GEOSPHERE ENVIRONMENTAL

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SITE:	Twickenham Riverside, Diamond Jubilee Gardens, London
DATE:	28/06/2021

DOCUMENT CONTROL SHEET

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This report is based on the site findings at the time of the associated walkover/site investigation works and information provided by the client at the time of writing. Should site conditions alter or development proposals alter, a reassessment of the enclosed findings should be undertaken. Refer to Appendix 1 for full details of report limitations.

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VERSION RECORD

Version	Date	Document Revision Details	Prepared By:	Admin
V1	16/11/2020	Draft text issued only for review by designers	JD	No Admin
V2	19/11/2020	Updated geotechnical assessments	SG, JD	CJ
V3	08/12/2020	Updated geotechnical assessments	SG, JD	CJ
V4	28/06/2021	Client-provide site description text and updated proposed development plans	JD	CJ

EXECUTIVE SUMMARY

DESK STUDY DATA REVIEW		
Site Location / Description		The site was located at Twickenham Riverside, Diamond Jubilee Gardens, London, TW1 3DS, to the south of the urban centre of Twickenham. The site was approximately L-shaped and comprised the landscaped public gardens area in the centre and west of the site, The Embankment to the south, various derelict buildings and an electrical substation in the centre-east, car park at the east end of the site, two-storey retail / bank structures at the northern corner. The scope of this investigation is limited to the areas depicted.
Previous site investigations		Two phases of previous site investigation have been provided; one within the central/west section of the current public gardens area and encountered Made Ground up to 3.5mbgl, over granular soils to ~5mbgl, over Clay (London Clay). A phase investigating the eastern (car park) section encountered corresponding ground conditions with localised detectable hydrocarbon concentrations in the soil and groundwater.
History		The early historical map editions indicated the site to be part of the ground of Richmond House with a public house in the northern corner. From the early 19th Century the majority of the site was the Twickenham Swimming Baths with associated structures; these became unused by circa 1980 then redeveloped for the Diamond Jubilee Gardens.
Conceptual Model		The site data provides a number of potential sources of contamination including the data from the previous site investigations. (It should be noted that the investigation of all of these is outside the scope of this investigation).
SITE INVESTIGATION DATA REVIEW		
Site Works		This phase of investigation comprised 2no. LCP BHs to 25mbgl, 2 no, trial pit soakaways, 4 no. hand-tool-excavated pits, 4 no. windowless sampler boreholes; 1 soil-gas/groundwater monitoring visit.
Ground Conditions		In-ground obstructions were encountered in 2no. initial attempts for the LCP BHs and all 10 positions attempted for the windowless sampler BHs. Made Ground was encountered to 1.70mbgl, underlain by River Terrace deposits to up to 5.5mbgl and London Clay (very stiff fissured clay) to 25mbgl.
Gas Monitoring		Two soil gas monitoring visits have been undertaken to date; very low soil gas concentrations (CO_2 and CH_4) with no significant flow values, groundwater levels measured between 2.4mbgl and 12.24mbgl.
Laboratory Results		The sampled and analysed soils indicate no significant contamination; groundwater sampled from the BHs of this phase indicates groundwater quality as anticipated with no evidence of contamination.
Updated Conceptual Model		Based upon the available soil quality data the risk to receptors is generally low. However, the extent of ground conditions investigated across the site is limited

		as a result of the obstructions encountered, preventing deeper drilling/ sampling; the extent of Made Ground across site is understood to be significant as a result of the backfilled swimming pool.
Geotechnical Considerations		It is assumed that a piled foundation scheme will be considered an option for the proposed structures and a raft foundation design is also applicable. The locally shallow groundwater level may need to be taken into consideration for basement excavations but based upon the limited data is currently considered to be below the likely excavation depths.
Further Works / Recommendations		A Detailed UXO threat assessment should be undertaken for the scheme; this may result in a requirement for UXO specialist presence or other mitigation measures during site preparation and construction phases. Assessment of the extent of the remaining in-ground obstructions and the Made Ground above and below the backfilled or demolished swimming pool structures. Investigation of soils within any areas of the site not yet intrusively investigated/analysed. Further investigation of the groundwater quality in the east of the site where previous investigation indicated hydrocarbon contamination. Continue the soil gas and groundwater monitoring but also assess the variation in groundwater elevations to help inform any potential dewatering requirements. Development of a scheme design and materials management plan/regime to remove the extant structures and in-ground structures to facilitate re-processing and re-use of suitable site-won materials.
This Executive Summary only provides a summary of the site data and its assessment. It does not provide a definitive engineering analysis and is for guidance only. It is recommended that the reader reviews the report in its entirety and any material referenced therein.		

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1. INTRODUCTION

Geosphere Environmental Ltd was commissioned by Arcadis LLP on behalf of the Client, London Borough of Richmond Upon Thames to undertake a Phase 1 Desk Study and Phase 2 Ground Investigation for a proposed residential development at Twickenham Riverside, Diamond Jubilee Gardens, London . Postcodes TW1 3SD and TW1 3SU centre at locations just to the north of the subject site.

It was understood that the site is to be redeveloped comprising the demolition of existing buildings and structures and redevelopment of the site comprising residential (Use Class C3), ground floor commercial/retail/cafe (Use Class E), and public house (Sui Generis) with associated landscaping, restoration of Diamond Jubilee Gardens and other relevant works.

Proposed development plans, drawing references TRS-HAL-A-2499 to TRS-HAL-A-2505 dated June 2021 are provided within Appendix 3, although specific details have been provided within the relevant report sections.

This investigation and resulting report have been undertaken to the requirements of a Site Investigation Scope of Works, produced by Webb Yates Engineers, document reference J3932-S-SC-001/Rev01, dated May 2020 and should be considered in conjunction with this report. A summary of report objectives is provided within the following sections.

1.1 Objectives of Phase 1 - Desk Study

The primary objectives of the desk study were to:

- Review the findings of a previous site investigation covering a portion of the current site;
- Provide an assessment of environmental sensitivity at the site and the surrounding area in relation to any suspected or known contamination which may significantly affect the site and the proposed development;
- Review historical mapping records and uses of the site and surrounding area;
- Review the findings of an Unexploded Ordnance assessment;
- Provide an environmental risk assessment based on the findings of desk-based information;
- Indicate whether further works are required, and the nature of the works, to enable a more complete assessment of the site.

These were achieved by:

- Undertaking a walkover of the site;
- Researching and assessing the available information regarding the current site status, including recorded geology, hydrogeology and hydrology of the site and surrounding area, as well as the history of the site;
- Developing a Conceptual Site Model.

1.2 Objectives of Phase 2 - Ground Investigation

The primary objectives of this ground investigation were to:

- Assess the ground conditions at the site for use in the structural design of the proposed development;
- Assess the potential risk to human health and the environment based on the findings of the investigation.

These were to be achieved by:

- Undertaking an intrusive investigation of the site, based upon the proposed development layout and the scope agreed with the client;
- Logging and sampling the soils on the site and noting any visual or olfactory evidence of contamination;
- Undertaking laboratory chemical analysis and geotechnical testing of selected soil samples to assess soil quality and ground conditions at the site;
- Installing monitoring wells for ground gas and groundwater level monitoring sampling;
- Creating a Conceptual Site Model and defining suitable remedial/mitigating and verification actions.

It should be noted that the scope of intrusive works is limited to the areas indicated within the Webb Yates scope document (with subsequent variations) and as illustrated within the exploratory hole location plans. It is understood that the data from the previous investigations (see below) and this phase of investigation will be combined by the designers.

2. SITE SETTINGS

2.1 Site Description

A Site Location Plan and Site Plan are included within Appendix 3 as Drawing references 4955,SI,001,Rev0 and 4955,SI,002,Rev0 respectively along with a provided topographic survey of the site. The latter is annotated to assist the description below.

The subject site was situated north west of the River Thames in Twickenham, to the south of the urban centre of Twickenham and opposite Eel Pie Island and may be located by National Grid Reference (NGR) TQ 16290 73170 and postcode TW1 5DS. The site was approximately L-shaped and comprised an area of 0.98 hectares (ha), with topography indicating the site to naturally slope downwards towards the south east and River Thames by approximately 2.5m, although a large portion of the site was level and at 2.5m height buttressed retaining wall existed in the south east (see below).

A site walkover was undertaken on 22 July 2020. At the time of the walkover, the site was multi-use and comprised a number of areas described as:

- The north-west and central portion of the site, forming the majority of the site was the public/communal area of the Diamond Jubilee Gardens, which included a children's' play area, a mix of artificially turfed and hard surfacing, vegetated plant beds and café, with various mature trees on the northern border.
- A number of derelict structures existed in the centre-east and far east of the site, understood to have historically been part of Twickenham Swimming Baths. An electrical substation is at the north of these. These areas were outside the areas of investigation of this phase.
- A number of current commercial 'high street' retail structures comprise the north-eastern corner, understood to be a bank and clothing retail. These were not accessed within this investigation phase. (See section 7).
- An area of hardstanding, vehicle access and (generally disused) car parking formed the eastern section, at the south east of the retail units. This was partially fenced-off with evidence of previous ground-breaking, possibly for ground investigation.
- The Embankment formed part of the southern / south-eastern section of the site and included the roadway and car parking along its length with pedestrian promenade fronting onto the River Thames.

In terms of elevations, the site varies as the Gardens area is a plateau of ~8mAOD with steps transecting the south-eastern boundary (a series of retaining walls) down to the Embankment at ~5mAOD. The eastern car park area is at <8mAOD in the north, sloping gently to the south to ~7mAOD, with a vehicle ramp leading to Water Lane down to ~5mAOD.

The north east boundary of the site was largely formed by Water Lane, beyond which was light retail and residential properties, leading down to the public open space of The Embankment. The south east and southern boundary was formed by the embankment/ promenade along the River Thames, with a boat

launch platform at the northern/ eastern end. The south western boundary was formed by Wharf Lane, beyond which were various lengths of brick wall, varying from 2.5m and 4.0m in height and were associated with adjacent residential properties and garages, car parking and retail structures. The north west boundary was formed by an unnamed road, with adjacent retail/residential properties located beyond and extending to King Street.

A number of features of interest existed on the site. An electricity sub-station was noted to the north of the larger of the derelict buildings, towards the end of the unnamed road. The retaining wall in the south east suggests the land behind it to have been 'made-up', with anecdotal and other evidence indicating that this was where a lido swimming pool existed, presently backfilled. Elsewhere onsite, a number of mature trees, largely Birch, were noted to exist.

Access was not provided within the onsite derelict structures, although it was understood that they included a toilet block and a facilities building for the historic swimming baths.

No visual or olfactory evidence of gross contamination was noted to exist during the site walkover.

Photographic records are presented in Appendix 12 of this report.

2.2 Previous Investigations

A previous phase of intrusive investigation has been provided and is reported by Southern Testing as a letter report dated 14 October 2010, reference SKT/ER/J1337 and is summarised below.
In addition, a previous Desk Study and Ground Investigation was undertaken by Geotechnical and Environmental Associates Ltd (GEA) for the area of land in the north and east of the subject site, reported under reference J17205 (Issue No 2) dated November 2017.
The purpose of the GEA report was to provide and assess environmental and historical baseline information and data for the preliminary assessment of contamination risk to the site, and to undertake an intrusive-based investigation so that quantitative assessment of contamination risk may be compiled for subsequent remediation recommendations, including hazardous ground gas assessment. Further to the above, investigation of the soil properties beneath the site was undertaken so that the geotechnical parameters could be proposed for the structural development of the proposed scheme.
An Unexploded Ordnance report was also undertaken for the investigation site, undertaken by others, which shall be summarised later within this report.

2.2.1 Southern Testing Letter Report

This phase of intrusive works targeted the "central" section of the subject site, the former swimming pool and baths area, prior to development into the extant Diamond Jubilee Gardens. A combination of handtool excavated pits and flight-auger boreholes (to up to 7.5mbgl) encountered Made Ground between 0.7 and 3.5m thickness, overlying sand/gravel to between 5.0 and 5.5mbgl, underlain by London Clay. The Made is interpreted to have the appearance of demolition material from the former baths (concrete cobbles, brick, paving slabs). The chemical analysis indicates no significant contamination when compared to

current screening concentrations. Hydrocarbons are recorded in concentrations greater than a conservative screening value of 100mg/kg; significant hydrocarbon contamination was not encountered but of course, cannot be fully discounted as a potential concern due to the variability of Made Ground and historic filling practices.

2.2.2 GEA Desk Study

Based upon the findings of the Desk Study, a low risk was determined for the site from potential contaminative sources, including Made Ground and hydrocarbons from an historic council depot (c. 1907). These sources were considered to present the perceived (low) risk to end-users of the site (future residents), groundwater, aquifer (permeable layers of soil), site workers and services (water pipes).

2.2.3 GEA Intrusive works

The intrusive works comprised the formation of a number of exploratory boreholes, extended to depths ranging from 4.0m and 5.0m (small diameter) and 25.0mbgl (cable percussion) and included the installation of monitoring wells together with regular recording visits.
The ground conditions encountered recorded a gravelly clay Made Ground from the surface, extending to depths from 0.6m and 1.7mbgl, with a range of anthropogenic materials and hydrocarbon odours noted. The Made Ground was underlain directly by granular soils of the Kempton Park Gravel Formation, extending to depths ranging from 4.9m and 5.8mbgl, with groundwater strikes at 4.5mbgl coinciding with hydrocarbon odours. The London Clay formed the bedrock stratum to the above and extended to the full depth of the investigation. Groundwater was monitored on 3 occasions in September and October 2017, between 2.66mAOD and 3.01mAOD; no comment was provided regarding the likelihood of tidal influence.

2.2.4 GEA Contamination Assessment

Based upon the results of chemical analysis on selected soil samples, no elevated concentrations of contaminants were noted to exist compared to the adopted threshold screening values. However, the screening values and land-use scenario utilised within the GEA report was for a commercial land-use.
(Arguably a more sensitive land use will require *consideration* in the current scheme, for example, residential without plant uptake, due to the residential properties proposed within part of the scheme. If these are constrained to the upper floors of the buildings and have no private garden areas at ground floor level, it is likely that a commercial land-use scenario should still apply.)
Groundwater sampling indicated some diesel type hydrocarbons to exist (within BH WS2, in the vicinity of the extant electrical substation) above contemporary drinking water standards, which was attributed to leaching of some tarmac through the ground. Whist development of the site was considered likely to remove a portion of the contaminants, it was recommended that further investigation was undertaken in the vicinity of borehole BH1 to delineate the affected area for remediation.
In consideration of the current proposed development scheme, it is possible that the proposed structure will provide a pathway break between any contamination and the end user receptors; this may require full consideration when the design is finalised. However, it would be prudent to assess the hydrocarbon

contamination regime (if still present) to address risk to construction workers, any potential dewatering activities in this area of the site, risk to controlled waters and placement of potable water pipes in this area. Regardless of the soil contamination risk, it was recommended that a 600mm clean topsoil layer was placed in areas of proposed soft landscaping as a barrier to end users from areas of remaining Made Ground, together with validation testing. Elsewhere onsite, excavations for basements may locate and remove contaminants, although if contamination is found to extend beyond the site boundary, containment barriers or treatment curtain may be required and additional investigation may benefit in determining this.

Ground gas monitoring indicated a low risk to the site, with Gas Screening Values (GSVs) falling within the CIRIA guidance as Characteristic Situation 1 – very low risk, although a vapour proof membrane may be prudent to protect against hydrocarbon odours within the groundwater.

The classification of soil wastes, under the European Waste Directive, indicated the Made Ground to be Non-Hazardous (17 05 04), natural soils around groundwater levels to be Hazardous (17 05 03) and other natural soils to be Inert (17 05 04), although it would be necessary to liaise with the receiving landfill operator (or other receiving facility) as to the specific characteristics, classification and resulting disposal costs.

2.2.5 GEA Foundation Assessment

The results of the intrusive investigation indicated the Kempton Park Gravel to be suitable as a bearing stratum for either spread or raft foundations, including within basements, although groundwater levels would need to be considered when designing basement floors at depth of 4.0m. The Kempton Park Gravels are considered to provide a Nett Allowable Bearing Pressure of 175kN/m^2.

Retaining walls for basement structures could be contiguous or secant and should be designed on an effective friction angle of 33 degrees within the Kempton Park Gravels, 27 degrees in the Made Ground and 24 degrees should retaining structures penetrate the London Clay Formation.

Alternatively, piles may be a more suitable option, dependent on final loadings imposed by the proposed structure. In the presence of possible instability of the gravels and in the presence of groundwater, continuous flight auger piles would be the most appropriate, where loads for a 20m pile would achieve in the region of 710kN (no basement) and 660kN (with basement).

2.3 Geological Setting

Details of the geology underlying the site have been obtained from the British Geological Survey (BGS) digital mapping at a scale of 1:50,000, which is provided within the Envirocheck Report included in Appendix 4.

2.3.1 Superficial Deposits

The geological map indicated the site to be underlain by superficial deposits of the Langley Silt Member – clay and silt. It should be noted that Alluvium – clay, silt, sand and peat, are reported within the footprint of the River Thames.

Further to the above, the wider area indicates the Kempton Park Gravel to exist and therefore there is a potential for the soil type to be encountered beneath the reported superficial deposits and above the bedrock soils.

The site was within an urban area and, although not indicated as present upon the site, the possibility that Made Ground is present cannot be discounted. (The site information regarding Made Ground is considered further below).

2.3.2 Bedrock Geology

The geological map indicated bedrock Geology underlying the site to comprise the London Clay Formation – clay and silt.

2.3.3 Geohazards and Ground Workings

Table 1 below, summarises the factors that may have a potential impact upon the engineering of the proposed development:

Table 1 – Geohazards and Ground Workings

Potential Hazard	Recorded Risk [m] / [Direction]			Comments
	Onsite	Within 250m	Within 500m	
Collapsible Ground.	Very low.	3/SE No hazard. 234/SE Very low.	-	
Compressible Ground.	No hazard.	3/SE High. 234/SE Moderate.	-	
Ground Dissolution.	No hazard.	-	-	
Landslide.	Very low.	250/SW Low.	-	
Running Sand.	No hazard.	3/SE Low.	234/SE Very low.	
Shrinking or Swelling Clay.	Very low – Moderate.	60/NE Low.	-	

2.4 Hydrogeological Setting

2.4.1 Underlying Aquifers

The hydrogeological data provided within the Envirocheck Report indicates the site is underlain by Unproductive Strata, although should the Kempton Park Gravel exist beneath the site, this is classified as a Principal Aquifer. Furthermore, should alluvial soils be encountered onsite, these should be classified as representing a Secondary Undifferentiated Aquifer.

The Environment Agency defines a **Principal Aquifer** as 'layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale'.

Secondary Aquifer Type A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

Secondary Undifferentiated Aquifer - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

Unproductive Strata - rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

2.4.2 Groundwater Vulnerability

In areas of unproductive strata, the groundwater vulnerability status remains unclassified, although in view of adjacent superficial soils which may occur beneath the site, the groundwater vulnerability is increased to Medium. The Environment Agency defines areas of medium vulnerability as areas that offer some groundwater protection. They are likely to be characterised by intermediate leaching soils and/or the presence of intermediate permeability superficial deposits.

Soils of intermediate leaching potential are soils that can possibly transmit a wide range of pollutants, or are soils that can "…possibly transmit non- or weakly adsorbed pollutants and liquid discharges but are unlikely to transmit adsorbed pollutants".

2.4.3 Source Protection Zones

The site was not located within a groundwater source protection zone (SPZ). There were no groundwater abstractions recorded within 1km of the subject site.

2.4.4 Groundwater

The Envirocheck data indicates the site is not in an area with potential for groundwater flooding to occur.

2.5 Hydrological Setting

The nearest surface watercourse or feature was the River Thames, located adjacent and south east of the site. It is assumed that all aspects regarding the flooding status / potential for the site are being investigated and assessed by others. Detailed flood risk assessment is outside the scope of this report, other than the data provided within Table 2 overleaf:

2.6 Radon

The HPA 'Indicative Atlas of Radon' 2007 (ref**. R.5**), indicates the site to lie within an area where there is a probability of <1% of present or future homes being above the action level of 200Bq/m^3. As such, the site is not classified as a Radon Affected Area. This is confirmed by the Building Research Establishment, Report 211, 2007, (ref. **R.7**).

2.7 Nitrate Vulnerable Zone

The site was not located within an area designated as a nitrate vulnerable zone.

3. ENVIRONMENTAL SEARCHES

3.1 Environmental Searches Summary

The environmental searches are detailed fully within the Envirocheck Report presented within Appendix 4.

Table 2 below, summarises the most relevant findings:

Table 2 - Environmental Searches Summary

Activity	Distance From The Site			Comments [m]/[direction]
	Onsite	Within 250m	250m to 500m	
1. Incidents and Registers				
Discharge Consents.	0	2	1	145/E: Unknown discharge. 184/NE, 454/N: discharge of other matter-surface water.
Local Authority Pollution Prevention and Control.	0	3	1	46/W, 104/N, 158/W: dry cleaning. 304/NE: petrol filling station.
Pollution Incidents to Controlled Waters.	2	8	7	0/NE: Category 3 (Minor) - storm sewage. 0/N, 16/E, 44/SW, 48/SW, 263/SW, 264/SW, 266/SW, 445/E: Category 3 (Minor) – oils. 262/SW: Category 2 (Significant) – oil. 12/S, 44/SW, 46/N: Category 3 (Minor) – unknown sewage. 90/NE, 111/NE, 259/SW: Category 3 (Minor) – general. 268/SW: Category 3 (Minor) – Miscellaneous.
2. Flooding				
Extreme Flooding from Rivers or Sea without Defences.	YES	YES	YES	Onsite: Small areas adjacent to the site boundary to the east. Off Site: Small areas adjacent to extent of Zone 3. Larger areas covering York House Gardens (200m/NE) and Ham Lands (250m/S).
Flooding from Rivers or Sea without Defences.	YES	YES	YES	Onsite: Adjacent to south east site boundary. Offsite: Adjacent to the river Thames (10m land coverage), extending across Eel Pie Island and between 100m – 200m of south bank.
Areas Benefiting from Flood Defences.	YES	YES	YES	Onsite: Small areas adjacent to south east site boundary. Offsite: Sporadic distribution adjacent to the River Thames.
Flood Defences.	YES	YES	-	Onsite: East. Offsite: 50m/SE.
3. Landfills and Waste Treatment / Disposal Sites				
Potentially Infilled Land (Non-Water).	-	-	1	364/SE: Unknown filled Ground (1992 mapping).

Table 2 - Environmental Searches Summary				
Activity	**Distance From The Site**			**Comments**
	Onsite	**Within 250m**	**250m to 500m**	**[m]/[direction]**
4. Contemporary Trade Entries of Concern				
Contemporary Trade Directory Entries.	0	61	46	*Only active entries or significantly contaminative entries will be reported below. For full listings see Appendix 4.* 40/W: carpet cleaners. 108/W: car body repairs. 117/E: antiques. 120+121/E: boatbuilders. 156/W, 179/N, 251/N,460/NE: dry cleaners 169/N: printers. 185/W: builder's merchants. 300/NE: petrol filling station.
Fuel Stations.	0	0	1	304/NE: Richmond Road Petrol Station.
Commercial Services.	0	9	4	96/SW, 107/W (3 entries), 113/W, 127/W: vehicle repairs. 185/W: metal workers. 204/N: Distribution (2 Entries).
Education and Health.	0	0	1	429/N: Hospital – St Johns and Amyand House.
Manufacturing and Production.	0	13	3	74/NW, 82/E, 83/E, 92/E (2 entries), 105/E, 124/N, 125/N, 132/W (2 entries), 218/E, 236/NW (2 Entries) - unspecified works.
5. Designed Environmentally Sensitive Sites				
Local Nature Reserves	0	1	0	147/SE Ham Lands

Where no relevant or significant data records exist for an activity, it is removed from the summary table, however, all data is included within Appendix 4.

4. SITE HISTORY

4.1 Historical Maps

A review of the history of the site has been conducted based upon the historical maps included within the Envirocheck report included in Appendix 5.

The relevant changes of the subject site and immediate surrounding area from the large-scale mapping are detailed in Table 3 below:

Table 3 - Historical Summary

Date	Potentially Contaminative Land Uses / Significant Changes	
	Onsite [Direction]	**Off-site [Distance/Direction]**
1869 - 1871 (1:10,560)	• Site appeared partially developed with a number of structures in the northern corner including a Public House and post office. • Richmond House structure forms part of the north west site boundary, with gardens and various buildings continuing across the remainder of the site. • Developed embankment to the River Thames appears adjacent to the south east site boundary. • A possible structure (unlabelled) in the eastern corner of the site.	• Surrounding area largely residential in the north with areas of orchard 100m/NW. • Richmond House continues off-site in north west. • 30m/SE - Eel Pie Island shown a largely undeveloped. • 120m/N – Brewery. • 200m/SE – Island Hotel. • 200m/S - Land south of River Thames shown as open undeveloped field.
1880 (1:2500)	• No significant changes of note.	• No significant changes of note.
1894 - 1896 (1:500) **1891 - 1898** (1:2,500) **1896-1899** (1:10,560)	• The developed embankment becomes part of The Embankment, with continues off-site in the north west. • Structure in eastern corner more defined but unlabelled.	• 10-20/NW - Town hall depicted. • 90/SW - Nursery. • 90m/N - Maltkiln • 100m/NW – Small-scale residential development of former orchards. • 200m/E – Thames Electric and Steam Launch Works (Eel Pie Island). • 250m/SW – Fish Pond.
1914 (1:2,500)	• No significant changes of note.	• 0m/NW – King Street indicated to include a tramway. • 50m/SE – Large-scale residential development of the eastern half of Eel Pie Island. • 90m/N – Maltkiln no longer noted. • 200/NW - Motor works. • 220m/NW – Large-scale residential development of former orchards.
1920 (1:10,560)	• Structural redevelopment in the northern corner of site, including a public house.	• No significant changes of note.
1934 (1:2,500)	• By 1934, swimming bath with associated structures depicted on site in the north west and central portion of the site.	• 0m/SW – Residential development of Thames Eyat, including present day garages and Tennis courts. • 0m/NE – High Street commercial development. • 90m/W – Picture Theatre.

Table 3 - Historical Summary

Date	Potentially Contaminative Land Uses / Significant Changes	
	Onsite [Direction]	**Off-site [Distance/Direction]**
1933 & 1934-1935 & 1938 (1:10,560)	• Additional structures in the centre-north and eastern section of site.	• 100m/W – Former nursery redeveloped as residential properties. • 200/NW Motor works becomes a rubber works and is structurally redeveloped.
1940 (1:10,560) **1948** (*ap*)	• Possible WW2 bomb damage in north-east of site.	• Possible bomb damage extending off-site up to 50m/NE.
1959 - 1962 (1:2,500) **1960 - 1966** (1:10,000)	• Area identified as Twickenham Baths and including a bath house and paddling pool.	• 0m/NW – King Street no longer indicated to include a tramway. • 50m/E – Works (Eel Pie Island). • 90m/W – Picture Theatre renamed Odeon Cinema. • 200/NW - rubber works identified as Works.
1972 (1:2,500) **1975** (1:10000)	• Car Park shown in North east of site. • Public conveniences shown in eastern corner of site. • Electricity substation noted in north of site.	• 5m/NE – Car Park.
1990 - 1991 (1:2500) **1992** (1:10000)	• Structural development of the Public House to include High Street commercial structures.	• 200/NW - Works redeveloped as a car park.
1999 (AP) **1999** (1:10,000)	• Roadway noted on The Embankment, together with vehicle parking.	• No significant changes of note.
2006 (1:10,000)	• No significant changes of note.	• 200m/E – Thames Electric and Steam Launch Works no longer noted.
2020 (1:10,000)	• Swimming pool on site shown as infilled and hardstanding.	• No significant changes of note.

• Notes:
• It should be noted that the dates of the maps do not always correspond with the time of the surveys.
• ap – aerial photography

Where no significant factors or changes occur within a map edition(s) it is summarised with "No significant changes of note".

Please note that the alignment and extent of the detailed site area in early map editions is often mis-aligned compared to modern mapping due to variation in mapping/digitisation processes; this is compensated for where possible within the interpretation.

4.1.1 Summary of other Site Data

The following website provides excellent information on the former layout of the swimming baths period of use of part of the site.
https://lidosalive.com/twickenham.html

This includes an aerial image viewing the site from the north, clearly showing the extent of the Twickenham Baths structure that occupied the southern section of the site, including what is now the Embankment area. The structure was substantial along with the two circular fountains depicted in the east and west of the Baths area and the two-storey structure at the east end of the Baths area, interpreted to be a café or similar. Of note also is the elevation drop from the north to south of the site, as current elevation changes; the baths structure at The Embankment is likely to have been between two and three storeys.

In addition, this website
https://www.britainfromabove.org.uk/en/image/EAW025282
provides a number of wider scale aerial images of the site. These generally confirm the above assessments.

It is understood that the baths closed circa 1980 following creation in the late 1920s or early 1930s. The pool was backfilled with, it is assumed and understood with site-won demolition material (or equally likely, imported demolition materials) circa 2004 with the creation of the extant Diamond Jubilee Gardens created between 2010 and 2012.

5. UNEXPLODED ORDNANCE

As mentioned within Section 1.3, a preliminary Unexploded Ordnance Risk Assessment (UXO) was undertaken by 1st Line Defence as part of the previous Desk Study and Ground Investigation Report undertaken by Geotechnical and Environmental Associates Limited.

The risk assessment was reported under reference EP5167-00, dated August 2017 and was focussed on an area of land in the north and east of the current site boundary.

The findings of the preliminary UXO assessment indicated that no recorded WW2 bomb strikes existed within the site area, although a V-1 bomb was recorded to have fallen immediately south of the site which is thought to have directly impacted the site. The historical maps within this report provide a 1948 aerial photograph indicating areas on and offsite visibly affected by the impact through the removal of former structure, although this is not conclusive evidence.

Based upon the findings of the preliminary UXO report, it was recommended that a detailed assessment was necessary to prove whether the site was damaged prior to the V-1 strike and therefore negate the risk.

A recent UXO assessment, undertaken as part of the current investigation, re-assessed the current site extent for UXO risk. The UXO assessment was undertaken by 1st Line Defence under reference EP11494-00, dated July 2020. The findings generally replicated that of the previous study; the report is provided at Appendix 13 for reference. Of note is the following summary:
"London bomb census mapping indicates that a V-1 bomb fell within the south-eastern section of the site during the war. Several bombs also fell within the general vicinity of the site. No damage was recorded onsite on MCC War Damage mapping, despite the fact that a V-1 flying bomb was recorded as falling within the south-eastern section of the site. Given the recorded bombing on site, it is anticipated that access on site would have been impeded until it was deemed safe to return, increasing the likelihood that items of UXO would have gone unnoticed and unreported."

Throughout the intrusive works of this phase UXO Risk Mitigation Measures were in place, comprising a UXO specialist with down-the-hole magnetometer being present onsite to supervise the drilling of the holes (to agreed depths or ground conditions). No magnetometer anomalies or other factors of concern in this regard were recorded.

As outlined above, a Detailed UXO Assessment is recommended for the redevelopment scheme.

6. PRELIMINARY CONCEPTUAL SITE MODEL

The risk assessment methodology is based upon current guidelines (ref. **R.1**), and legislation (refs**. R.12** and **R.13**).

The current guidance requires that a conceptual model be formulated, based upon the findings of the research. The conceptual site model is limited at this stage to the identification and assessment of potential 'hazards', identified or suspected from the results of the research; the potential 'receptors' that may be affected and the anticipated 'pathways' to those receptors. The findings are summarised in the following subsections.

The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification;
- Hazard Assessment;
- Risk Estimation;
- Risk Evaluation.

In accordance with the guidance, (ref. **R.1**), only the first two stages are addressed in the preliminary conceptual site model; should hazards exist which are a potential risk then more intrusive investigation works are recommended.

6.1 Hazard Identification: Onsite

The desk-based research and historical review identified the following potential hazards on the site:

1. Minor pollution incidents (sewage and oils);
2. Made Ground associated with historic infilling of land;
3. Made Ground associated with backfilling of former swimming baths;
4. Potential leaching of contaminated water from former swimming baths;
5. Current on-site structures associated with former swimming baths;
6. Oil/fuel spillages within car park area in the north of the site;
7. Previously identified contaminants: hydrocarbons within groundwater;
8. Electricity sub-station.

A proportion of these can be discounted as low-risk or low-impact, or have other mitigating factors. Others may require investigation and risk assessment as part of a pre-construction preparation phase to limit risk or delays.

For example: Items 4 and 5, are likely to pose a low level of impact to the soils / groundwater at the site. Items 2 and 3 are the principal reasons for these phases of ground investigation.
Items 1 and 6 and 8 *may* be related; the previous investigation assessed soil quality in the vicinity of the electrical substation (WS2).
The potential sources and extents of hydrocarbon contamination are wide and could be either of these potential sources or others. WS2 exhibits detectable or marginally elevated PAH and speciated TPH concentrations in soils to 3.7mbgl; an absence of detectable concentrations of PCBs is reported in the soil sample at 0.4mgl but if there had been a significant transformer oil leak it is more likely to have migrated vertically and laterally, to be potentially detected within the sample at 3.7mbgl (that was not scheduled for PCBs).
Considering that there are detectable concentrations (>620mg/kg) of hydrocarbons at 3.7mbgl at WS, the presence of oils and PCBs in soils and shallow groundwater in the vicinity of WS2 cannot be fully discounted. Similarly, the source of these being the electrical substation cannot be ruled out.
Further investigation is warranted (but is outside the scope if this current phase of investigation.

6.2 Hazard Identification: Offsite

The desk-based research and historical review identified the following potential hazard(s) offsite that may impact upon the site:

- Made Ground associated with redevelopment activities.

6.3 Hazard Assessment

The preliminary risk assessment has identified a few potential sources of contamination that may pose risk to human health and the Controlled Waters. Potential pollutant linkages that require further consideration are presented in Table 4 shown overleaf:

Table 4 – Conceptual Model

Sources	PATHWAYS:					RECEPTORS:						Risk Rating	Comments
	Root Uptake	Direct Contact	Ingestion	Respiration	Gas Accumulation	Plants	End Users	Structures (Concrete)	Services/Utilities	Construction Workers	Controlled Waters (GW)		
Minor pollution incidents (sewage and oils).	U	U	U	U	U	N	Mi	N	Mi	Mi	Mi	NR-LR	The minor categorised pollution incidents were both recorded in the north of the site and were reported in 1992 and 1998, therefore it is likely that any substances have dissipated to a low level of risk, where applicable.
Made Ground associated with historic infilling of land.	Li	Li	Li	Li	Li	Mi	S	Mi	Mi	Mo	Mo	MR-VH	The topography of the site indicates the site to have been artificially raised by approximately 2.5m. It is unknown the type of materials which may reside in the Made Ground, although given the historic period in which the site was developed to its current site level (c. 1934) it is possible hazardous materials (i.e. asbestos, metals, aromatic hydrocarbons, tar, etc) exist within the soils.
Made Ground associated with backfilling of former swimming baths.	U	U	U	U	U	N	Mi	N	Mi	Mi	Mi	NR-LR	The historical maps indicate the swimming baths were infilled between the period of 2006 and 2020. It is likely that materials used to backfill within this period were sourced from a controlled supplier and therefore is less likely to contain harmful contaminants.
Current onsite structures associated with former swimming baths.	Li	Li	Li	Li	Li	Mi	N	N	N	S	Mi	NR-VH	The historic maps indicate current on-site structures to have been constructed c. 1934, therefore the potential for asbestos to exist within the building fabric is high, presenting a risk during their removal as part of the proposed development. Furthermore, chemicals or fuels associated with maintenance of the swimming baths may still reside if not appropriately decommissioned prior to dereliction.
Oil/fuel spillages within car park area in the north of the site.	Li	Li	Li	U	U	Mi	Mi	N	Mi	Mi	Mo	NR-HR	Whist it is unknown the severity of the contamination potential, previous investigation in this area (particularly borehole no. 1) recorded elevated hydrocarbons in conjunction with groundwater. Although this was attributed

				to leaching of tarmac, there may also be contribution from this source.
Previously identified contaminants: hydrocarbons within groundwater.	Li Li Li U U	N N N N Mi Mo	MR	This proven linkage from the previous investigation shall require further investigation to delineate its effect on the site.
Electricity sub-station.	U Li Li N N	Mi Mi Mi Mi Mi S	LR-HR	The historic maps indicate this feature to appear from the 1972 maps. Leaks of oils containing Polychlorinated Biphenyls (PCBs) from the equipment cannot be ruled-out although or, generally, a low likelihood (see item 8 above). A worst-case scenario is that the hydrocarbons in soils/groundwater discussed in items 6 and 7 above (Section 6.1) also contain PCBs from a transformer leak.
Made Ground associated with redevelopment activities.	U U U U U	Mi Mi Mi Mi Mi Mi	LR	The surrounding topography does not show signs of large quantities of Made Ground to exist, although re-development of structures may introduce leachable contaminants to the soils that may migrate to the site, including hazardous ground gases.

Legend:-

See Comparison of Consequence Against Probability within Appendix 6 for Key to Legend.

Probability:		**Consequence (Severity):**		**Risk Rating:**	
				Very High Risk	**VH**
Negligible (N)		Negligible (N)		High Risk	**HR**
Unlikely (U)		Mild (Mi)		Medium Risk	**MR**
Likely (L)		Moderate (Mo)		Low Risk	**LR**
Highly Likely (HL)		Severe (S)		Negligible Risk	**NR**

7. PHASE 2 - SITE WORKS

7.1 Methodology

This site investigation was carried out in accordance with the practices set out in BS 10175: 2011+A1:2013, (ref. **R.14**) and BS 5930: 2015 (ref. **R.15**).

The location of exploratory holes was based on a proposed exploratory hole location plan provided by Webb Yates Engineers, reference J3932-S-SK-0001 dated May 2020. The final locations of exploratory holes were positioned to account for restrictions to access or encountered obstructions and are shown on Drawing numbers 4955,SI/003-005/Rev0 within Appendix 3.

Soil infiltration testing was carried out on the basis of the practices set out in BRE Digest 365, 'Soakaway Design'. 2016 (ref. **R.9**), which requires, in summary, a total of three infiltration tests to be undertaken in succession over a 24-hour period or tests to be undertaken on consecutive days. Where a test exhibited appreciable infiltration and the "75%" infiltration level was achieved, a further infiltration "run", or more was undertaken.

7.2 Scope

Site works were carried out from 24 August 2020 to 28 August 2020 and comprised the following:

- Formation of four handtool-dug trial pit excavations (HP01 to HP03), extending to depths ranging from 0.2m and 1.2mbgl;
- Formation of two machine excavated trial pits (TP101 and TP102), extending to depths ranging from 2.2m and 2.3m, together with subsequent soil infiltration testing to the requirements of BRE365:2016;
- Formation of ten small diameter exploratory holes (WS01, WS01A, WS01B, WS02, WS2A, WS02B, WS03, WS03A, WS03B, WS04), using windowless sampler methods, extended to depths ranging from 0.50mbgl to 1.4mbgl (encountering shallow impenetrable obstructions in all locations);
- Formation of two exploratory holes (BH01 and BH02), using cable percussion techniques, extended to a depth of 25.0mbgl;
- Installation of two no. dual-pipe ground gas/groundwater well pipes within BH1 and BH2 respectively, together with subsequent monitoring and sampling; and
- Associated soil logging, sampling and in situ testing within each exploratory hole.

BH01, was relocated towards the north east of the former swimming baths due to obstructions at initial attempts to undertake the hand-tool-excavated service inspection pits at 1.0mbgl (BH01A and BH01B). See below for further information.

7.3 Ground Conditions Encountered

The sequence and indicative thickness of the strata encountered are provided in Table 5 below:

Table 5 - Ground Conditions

Strata	Depth Encountered (mbgl)		Strata Thickness (m)	Composition
	From	To		
Surfacing materials.	GL	0.04 – 0.35	0.04 – 0.35	**BH01**: Paving slab. **BH02, TP101 and HP02:** Black flexible surfacing **WS01 – WS03:** Topsoil.
Made Ground.	GL – 0.35	0.50 – 1.70	0.60 – 1.70 (where proven)	**BH02** Type 1 granular sub-base. **ALL OTHER EXPLORATORY HOLES** Typically, a dark grey brown sand with varying organic content, brick and concrete gravel. **HP02** With concrete at base.
River Terrace Deposits (Kempton Park Gravels).	1.00 – 1.70	2.20 – 5.50	2.60 – 3.80 (Where proven)	**BH01, BH02, TP101 and TP102** Typically, a gravelly sand with flint as gravel.
London Clay Formation.	3.60 - 5.50	25.00	Unproven	**BH01 and BH02** A dark greyish brown fissured clay.

7.3.1 Encountered obstructions - Discussion and Interpretation:

The target depth for the window sampler boreholes was 5.0mbgl, although these were terminated due to drilling refusal upon obstructions; at all except WS4, these were at between 0.5mbgl and 1.0mbgl and these are interpreted to have been on a extant slab of concrete (or similar) that may have formed the base of the former Swimming Baths building in this part of the site.

Similarly, the obstructions encountered in the hand-tool-excavated service inspection pits of BH01A and BH01B, and interpreted to be remnant of the former swimming pool. Within BH01A, a ceramic pipe was encountered at 1mbgl; although unlikely to be live, further progress was not appropriate and it was not possible to relocate the rig within this immediate area due to access constraints and other suspected buried services. Within the pit at BH01B a blue-painted concrete obstruction was encountered at 1.0mbgl, with the appearance of a swimming pool floor, despite being located outside the swimming pool extent, as *indicated* by tiles / marking at ground surface; the latter may have been placed approximately.

WS4, was located within the petanque pitch in the centre-south of the scheme. This encountered a brick obstruction at circa 0.7mbgl, interpreted to be a former foundation. Further progression was halted at an obstruction at 1.4mbgl; this may be associated with the obstruction encountered in WS1 to WS3.

Within HDP03, located at the southern face of the buildings in the northern corner of the site (the rear of the retail or bank building) a suspected basement was encountered. Underneath the surface asphalt and underlying concrete, during breaking-out, a series of reinforcing bars were encountered and voids noticed into a suspected basement. Drawings later provided by the client indicate a series of potential basements along this section of the site; no damage was made and the shallow excavation (0.15mbgl) was carefully sealed and re-instated.

7.4 Visual and Olfactory Evidence of Contamination

The intrusive works recorded a variety of anthropogenic materials within the Made Ground, including brick and concrete, paving slabs and, within the holes encountering obstructions, items such as concrete slabs.

With the exception of the above, no other evidence of contamination was noted within the soils encountered. No evidence of gross contamination was noted in any of the exploratory holes formed.

8. LABORATORY TESTING

8.1 Methodology

Representative disturbed and undisturbed samples were taken at the depths shown on the exploratory hole records and dispatched to the laboratory. The exploratory hole logs are included in Appendix 7.

Samples were collected for environmental purposes in amber glass jars and sealed plastic pots and kept in a cool box with cooling aid.

Geotechnical samples were recovered in plastic tubs, plastic bulk bags and undisturbed U100 liners to prevent moisture loss.

8.2 Environmental Testing Suite

8.2.1 Quality Control

The environmental laboratories used (DETS and I2 Analytical) are accredited laboratories by the United Kingdom Accreditation Service (UKAS), and at least 50% of individual parameters are from methods pending accreditation to the Environment Agency Monitoring Certification Scheme (MCERTS) for the range of analyses undertaken as part of this investigation. The MCERTS performance standard for the chemical testing of soil is an application of ISO 17025: 2005, specifically for the chemical testing of soil.

8.2.2 Environmental Testing Suite – Soils

The suite of chemical analyses was based upon a standard suite of test to assess potential contamination along with the findings of the Phase 1 desk study, the conceptual model, observations on site and the client's scope. The chemical analyses were carried out on a number of soil samples and four groundwater samples. The nature of the analyses is detailed below:

- Metals screen - arsenic, cadmium, chromium, lead, mercury, selenium, boron (water soluble), beryllium, copper, nickel, vanadium and zinc;
- Organic screen – total extractable hydrocarbons (EPH) or speciated (TPHCWG) total petroleum hydrocarbons (TPH) including benzene, toluene, ethylbenzene and xylenes (BTEX); polyaromatic hydrocarbons (PAH) – USEPA 16 suite;
- Inorganics screen - cyanide (total), sulphate (water soluble);
- Others - pH, organic matter, asbestos screen (soil only).

The groundwaters obtained were subject to similar suite of analyses.

8.2.3 Waste Acceptance Criteria

Two soil samples were subject to a full Waste Acceptance Criteria suite of analyses, to assist waste classification in anticipation of soils being removed from site for construction purposes. A copy of the laboratory test results is included in Appendix 10.

8.3 Geotechnical Testing

The geotechnical testing has been chosen based on the soils encountered during the site investigation and was undertaken in accordance with BS 1377 at a UKAS accredited laboratory.

The following tests were undertaken:

- Moisture content determination;
- Plasticity testing;
- pH and soluble sulphate testing;
- Particle size distribution testing by wet sieve method;
- Determination of undrained shear strength by triaxial compression.

A copy of the laboratory test results is included in Appendix 11.

9. MONITORING

9.1 Ground Gas

Ground gas monitoring was undertaken by a suitably qualified environmental consultant or technician, using a GFM436 landfill gas analyser and a MultiRaeLite Photo-ionisation detector (PID). The main determinants recorded were methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), VOCs as well as flow.

Ground gas monitoring has been carried out on two occasions to date with future visits planned on approximately quarterly basis as requested by the scope. These will be reported as an updated report.

The results of ground gas monitoring are included in Appendix 9 and a summary is presented in Table 6 below:

Table 6 - Ground Gas Monitoring Results Summary

Location	Typical Concentration					Flow Rate (max.)	VOC	Atmos.c Pressure
	Methane (CH_4)	Carbon Dioxide (CO_2) [% v/v]		Oxygen (O_2) [% v/v]				
	[% v/v]	(Max.)	(Min.)	(Max.)	(Min.)	(l/hr)	(ppm)	(mb)
BH1 (shallow and deep).	<0.1	2.5	0.8	19.1	19.1	0.4	2	1028
BH2 (shallow and deep).	<0.1	0.6	0.1	19.7	18.8	<0.1	1	1030

9.2 Groundwater

The measured groundwater levels were recorded during the two monitoring visits undertaken to date, using a dipmeter and the results of monitoring are presented in Table 7 below:

Table 7 – Groundwater Monitoring Results

Monitoring Well	Depth of Monitoring Well (mbgl)	Groundwater Encountered at (mbgl)					
		Visit 1	Visit 2	Visit 3			
		17/09/20	02/12/20				
BH1 (shallow).	6.3	5.30	4.96				
BH1 (deep).	20.4	5.05	5.36				
BH2 (Shallow).	4.2	2.47	2.44				
BH2 (deep).	20.7	12.24	2.76				

Notes:
Dry - no groundwater encountered
n/m – not measured
0 - well filled with water

10. RISK ASSESSMENT

10.1 Risk to Human Health

10.1.1 Methodology

The current guidance requires that a conceptual model be formulated, based upon the findings of the research. The conceptual model is limited at this stage to the identification and assessment of potential 'hazards', identified or suspected from the results of the research; the potential 'receptors' that may be affected and the anticipated 'pathways' to those receptors. The findings are summarised in the following subsections.

The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification;
- Hazard Assessment;
- Risk Estimation;
- Risk Evaluation.

The risk assessment for UXO is addressed within Section 5 and the Preliminary UXO threat assessment report in Appendix 13.

10.1.2 Soil Quality Screening Values

The results of the soil analyses have been compared to soil quality screening values where deemed applicable, such as:

- The LQM/CIEH S4ULs for Human Health Risk Assessment, (ref. **R.32**);
- Defra/CL:AIRE Final C4SLs, (ref. **R.31**).

Where the concentrations reported by the laboratory analysis (and thus determined onsite) are at or below the respective screening concentrations, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated in the following sections.

10.1.3 Soil Quality Data and Land Use Scenarios

Details of proposed development indicates residential end-use (buildings and hardstanding) with limited soft landscaping, as outline in Section 1.

The land-use scenario for the scheme applied to this risk assessment is Residential with Plant Uptake ("RwPu") as a preliminary measure, with a Soil Organic Matter of 1%', as an initial data screening approach.

This is likely to be slightly conservative because the scheme is unlikely to have residential garden areas at ground level straight ono the extant ground conditions.

10.2 Soil Quality assessment

Table 8 below, summarises the soil quality assessment of this phase of soil sampling and analysis. No elevated concentrations of the subject analytes were recorded:

Table 8 - Summary of Soil Analyses and Comparison with Current Screening Values

Analyte	Analyte Concentration Range (mg/kg)		Screening Value (mg/kg) for Land Use	Number of Elevated Concentrations
	Minimum	Maximum	Residential With Plant Uptake (1% SOM Assumed)	
Arsenic	9	16	37	0
Beryllium	<0.5	0.9	1.7	0
Boron	<1	2.3	290	0
Cadmium	<0.2	<0.2	11	0
Chromium	15	31	910	0
Chromium VI	<2	<2	6	0
Copper	15	20	2400	0
Lead	10	207	200	0
Mercury (inorganic)	<1	<1	40	0
Nickel	9	29	180	0
Selenium	<3	<3	250	0
Vanadium	30	54	410	0
Zinc	45	83	3700	0
Cyanides	<2	2	5/20 Δ	-
pH	7.6	8.8	n/a	-
w/s sulphate (mg/L)	0.1	0.36	n/a	-
PAHs (Total USEPA 16)	<1.6	4.6	n/a	0
Benzo(a)pyrene	<0.1	0.5	2.2	0
Dibenz(a,h)anthracene	<0.1	<0.1	0.24	0

Naphthalene	<0.1	<0.1	2.3	0
EPH / TPH	<6	<42	100*	0
BTEX (sum)	<0.018	0.02	0.13◇	0
PCBs (sum)	<0.1	<0.1	n/a	n/a

*Nominal screening value along with assessing individual EC Groups concentrations where necessary. All soils with speciated TPHCWG data exhibit concentrations <LLODs for each EC band group.
Δ superceded but indicative value
◇ indicative sum value

With regard to the analysis for PCBs, the sampling locations were not in the vicinity of the electrical transformer but the soil samples do not record detectable concentrations.

10.2.1 Asbestos

Results of asbestos screening did not indicate the presence of asbestos within the (Made Ground) soils. However, it is recommended that a discovery strategy is in place for asbestos should it be encountered within the soils during the construction phase, due to the variable nature of Made Ground.

Any suspected asbestos encountered within the soils during the demolition and construction phase of the proposed development should be left in situ and temporarily fenced off, until its identification and removal/treatment has been established. Works in the immediate area of the suspected asbestos should cease during this period until a suitably qualified and authorised person has given permission for works to continue.

10.3 Ground Gas

The results of the soil gas monitoring have been compared with current guidance (ref.**R.35**) however, only one return visit has been undertaken to date, based upon the scope. Further (~quarterly visits) will be undertaken and the report updated accordingly. Outline soil gas assessment is provided here but for the complete assessment further data is required.

The results show no detectable methane concentrations within the monitoring wells and negligible to very low concentrations of carbon dioxide and VOCs. No significant gas flow was detected within the wells; a maximum of 0.4l/hr at BH2 only.

On the basis of this limited dataset the gas screening values of <0.01l_{CH4}/hr and <0.01 l_{CO2}/hr have been calculated.
Based upon this and the current guidance, no gas protection measures are required for the proposed structure's however, this is subject to (i) further soil gas data monitoring and (ii) the potential re- assessment of the soil gas regime when replaced following construction. This is consistent with the assessments made with the previous reports.

10.4 Risk to Controlled Waters

The risk to Controlled Waters is assessed utilising the available data from this phase of investigation. Further assessment may be required to assess the groundwater conditions within pre-existing monitoring wells and groundwater sampling points.

The groundwater sampling undertaken from BH01 and BH02 of this investigation indicate no elevated concentrations of analytes within the water samples. The sampled groundwater shows no impact by contaminants / the analytes and a low risk is posed based upon this data.

However, as outlined below within Section 12, further assessment is necessary in the eastern section of the site where previous investigation encountered hydrocarbons in groundwater at GEABH2. The risk to controlled waters in this part of the site is not low.

10.5 Risk to Plants

A review of the commonly occurring phytotoxic chemicals boron, copper, nickel and zinc, has been undertaken based upon the now superseded ICRCL guidance. Although the ICRCL trigger threshold levels have been withdrawn, there are no equivalent guidance values for phytotoxicity.

Concentrations of metals were recorded at concentrations below the thresholds considered to have phytotoxic effects – a low risk is posed to plants. However, any proposed soft-landscaped and planting areas will likely be created as part of the scheme and suitable quality subsoils and topsoils should be imported.

10.6 Risk to Services - Pipes

A comparison of the laboratory results has been made against the Contaminated Land Assessment Guidance, published by Water UK (ref. **R.18**). Note, the full range of thresholds given in this guidance have not specifically been tested for.

Whilst no specific potable water pipeline protection is envisaged necessary, based upon the available near-surface soil data, it is advised that the UK Water Industry Research Guidance (ref. **R.19**) is adopted and consultation with the local water company is sought prior to laying any services. For example, considering the civil engineering works and soil movements to construct the scheme, new potable water pipes are likely to be laid within Made Ground in most parts of the site and this should be of suitable quality when placed in areas of potable water pipe runs.

10.7 Updated Conceptual Site Model

Following the findings of the site investigation the Preliminary Conceptual Site Model for the site has been reviewed and the conclusions are presented in Table 9 overleaf:.

Table 9 – Updated Conceptual Site Model

Sources	PATHWAYS: Root Uptake	Direct Contact	Ingestion	Respiration	Gas Accumulation	RECEPTORS: Plants	End Users	Structures (Concrete)	Services/Utilities	Construction Workers	Controlled Waters (GW)	Risk Rating	Comments
General soil quality: Made Ground	U	U	U	U	U	N	N	N	N	N	N	NR/LR	Soil quality of this phase of investigation does not pose a hazard to receptors; other phases of investigation have encountered localised contamination or potential hazard sources. Recommendations are provided below.
Hydrocarbons in groundwater (GEABH2)	N	U	U	U	U	N	N	Mi	Mo	Mo	Mo	MR	Further investigation of the groundwater regime and the hydrocarbons concentrations in (soil and) groundwater in the east of the site is warranted.

Legend:-
See Comparison of Consequence Against Probability within Appendix 6 for Key to Legend.

Probability:		Consequence (Severity):		Risk Rating:	
Negligible (N)		Negligible (N)		Very High Risk	**VH**
Unlikely (U)		Mild (Mi)		High Risk	**HR**
Likely (L)		Moderate (Mo)		Medium Risk	**MR**
Highly Likely (HL)		Severe (S)		Low Risk	**LR**
				Negligible Risk	**NR**

11. GEOTECHNICAL CONSIDERATIONS

11.1 Proposed Development

As mentioned previously, the site is to be redeveloped to comprise the demolition of existing buildings and structures and redevelopment of the site comprising residential (Use Class C3), ground floor commercial/retail/cafe (Use Class E), and public house (Sui Generis) with associated landscaping, restoration of Diamond Jubilee Gardens and other relevant works.

Proposed development plans, ref. TRS-HAL-A-2499 to TRS-HAL-A-2505 dated June 2020 are provided within Appendix 3.

Development information provided by Webb Yates Engineers indicate finished floor levels on the Upper Terrace to reside at 7.6maOD, with basement level in the vicinity of Wharf Lane residing at 4.6maOD. The Lower Terrace is proposed to reside at the current level of 4.2maOD. Structural information indicates internal column design loads to be in the region of 3,750 kN, with live loads in the region of 1,400 kN, although it is anticipated that the final design of structures will utilise a lighter superstructure and therefore reduce the design load.

The following recommendations should therefore be reviewed and updated, where applicable, once the final design is known.

11.2 Summary of Ground Conditions

Given the variability in site levels across the investigated area, together with refusals noted within a number of exploratory holes, the full soil profile was only encountered within a small number of holes. Therefore, for background information only, the findings of the previous investigation have been utilised.

Made Ground, including any surface materials, was recorded to extend to depths ranging from 0.6m to 1.7mbgl. This was underlain by granular soils of the River Terrace Deposits, extending to depths ranging from 2.2m to 5.8m, and was underlain by soils of the London Clay Formation extending to the full depth of this investigation. It can be noted that within the other phases of investigation by others the Made Ground was recorded to 3.5mbgl (Southern Testing borehole SH2, interpreted to be located to the east of the extant café building within the Gardens; deep Made Ground here to be anticipated).

Groundwater was encountered to reside within the River Terrace Deposits at depths ranging from 2.44m and 5.36m below current ground levels, with the shallower encountered depth being located in the vicinity of BH02 of the current investigation and the deeper groundwater being encountered with BH01 of the current investigation and located at a higher ground level.

11.3 Foundations

11.3.1 Ground Desiccation

Where soils are identified as being non-plastic, they are generally regarded as not having volume change potential and therefore not likely to induce any ground movements associated with changing soil moisture conditions. These soils include granular soils of the Made Ground and River Terrace Deposits.

The results of geotechnical classification testing indicate the London Clay to typically contain soils that are of very high plasticity and high-volume change potential, although the moisture condition of the soils indicate that no desiccation exists with the soils.

Whilst the effect of trees upon cohesive soils is typically assessed as to the effect on the proposed development, it is unlikely that this would present a problem given the soil profile and the assumed foundation type (Piles).

11.3.2 Foundation Options

Based upon the anticipated loads associated with the proposed development, a conventional trench fill or pad foundation would be considered not suitable and an alternative foundation solution should be adopted. Possible alternative foundation types include piles, terminating within the underlying bedrock London Clay Formation, or a raft foundation bearing on to the loose to dense granular River Terrace Deposits.

For a raft foundation of size 6.7m x 7.3m, an equivalent square raft of dimensions 7.0m has been derived and used to undertake the following assessments. In order to estimate the total settlement of a raft of the above dimensions with an imposed pressure of 60kN/m^2 and 80kN/m^2 at founding level, the following assumptions have been made:

- The raft is evenly distributed with no allowance for point loads beneath the underside of the foundation;
- Where a basement is absent, the existing granular Made Ground soils are utilised as a capping layer to the natural soils and hold a minimum compaction of 50kN/m^2;
- Where a basement exists, the raft bears directly onto the soils of the River Terrace Deposits;
- River Terrace Deposits are designed to a minimum of 40kN/m^2, based on in-situ testing results.

Based upon the above, total drained settlements of between 14mm and 19mm have been calculated. Settlements in granular soils will typically comprise immediate settlement. Based upon recorded groundwater levels and proposed finished floor levels, the design of raft foundations is unlikely to require precautions for buoyancy due to the presence of groundwater.

Alternatively, piled foundations are considered suitable and are likely to be carried by a combination of adhesion (skin friction) and end bearing within the River Terrace Deposits and London Clay Formation soils, terminating within the latter. Piling would also allow the volume of soil to be disposed of to be minimised.

The proven ground conditions would indicate that bored piles could be employed to provide a suitable foundation solution. However, the method of installation will have to accommodate the presence of groundwater within the River Terrace Deposits.

Dependent upon the method employed it is considered likely that driving displacement (driven piles) through River Terrace Deposits would prove disruptive to nearby properties and their occupants and as such is unlikely to be permitted.

For the purposes of this initial discussion and for reasons given above, consideration has been given to the adoption of cast in situ piles (e.g. CFA). The use of CFA piles would prove beneficial as this method does not require casing or the use of bentonite slurries. However, there are certain practical constraints when considering the incorporation of pile reinforcement.

The modelled ground profile has been taken from BH01 as this incorporates soil information relevant to finished floor level, although in-situ and laboratory-based information has been derived from both deep boreholes. The finished floor level has been taken to be 7.6maOD. Groundwater level has been monitored at 3.1maOD and so interpreted that this is within the range of groundwater elevations; season and tidal fluctuations are likely to apply, of course.

In consideration of the inclusion of a basement structure into design proposals, an initial 3.0m of the soil profile has been removed and represents the most conservative approach, although a comparison has been provided for the structure absent of a basement.

The competency of the soil profile used for these calculations is based upon the examination of the recovered samples and the results of in situ and laboratory testing.

The illustrative calculations provided within Table 10 below, for axially loaded pile capacities have been undertaken for a single pile acting in compression. Available capacities may vary for piles acting in tension:

Table 10 – Preliminary Pile Loads (kN)

Pile Diameter (mm)	Pile Depth (m bgl)			
	15		20	
	Inc. 3.0m Basement	No Basement	Inc. 3.0m Basement	No Basement
300	210	226	357	374
450	342	367	550	574
600	492	525	769	802

Notes:

[1] The above values have been calculated based on N60 SPT values as these represent a conservative approach.

[2] In this case, the upper 1.5m/3.0m of the soil profile has been ignored to account for the loss of friction from the Made Ground/inclusion of a basement.

Table 10 – Preliminary Pile Loads (kN)				
Pile Diameter (mm)	**Pile Depth (m bgl)**			
	15		**20**	
	Inc. 3.0m Basement	**No Basement**	**Inc. 3.0m Basement**	**No Basement**
[3] A global factor of safety of 2.5 has been used in all cases.				
[4] The soil profile assumes a final site level (ground level) of 7.60m aOD (BH01)				

Working capacities for pile groups should be assessed when final design details are known, although for preliminary design purposes it is likely that piles spaced at least 3 x pile diameter from other piles in any group will behave as single piles.

Where preliminary and working pile load tests are undertaken it may be appropriate to reduce Safety Factors, although 2.5 may be a minimum local authority requirement. Should testing not be undertaken it is suggested that a factor of safety of at least 3.0 should be adopted.

For all piling options it is recommended that the advice of specialist foundation contractors be sought at the earliest opportunity. Piling specifications should be obtained from specialist contractors with reference to their particular products as this may affect the calculated capacity.

The selection of piling techniques should not only consider attainable pile capacities but also consider access constraints applicable to particular plant and potential vibration effects on existing adjacent foundations.

11.3.3 Excavations, Temporary Works and Groundwater Ingress

All excavations within the Made Ground and River Terrace Deposits must be assumed to be subject to short term instability. Excavations below the water table are likely to be problematic without positive groundwater control.

It is expected that excavations within the cohesive London Clay Formation soils will be stable in the short term. However, where excavations are required to remain stable in the medium or long term they should be suitably supported or side slopes battered back to a safe angle of repose.

Where personnel access is required to any excavation its stability should be assessed by a suitably qualified and experienced responsible person. For general guidance it is recommended that where access is required to excavations greater than 1.2m depth excavations should be fully supported or side slopes battered back to a safe angle of repose.

Further guidance may be obtained from CIRIA document 97, 'Trenching Practice (ref. **R.19**).

Particular attention must be paid to ensuring the stability of adjacent structures, neighbouring sites as well as road frontages and the adjacent River Thames.

Standing water levels were recorded between 2.47mbgl (BH2, shallow installation) and 12.24mbgl (BH2 deep installation) depth across the site. At BH1, the GWL varied between 5.05mbgl and 5.30mbgl. These standing water levels indicate that the potential for perched groundwater at various levels within the made ground and natural soils should be considered during excavations.

Excavations beneath the water table, and particularly granular soils, will require positive drainage to maintain adequately dry working conditions and excavation stability. Where encountered, ingress of perched water should be adequately dealt with by pumping from sumps.

The control of groundwater may also be addressed in the structural design, for example by raising the basement floor construction above the standing groundwater level, or by adopting a contiguous or secant piled walls sealed into the London Clay Formation soils around the perimeter of the basement. Although based on the recorded groundwater levels, it is unlikely that this will be required.

All structures founded below the water table must be designed to accommodate the forces of buoyancy, either by self-weight or by tension piles, if necessary.

11.4 Retaining Structures

The construction of a basement will require careful consideration to be given to the stability of adjacent structures, services and property. Given the proximity of sensitive structures adjacent to proposed basements, it is considered unlikely that a basement could be constructed in an 'open' unsupported excavation. Retaining structures are likely to be required, i.e. propped opposing walls or cantilevered piled walls. Alternatively, a contiguous or secant pile wall could be constructed into the River Terrace Deposits to provide a suitable retaining structure, either acting in cantilever or propped. A secant pile wall or wing-jetted contiguous pile wall would effectively ensure control against water ingress associated with known water bodies or perched water bodies not revealed by the investigation.

It is recommended that retaining structures should be designed using effective shear strength parameters. Suggested geotechnical parameters for use in design are provided in Table 11 below:

Table 11 – Summary of Drained Soil Properties

Strata	Angle of Internal Friction (ϕ) (degrees)	Cohesion (kPa)	Bulk Density (kN/m^3)
Made Ground	28	0	18
River Terrace Deposits	33	0	22
London Clay Formation	18	0	19

Excavations - Stability of Cut Slopes

To minimise the risk of slope instability, temporary cut slopes, where required, should ideally be limited to the narrowest practicable bay widths, preferably working by progressive cutting and backfilling of narrow bays. Short lengths of open slope face will have a greater degree of stability as they will have some support by arching.

Should cuttings be made below the standing water level they must be expected to be unstable and prone to collapse.
Temporary slopes should be cut to as shallow a gradient as is practicable, although a shallower gradient will, of course, attract less risk. The slopes should be regularly inspected for evidence of movement or distress.
Temporary faces should be left open for the minimum period possible. Care should be taken during construction to prevent the crests of temporary slopes from being loaded, (e.g. haulage traffic should be routed away from the crest).

Specific measures to prevent ponding at the top of the slope, and to prevent water flowing down the face of the excavation should be adopted.
Long Term Stability - Hydrostatic (Uplift) Pressures: Seepage into excavations must be anticipated, and this can be expected at shallow depth. The possibility of perched groundwater at various levels within the made ground soils should not be overlooked.
Where the maintenance of lateral drainage from behind and beneath deep structures or through floor slabs cannot be guaranteed they must be built with sufficient dead weight to counteract the effect of uplift (hydrostatic) pressure that may be created by the presence of water. Alternatively, uplift may be resisted by the installation of tension piles or ground anchors.

11.5 Floor Slabs

In view of the adoption of a piled foundation, it is likely that ground floors will be suspended for all sensitive structures. However, where River Terrace Deposits are proven at formation level, ground bearing floor slabs may be adopted. It is not considered appropriate to use the existing Made Ground as a formation soil.
Where ground bearing floors are adopted, formations should be adequately proof rolled and any soft / loose or otherwise unsuitable materials excavated and replaced with a suitable engineered fill.
Differential movement between the floor slab and structural walls and across the floor slab itself should be anticipated. It is therefore recommended that ground bearing floors should be fully debonded from structural load bearing walls and suitably reinforced top and bottom to enable spanning of soft spots.
The detailing of services through or beneath ground bearing floors should incorporate flexible connections and where appropriate enhanced falls.

11.6 Soil Infiltration Data

Planning policy, together with the support of The Environment Agency, recommend the maximum practical use of Sustainable Urban Drainage Systems, (SuDS), within proposals for new developments. There is a requirement that SuDS be installed, where appropriate, in order to limit the amount of surface runoff

entering drainage systems and to return surface water into the ground to follow its natural drainage path. Further guidance, including details of SUDS methods, is provided within CIRIA Report C753 'The SuDS Manual', 2015 (ref. **R.22**). CIRIA 687 entitled 'Planning for SUDS – Making it Happen', published in 2010 (ref. **R.23**), states that the Flood and Water Management Act 2010 aims to encourage Local Authorities to be responsible for the approval and eventual adoption of SuDS, although adoption of roadways which include permeable paving is often rejected.

Soakaway testing was undertaken in two trial pits (TP/SK01 and TP/SK02) and was undertaken in general accordance with the guidance provided within BRE Digest 365 'Soakaway Design', 2016 (ref. **R.9**). In addition, a borehole falling head test was undertaken in the BH01 and BH02 of this phase. A summary of the infiltration rates is presented in Table 12 below, and provided in full within Appendix 8:

Table 12 – Infiltration Testing Results (m/s)

Location	Test 1	Test 2	Test 3	Comments
TP/SK101	$3.31x10^{-5}$	$2.23x10^{-5}$	$1.86x10^{-5}$	
TP/SK102	No result	$4.66x10^{-5}$	$6.64x10^{-5}$	Collapse of pit due to loose soils.

Based upon the results of the infiltration testing, it is clear that infiltration within both test locations was appreciable. It is therefore considered that soakaways in these locations are considered to be designed to an infiltration value of $1.86x10^{-5}$ m/s.
It is recommended that liaison with the relevant regulatory bodies and third parties (i.e. the LPA, The Environment Agency, Thames Water) is undertaken at an early stage to ensure any surface water drainage proposals are approved.

11.7 Concrete Classification

The results of chemical tests within the Made Ground and River Terrace Gravels indicate a sulphate concentration of between <10mg/l and 16mg/l as a 2:1 water/soil extract. Within the London Clay Formation soils, sulphate concentrations are reduced in the range of between 218mg/l and 604mg/l as a 2:1 water/soil extract. A pH value in the range of 7.6 to 8.8 was recorded across all soils encountered.

In consideration of the previous usage of the site, it is recommended that brown-field conditions be assumed for the purposes of assessing the aggressive chemical environment for concrete classification (ACEC class).

Given the presence of permeable natural soils (River Terrace Deposits) and the noted occurrence of groundwater seepages, mobile conditions can be reasonably assumed for shallow buried structures. Although any foundations (i.e. piles) crossing into the London Clay Formation may be designed to accommodate for static groundwater conditions

In accordance with the BRE digest (ref. **R.6**), a DS-1 Design Sulphate Class and an AC-1 ACEC classification may be assumed as a minimum for the design of concrete in contact with Made Ground and natural River

Terrace Deposits at the site. However, where deeper foundations are adopted and cross into the London Clay Formation, a DS-2 Design Sulphate Class and an AC-1s ACEC classification may be assumed as a minimum for the design of concrete

11.8 Waste Materials – Considerations

Under the European Waste Directive, waste materials from the scheme will require waste category classification; in addition to which, it will be required to be pre-treated, prior to disposal, in order to apply any possible waste volume reduction.

The pre-treatment process(es) must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a Position Paper#13 which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils in situ prior to excavation. The latter segregation of soils and other site materials is common / standard practice on construction sites but a detailed Materials Management Plan that is adhered-to can greatly assist waste reduction/recycling/re-use rates.

The soils encountered within this phase of investigation have been considered to be likely to be excess or waste soil, in the absence of a Materials Management Plan or similar for the scheme at this stage.

If the Claire DoWCoP (ref. **R.37**) is applied to this scheme so that soils and site clearance / preparation / demolition materials are assessed within a mass-balance / volume assessment, then it may be possible to design the scheme as a zero-waste-soil (or low volume waste soil) scheme, by re-using as much as possible onsite.

Granular and anthropogenic materials (i.e. demolition waste / rubble, hardcore) from the site will require assessment and re-processing to enable suitability for re-use onsite. This may be more cost effective than disposal of material and re-import. Alternatively, it may be applicable to remove the soils to an off-site treatment / processing facility for re-import with cost-savings remain, due to the avoidance of landfill taxes. Reputable, suitably licenced and competent contractors should be engaged to assist the designs and costings.

11.8.1 Soil – Waste classification

Waste is classified as being either Hazardous or Non-Hazardous; in addition, landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste, in accordance with the Waste Directive. Similarly, the facilities providing soil / materials treatment and re-use will require the material to be classified as either non-hazardous or hazardous. Waste classification is a staged process and this investigation (along with other site data) represents the initial

phases of that process. Landfilling excess soil/materials normally incurs significantly greater costs that the various options for re-use, treatment-and-re-use or others.
Once the extent and location of the excess or waste (soil / materials) that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing and, moreover, the optioneering and design for soil re-use, aggregate manufacture etc. within the scheme and for export and re-use.

(It should be noted that "WAC" analysis (leaching test results) must not be used for waste classification purposes, other than for some landfill destinations. However, undertaking WAC testing at the time of analysis does enable all waste soil removal and disposal options to be considered.)

The below assessments of the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving facility (landfill/non-landfill) once the soils to be discarded have been identified and, where necessary, re-analysed.

Analysis has been undertaken to assist this assessment, utilising the available soil analysis data from this phase and has been assessed, in accordance with WM3 (ref. **R.33**).

- All of the assessed soils are non-hazardous (for non-landfill destinations).
- The sample BH1+BH2, composite, 2.0-24.0 (laboratory report reference 20-10989) was analysed to assess the likely pile arisings waste category. For non-landfill destinations this soil is indicated to be non-hazardous. For landfill destinations this is indicated to be not inert, thus hazardous (SNRH) due to a marginally elevated leachable selenium concentration only. This is common for London clay soils.
- Various samples including *BH01A +BH01B, composite, 0.20-0.80* were analysed to assess the likely waste classification of the materials (demolition rubble) encountered near-surface. For non-landfill destinations this soil is indicated to be non-hazardous. For landfill destinations this is indicated to be inert.
- Soil represented by sample *WS01A and WS2, J1, Combined, 0.2mbgl* (laboratory report 20-10290) is not inert (if destined for landfill) due to an elevated TOC value (only).

However, the volume of samples encountered from these investigation works should be considered compared to the volumes of Made Ground soil onsite and the inherent variability of Made Ground. Further testing, once the ground is accessible is recommended.
In summary, the natural soils, as arisings from excavations or piles, are suitable for re-use on site. As are some of the Made Ground soils, based upon this phase of soil sampling and assessment but as with the variability of Made Ground as indicated by the previous reports, this is subject to variation and should be assessed further as the scheme progresses.

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

A phase of previous investigation of the northern / eastern section of the site indicates that the ground conditions comprise Made Ground over Kempton Park Gravel (encountered to depths up to 5.8mbgl), overlying London Clay and are consistent with the anticipated geology. Localised detectable concentrations of hydrocarbons and PAHs in soils were recorded, with recommendations considered below.

As assessed by the previous investigations(s) for other parts of the scheme, the site comprised formerly (i) the premises and gardens of Richmond Gardens and (ii) various buildings (public house) in the north of the site before being developed in the early 20th century into the Twickenham Swimming Baths (Lido) and associated buildings and facilities. These became unused and derelict by the 1980s with demolition/clearance in 2004 and redevelopment into the extant Diamond Jubilee Gardens in 2011/2012.

Anecdotal evidence suggests that the base of the swimming pool was not removed as part of the site clearance scheme and the demolition rubble / materials were used to fill the void. Evidence to further this assessment was encountered in the hand-tool-excavated service inspection pit of BH01B.

The scope of this investigation was limited to defined areas and encountered significant in-ground obstructions at a number of locations; these are interpreted to be the floor / base of the former swimming pool and a structural floor slab (or similar) of the former Swimming Baths structure along the centre-south of the site.

The quality of the soils and groundwater sampled within this phase of investigation do not pose a significant risk to all modelled receptors. However, soil quality / potential groundwater contamination factors from previous investigations with different risk assessments are considered below.

12.2 Recommendations

The previous phase of investigation included recommendation to investigate soil and groundwater quality at a location WS2; this is in the vicinity of the extant electrical transformer in the centre-north of the site. This investigation was outside the scope of this scheme and is should be noted that a high voltage cable is recorded in that area.

The chemical data within that report (including assessment of PCBs in a soil sample at 0.4mbgl) can discount the presence of PCBs in the shallow soils but the potential for PCBs to be in soils and possibly groundwater at depth at this location cannot be fully discounted because there are detectable concentrations of TPH (>620mg/kg) at 3.7mbgl but PCBs were not analysed in that sample. The TPH concentration in soil is not significantly elevated but the presence of PCBs within it cannot be discounted. However, a groundwater sample from BH2 reports elevated concentrations of hydrocarbons (but PCBs were not-analysed-for. These hydrocarbon concentrations require further assessment, if only to (a) inform the

costs of any dewatering activities that may be necessary in this part of the site and (b) determine the risk to Controlled Waters.

As part of the preparation to upgrade, relocate or decommission this electrical substation it is recommended that further investigation of soils and groundwater in this part of the site is undertaken to inform any basement excavations and general scheme risk assessments.

In consideration of the current proposed development scheme, it is possible that the proposed structure will provide a pathway break between any contamination and the end user receptors; this may require full consideration when the design is finalised and subject to any further ground data. However, it would be prudent to assess the hydrocarbon contamination in the east of the site (if still present) to address risk to construction workers, any potential dewatering activities in this area of the site, risk to controlled waters and placement of potable water pipes in this area. The previous report recommends consideration of designing with a hydrocarbon-vapour proof/resistant membrane to the structure(s). Until the risks presented by this potential contamination are proved to be sufficiently low, this is a prudent measure for the structure(s) in the east of the site.

Due to the nature of the site, the ground conditions, buried services and obstructions present, the various phases of intrusive investigation have been constrained and provide a limited picture of (a) the nature of the swimming pool backfill material (b) the general ground model and potential risks to the scheme. It is assumed that an appropriate juncture the site will be made available for a wider scheme of intrusive works to expose the remnant structures across the site, assess the ground conditions in more detail and the risks to all receptors and develop the ground model and designs.

It is assumed that to facilitate the proposed structures and site remodelling at least some of the remaining swimming pool base / floor slab, as assumed to be present and intact, will have to be removed. This has the potential to create a large volume of re-processable materials (brick, concrete, rubble etc.) for re-use on site, if determined to be suitable for that re-use. A scheme of re-use of site-won materials would form part of a Materials Management Plan for the redevelopment, for submission to Claire for use throughout the scheme and would require validation at the completion of the scheme.

The infiltration testing indicates suitable ground conditions within the River Terrace Gravels. Additional or confirmatory infiltration testing is likely to be warranted when ground-access is possible in the areas of proposed SUDs within the final scheme design. Similarly, the status of the hydrocarbon contamination in groundwater in the east of the site may prevent the use of this area for SUDs, unless any hydrocarbons contamination is removed or remediated.

Continue the soil gas and groundwater monitoring within this phase of works but also undertake groundwater sampling of any serviceable monitoring wells of the previous ground investigation phases. For example: assessment of groundwater quality (hydrocarbon content) in the east of the site, based upon previous hydrocarbon concentrations within BH2 (GEA) that may still be present and the source is undefined

at this stage. Assessment of concentrations of PCBs would also address the potential source being the electrical substation.

To determine in more detail the variation in groundwater elevation, further regular monitoring undertaken or the installation of a series of dataloggers could be could be combined with the above for circa 1 week: if a datalogger was installed within each of the serviceable monitoring points to attain regular readings greater clarity of the groundwater regime would be available.

A Detailed UXO risk assessment should be undertaken for the scheme. This may result in a requirement for UXO specialist presence or other mitigation measures during site preparation and construction phases. Further site wide investigation of shallow ground conditions and remaining obstructions / structures, to inform risk and designs is required site-wide. Development of a scheme design and materials management regime to clear the extant structures, assess and penetrate or remove the remaining in-ground obstructions while also facilitating re-processing and re-use of suitable site-won materials (where proven safe-to-do-so) for regrading, and in retaining structures.

Assuming that demolition of the remaining buildings will be necessary to progress the scheme it would be necessary to (a) fully update the building Asbestos Register, where present or (b) undertake a Refurbishment and Demolition (asbestos survey) of the buildings, in accordance with MDHS guidance (ref. **R.16**) and in advance of any disturbance works. The extant electrical substation will require appropriate liaison with the owners/ operators along with the same for all buried services such as cable and the sewerage system in the southern corner of the site.

Cohesive ground conditions and the presence of mature trees should be taken into consideration; this generally applies to the north of the site, where the mature tree will require protection (assuming they are to be retained) and cohesive soils over the granular river terrace deposits may have an influence.

Any further site investigation should be designed in general accordance with and undertaken in general compliance with BS10175, (ref. **R.14**) and BS5930, (ref. **R.15**), CLR 11 and other current guidances.

It is recommended that this report be submitted to the Local Authority as part of the planning submission for the site.

12.3 Recommendations – summary

A Detailed UXO assessment is required for the scheme along with groundwater quality sampling in the east of the site; site-wide further soil / obstruction investigation is likely to be beneficial to the scheme design when ready access is permitted. Groundwater elevation measurements using dataloggers within monitoring wells should inform any groundwater level variation design considerations, potentially due to tidal influences.

APPENDICES

Appendix 1 – Report Limitations and Conditions

General Limitations and Exceptions

This report was prepared solely for our Client for the stated purposes only and is not intended to be relied on by any other party or for any other use. No extended duty of care to any third party is implied or offered.

Geosphere Environmental Ltd does not purport to provide specialist legal advice.

The Executive Summary, Conclusions and Recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon, until considered in the context of the whole report.

Interpretations and recommendations contained within the report represent our professional opinions, which were arrived at in accordance with currently accepted industry practices at the time of reporting and based upon current legislation in force at that time.

Environmental and Geotechnical Reporting (including Phase 1, Phase 2 and Site Walkovers) Limitations and Exceptions

The comments given in this report and the options expressed herein, are based on the readily available information collated for the report and an assessment based upon the current guidance which for Phase 1 / Phase 2 report is primarily the Contaminated Land Research (CLR) Report and notable, CLR report 3, 'Documentary research on industrial sites'.

The report has been prepared in relation to the proposed end-use and should another end-use be intended, reassessment may be required.

No warranty is given as to the possibility of future changes in the condition of the site.

The opinions expressed cannot be absolute, due to the limitation of time and resources imposed by the agreed brief.

With regards to any aspect of land contamination referred to, this is limited to those aspects specifically stated and necessarily qualified. No liability shall be accepted for other aspects which may be the result of gradual or sudden pollution incidents, past or present land uses and the potential for associated contamination migration.

Any Desk Study Report / data has been produced largely from the information purchased from The Landmark Information Group. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. The information purchased has been assumed to be correct and free from errors. However, there is the possibility that some data may be missing from the report including (but not limited to) unrecorded land uses both onsite and offsite or unrecorded pollution events. No attempt has been made to verify the information.

The accuracy of any map extracts cannot be guaranteed. It is possible that different conditions existed onsite, between and subsequent to the various map surveys provided.

Any site walkover undertaken is a snapshot of the site recording the visually evident conditions at the time of the walkover in the areas readily accessible. It is possible that after the walkover, the site was altered (for example by fly-tipping or groundworks) or before the walkover, the site conditions changed removing evidence of potentially contaminative features (such as oil tanks removed).

Any intrusive works only cover a tiny proportion of the site. Where exploratory holes are positioned by Geosphere Environmental Limited, they are located to give as good a coverage of the site as possible and to target features / proposed land use where applicable, whilst allowing for areas that cannot be accessed, Client requested locations and other site / time / budget constraints. While assumptions may have been drawn between exploratory holes on the ground conditions and / or extent or otherwise of any contamination, this is for guidance only and no liability can be accepted on its accuracy.

Foundation design is outside of the remit of Geosphere Environmental Limited unless specifically stated and it is recommended that the services of foundation design specialists are sought as required. Any foundation appraisal contained within the report is limited to foundation optioneering.

Any conceptual site model is based upon the information available at the time of conducting this assessment and is an interpretive assessment of the conditions at the site. Redevelopment and / or further investigation of the site may reveal additional information and therefore alter the conceptual site model and the report conclusions.

Any infiltration testing results are considered to be representative of the ground conditions at the locations tested and at the time of testing. As well as lateral variation in ground conditions, seasonal changes in ground water level may affect the results.

Any post-fieldwork monitoring (including ground gas / groundwater) is a snapshot of the conditions at the time of monitoring.

Appendix 2 – References

R.1. CLR 11, 'Model Procedures for the Management of Contaminated Land: Risk Assessment Procedure', DoE 2004.

R.2. CIRIA SP69, 'The Engineering Implications of Rising Groundwater Levels in London, 1989.

R.3. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

R.4. "The Lost Rivers of London: A Study of Their Effects Upon London and Londoners, and the Effects of London and Londoners on Them", N Barton, 1962.

R.5. Health Protection Agency and British Geological Survey, Report HPA-RPD-033 'Indicative Atlas of Radon in England and Wells', 2007.

R.6. BRE Special Digest 1, 'Concrete in Aggressive Ground, 2005.

R.7. BRE Report 211, 'Radon, Guidance on the Protective Measures for New Buildings, 2015.

R.8. BRE Digest 240, 'Low-rise Buildings on Shrinkable Clay Soils: Part 1'. September 1993.

R.9. BRE Digest 365, 'Soakaway Design', 2016.

R.10. BRE Digest 412 'Desiccation on Clay Soils', 1996.

R.11. Nitrates Directive (91/676/EEC) 1991.

R.12. The Environmental Protection Act, Part IIA, Section 78, 1990.

R.13. Environment Act 1995, Section 57, DoE 1995.

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Appendix 3 – Drawings

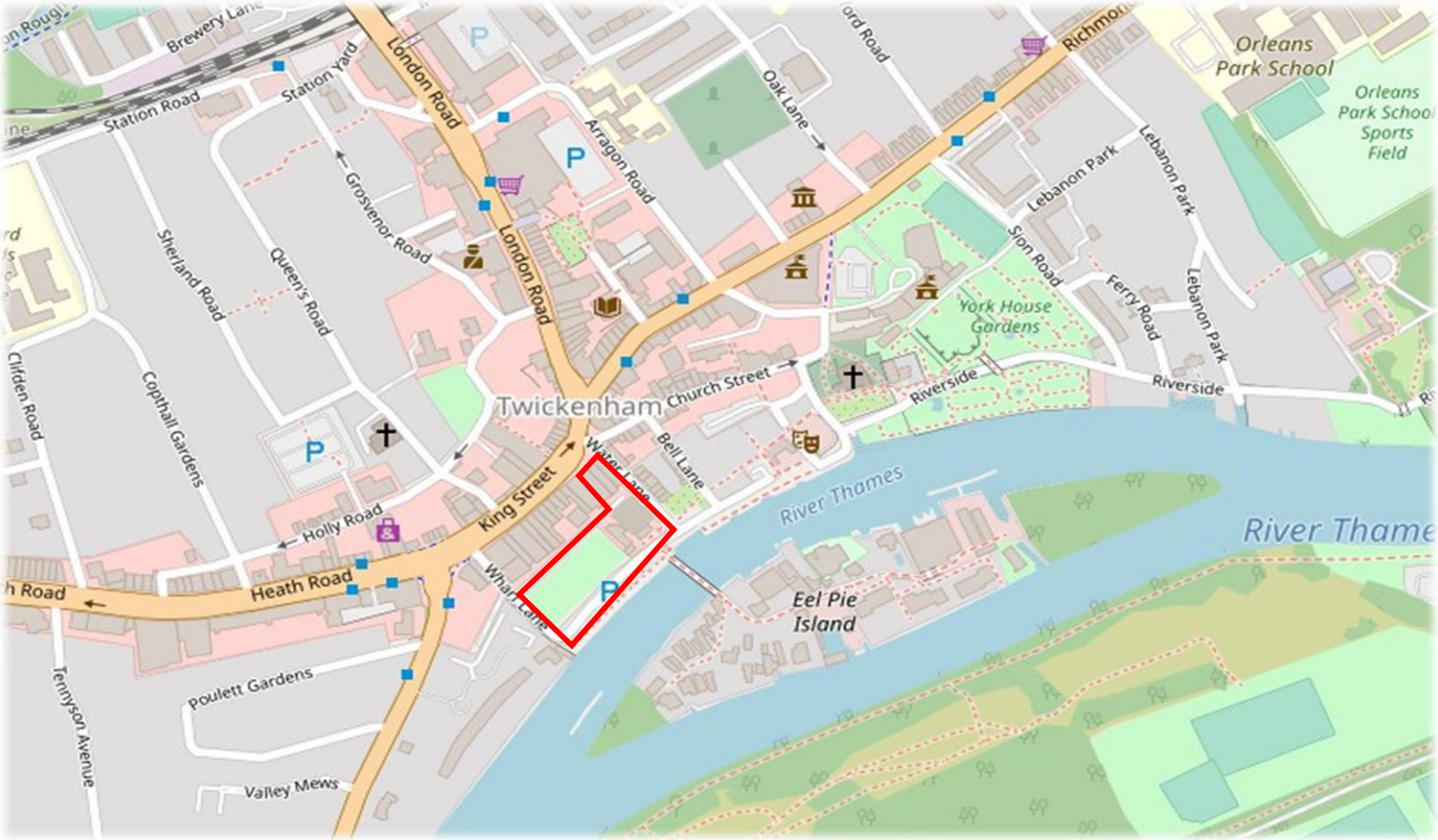
Site Location Plan – Drawing ref. 4955,SI/001/Rev0

Exploratory Hole Location Plans – Drawing refs. 4955,SI,003/Rev0 to 005/Rev0

HP02 Detail – Drawing ref 4955,SI/006/Rev0

Topographic and Buried Utilities Survey (as provided) - Drawing ref. 16304cv-01 Rev B

Proposed Development Plans – Drawing refs. TRS-HAL-A-2499 to TRS-HAL-A-2505



GEOSPHERE ENVIRONMENTAL

LEGEND

Site Location (approximate outline)

SOURCE

© OpenStreetMap contributors

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

TITLE

Site Location Plan

DRAWING NUMBER

4955,SI/001/Rev0

SCALE	DATE
NTS	16/09/2020
DRAWN BY	**CHECKED BY**
PC	JD

N

GEOSPHERE ENVIRONMENTAL

LEGEND

Area with no access for site investigation equipment (extant structures / overgrown or outside of Scope)

Added comments / annotations

Electrical substation

Retaining wall / structure (approximate location and extent)

SOURCE

Excerpt from provided drwg ref:26576se-01 (dated26/06/2020)

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

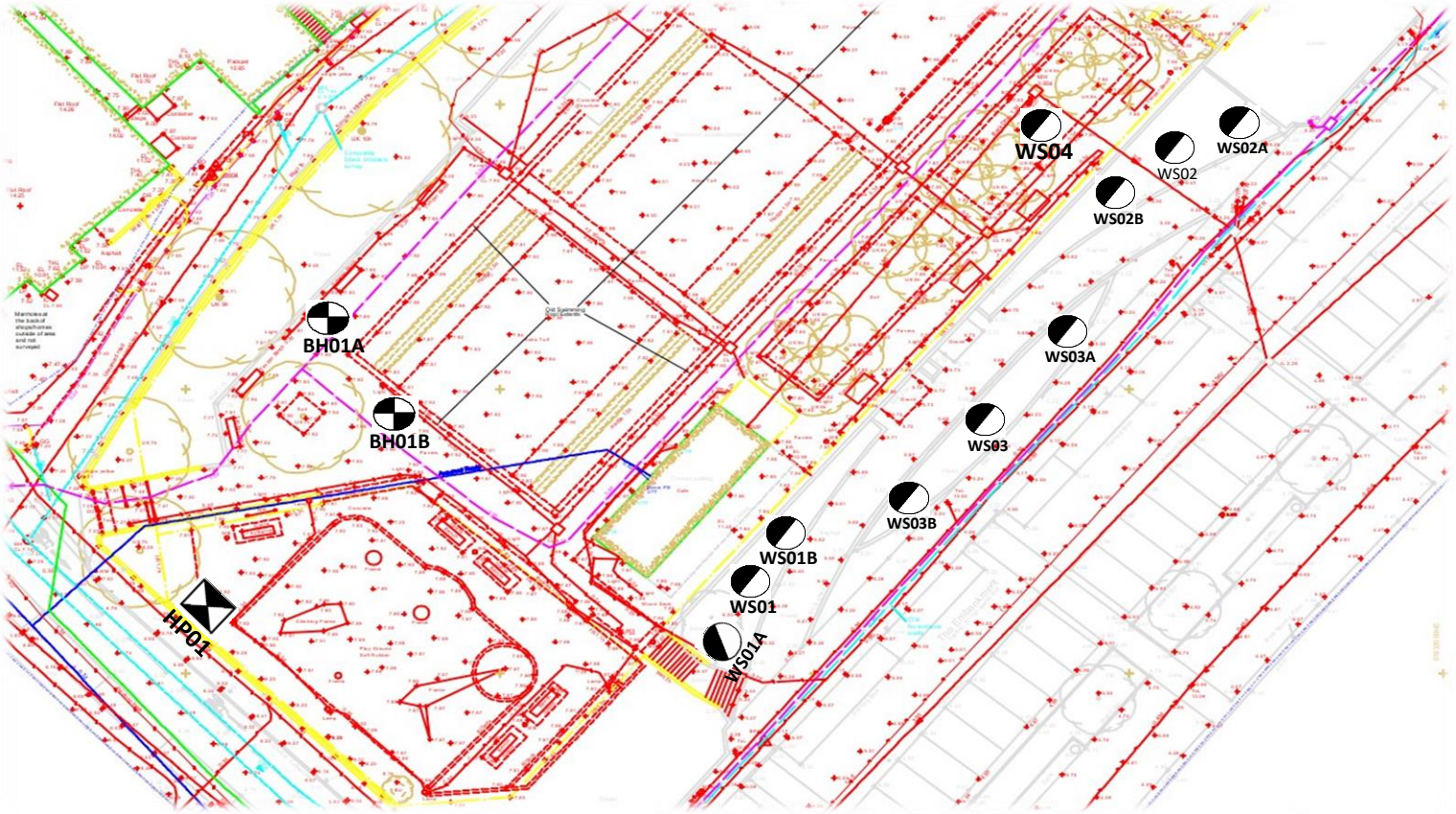
TITLE

Site Plan

DRAWING NUMBER

4955,SI/002/Rev0

SCALE	DATE
See original Plan	16/09/2020
DRAWN BY	**CHECKED BY**
JD	SG



GEOSPHERE ENVIRONMENTAL

LEGEND

- Site boundary
- Borehole
- Window Sample
- Trial Pit (Infiltration Test)
- Hand Excavated Pit (Foundation Exposure)

SOURCE

Excerpt from provided drwg ref:26576se-01 (dated26/06/2020)

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

TITLE

Site Plan

DRAWING NUMBER

4955,SI/003/Rev0

SCALE	DATE
NTS	16/09/2020

DRAWN BY	CHECKED BY
JD	

N

GEOSPHERE ENVIRONMENTAL

LEGEND

Borehole

SOURCE

Excerpt from provided drwg ref:26576se-01 (dated26/06/2020)

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

TITLE

Exploratory Hole Location Plan (West 2)

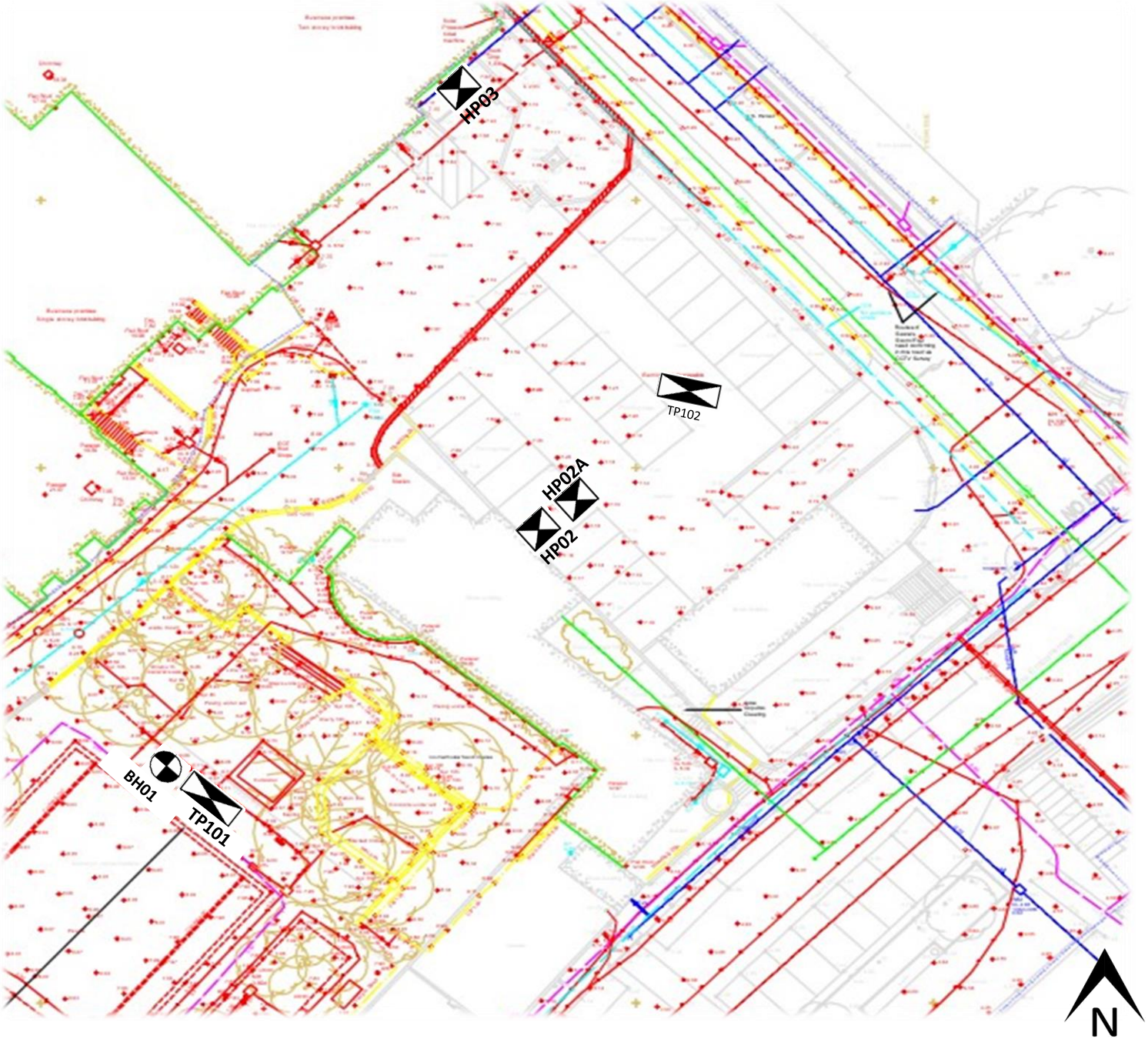
DRAWING NUMBER

4955,SI/004/Rev0

SCALE	DATE
NTS	16/09/2020

DRAWN BY	CHECKED BY
JD	

N



GEOSPHERE ENVIRONMENTAL

LEGEND

- Trial Pit (Infiltration Test)
- Hand Excavated Pit (Foundation Exposure)
- Borehole

SOURCE

Excerpt from provided drwg ref:26576se-01 (dated26/06/2020)

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

TITLE

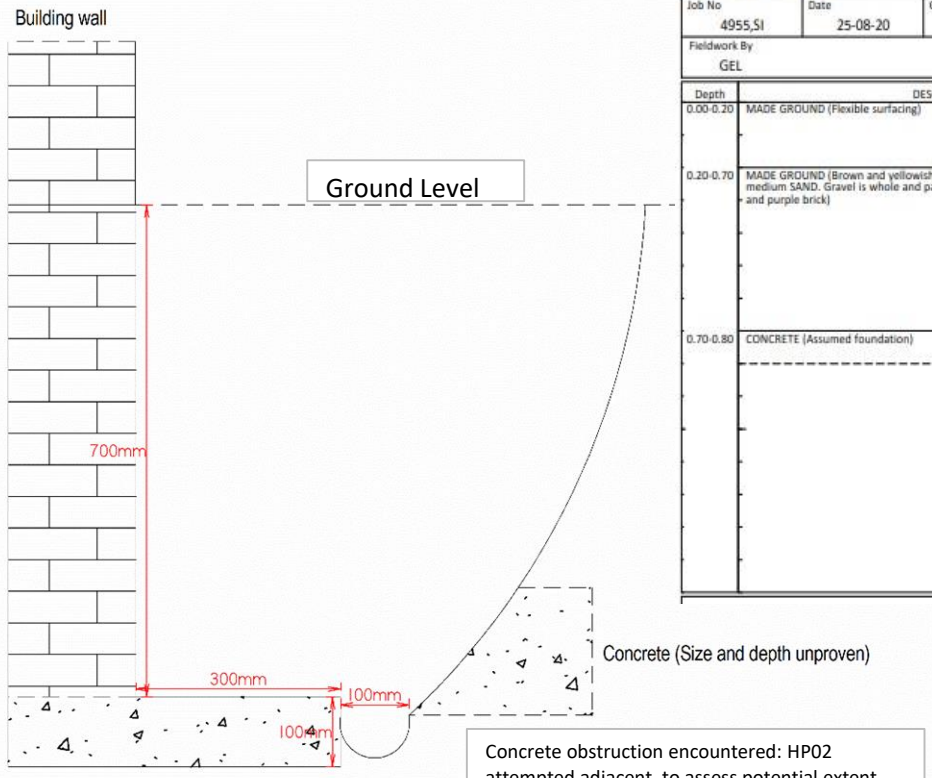
Exploratory Hole Location Plan (East 1)

DRAWING NUMBER

4955,SI/005/Rev0

SCALE	DATE
NTS	16/09/2020
DRAWN BY	**CHECKED BY**
JD	

HP02 Section View



Geosphere Environmental Ltd
Unit 11 Brightwell Barns
Brightwell, Ipswich, IP10 0BJ
Telephone: 01603 298 076

TRIAL PIT LOG

Project	Client	TRIAL PIT No
Twickenham Riverside	LB of Richmond Upon Thames	HP02

Job No	Date	Ground Level (m)	Grid Reference ()	Sheet
4955,SI	25-08-20			1 of 1

Fieldwork By	Logged By
GEL	PC

Depth	DESCRIPTION	Legend	Depth	No	Remarks/Tests
0.00-0.20	MADE GROUND (Flexible surfacing)				
0.20-0.70	MADE GROUND (Brown and yellowish brown very gravelly fine and medium SAND. Gravel is whole and partial red brick, concrete, yellow and purple brick)				
0.70-0.80	CONCRETE (Assumed foundation)				Hand dug pit terminated at 0.8m due to concrete obstruction

GEOSPHERE ENVIRONMENTAL

LEGEND

SOURCE

© OpenStreetMap contributors

PROJECT

TWICKENHAM RIVERSIDE PROJECT - Diamond Jubilee Gardens and Wharf Lane

TITLE

HP02 Details

DRAWING NUMBER

4955,SI/006/Rev0

SCALE	DATE
As marked	16/09/2020
DRAWN BY	**CHECKED BY**
PC	JD

N

Area not Fully surveyed due to no Topographical information

No Access

TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

ABBREVIATIONS & SYMBOLS

AH	Arch Head Height	FH	Fire Hydrant	RSJ	Rolled Steel Joist
AR	Assumed Route	FBD	Floor Board Direction	SI	Sign Post
AV	Air Valve	FH	Fire Hydrant	SP	Arch Spring Point/ Height
BB	Bellcrie Beacon	FL	Floor Level	SV	Stop Valve
BH	Bore Hole	FP	Flag Pole	SW	Surface Water
BL	Bed Level	FW	Foul Water	SY	Stay
BO	Bollard	GG	Gully Grate	Tac	Tactile Paving
BP	Brace Post	GV	Gas Valve	TC	Telecom Cover
BS	Bus Stop	HH	Head Height	TH	Trial Pit
BU	Bush	IC	Inspection Cover	THL	Threshold Level
B/W	Barbed Wire Fence	IL	Invert Level	TL	Traffic Light
BX	Box (Utilities)	IR	Iron Railings	TOW	Top of Wall
CF	Chestnut Paling Fence	LD	Lamp Column	TP	Telegraph Pole
CH	Cill Height	LP	Lamp Post	TV	Television/ TV Cover
CL	Cover Level	MH	Manhole	UB	Unikerseal Beam
C/L	Chain Link Fence	MP	Marker Post	UC	Unknown Cover
C-Lev	Ceiling Level	NB	Name Board	UK	Unknown Tree
Col	Column	OHL	Overhead Line (approx)	USB	Under Side Beam
C/P	Chestnut Paling Fence	Pan	Panel Fence	U/L	Unable To Lift
CR	Cable Riser	PB	Point Box	VP	Vent Pipe
DC	Drainage Channel	PM	Parking Meter	WB	Waste Bin
DH	Door Head Height	PO	Post	WH	Weep Hole
DP	Down Pipe	P/R	Post & Rail Fence	WL	Water Level
DR	Drain	P/W	Post & Wire Fence	WM	Water Meter
EL	Eaves Level	PWall	Random Wall	WO	Wash Out
EP	Electric Pole	RE	Rodding Eye		Floor to Ceiling Height
ER	Earth Rod	RL	Ridge Level		
ET	EP+Transformer	RP	Reflector Post	F/C	Floor to False Ceiling Ht
FB	Flower Bed	RS	Road Sign		
FBD	Floor Board Direction	RSD	Roller Shutter Door		Survey Control Station

DRAWING NOTE

Topographical Surveys

Trees are drawn to scale showing the average canopy spread. Descriptions and heights should be used as a guide only.

All building names, descriptions, number of storeys, construction type including roof line details are indicative only and taken externally from ground level.

All below ground details including drainage, voids and services have been identified from above ground and therefore all details relating to these features including; sizes, depth, description etc will be approximate only. All critical dimensions and connections should be checked and verified prior to starting work.

Detail, services and features may not have been surveyed if obstructed or not reasonably visible at the time of the survey.

Measured Building Surveys

Measurements to internal walls are taken to the wall finishes at approx 1m above the floor level and the wall assumed to be vertical.

Cill heights are measured as floor to the cill and head heights are measured from cill to the top of window.

General

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work. Any errors or discrepancies must be notified to Survey Solutions immediately.

The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The survey control listed is only to be used for topographical surveys at the stated scale. All control must be checked and verified prior to use.

Do not scale from this drawing.

The coordinate system established for this survey is related to Ordnance Survey (OS) national grid at a single point using Smartnet, then orientated to grid north with a scale factor of 1.000

The level datum established for this survey is related to Ordnance Survey (OS) using GPS Smartnet.

To avoid discrepancies any coordinated data used in conjunction with this survey must be derived directly from this control data.

CONTROL CO-ORDINATES

STATIONS	EASTINGS	NORTHINGS	LEVEL	DESCRIPTION
S101	516206.541	173267.125	7.744	PK Nail
S201	516303.004	173149.488	5.243	PK Nail
S202	516338.582	173175.115	5.099	PK Nail
ST01	516314.247	173232.087	6.601	PK Nail
ST02	516348.086	173181.534	4.853	PK Nail
ST03	516331.967	173207.457	6.984	HW Nail
ST04	516296.539	173211.240	7.849	HW Nail
ST05	516277.805	173181.813	8.120	PK Nail
ST06	516241.909	173155.660	7.734	PK Nail
ST07	516248.380	173140.250	7.904	PK Nail
SB01	516347.116	173183.397	4.482	PK Nail
SB02	516215.917	173087.514	4.884	PK Nail
SB03	516236.210	173124.970	6.835	PK Nail

REV	DESCRIPTION	DRAWN	APPR	DATE
B	Additional Detail Surveyed	SB	JM	13/11/2017
A	Additional Detail Surveyed	SB	DJB	12/10/2016

SURVEY SOLUTIONS

Ipswich Coventry Yeovil Norwich Perth Nottingham Brentwood

Tel No: 0845 0405 969 Fax No: 0845 0405 970

www.survey-solutions.co.uk enquiries@survey-solutions.co.uk

LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE: WATER LANE, TWICKENHAM, TW1 3NP			
DRAWING DETAIL: TOPOGRAPHICAL SURVEY Sheet 1 of 1			
CLIENT: LONDON BOROUGH OF RICHMOND			SCALE: 1:200
SURVEYOR: DAP	SURVEY DATE: 24/08/2015	CHECKED BY: JPH	APPROVED BY: PDS	DWG STATUS: FINAL
DRAWING NUMBER: 16304cv-01		REVISION: B	ISSUE DATE: 01/09/2015

Original Sheet Size A0+1

Date	Rev.	Description	Approved By
11/06/2021	P01	M125 - Draft Planning Issue	MB

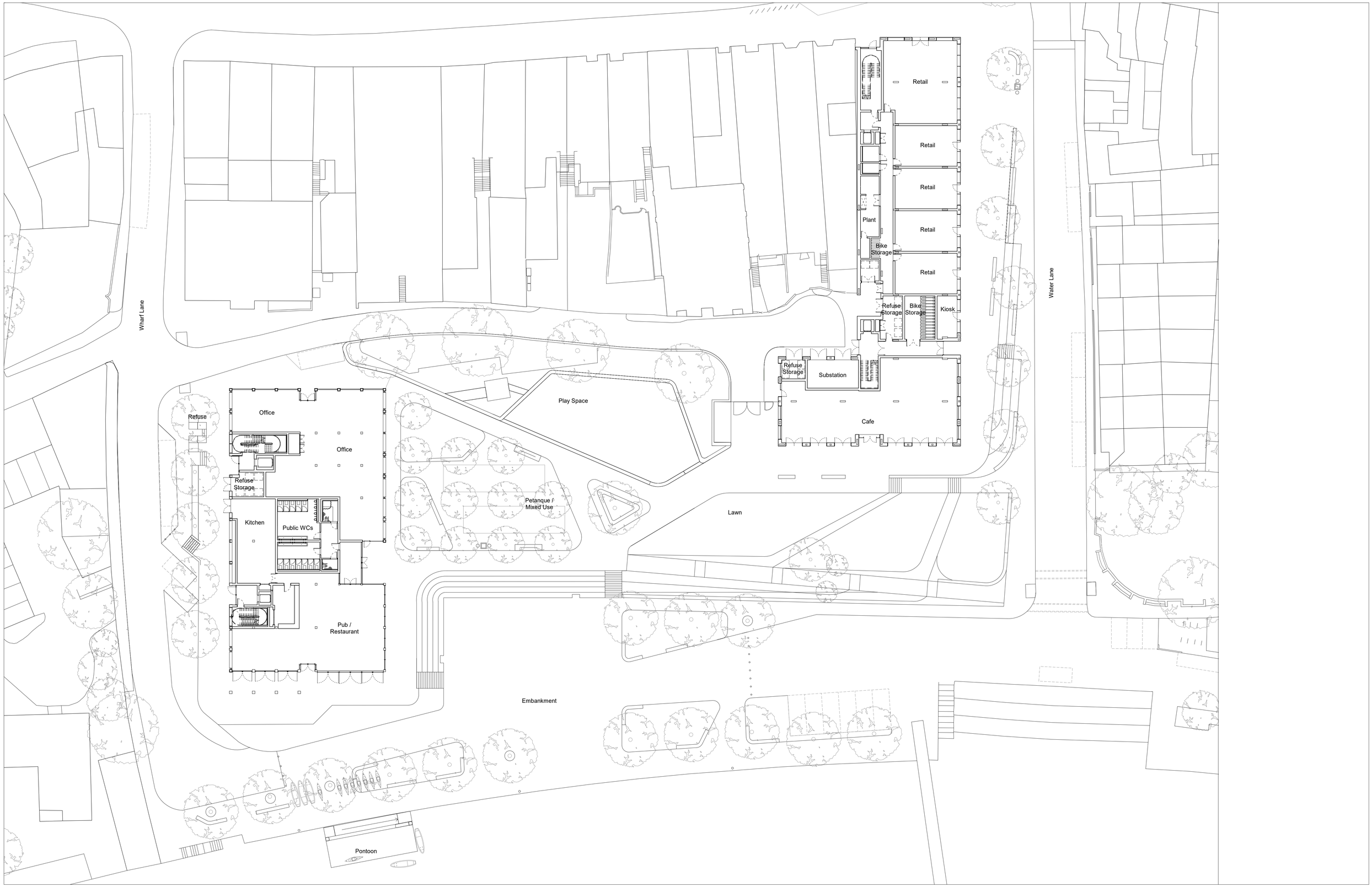
Date	Rev.	Description	Approved By

DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Proposed Lower Ground Floor GA Plan			TRS-HAL-ZZ-B1-DR-A-	2499 / P01
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 06/08/21	Scale 1 : 250 at A1



Date	Rev.	Description	Approved By
11/06/2021	P01	M125 - Draft Planning Issue	MB

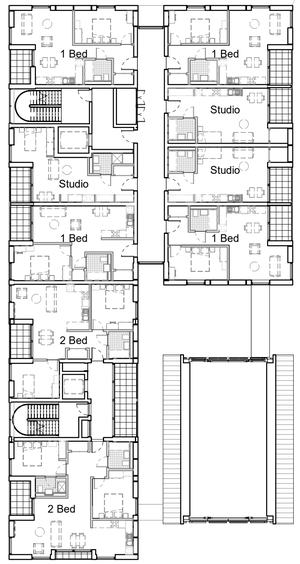
Date	Rev.	Description	Approved By

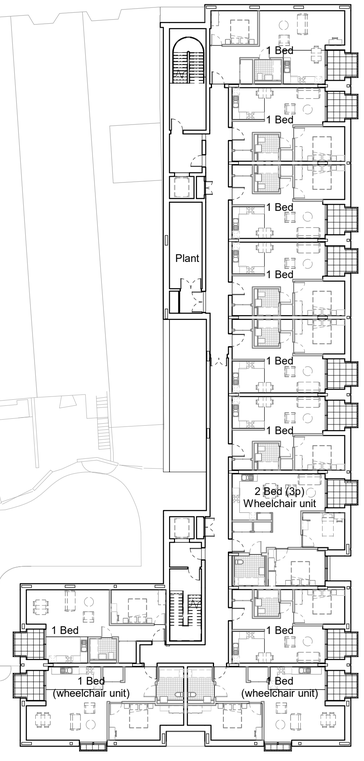
DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code TRS	File Name	Number / Rev.
Subject	Proposed Ground Floor GA Plan		TRS-HAL-ZZ-00-DR-A-	2500 P01
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk		Date 06/08/21	Scale 1 : 250 at A1





Date	Rev.	Description	Approved By
11/06/2021	P01	M125 - Draft Planning Issue	MB

Date	Rev.	Description	Approved By

DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code	TRS	File Name	Number / Rev.
Subject	Proposed First Floor GA Plan			TRS-HAL-ZZ-01-DR-A-	**2501** **P01**
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk			Date 06/08/21	Scale 1 : 250 at A1

Date	Rev.	Description	Approved By
11/06/2021	P01	M125 - Draft Planning Issue	MB

Date	Rev.	Description	Approved By

DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code TRS	File Name	Number / Rev.
Subject	Proposed Second Floor GA Plan		TRS-HAL-ZZ-02-DR-A-	2502 / P01
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk		Date 06/08/21	Scale 1 : 250 at A1

Date	Rev.	Description	Approved By
11/06/2021	P01	M125 - Draft Planning Issue	MB

Date	Rev.	Description	Approved By

DRAFT

Scale at 1:250

0 2 5 10m

Project	Twickenham Riverside	Code TRS	File Name	Number / Rev.
Subject	Proposed Third Floor GA Plan		TRS-HAL-ZZ-03-DR-A-	2503 / P01
Architects	Hopkins Architects Limited 27 Broadley Terrace, London, NW1 6LG T: 020 7724 1751 E: mail@hopkins.co.uk		Date 06/08/21	Scale 1 : 250 at A1

Appendix 4 – Envirocheck Data Search Report

Appendix 5 – Envirocheck Historical Maps

Appendix 6 – Comparison of Consequences Against Probability

		Consequence (Severity of Linkage)			
		Severe (S)	Moderate (Mo)	Mild (Mi)	Negligible (N)
Probability (Likelihood of linkage from)	Highly Likely (HL)	Very High Risk (VH)	High Risk (HR)	Moderate Risk (MR)	Moderate/Low Risk (MR-LR)
	Likely (L)	High Risk (HR)	Moderate Risk (MR)	Moderate/Low Risk (MR-LR)	Low Risk (LR)
	Unlikely (U)	Moderate Risk (MR)	Moderate/Low Risk (MR-LR)	Low Risk (LR)	Negligible Risk (NR)
	Negligible (N)	Moderate/Low Risk (MR-LR)	Low Risk (LR)	Negligible Risk (NR)	Negligible Risk (NR)

This table is to provide reference information in conjunction with the GEL Conceptual Model attached within the Hazard Risk Assessment section of this report, Table 4 – Conceptual Model.

Very High Risk (VH)

- There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is happening currently.
- Urgent investigation and remediation are likely to be required and advised.

High Risk (HR)

- Harm is likely to arise to a designated receptor from an identified hazard.
- Urgent investigation is required and remedial works are likely necessary in both the short to long term.

Moderate Risk (MR)

- It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
- Investigation is required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.

Low Risk (LR)

- It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild. Limited investigation recommended.

Negligible Risk (NR)

- There is a minimal possibility that harm could arise to a receptor. In the event of such harm being realised it is high likely to not be severe. Investigation not deemed necessary.

Appendix 7 – Exploratory Hole Logs

Borehole Logs
(BH01A, 01B, BH1, BH2)

Windowless Sample Hole Logs
(WS1A to 3B, WS4)

Hand Dug Pit Logs
(HA01 to HA03A)

Trial Pit (Infiltration pit) Logs
(TP/SK1 to TP/SK2)

Appendix 8 – Infiltration Test Results

Appendix 9 – Gas and Groundwater Monitoring Data

Appendix 10 – Environmental Laboratory Test Results

Appendix 11 – Geotechnical Laboratory Test Results

Appendix 12 – Photographs

Appendix 13 – UXO Preliminary Report

Appendix 14 – Soil Waste Classification Report