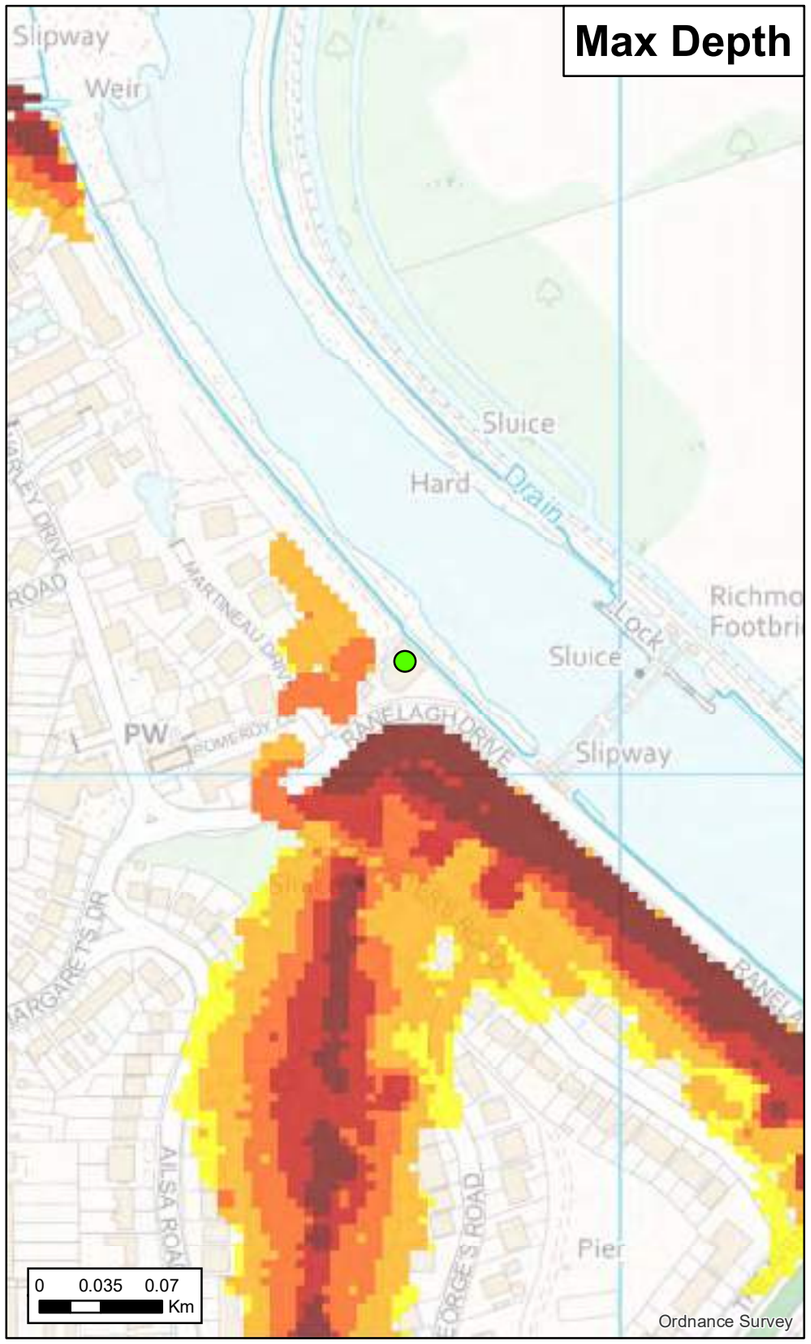
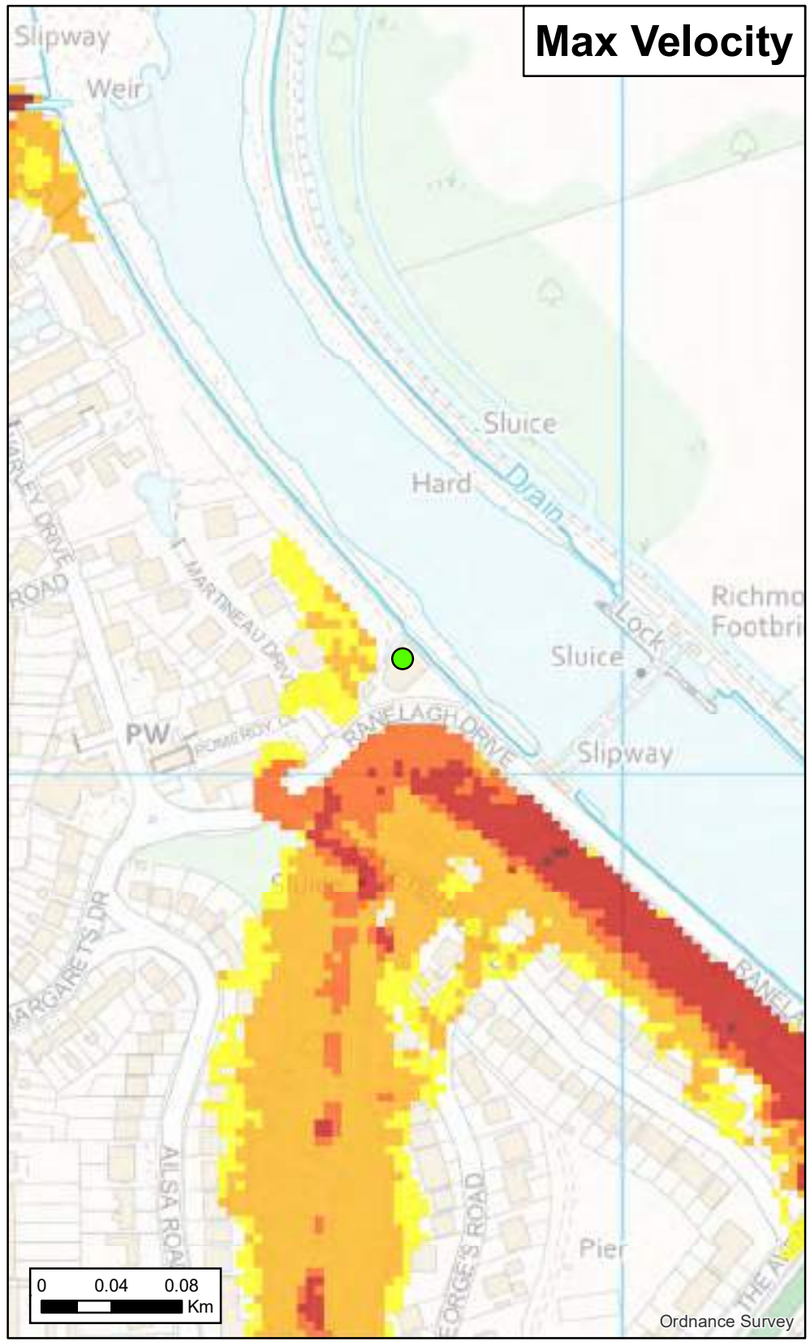






Max Hazard

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

Max Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Max Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

Date Printed	26/04/2022	**Scenario year**	2005	**Scenario Annual Chance**	0.5% (1 in 200)

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

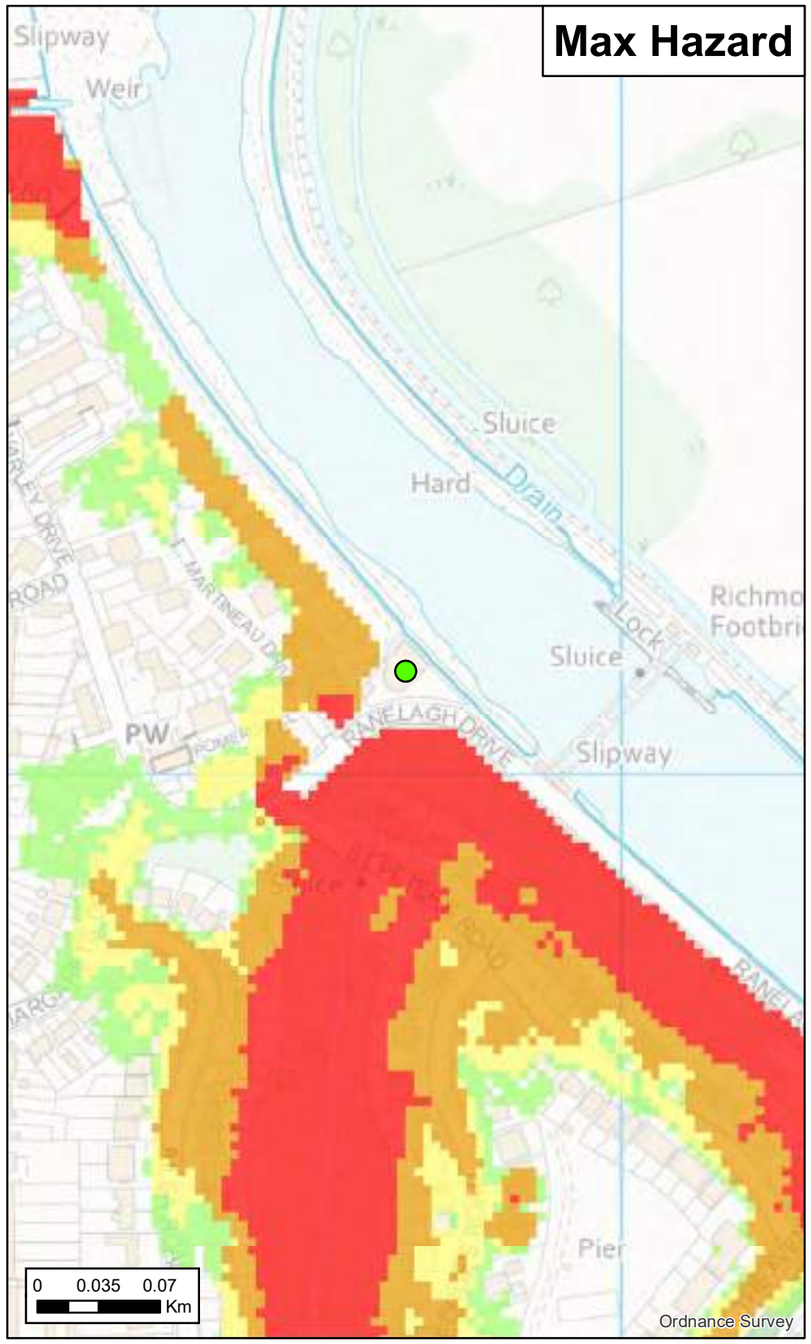
Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

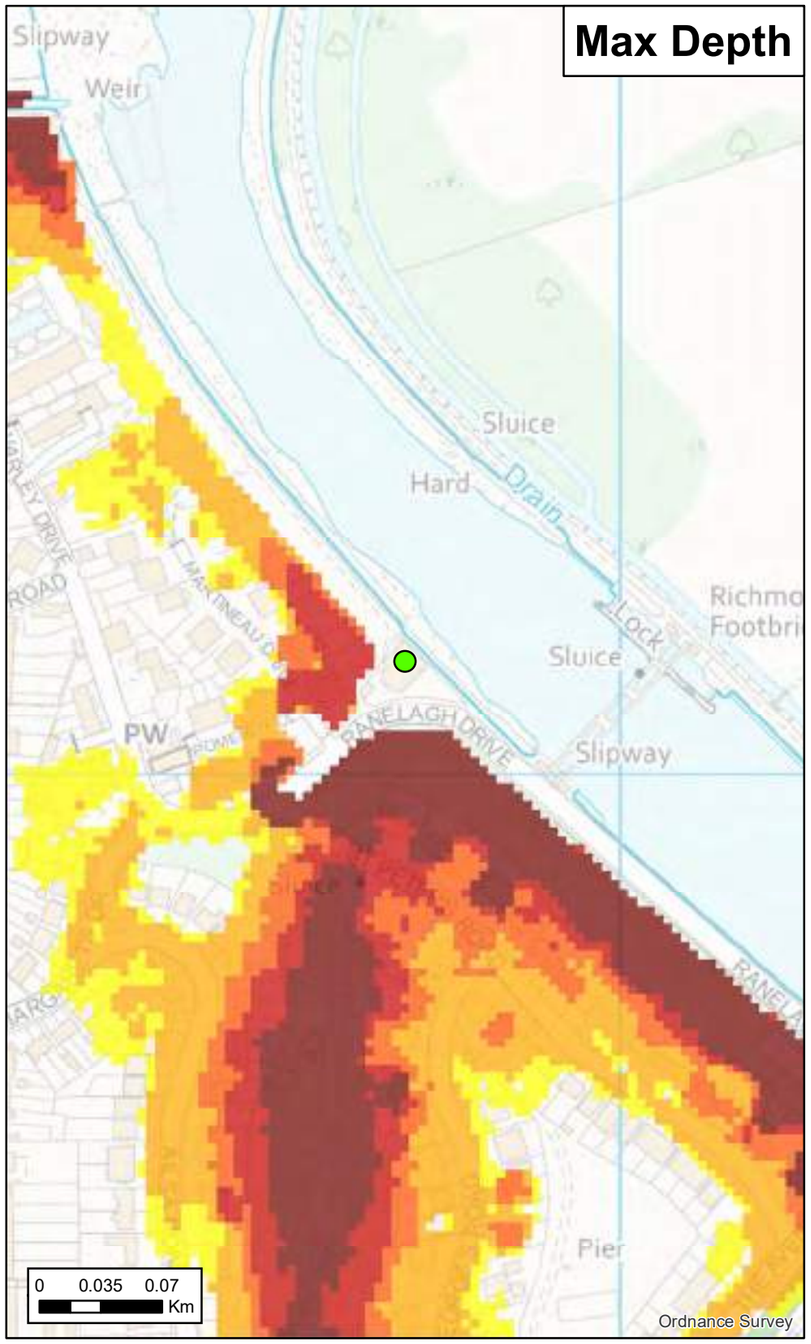
General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

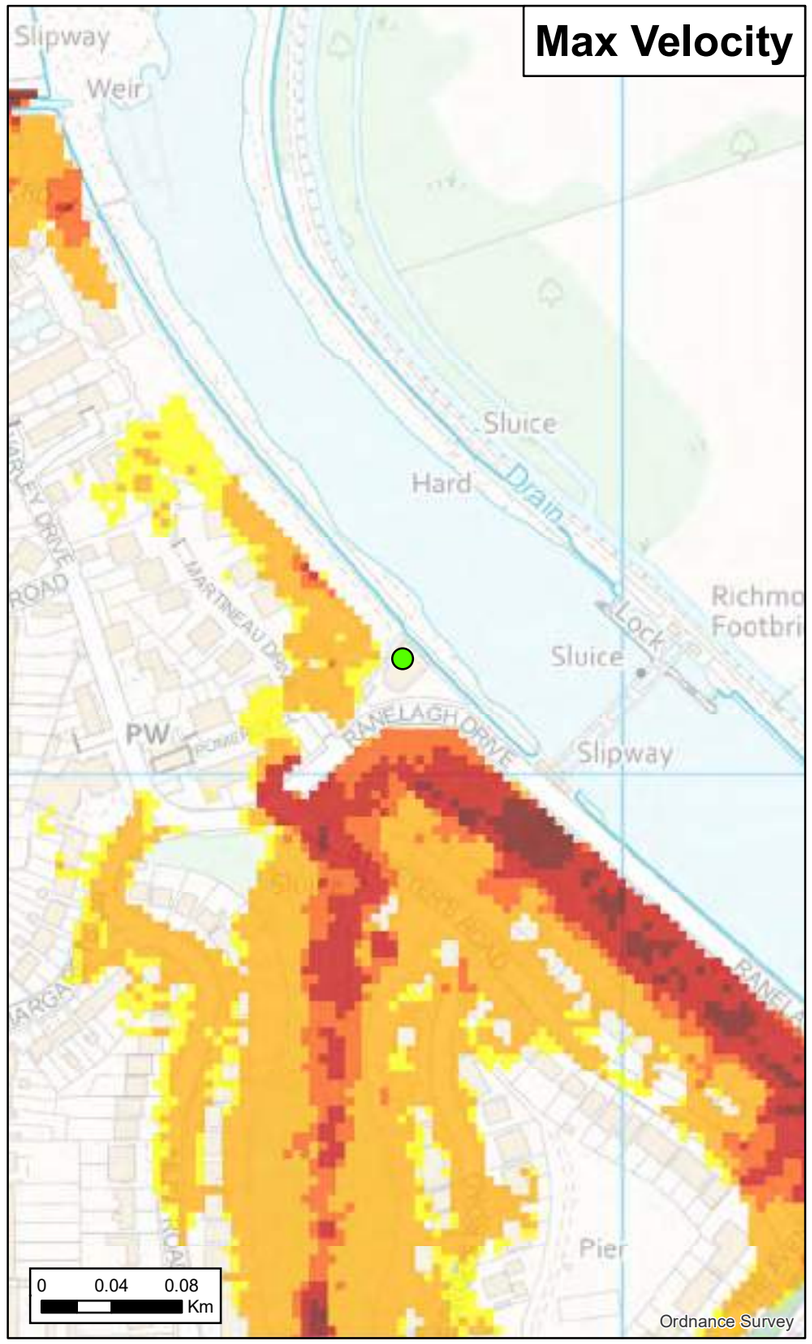
Environment Agency

Thames Tidal Breach Hazard Mapping

Map Centred on 529101, 178218







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Max Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Max Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

Date Printed	26/04/2022	Scenario year	2100	Scenario Annual Chance	0.5% (1 in 200)

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

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Environment Agency

Thames Tidal Breach Hazard Mapping

Map Centred on 529101, 178218

Appendix 05: London Borough of Richmond upon Thames SuDS Pro-Forma

1. Project & Site Details

Project / Site Name (including sub-catchment / stage / phase where appropriate)	The Boathouse, Twickenham
Address & post code	The Boathouse, Ranelagh Drive, Twickenham, TW1 1QZ
OS Grid ref. (Easting, Northing)	E 516879
	N 175062
LPA reference (if applicable)	
Brief description of proposed work	demolition of the existing building and the construction of a residential scheme comprising 3 properties with associated hardstanding and soft landscaping
Total site Area	1175 m^2
Total existing impervious area	1175 m^2
Total proposed impervious area	940 m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	No
Existing drainage connection type and location	Assumed discharge into Thames Water Sewer beneath Ranelagh Road
Designer Name	Chloe Nelson
Designer Position	Project Hydrologist
Designer Company	SLR Consulting

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	Secondary B (undifferentiated)	
Bedrock geology classification	Unproductive	
Site infiltration rate	N/A	m/s
Depth to groundwater level	c.0.77	m below ground level
Is infiltration feasible?	No	

2b. Drainage Hierarchy

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

2c. Proposed Discharge Details

Proposed discharge location	Thames Water Sewer using the existing (or if not possible, new) manhole connection at around NGR: TQ168750
Has the owner/regulator of the discharge location been consulted?	No

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar				
1 in 1				
1 in 30				
1 in 100				
1 in 100 + CC				
Climate change allowance used		40%		
3b. Principal Method of Flow Control		N/A - Piped outflow for discharging into tidal watercourse		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	470	79	2.4
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	705	470	42.3
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	0		60
Total	**1175**	**549**	**104.7**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Section 2.4
Drainage hierarchy (2b)	Section 6.4
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Appendix 06
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Section 6.7
Proposed SuDS measures & specifications (3b)	Section 6.6
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	Appendix 01
Detailed drainage design drawings, including exceedance flow routes	Appendix 06
Detailed landscaping plans	Appendix 01
Maintenance strategy	Section 6.10
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Green Roof, Permeable Paving
b) biodiversity?	Green Roof
c) amenity?	Vegetative Planting Sitewide

Appendix 06: Surface Water Drainage Drawing

N

River Thames

River side walk

Existing

Proposed

ne of Existing
oundary Wall

Existing trees
retained

Line of Existing
Boundary Wall

Permeable stone
seating area

House 01

House 02

House 03

Flat roof

Fall

RANELAGH DRIVE

New permeable Path

New permeable Path

Existing wall rebuilt
to existing wall height

PERMEABLE PAVING

COVER LEVEL:	**4.47m AOD**
INVERT LEVEL:	**4.02m AOD**
SURFACE AREA:	**470m²**
MEMBRANE DEPTH:	**150mm**
DEPTH OF GRAVELS:	**300mm**
VOID RATIO:	**0.3**
VOLUME AVAILABLE:	**42.3m³**

Car Park 05

Car Park 06

Open gantry steps up to
each property door threshold
@ 6.9 datum

Line of
1st floor /
2nd floor
above

Car Park 04

Car Park 03

FFL : 4.470

Cycle
Store

Bin
Store

Bins

Cycles
Store

Pedestrian entrance

NON RETURN VALVE

Site entrance maintained
New sliding gate

Car Park 02

Car Park 01

BELOW GROUND TANK

COVER LEVEL:	**4.47m AOD**
SOFFIT LEVEL:	**3.67m AOD**
INVERT LEVEL:	**2.47m AOD**
SURFACE AREA:	**52m²**
VOLUME AVAILABLE:	**62.4m³**

NEW MANHOLE CONNECTION INTO THAMES WATER SURFACE WATER SEWER WITH AN ASSUMED INVERT LEVEL OF 1.3m AOD. EXISTING POINT OF CONNECTION TO BE ADOPTED IF FEASIBLE

0 2 4 6 8m 12 16 20

Metres 1:200

425.064470.00001.18.0_SW_DRAINAGE.dwg

NOTES

1. DRAWING IS BASED ON SILVER JETTY LTD SCHEDULE OF ACCOMMODATION AND PROPOSED ROOF PLAN, REFS: PL-040 171001 AND PL 054 171001, DATED: NOVEMBER 2021.

LEGEND

- SITE BOUNDARY
- BUILDING FOOTPRINT
- EXTENT OF ROOF
- GREEN ROOF
- PERMEABLE PAVING
- BELOW GROUND TANK
- PIPED CONNECTION
- EXITING THAMES WATER SURFACE WATER SEWER
- NEW MANHOLE
- NON RETURN VALVE
- EXCEEDANCE ROUTE

BOATHOUSE TWICKENHAM LTD

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FLOOR 3
THE CURISTOR BUILDING
38 CHANCERY LANE
LONDON
WC2A 1EN
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www.slrconsulting.com

THE BOAT HOUSE
TWICKENHAM

SURFACE WATER DRAINAGE STRATEGY

SURFACE WATER DRAINGE PLAN

DRAWING 01

Scale 1:200 @ A3

Date SEPTEMBER 2022

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