



Manor Road / Richmond

Flood Risk Assessment & Drainage Strategy

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Former Homebase, Manor Road, Richmond

Flood Risk Assessment & Drainage Strategy

December 2018

126782-RP-C-001



FAIRHURST

CONTROL SHEET

CLIENT: Avanton

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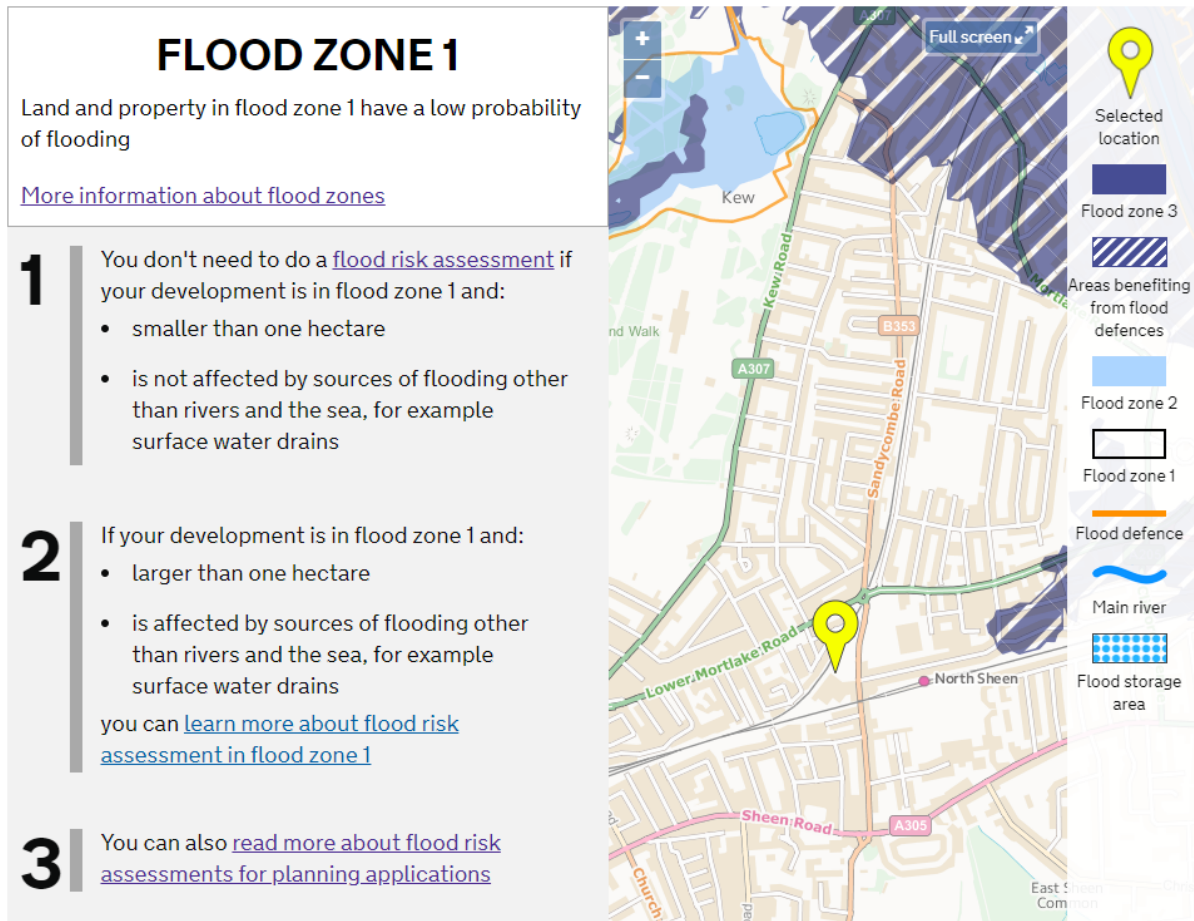
This document has been prepared in accordance with procedure OP/P02 of the *Fairhurst Quality and Environmental Management System*

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1 Introduction

- 1.1.1 Fairhurst have been appointed by Avanton to provide engineering services for the project known as Manor Road, Richmond.
- 1.1.2 The proposed development site is approximately 1.65ha.
- 1.1.3 The proposed development is located in Flood Zone 1, meaning there is a less than 1 in 1000 year risk of flooding from rivers or seas.



- 1.1.4 Under current Environment Agency requirements, a site of this size and Flood Zone classification requires a Flood Risk Assessment to be completed.
- 1.1.5 The site is located within the boundary of London Borough of Richmond upon Thames Local Planning Authority.
- 1.1.6 This FRA has been compiled in accordance and guidance of the Richmond Strategic Flood Risk Assessment (SFRA), National Planning Policy Framework (NPPF) and other relevant guides and reports.
- 1.1.7 Richmond Planning Guidance Chapter 6.2 includes a checklist of information required to accompany a planning application for Drainage and Flood Risk. A copy of this table and where information can be found is included as an appendix to this report.

2 Planning policy

2.1 National planning policy framework & planning practice guidance

- 2.1.1 The National Planning Policy Framework (NPPF), published in 2012 and as revised in 2018 and the associated Planning Practice Guidance (PPG), published in 2014, identify flood risk as a specific material consideration in the planning process and in the allocation and release of sites for development or re-development.
- 2.1.2 The NPPF & PPG replaced previous guidance and policy set out in PPS 25: Development and Flood Risk, however much of the technical criteria for Flood Risk Assessments remain largely unchanged. The NPPF seeks to strengthen the co-ordination between land-use planning and development planning and the operational delivery of flood and coastal defence strategy. Through the NPPF, Local Planning Authorities will continue to use their existing powers to guide, regulate and control development in relation to flooding and flood risk. The NPPF places a presumption in favour of sustainable development whilst meeting the challenge of climate change, flooding and coastal change. In accordance with the PPG, inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk through the application of the Exception and Sequential Tests.
- 2.1.3 The Water Resources Act 1991 [Section 105] requires the Environment Agency to exercise general supervision over all flood defence matters, including flood plains and washlands which accommodate waters during periods of flood. In discharging their functions, the Environment Agency from time to time carries out surveys and flood studies, largely of 'main rivers' within its jurisdiction.
- 2.1.4 Environment Agency flood maps indicating the extents of the modelled floodplain are provided to Local Planning Authorities, to enable them to make more informed decisions when considering proposed development in flood-susceptible areas. If development is proposed in a flood-susceptible area, or in an area where there is a history of flooding, the Environment Agency, as a statutory consultee in the planning process, will generally recommend that the risk of flooding be formally assessed in accordance with the NPPF, and that a Flood Risk Assessment report is produced to support the Planning Application. The broader modelled flood extents are also indicated on the Environment Agency's Flood Zone Maps, available through their website.

2.2 Local planning policy

- 2.2.1 As part of the new Richmond Local Development Plan adopted in July 2018, the council has developed policies to take forward the Core Strategy of the council including *A Sustainable Future*.
- 2.2.2 Extracts from the LDP relevant to the proposed development and flood risk / water management are given below¹;

¹ Only relevant sections of the policy are included within this report. For full policy and further information, refer directly to the original report.

Policy LP 17 – Green Roofs and Walls:

Policy LP 17

Green roofs and walls

Green roofs and/or brown roofs should be incorporated into new major developments with roof plate areas of 100sqm or more where technically feasible and subject to considerations of visual impact. The aim should be to use at least 70% of any potential roof plate area as a green / brown roof.

The onus is on an applicant to provide evidence and justification if a green roof cannot be incorporated. The Council will expect a green wall to be incorporated, where appropriate, if it has been demonstrated that a green / brown roof is not feasible.

The use of green / brown roofs and green walls is encouraged and supported in smaller developments, renovations, conversions and extensions.

2.2.3 The policy notes that roof terraces are not classed as living roofs to fulfil this policy and states roofs should be minimum 70% soil / vegetation over a minimum 85mm substrate

Policy LP 21 – Flood Risk:

Policy LP 21

Flood Risk and Sustainable Drainage

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

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

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

Basements and subterranean developments

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

Flood Zone 1	No restrictions on new or extensions to existing basements
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Sustainable drainage

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

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

Policy LP 22 – Sustainable Design and Construction:**Policy LP 22****Sustainable Design and Construction**

A. Developments will be required to achieve the highest standards of sustainable design and construction to mitigate the likely effects of climate change. Applicants will be required to complete the following:

1. Development of 1 dwelling unit or more, or 100sqm or more of non-residential floor space (including extensions) will be required to complete the Sustainable Construction Checklist SPD. A completed Checklist has to be submitted as part of the planning application.
2. Development that results in a new residential dwelling, including conversions, change of use, and extensions that result in a new dwelling unit, will be required to incorporate water conservation measures to achieve maximum water consumption of 110 litres per person per day for homes (including an allowance of 5 litres or less per person per day for external water consumption).
3. New non-residential buildings over 100sqm will be required to meet BREEAM 'Excellent' standard.
4. Proposals for change of use to residential will be required to meet BREEAM Domestic Refurbishment 'Excellent' standard (where feasible).

2.2.4 A number of water saving measures and equipment may be incorporated into developments to comply with the maximum water consumption levels set out in Part A, criterion 2 above:

- There should be full use of water saving devices, water efficient fixtures and fittings.
- Rainwater and grey water recycling (water butts or more complex collection and treatment systems) can significantly reduce water consumption, particularly potable water. Grey water recycling will need to be energy efficient.
- Landscaping and gardens should be designed to lower water demand.
- Sustainable Drainage Systems (SuDS), including rainwater harvesting and storage from roofs and other surfaces can significantly reduce demand for water

Policy LP 23 – Water Resources and Infrastructure:

Policy LP 23

Water Resources and Infrastructure

Water and sewerage provision

C. New major residential or major non-residential development will need to ensure that there is adequate water supply, surface water, foul drainage and sewerage treatment capacity to serve the development.

Planning permission will only be granted for developments which increase the demand for off-site service infrastructure where:

1. sufficient capacity already exists, or
2. extra capacity can be provided in time to serve the development, which will ensure that the environment and the amenities of local residents are not adversely affected.

Applicants for major developments will be required to provide evidence in the form of written confirmation as part of the planning application that capacity exists in the public sewerage and water supply network to serve their development.

Any new water supply, sewerage or waste water treatment infrastructure must be in place prior to occupation of the development. Financial contributions may be required for new developments towards the provision of, or improvements to, such infrastructure.

2.3 Strategic flood risk assessment (SFRA)

- 2.3.1 Local Planning Authorities are required to produce Local Development Frameworks, which are a portfolio of Local Development Documents (LDD) that collectively deliver the spatial planning strategy for the Authority area. The LDDs undergo a sustainability appraisal which assists Planning Authorities in ensuring their policies fulfil the principles of sustainability. Strategic Flood Risk Assessments (SFRAs) are used as the evidence base for planning decisions and form a component of the sustainability appraisal process. Therefore, SFRAs should be used in the review or production of LDDs.
- 2.3.2 To assist Local Planning Authorities in their strategic land-use planning, SFRAs should present sufficient information to enable Local Authorities to apply the Sequential Test to their proposed development sites: 'Decision-makers should use the SFRA to inform their knowledge of flooding, refine the information on the Flood Map and determine the variations in flood risk from all sources of flooding across and from their area. These should form the basis for preparing appropriate policies for flood risk management for these areas.'
- 2.3.3 A Strategic Flood Risk Assessment (SFRA) was carried out for London Borough of Richmond upon Thames Council in March 2016.

2.4 Sequential test

- 2.4.1 The Sequential Approach is detailed within the Planning Practice Guidance and aims to ensure preference is given to land within Flood Zone 1 prior to Zones 2 and 3. It also ensures that flood vulnerability of the Proposed Development is taken into consideration when locating development in Flood Zones 2 and 3.
- 2.4.2 Where the Sequential Approach shows that it is not possible to locate development in zones of lower flood risk due to other wider sustainability issues; it may be possible to

justify, using the Exception test, that development is still feasible by the management of flood risk.

2.5 CIRIA guidance

2.5.1 CIRIA publication ‘C624 Development and Flood Risk – Guidance for the Construction Industry’, defines three levels of Flood Risk Assessment which can be undertaken:

FRA Level	Description / Scope
Level 1	<p>Screening Study to identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information, including the SFRA, Environment Agency Flood Map and Standing Advice.</p> <p>The Screening Study will ascertain whether a FRA is required.</p>
Level 2	<p>Scoping Study to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off. This Study should confirm the sources of flooding which may affect the site and should include the following:</p> <ul style="list-style-type: none"> an appraisal of the availability and adequacy of existing information; a qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. <p>The Scoping Study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.</p>
Level 3	<p>Detailed Study to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The Study should include:</p> <ul style="list-style-type: none"> quantitative appraisal of the potential flood risk to the development; quantitative appraisal of the potential impact of development site on flood risk elsewhere; quantitative demonstration of the effectiveness of any proposed mitigation measures.

2.5.2 This Flood Risk Assessment will follow the requirements of a Level 1 Scoping Study.

3 Development description & locations

3.1 Existing surroundings description

3.1.1 The Site is located at Former Homebase Manor Road, Richmond, TW9 1YB as shown in Figure 2. The approximate coordinates at the centre of the site are 518901, 175426.

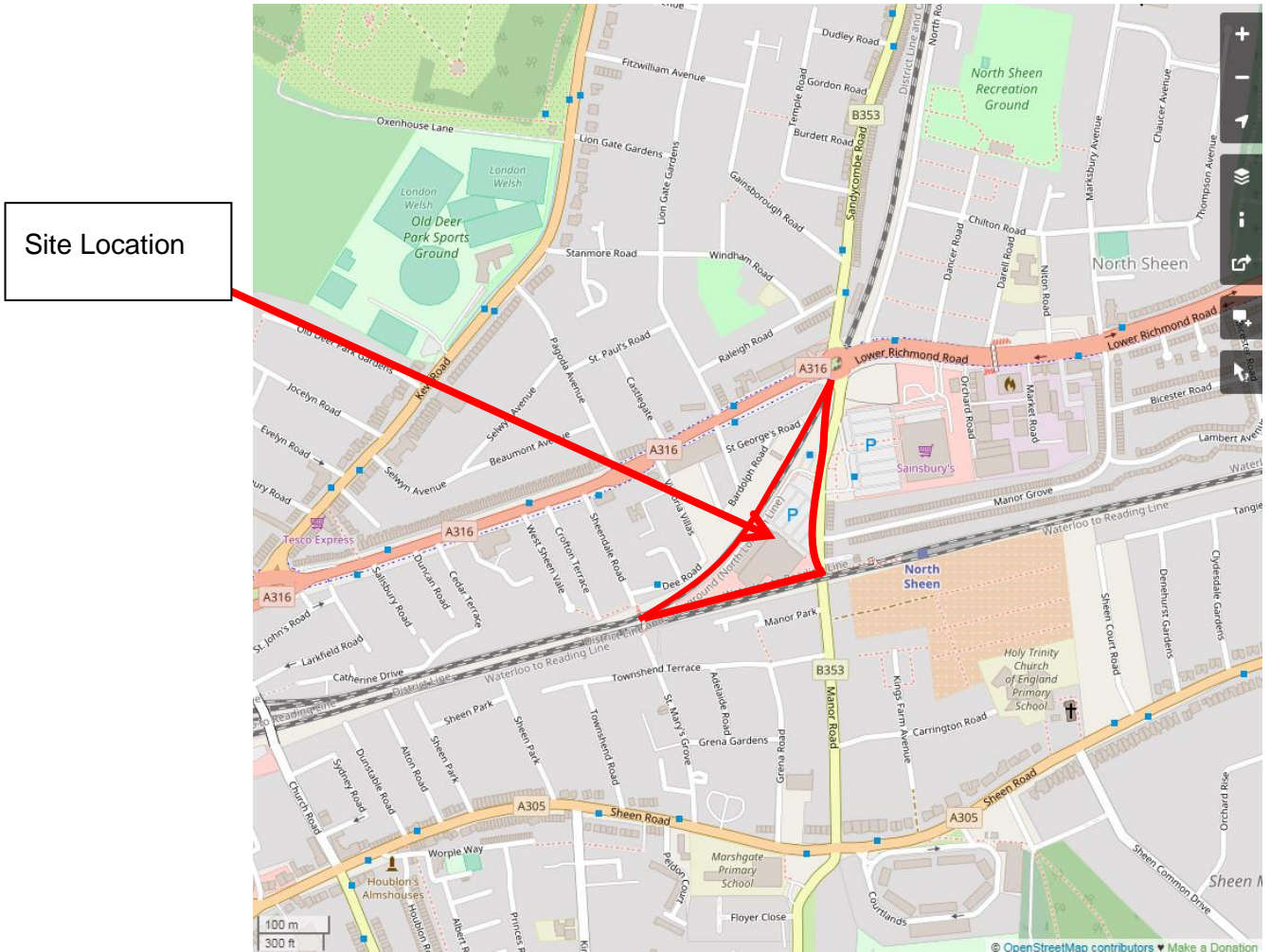


Figure 2 – Former Homebase, Manor Road, Richmond

3.1.2 The site is roughly triangular in shape and bounded to the north and south by merging railway lines and Manor Road (B353) to the east. In the north east corner of the site, Manor Road crosses the railway lines on an elevated roundabout.

3.2 Description of Existing Site

3.2.1 The total site area is 1.65ha which is almost entirely impermeable either (i) under buildings or (ii) paved parking, roads and other hardstanding areas.

3.2.2 In the pre-redevelopment layout, the site is almost fully paved with several small areas of vegetation and trees throughout the site. These can be seen on the Topographical Survey (Point2Surveys Ltd, Drawing No. LS2024/T/01-10 dated August 2018) included as an appendix to this report.

3.2.3 The Topographical Survey indicates the site to be approximately 7mAOD at the east of the site, sloping to approximately 6mAOD at the south west of the site. The south west of the site is contained by a retaining wall with the railway alongside the site at approximately 7.3mAOD.

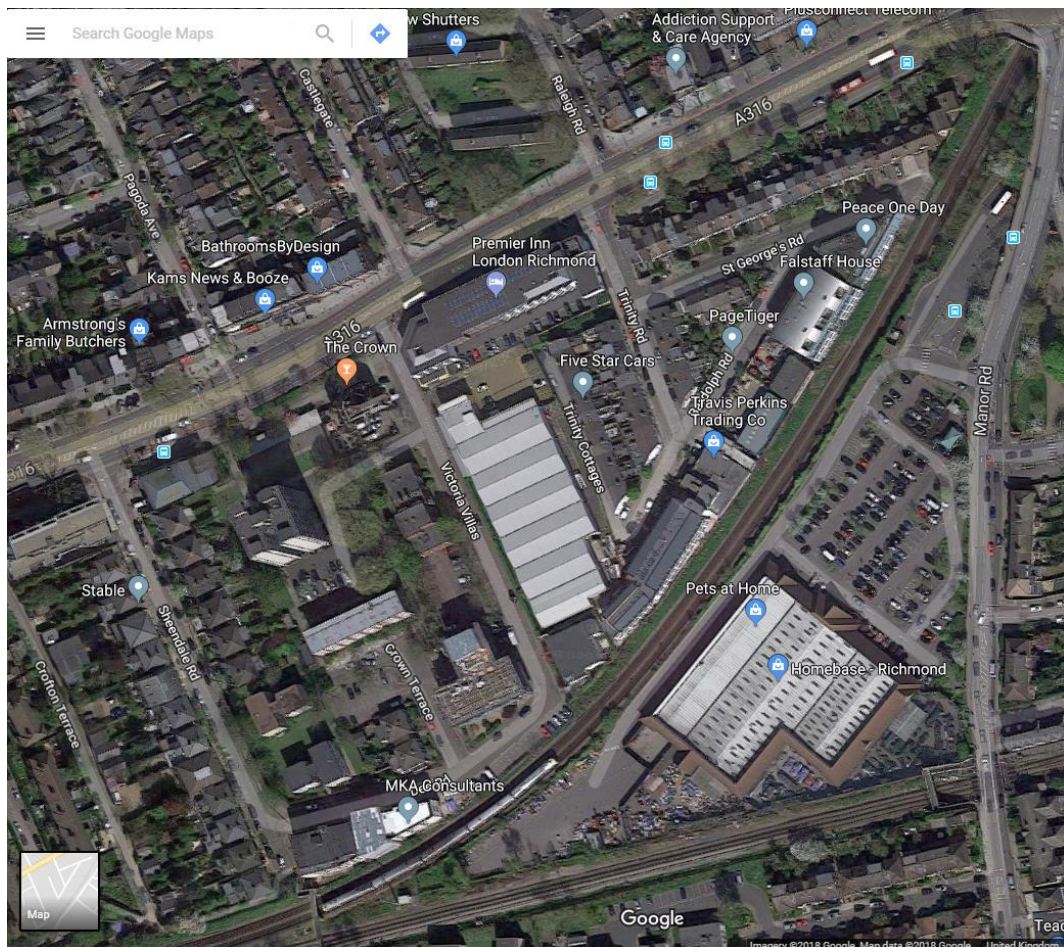


Figure 3 – Satellite imagery of the site (via Google Maps)

3.3 Existing geology & groundwater protection

- 3.3.1 At the time of writing, no intrusive geotechnical testing had been completed however a Preliminary Geotechnical Risk Assessment (PRA) has been completed using a site walkover and desk study review of nearby boreholes.
- 3.3.2 Boreholes near the site identified made ground over sands and gravels underlain by clay. Groundwater was also identified in these boreholes.
- 3.3.3 Ground conditions can vary greatly over short distances and intrusive tests will be required to confirm the conditions of the site. These have been commissioned and results are awaited.
- 3.3.4 DEFRA (Department for Environment Food and Rural Affairs) publish groundwater and drinking water source protection zone maps online through Magic Map. A search on the site location identifies no protection zones with the site, see figure below.

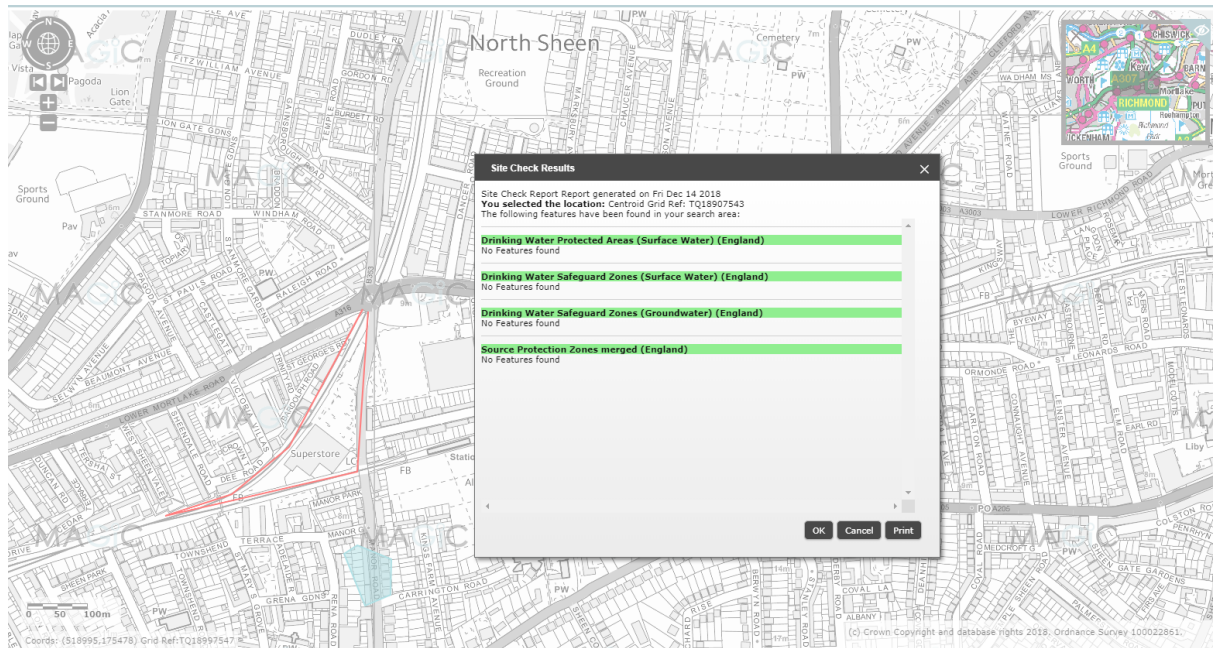


Figure 4 – Groundwater / drinking water source protection zones

3.4 Sequential Test and Exception Test

- 3.4.1 With reference to Table 2: ‘Flood Risk Vulnerability Classification’ in NPPF Planning Practice Guidance, residential development is considered as ‘more vulnerable’ and Commercial properties are classed as ‘Less Vulnerable’ in terms of planning issues.
- 3.4.2 The Sequential Test should be applied to new developments located within a Flood Zone 2, 3 or functional floodplain in order to steer them to areas with a lower risk of flooding. As the proposed development site is located in a Flood Zone 3 (High Probability of flooding) the Sequential Test should be applied.
- 3.4.3 Table 3: ‘Flood Risk Vulnerability and Flood Zone Compatibility’ in the NPPF Planning Practice Guidance only classifies ‘Less Vulnerable’ and ‘Water Compatible’ classifications as appropriate for Flood Zone 3 without having to address the Exception Test.
- 3.4.4 The National Planning Policy Framework (Section 104) also states that ‘Applications for minor development and changes of use should not be subject to Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments.’
- 3.4.5 Based on the NPPF statement identified in 3.6.4, a Sequential or Exemption Test is no longer required and this Flood Risk Assessment will identify the various potential flood sources and attempt to ascertain any specific risk to the property.

4 Definition of flood hazard

4.1 Flooding from Rivers

- 4.1.1 River flooding that occurs when a watercourse cannot cope with the water draining into it from the surrounding land. This can happen, for example, when heavy rain falls on an already waterlogged catchment.
- 4.1.2 The site is located south of a bend in the River Thames, with the closest point being approximately 1.6km to the east. Environment Agency mapping shows that neither it nor other watercourses pose any significant flood risk to the site.

4.2 Flooding from Sewers (Surface Water Flooding)

- 4.2.1 Sewer flooding that occurs when sewers are overwhelmed by heavy rainfall or when they become blocked. The likelihood of flooding depends on the capacity of the local sewerage system and the type of sewer (combined or separate) in the local area. Land and property can be flooded with water contaminated with raw sewage as a result. Rivers can also become polluted by sewer overflows. It is difficult to predict and pinpoint; much more so than river or coastal flooding.
- 4.2.2 The EA Surface Water flood maps identify the potential depths, velocities and hazard rating of surface water flooding during a 30, 100 & 1000 year probability storm events.

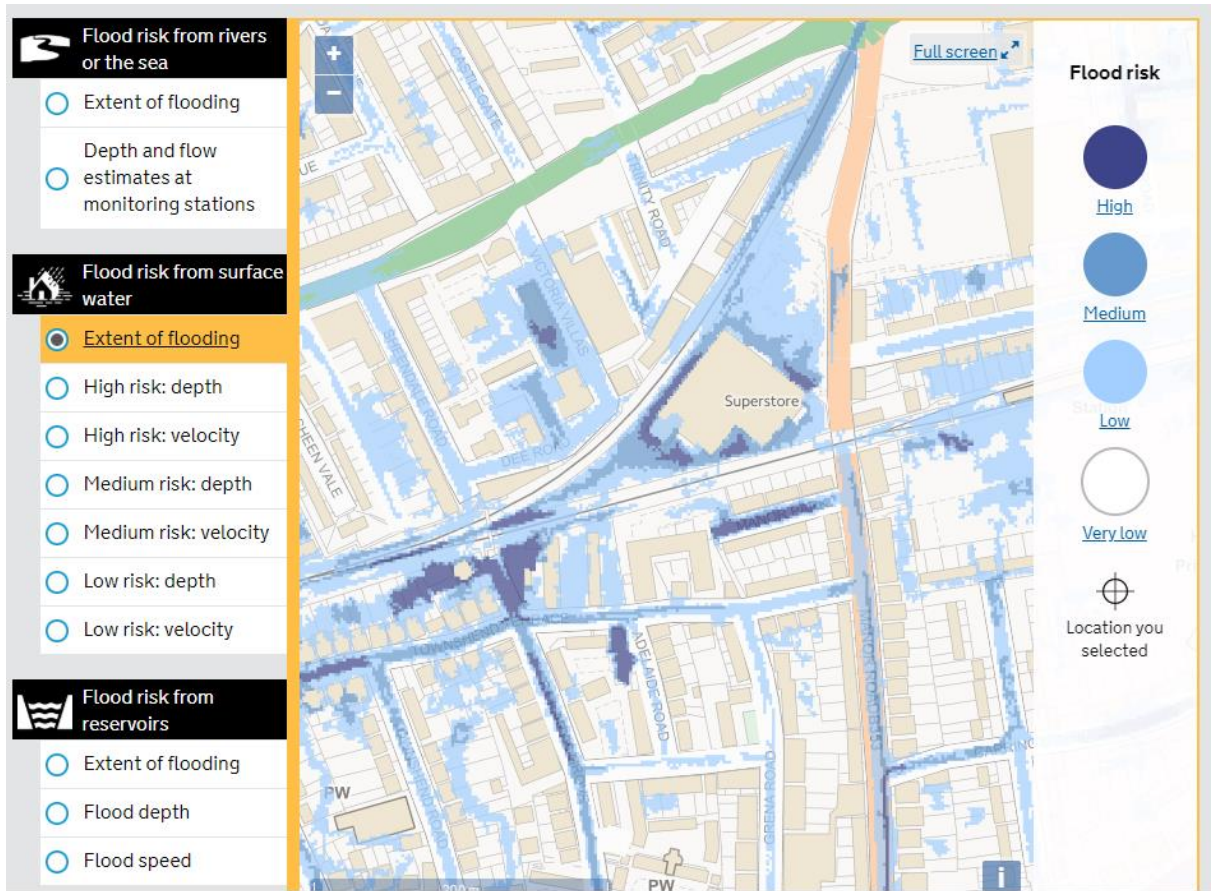


Figure 5 – Flood Risk Maps (Surface Water) - Environment Agency

4.3 Flooding from Artificial Sources

- 4.3.1 Flooding from artificial sources can be defined as a failure of man-made infrastructure or human intervention that causes flooding. Consideration should be given to features such as reservoirs, canals and lakes where water is retained above natural ground level.

5 Probability of flooding

5.1 Probability of Flooding from Rivers

- 5.1.1 In accordance with the Environment Agency's indicative flood map, the site is located in Flood Zone 1, which has less than 0.1% annual probability of fluvial flooding (equivalent of 1 in 1000 year return period).
- 5.1.2 The site is outside of the influence of the Thames Flood defences which are designed to protect against a greater than 1 in 1000 year return period. Therefore there is negligible risk that flooding may occur during extreme future flood events in a breach scenario.

5.2 Probability of Flooding from Sewers / Surface Water

- 5.2.1 The Environment Agency produces flood risk maps to show the risk of flooding from surface water / sewers (Figure 5 above). These show the site to be at risk of flooding from surface water.
- 5.2.2 It should be noted that the EA maps are caveated with the guidance note
due to the difficulty in surface water flooding prediction, maps report property information for the highest risk within 20m of the site
- 5.2.3 More accurate information relating to the specific flooding of individual properties by surface water due to sewer surcharge is held by Thames Water.
- 5.2.4 A search request for this site returned no evidence of surface water flooding of the site due to surcharging events on record. A copy of this search result is contained within the appendices.
- 5.2.5 Based on this more accurate flooding information, the site is assessed as not at risk of surface water flooding from surcharging sewers.
- 5.2.6 Properties are at risk of foul water flooding in areas of combined foul and surface water. The local area is served by separate foul and surface water sewers. The site is therefore deemed not to be at risk of flooding of foul water.

5.3 Probability of Flooding from Artificial sources

- 5.3.1 The EA maps (Figure 6) show a low / no probability of flooding occurring from artificial sources.

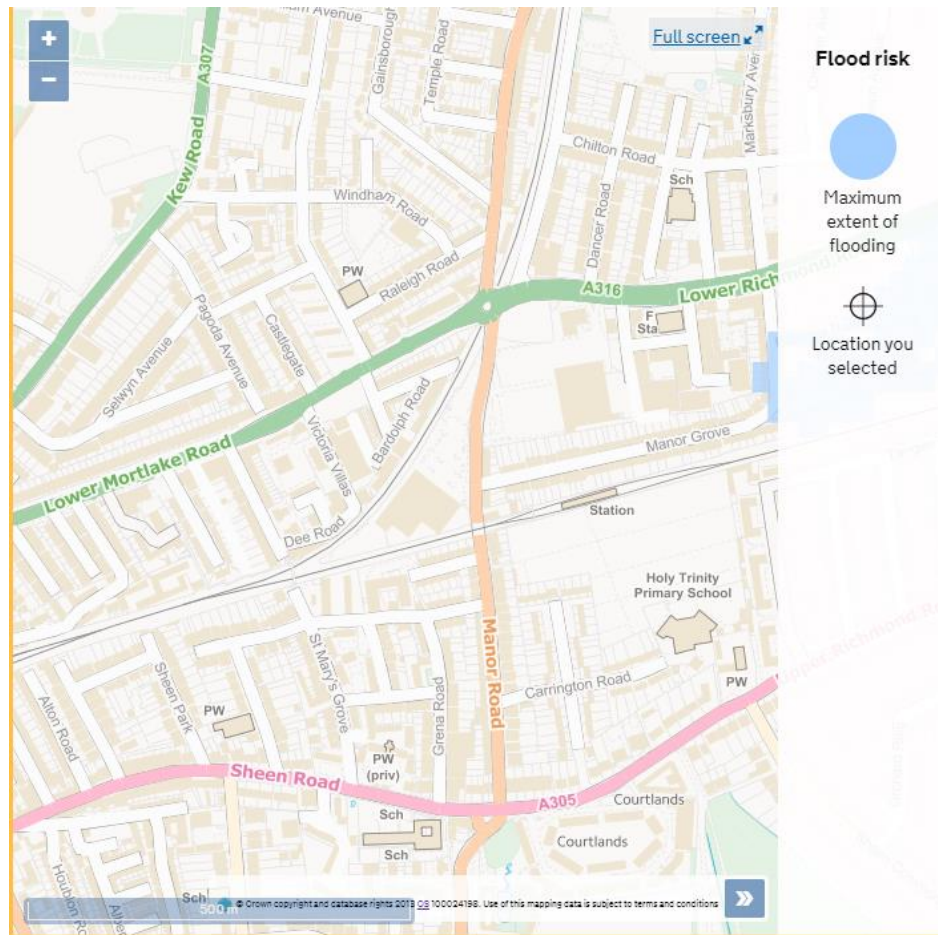


Figure 6 - Flood Risk Maps (Artificial Sources) - Environment Agency

6 Development proposal

- 6.1.1 The proposed development plans are included as an appendix to this report.
- 6.1.2 The development proposals include 5No. blocks of mixed commercial and residential units.
- 6.1.3 The development includes approximately 1,955m² of basement areas for refuse and cycle parking.
- 6.1.4 The proposed external layout includes small islands of soft landscaping and trees of a similar total size to the landscaped islands in the pre-development state.

7 Flood risk mitigation measures

7.1 Surface water flooding

- 7.1.1 As discussed in previous sections, it is policy in Richmond for developments to, where possible, reduce the flood risk to the local area and reduce peak runoff rates to greenfield rates (where feasible) using Sustainable Drainage Measures (SuDS).
- 7.1.2 The proposed development site is currently brownfield land. A utility and drainage survey identified a series of ring soakaways in the existing site car park which it is believed all the surface water in the site discharges through. No surface water

connection to the Thame Water sewer was identified during any of the site investigations completed to date.

- 7.1.3 The site is split into (i) buildings with roofscapes (approx. 0.65ha) and (ii) ground level landscaping (approx. 1.0ha).
- 7.1.4 In line with LBRuT policy, green roofs should be incorporated at roof level. Due to the build-up of the soil, this reduces runoff leaving the roof. Smart controls and additional storage can be provided at roof level to limit the roof run-off.
- 7.1.5 The proposed development includes large areas of hardstanding. Where possible, these should be constructed of a porous material and with a permeable lined porous subbase. This will allow rainfall to infiltrate to the natural environment.
- 7.1.6 As the site currently drains via infiltration, it is assumed the local geology is suitable for infiltration drainage. Infiltration tests in accordance with BRE365 have been commissioned and the results are awaited to confirm this and the infiltration rate for design.

7.2 Climate change

- 7.2.1 An allowance within the drainage network should be made to accommodate climate change.
- 7.2.2 The Environment Agency (EA) publishes tables of anticipated climate change based on river basin districts for different design life lengths.

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

Figure 7 - Peak river flow allowances by river basin district (use 1961 to 1990 baseline), source: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>, Aug 2018

- 7.2.3 The proposed development lies within the Thames district and the upper end allowance for the 2050's should be applied.
- 7.2.4 Based on the table above and current guidance, this advises an allowance of 35%.

7.3 Basements

- 7.3.1 In line with LRBuT policy, drainage should be provided (if required) to allow free movement of groundwater around any proposed basement structure.

8 Surface Water Drainage

8.1 Existing private drainage

- 8.1.1 The existing site contains surface and foul water drainage serving the existing retail store (to be demolished as part of the proposed works).
- 8.1.2 A topographical and drainage survey (see appendices) shows the drainage network including conveyance features and soakaways. Due to the scale of the proposed development, it is not anticipated that any of the existing drainage within the site will be suitable for reuse. This includes the existing soakaways that cannot remain in their current location within the proposed development.

8.2 Existing surface water runoff

- 8.2.1 The current site is brownfield land with negligible soft landscaping.
- 8.2.2 The existing surface water runoff rates have been calculated using the Wallingford Procedure for various return periods. The results are summarised in the table below and the full calculations are included as an appendix to this report. For comparison, the site greenfield equivalent rates are also given.

Return Period	Greenfield Rates		Brownfield Rates
	Runoff ha (l/s)	Runoff (site) (l/s)	Runoff (site) (l/s)
1yr	4.1	6.7	252.5
30yr	11.0	18.2	594.7
100yr	15.3	25.2	753.6

8.3 Proposed surface water runoff

- 8.3.1 It is proposed to drain the site using infiltration devices on the site, as per the predevelopment condition, subject to confirmation of suitable infiltration rates.

Greenfield Runoff

- 8.3.2 Pending the infiltration results, the site has also been assessed to consider the possibility of a connection to the public sewer network for the case of unfavourable infiltration results being reported.
- 8.3.3 The site has been assessed using *Quick Storage Estimates* in MicroDrainage software to estimate the required volumes to attenuate the site to existing greenfield runoff rates for various storm return periods.
- 8.3.4 The estimated volume for the 100yr + 35% climate change storm is shown in the table below as the maximum attenuation that would be required to match greenfield runoff. The MicroDrainage calculations are included as an appendix to this report.

Return Period	Flow Limit (l/s)	Volume (m ³)
100yr + 35% Climate Change	25.2	1020

8.3.5 It is anticipated that this would be attenuated using a combination of above ground blue / green roofs and below ground tanks. Complex flow controls would be used to flow match different storm return periods.

8.4 Sustainable Drainage Systems (SuDS)

8.4.1 Sustainable Drainage Systems (SuDS) aim to reduce runoff rates by mimicking the natural environment and discharge routes.

8.4.2 The SuDS Manual (CIRIA C753) provides guidance on the different types of SuDS components and how they can be used.

8.4.3 The table below summarises the SuDS components as listed in the SuDS manual and indicates their suitability for use on the proposed development.

SuDS Feature	Description	Suitability / comment
Rainwater harvesting	Rainwater harvesting is the collection, storage, treatment (where necessary) of rainwater runoff from roofs and other impermeable areas for reuse within the site. In addition to reducing volume runoff from the site, they can reduce the water demand of the site delivering climate resilience and sustainability benefits	This is suitable for irrigation and external uses within the site, subject to requirements of the landscape architect. Building constraints do not allow for dual potable and non-potable water supply pipes to units within the buildings. Suitable treatment should be used in accordance with specialist guidance.
Green roofs	Green roofs are areas of living vegetation included on the roofscape of buildings. They can be either extensive or intensive and accessible or non-accessible. The plant and soil reduces the rate of discharge extending the time between rainwater falling on the roof and reaching the rainwater outlet / drain. They also provide ecological and visual benefits.	This is suitable for use in the development. Extensive sedum roofs are suitable for non-accessible roof areas. Intensive landscaped roofs are suitable for amenity areas on podiums / select roofs.
Infiltration systems	Infiltration systems hold water and allow it to percolate back into the ground as it would naturally in permeable areas. These can either be traditional shallow soakaways or deep bore soakaways. Their suitability depends on the soil permeability. Due to the effect of water on structural stability, these need to be sited sufficient distances from buildings / foundations. These can reduce volume runoff from sites and contribute	This is proposed for the site pending results of infiltration tests.

SuDS Feature	Description	Suitability / comment
	to recharging groundwater	
Proprietary treatment systems	Proprietary treatment systems are manufactured products to remove specified pollutants from runoff. These can reduce downstream maintenance requirements and provide additional benefit, if required, by receiving watercourses / discharge locations.	Catchpits will be included to reduce silt build up within pipes and drainage components. There is no special protection to the discharge destination and therefore additional treatment (on discharge) is not required.
Filter strips	Filter strips are uniformly graded gently sloping strips of grass or vegetation to treat runoff by slowing down flows, promoting sedimentation and infiltration.	These are suited for large open spaces and therefore not suitable for use on the proposed development.
Filter drains	Filter drains are shallow trenches filled with gravel to attenuate, treat and convey surface water runoff. They can convey / attenuate only or, depending on site conditions, allow infiltration direct to the ground.	The proposed landscaping plan does not include areas of gravel paths / surfacing.
Swales	Swales are shallow flat bottomed channels to convey, infiltrate (where possible) and treat surface water runoff. They can enhance site design and provide biodiversity enhancements. They are often used to drain roads, paths or car parks. Swales can replace traditional pipes as a means to convey flows and used as part of a SuDS train of elements.	Swales are most suitable along roads with large verges or car parks surrounded with vegetation. They are not suitable for use on the proposed development.
Bioretention systems	Bioretention systems including rain gardens are shallow landscaped depressions to treat and store runoff using engineered soils and vegetation. They provide amenity and visual benefit alongside additional climate benefits. They are usually used for containing / managing frequent storm events.	These require areas of open space suitable for frequent flooding / surface water storage. These are not suitable for use with the intensity of the proposed development.
Trees	Trees help protect the environment in a number of ways including reducing runoff rates through interception of rain water in their canopies, and promoting infiltration in permeable / soft landscaping as well as the visual benefit they provide to the area.	Trees are proposed to be included within soft landscaped areas of the development.
Pervious pavements	Pervious pavements provide pavement surfaces suitable for pedestrian / trafficked applications whilst allowing runoff to permeate through their structure. This provides filtration	These may be suitable within the development subject to detailed design. Site conditions are not suitable for full infiltration however these can facilitate partial

SuDS Feature	Description	Suitability / comment
	benefit to treat runoff. Pervious pavements can be used to collect, treat and convey flow only, or if site condition permit, allow infiltration to the ground direct from their base.	infiltration. Additional benefits to the development of pervious pavements will be to convey flows – reduce the number of drains and pipes required, and attenuation - reducing the size of underground storage tanks required.
Attenuation storage tanks	Attenuation storage tanks temporarily hold back water for gradual release or reuse at a controlled rate to reduce the peak runoff rate. These can be in the form of above ground tanks (bluroofs), below ground geocellular / concrete tanks or oversized pipes.	The sedum greenroofs / landscaped greenroofs are proposed to include podium storage crates to attenuate water at roof level. Below ground tanks for storage / infiltration is proposed to increase available storage as required and discharge surface water.
Detention basins	Detention basins are landscaped depressions which are normally dry except for during and immediately after storm events. These attenuate flows through controls on the outfalls to store rainwater upstream in networks providing treatment and amenity benefits. With careful design, these can be used for leisure / amenity uses during normal / dry periods.	These are suitable for large open spaces. These are not suitable for use with the intensity of the proposed development.
Ponds & wetlands	These are similar to detention basins, however they are designed to have a permanent level of water within them to provide biodiversity and amenity benefits.	These are suitable for large open spaces. These are not suitable for use with the intensity of the proposed development.

Red – Not suitable; Orange – May be suitable; Green - Suitable

8.5 Drainage hierarchy

- 8.5.1 In accordance with the Flood Risk and Sustainable Drainage policy LP 21, the development should follow the drainage hierarchy.
- 8.5.2 The table below summarises the hierarchy and how the proposed drainage strategy complies with the drainage hierarchy.

Stage	Suitability / comment
Store rainwater for later use	This may be suitable for some attenuated water subject to landscape architect requirements. This is not considered to be a viable solution for the main discharge due to the volumes of water required for irrigation.
Use infiltration techniques such as porous surfaces	This is proposed for the site pending infiltration test results.
Attenuate rain water in	The intensity of the proposed development is not suitable for

Stage	Suitability / comment
ponds or open surface features	open water features
Attenuate rainwater by storage in sealed features or tanks	Attenuation (above and below ground) is proposed on the development.
Discharge direct to a water course	There are no water courses within the development that can be used for discharge.
Discharge to a surface water sewer	This may be required subject to infiltration test results. A hybrid solution with infiltration tanks and an overflow connection to the sewer may be required depending on the infiltration rates at the site.
Discharge to a combined sewer	Not required
Discharge to a foul water sewer	Not required.
<i>Red – Not suitable; Orange – possible discharge location; Green – Discharge location</i>	

8.6 Proposed drainage layout

- 8.6.1 The proposed drainage strategy has been developed in accordance with the relevant policy and guidelines as set out in the Flood Risk Assessment.
- 8.6.2 The proposed drainage strategy is shown on Fairhurst drawing 126782-C-4000 and is included as an appendix to this report.
- 8.6.3 A pre-planning application may be required to Thames Water to confirm capacity in the network if a new connection is required. This will be completed (if required) following the receipt of infiltration test results
- 8.6.4 The drainage strategy includes blue / green roofs to attenuate roof drainage at source. Low flow orifices are available which can restrict roof run off to low flow rates. Using these will minimise the volume of below ground attenuation required.
- 8.6.5 Below ground infiltration and attenuation tanks are proposed to attenuate and discharge surface water.

Infiltration

- 8.6.6 The Geotechnical Preliminary Risk Assessment (included in appendix) states;

Soakaways may be feasible within the granular Kempton Park Gravel Formation; however, given the potential for contamination identified, further risk assessments may be required to ensure that these do not result in increased mobilisation of potential contamination. Furthermore, BGS borehole logs have identified a groundwater table from c.1.5m bgl and the shallow depth to groundwater may preclude the use of soakaway drainage.(Report Fairhurst 126782-R1)
- 8.6.7 This was written prior to the receipt of the survey showing the current site draining to soakaways.

8.6.8 Based on the current site drainage regime and the geotechnical conclusions, it is determined the site may be suitable for infiltration drainage. Pending the result of the site specific testing, infiltration rates have been assumed based on conservative estimates for the anticipated soil conditions.

Soil condition	Typical Infiltration Rate Range (m/hr)
Gravel	10 - 1000
Sands	0.1 – 100

8.6.9 For the preliminary drainage strategy, a conservative rate of 0.1m/hr has been used.

8.6.10 A simple drainage network has been modelled in MicroDrainage simulating blue / green roofs restricted to a cumulative total of 5.0l/s (0.65ha) and 1.0ha of area direct to the infiltration tank.

8.6.11 The site is bounded by Network Rail land who typically require any infiltration devices to be minimum of 10m from their land boundary. Based on this and the site layout, there is nominally 450m² of space available for infiltration.

8.6.12 The model indicates a 1.2m deep tank will provide sufficient surface area for infiltration and attenuation required to contain and discharge all storms up to the 1 in 100yr + 35% climate change.

8.6.13 The tank size should be confirmed following the results of the infiltration tests.

8.6.14 As part of the infiltration tests, groundwater monitoring should also be completed to confirm there is a minimum of 1.0m below the base of the infiltration device and the maximum groundwater level.

Connection to the Public Water Sewer / Overflow

8.6.15 If the infiltration results prove unsuitable for infiltration discharge, a new connection may be required to the Thames Water sewer.

8.6.16 Dependant on the infiltration rates, this may be for all discharge (limited to greenfield rate) or partial discharge as an overflow.

8.6.17 The table below shows the volume of attenuation required on site if the site is to solely discharge to Thames Water sewers at greenfield rates.

Return Period	Flow Limit (l/s)	Volume (m ³)
100yr + 35% Climate Change	25.2	965

8.6.18 A preplanning application has been submitted to Thames Water to confirm capacity in the network should this be required. Thames Water have advised that as the site currently drains via infiltration, they will not fully assess the site for a sewer connection prior to completion of infiltration tests.

8.6.19 Thames Water have indicated if infiltration drainage is not possible, they may consider a new connection restricted to the lower of greenfield runoff rate and 5l/s subject to Lead Local Flood Authority agreement.

8.6.20 A copy of Thames Water's response to the preplanning enquiry is included in the appendix to this report.

8.7 Drainage Form

8.7.1 London Borough of Richmond upon Thames has developed a drainage assessment form for developers to complete.

8.7.2 A completed copy of this form is included in Appendix A.8

9 Foul Water Drainage

9.1 Existing drainage

9.1.1 The existing site is served by a network of private drains and connects to the Thames Water foul sewer as shown on the surveys in the south east corner of the site.

9.2 Proposed drainage

9.2.1 Due to the extents and type of the proposed development, the existing drainage network within the site will not be suitable for reuse due to the layout of the pipes / proposed buildings.

9.2.2 It is proposed to maintain the existing connection between the final private manhole and the Thames Water sewer and connect the proposed site via this existing connection.

9.2.3 Due to the scale of the development, there will be an increase in peak foul flow from the site. A preplanning application has been submitted to Thames Water to confirm capacity in the network. Thames Water have confirmed there is currently capacity in the network for the proposed foul water requirements.

9.2.4 A copy of the Thames Water's response is included in the appendices of this report.

10 Drainage maintenance

10.1.1 As with all engineering systems, SuDS networks require a maintenance regime to be established and followed to ensure it acts as designed.

10.1.2 The SuDS Manual, CIRIA C753 provides guidance on the general maintenance requirements for different SuDS elements.

10.1.3 Typical drainage maintenance schedules are included as an appendix to this report. These should be updated as required during detailed design to reflect the constructed drainage system's requirements.

11 Conclusions

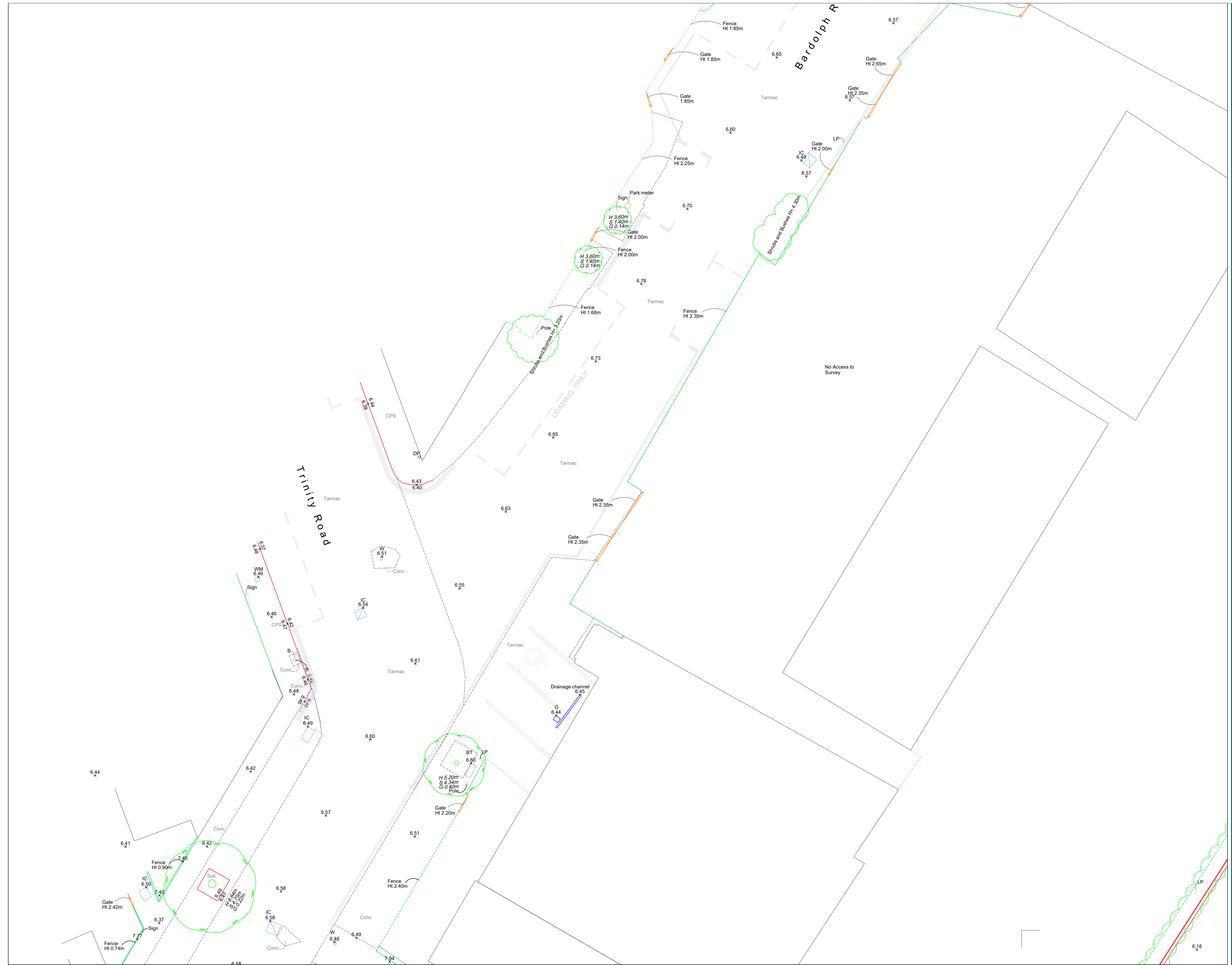
11.1.1 The proposed development is 1.65ha in Flood Zone 1.

11.1.2 The existing site drains to soakaways and does not connect to the surface water sewers.

- 11.1.3 A surface water drainage strategy using blue / green roofs and attenuation / infiltration tanks is proposed to manage surface water on the site including an allowance for climate change.
- 11.1.4 A detailed drainage design based on the strategy and comments in this report should be developed. By implementing these measures, surface water will be managed on site and not increase downstream flood risk.
- 11.1.5 By implementing these measures, surface water flood risk has been managed and the site is deemed to be not at risk of surface water flooding.
- 11.1.6 A connection to Thames Water sewers may be required for surface water if unsuitable infiltration results are recorded on the site.
- 11.1.7 A foul water drainage strategy will be developed using the existing connection from the site to the public sewer network.

A.1 Surveys

- Topographical survey
- Utility Survey
- Drainage CCTV Survey



Level Change
 Ice Outlet
 Valve
 Phone Call Box
 FPS Paving
 Inspection Cover
 Meter

	S1	S2
	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Title: Topographic Survey
 Sheet 1

Point 2 Surveyors Ltd,
 3rd Floor,
 17 Slingsby Place,
 London WC2E 9AB,
 0207 836 5828
 www.point2surveyors.com

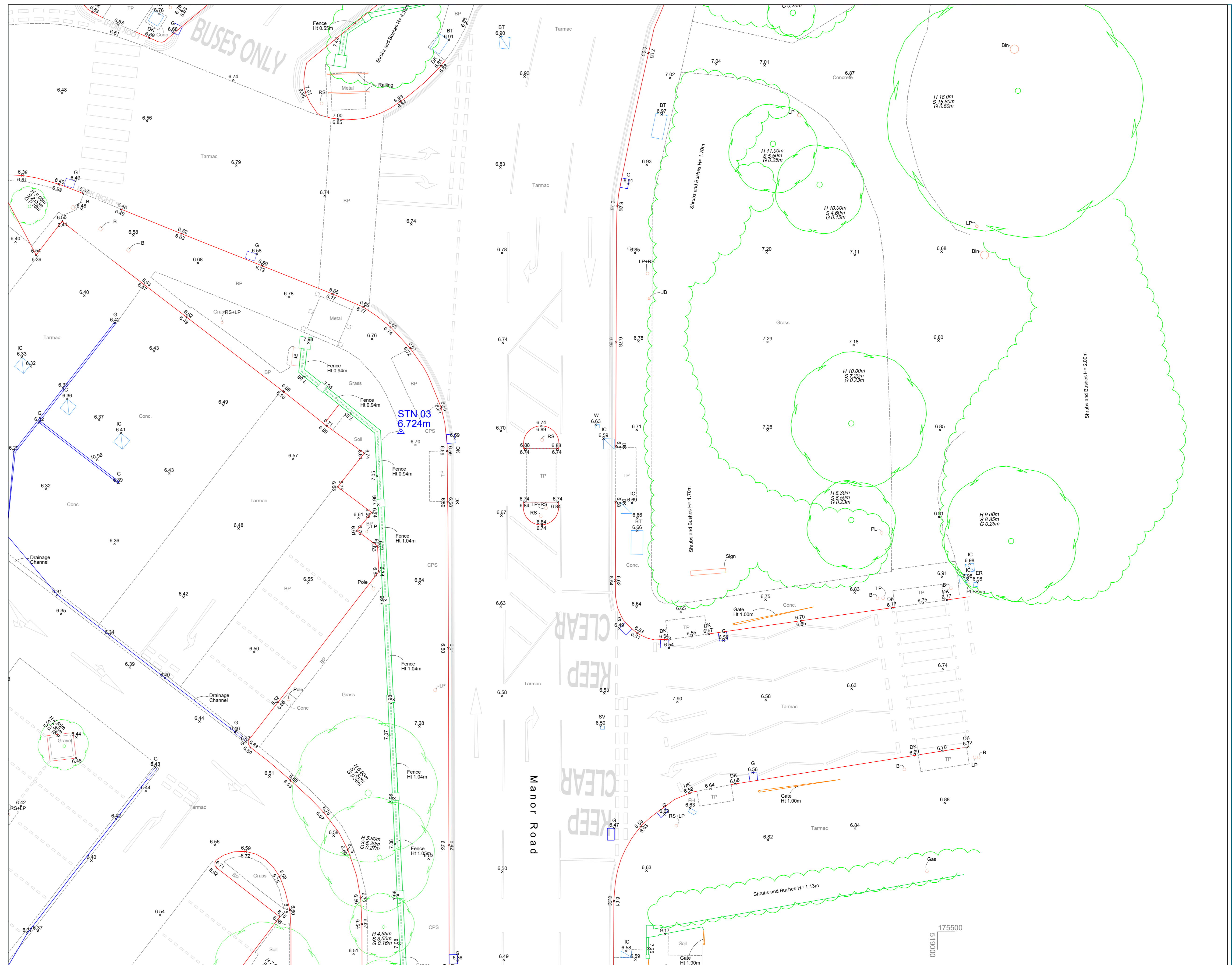


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Date: August 2018

Dwg No: LS2024/T/01



Level
Change
Outlet
Valve
Phone Call Box
FPS Paving
Inspection Cover
Meter

	S1	S2
	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Title: Topographic Survey
Sheet 2

Point 2 Surveyors Ltd,
3rd Floor,
17 Slingsby Place,
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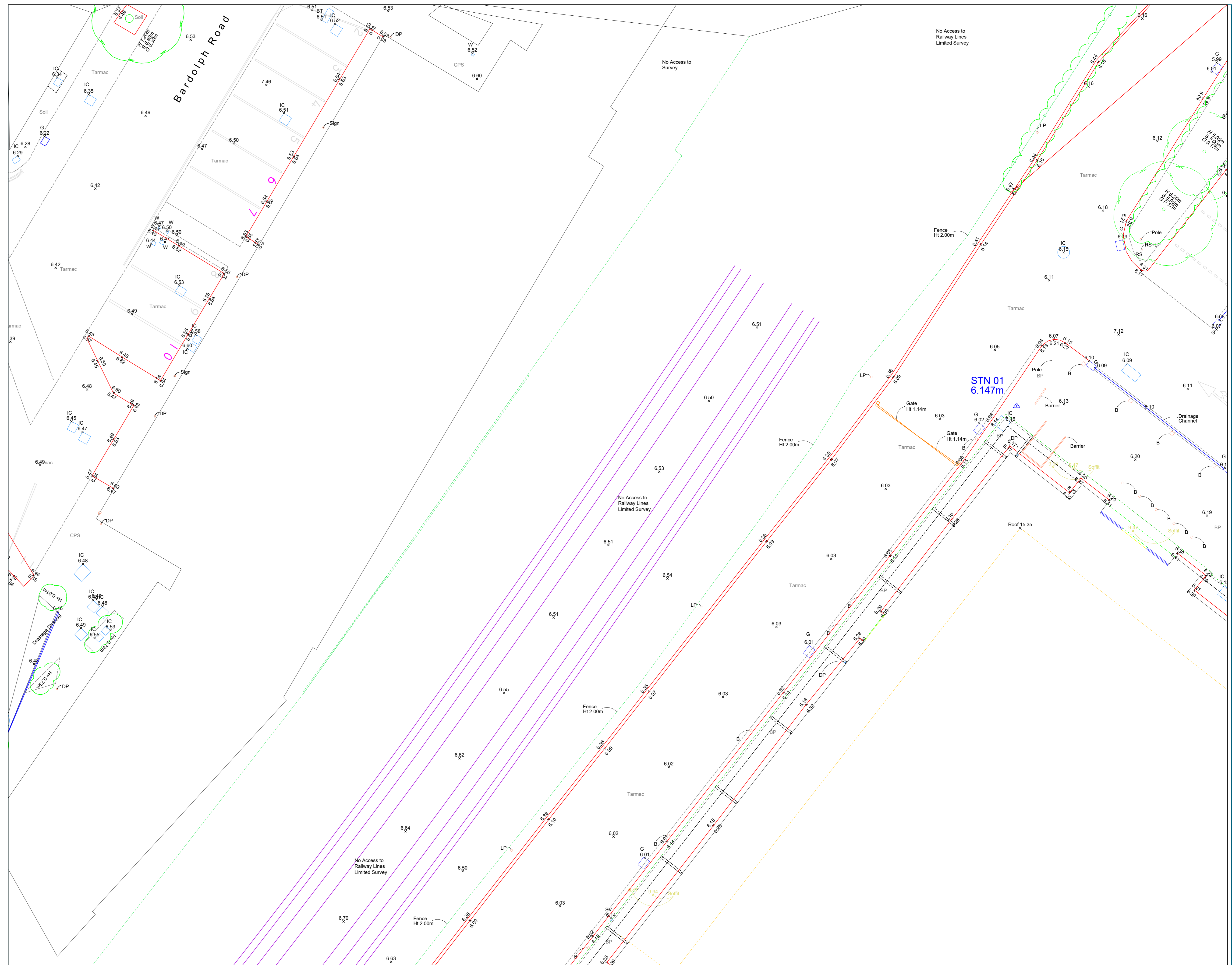
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Date: August 2018



Dwg No: LS2024/T/02



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Project: Homebase, Richmond

Drawn By: SB

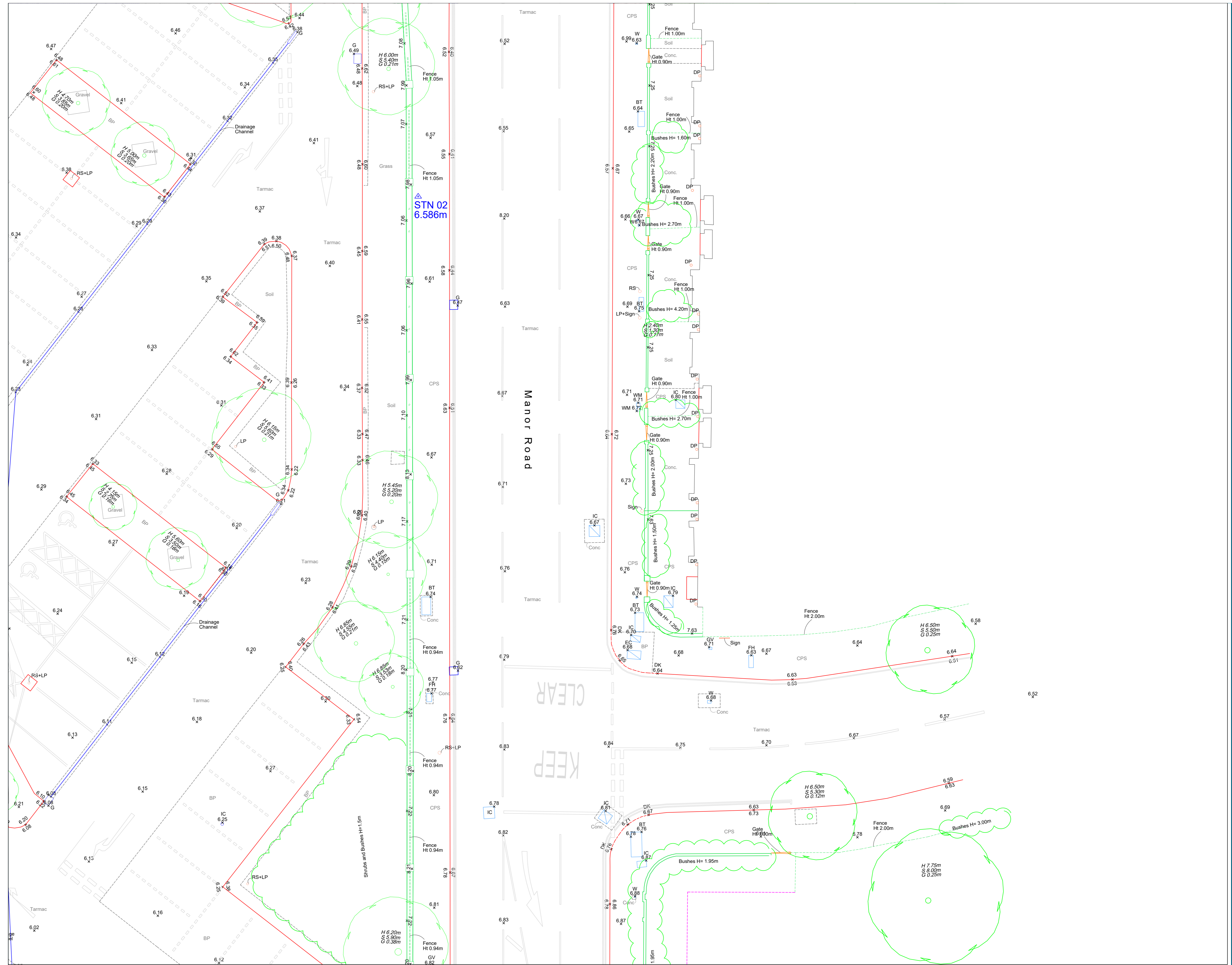
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Date: August 2018

Title: Topographic Survey
Sheet 3

Dwg No: **LS2024/T/03**

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Level
 Change
 Outlet
 Valve
 Phone Call Box
 Paving
 Inspection Cover
 Meter

	S1	S2
	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Title: Topographic Survey
 Sheet 4

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 3rd Floor,
 17 Slingsby Place,
 London WC2E 9AB,
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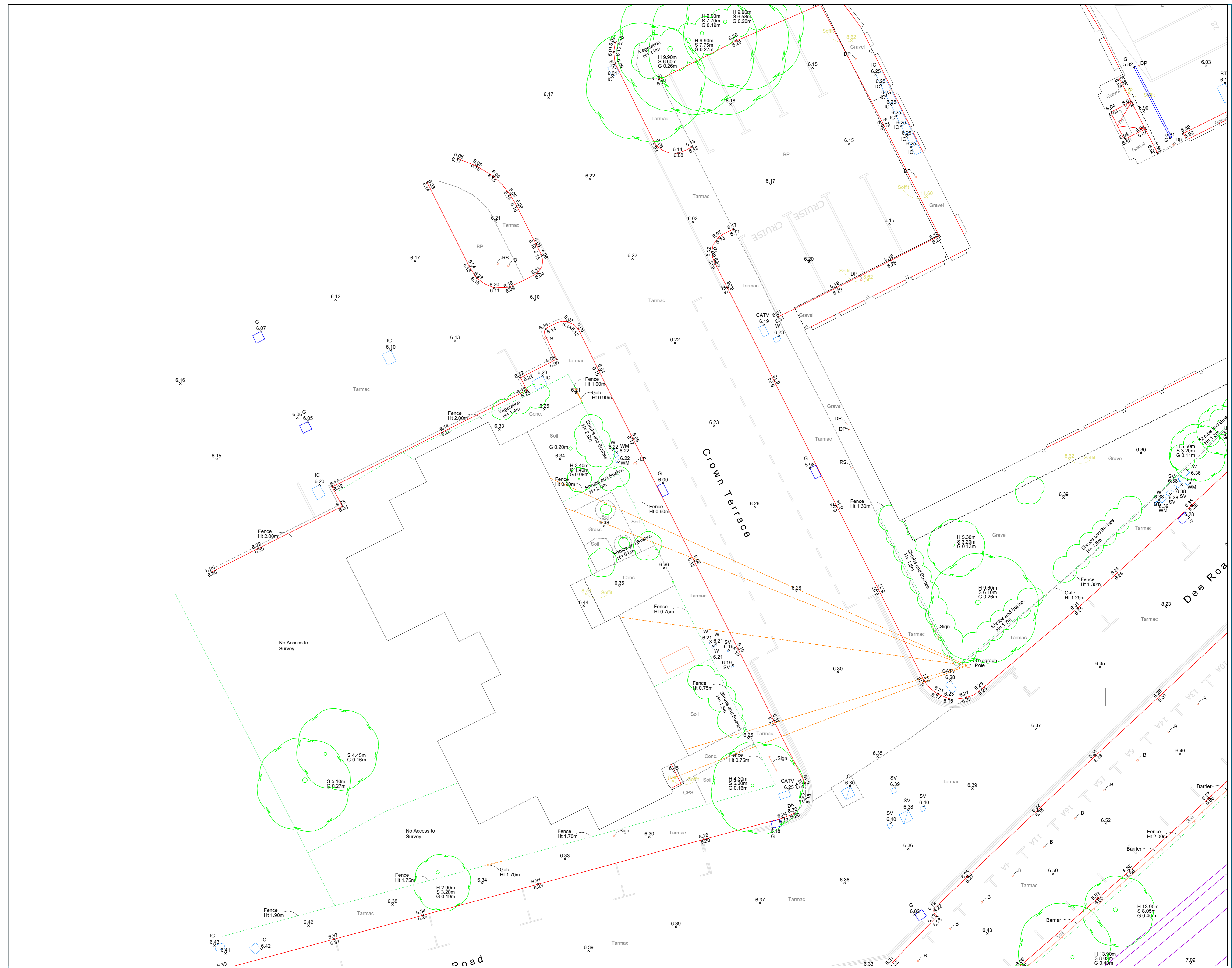
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Date: August 2018

Dwg No: LS2024/T/04





Level Change
 Ice Outlet
 Valve
 Phone Call Box
 FPS Paving
 Inspection Cover
 Meter

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	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Drawn By: SB

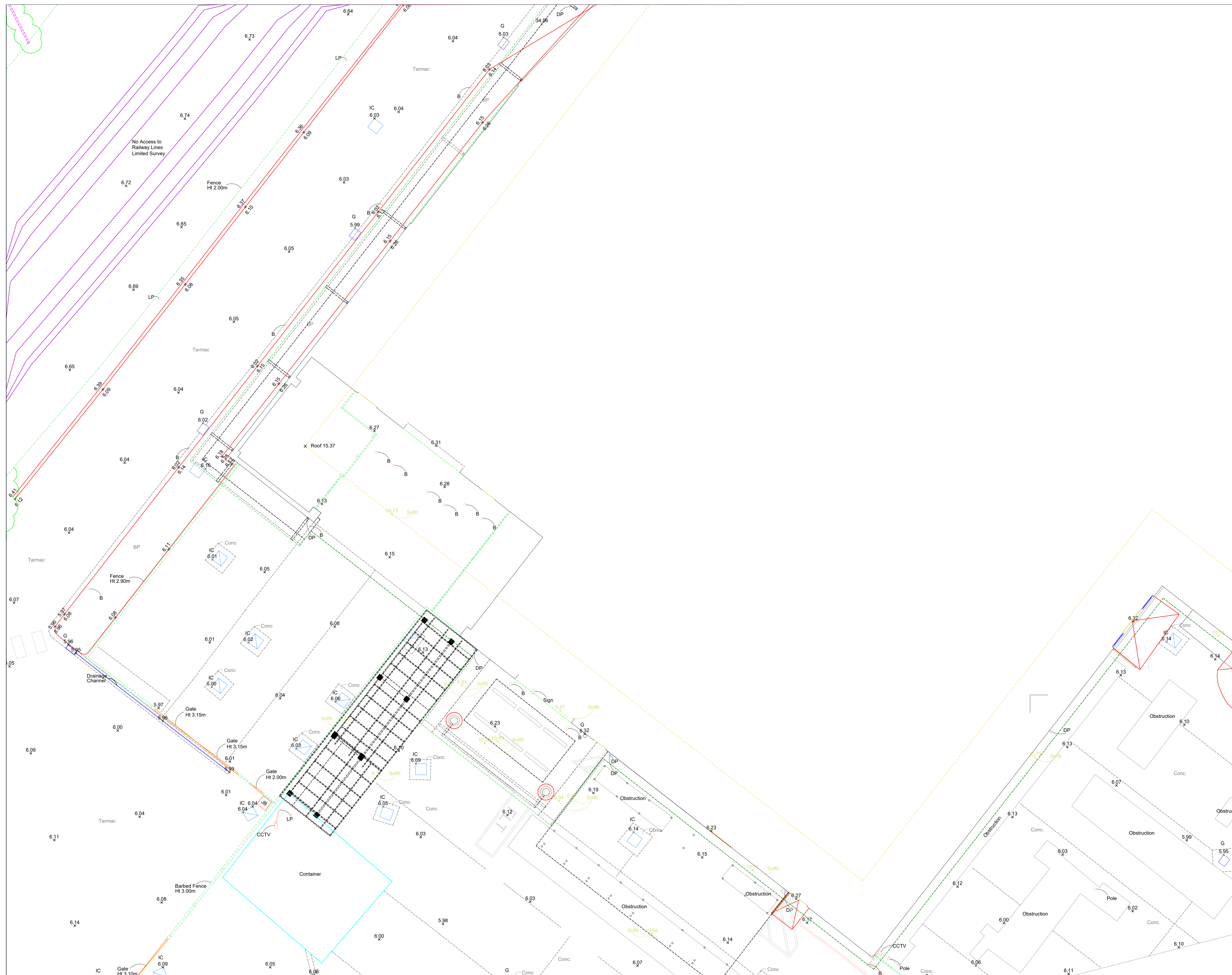
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Date: August 2018

Title: Topographic Survey Sheet 5

Dwg No: **LS2024/T/05**

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Level
 Change
 Outlet
 Valve
 Phone Call Box
 PS Paving
 Inspection Cover
 Meter

	S1	S2
	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Title: Topographic Survey
 Sheet 6

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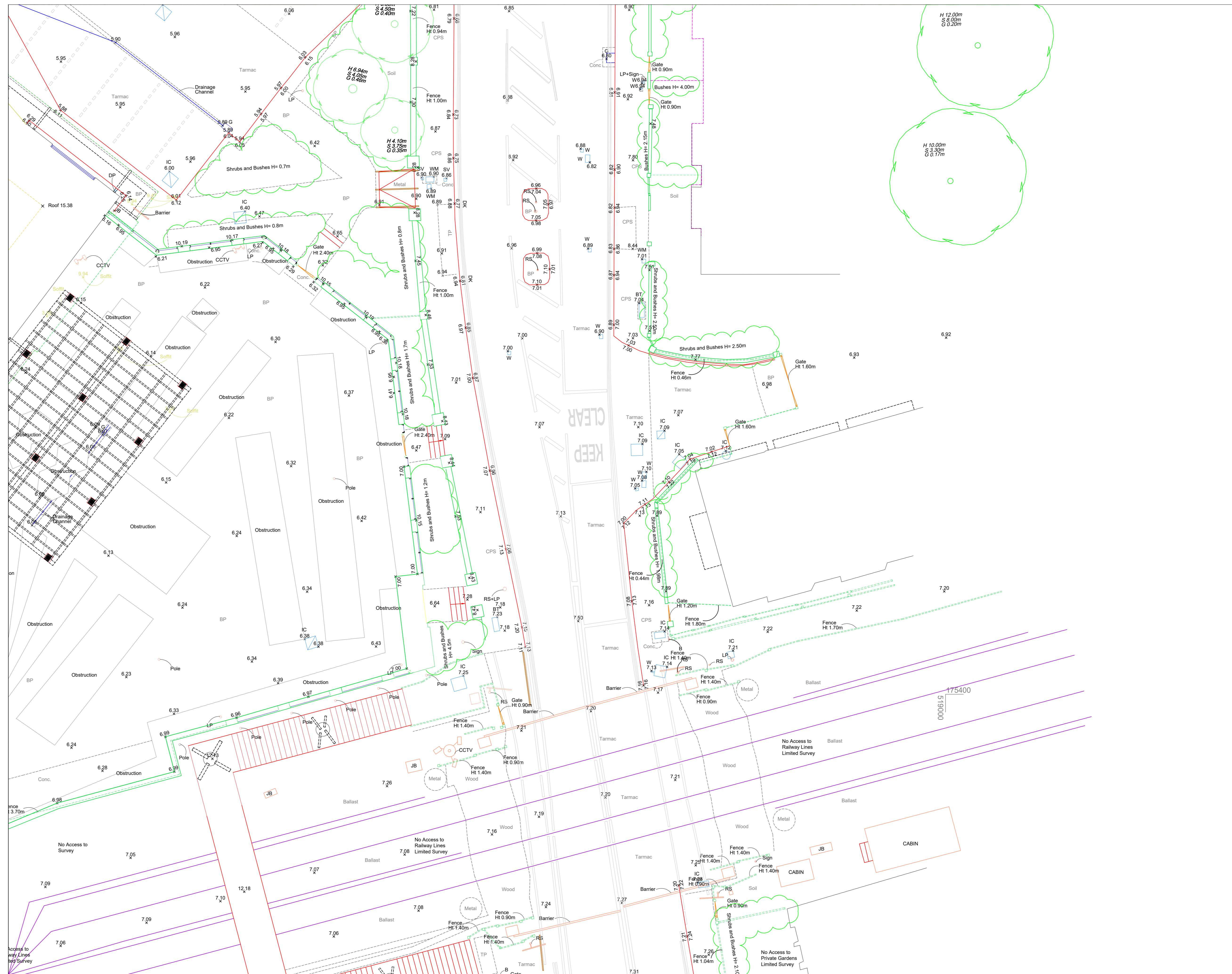
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Date: August 2018

Dwg No: **LS2024/T/06**





Level Change
Ice Outlet
Valve
Phone Call Box
FPS Paving
Inspection Cover
Meter

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Project: Homebase, Richmond

Drawn By: SB

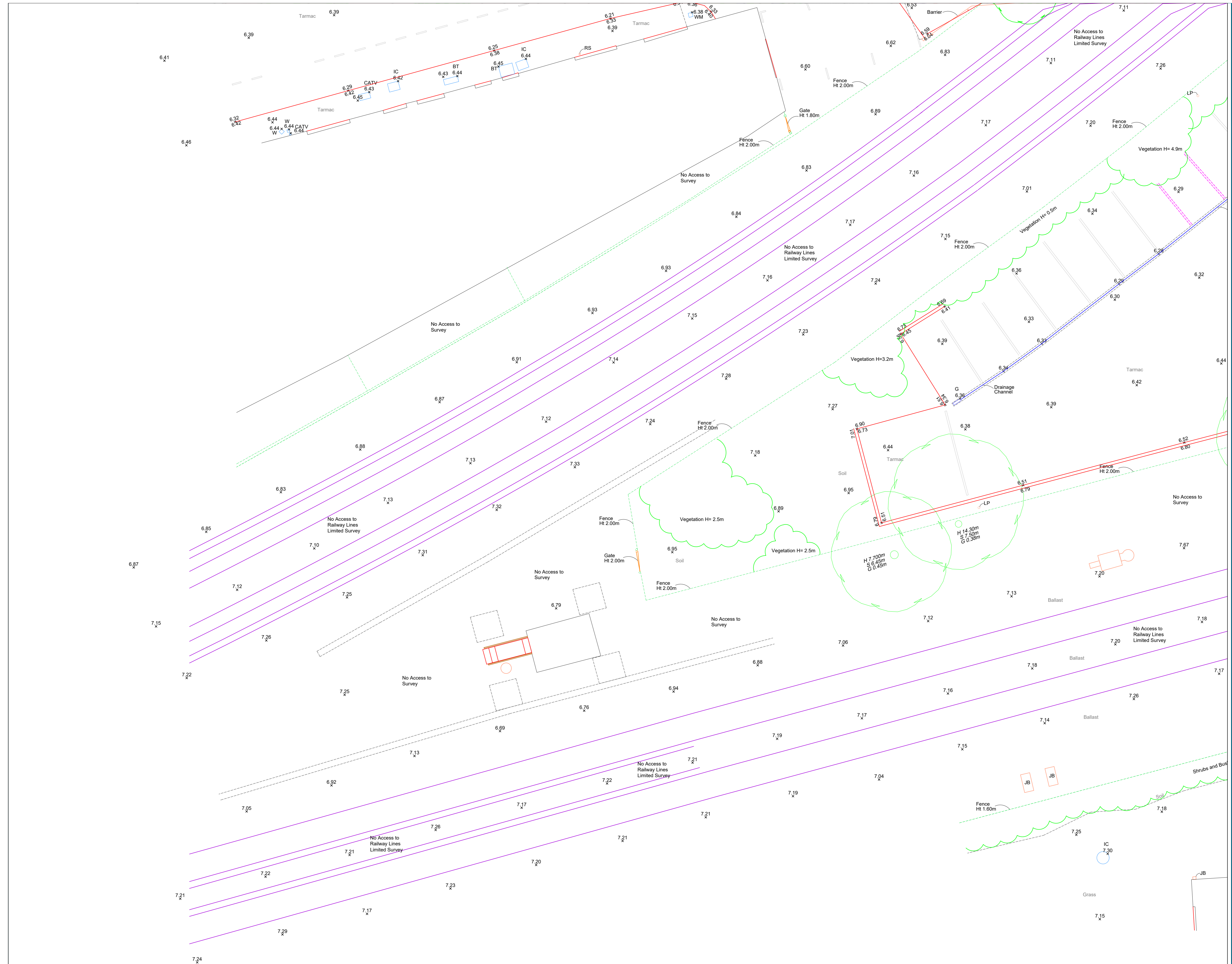
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Date: August 2018

Title: Topographic Survey Sheet 7

Dwg No: **LS2024/T/07**

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Level Change
 Ice Change
 Waste Outlet
 Valve
 Telephone Call Box
 IPS Paving
 Manhole Inspection Cover
 Street Meter

	S1	S2
	S3	S4
S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Drawn By: SB

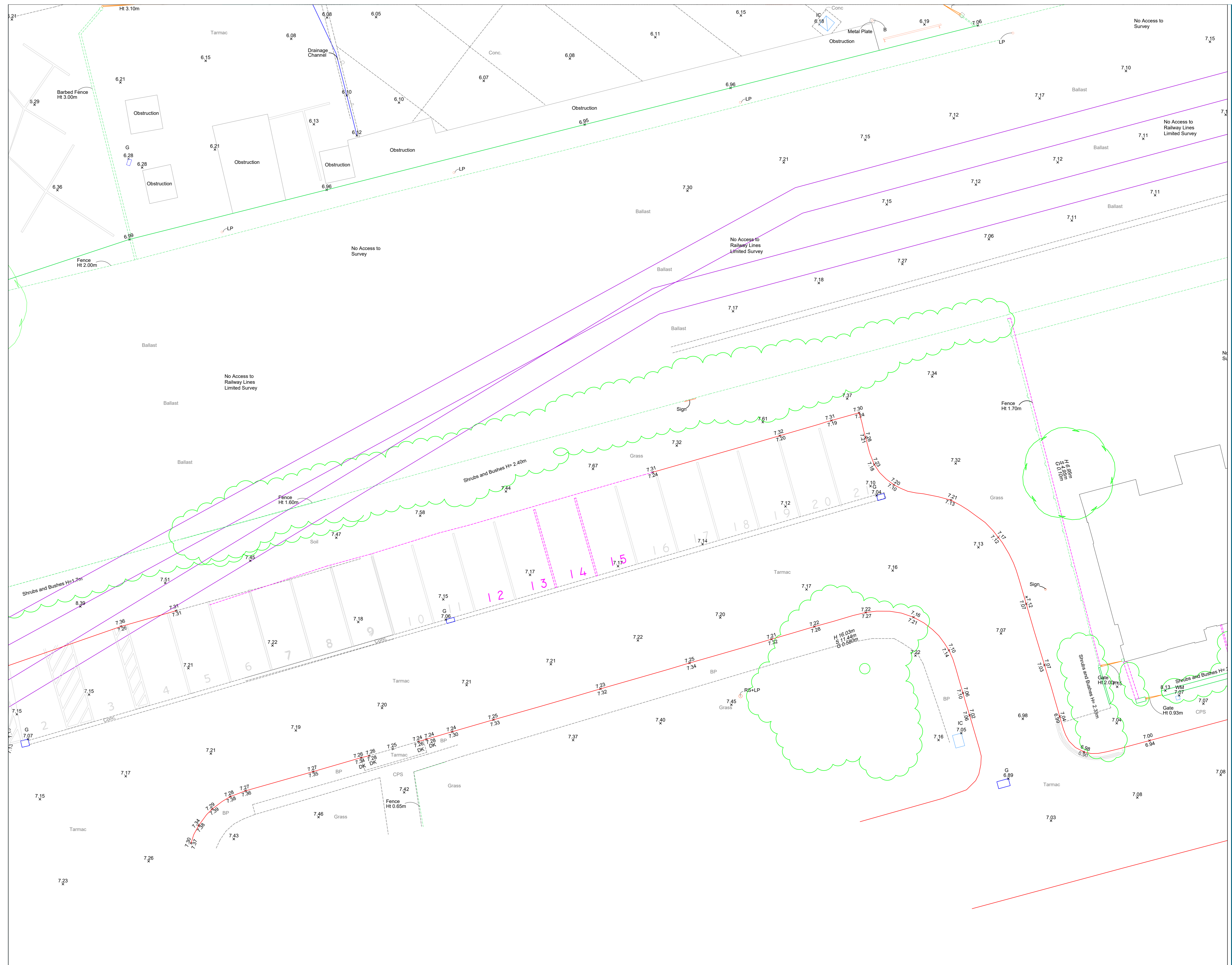
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Date: August 2018

Title: Topographic Survey
 Sheet 8

Dwg No: **LS2024/T/08**

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Level Change
 Ice Outlet
 Valve
 Phone Call Box
 FPS Paving
 Inspection Cover
 Meter

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S5	S6	S7
S8	S9	S10

Project: Homebase, Richmond

Drawn By: SB

Scale: 1:100 @ A0

Date: August 2018

Title: Topographic Survey Sheet 9

Dwg No: **LS2024/T/09**

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Level
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 Outlet
 Valve
 Phone Call Box
 FPS Paving
 Inspection Cover
 Meter

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S5	S6	S7
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Project: Homebase, Richmond

Drawn By: SB

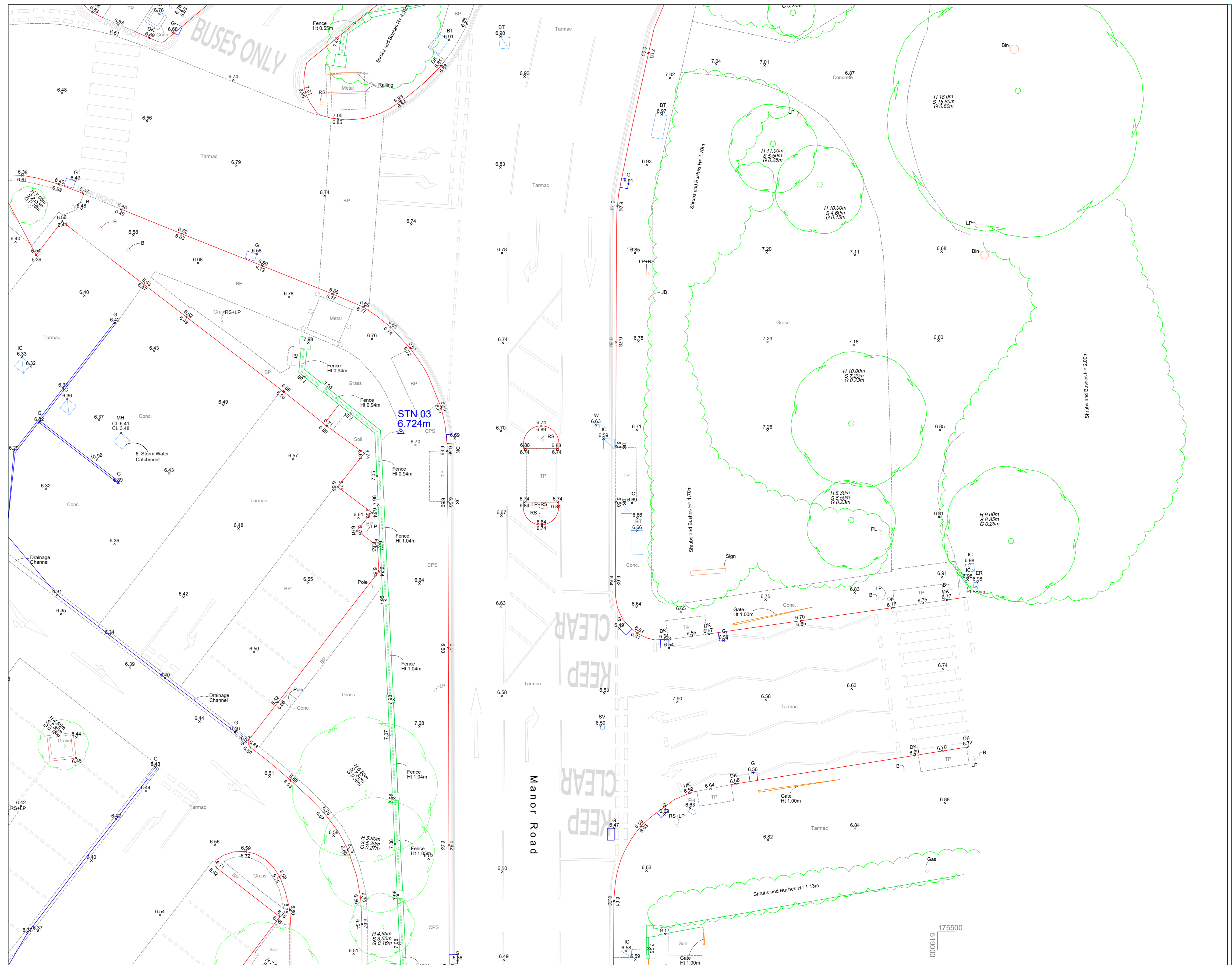
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Title: Topographic Survey
 Sheet 10

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Level
Change
Outlet
Valve
Phone Call Box
Paving
Inspection Cover
Meter

S1
S2
S3

Project: Homebase, Richmond

Drawn By: SB

Title: Topographic Survey - Services
Sheet 1

Dwg No: **LS2024/T/S/01**

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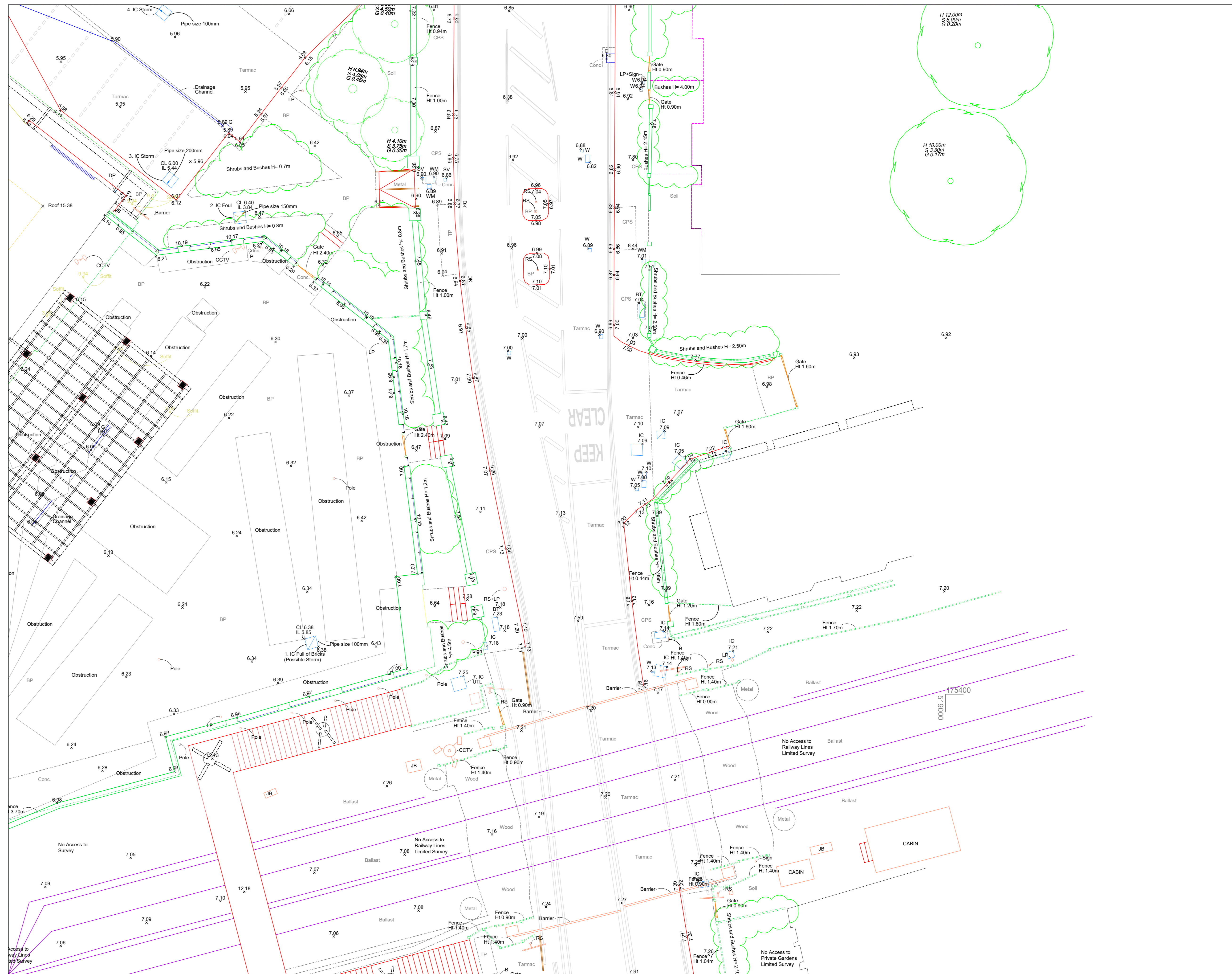
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Date: August 2018

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Date: August 2018

Dwg No: **LS2024/T/S/01**



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S3

Project: Homebase, Richmond

Title: Topographic Survey - Services
Sheet 3

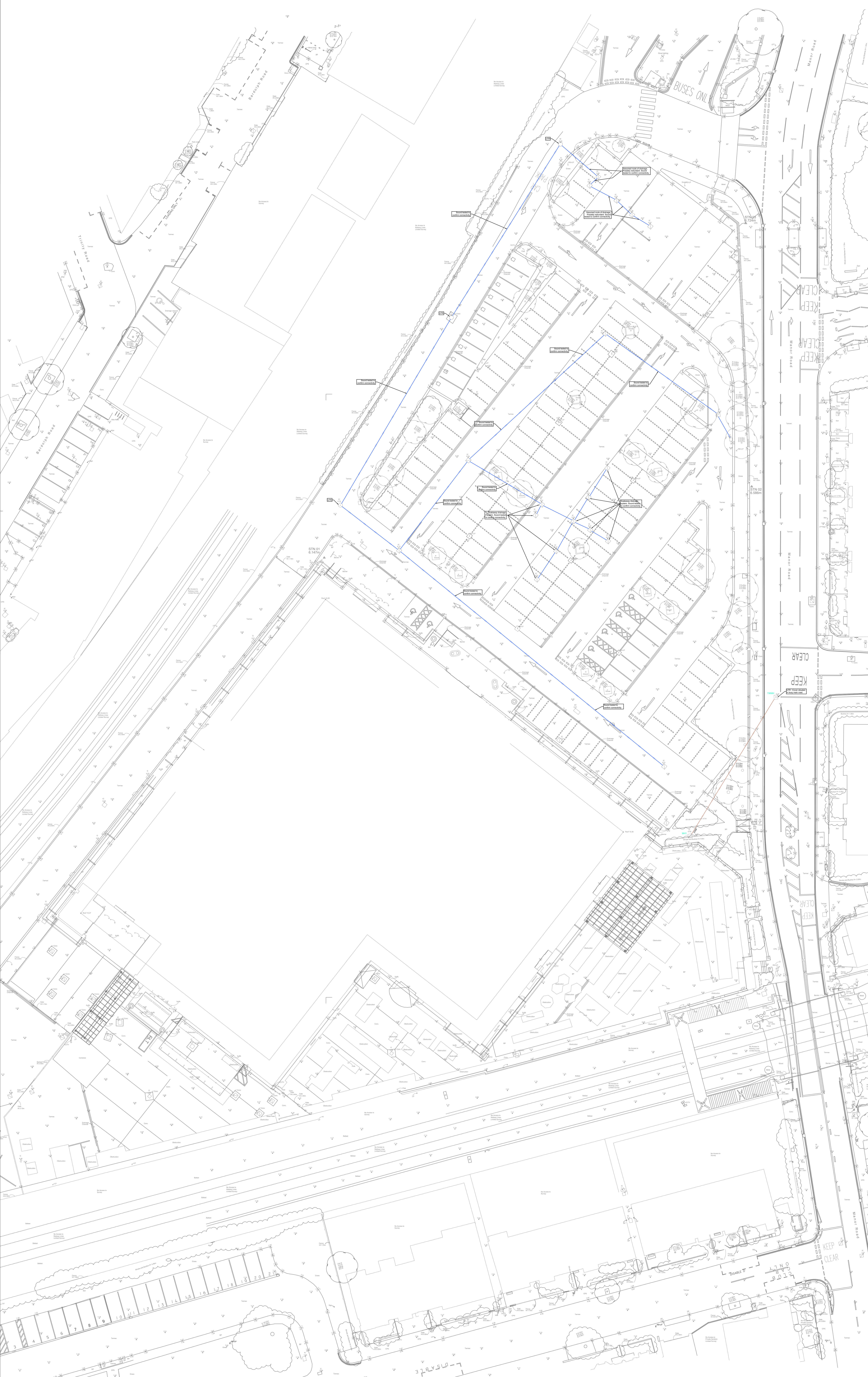
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17 Slingsby Place,
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Date: August 2018

Dwg No: LS2024/T/S/03



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Topographical Survey Key

- AV - ...
- BT - ...
- SA - ...
- SV - ...
- TV - ...
- ... (many more symbols and abbreviations)

Sub Surface Key

- ... (many more symbols and abbreviations)

Notes

- ...
- ...
- ...

Layout

AD P1

Approximate Direction of North

GRID : DATUM

SUBSCAN
 www.subscan.com

CLIENT
 Fairhurst

SITE
 Former Homebase
 Richmond TW9 1YB

DRAWING TITLE
 CCTV Drainage Investigation

DRAWING REF. LAYOUT TAG
 1985 (AD P1)

SCALE
 AS SHOWN

PRODUCT REF
 19857

SURVEYED
 JWP/PV

DRAWN
 AS

CHECKED
 AS

DATE
 05/11/16

A.2 Geotechnical Reports

- Geo-Environmental and Geotechnical Preliminary Risk Assessment, Ref 126782-R1

Geo-Environmental and Geotechnical Preliminary Risk Assessment

Manor Road, Richmond

January 2019



FAIRHURST

CONTROL SHEET

CLIENT: Avanton Richmond Development Limited




PROJECT TITLE: Manor Road, Richmond







REPORT TITLE: Geo-Environmental and Geotechnical Preliminary Risk Assessment

PROJECT REFERENCE: 126782

DOCUMENT NUMBER: R1.2

STATUS: ISSUE

Issue & Approval Schedule	ISSUE 1 FINAL		Name	Signature	Date
	Prepared by	F Siemers			01/10/2018
	Checked by	C Barber			02/10/2018
	Approved by	C Barber			03/10/2018

Revision Record	Rev.	Date	Status	Description	Signature	
	1	04/12/18	DRAFT	Revision following design freeze.	EY	
					AS	
					AS	
	2	03/01/19	ISSUE	Revision following client comment	EY	
					AS	
AS						

This document has been prepared in accordance with procedure OP/P02 of the Fairhurst Quality and Environmental Management System

This document has been prepared in accordance with the instructions of the client, Avanton Richmond Development Limited for the client's sole and specific use. Any other persons who use any information contained herein do so at their own risk.

EXECUTIVE SUMMARY

Current Status	Site The site currently comprises a warehouse structure occupied by a DIY and pets store, positioned to the west of Manor Road, Richmond (Post Code - TW9 1YB).
Assessment Rationale	It is understood that Avanton Richmond Development Ltd. propose to redevelop the former Homebase site, to include a residential led development with commercial areas and associated car parking, soft landscaping and infrastructure. The purpose of this assessment is to review available environmental, historical and geological data to identify potential geo-environmental and geotechnical constraints associated with the proposed development.
Geology & Controlled Waters	The site is reported to be underlain by Made Ground and further underlain by the Kempton Park Gravel Member to c.6m bgl and further underlain by the London Clay Formation. Groundwater is considered to be present in the Kempton Park Gravel Member from c.1.5m bgl. The nearest surface water feature is the River Thames positioned c.1.6km north-west of the site. The Kempton park Gravel Member is classified as a Secondary A Aquifer by the Environment Agency and the London Clay Formation bedrock as an Unproductive Stratum.
Contamination Considerations	This report has identified potential sources of contamination on-site, including those that predate the commercial building, including Made Ground, timber yards, electrical substations, car wash, coal hoppers, fuel depot, power station and car parking. Furthermore, off-site sources of contamination were identified, most notably the former Richmond Gas Works positioned to the north-east of the site beyond Manor Road. Potential risks were assessed against sensitive receptors including human health, building structures and services and controlled waters as the underlying Kempton Park Gravel Member (Secondary A Aquifer). Typically a moderate risk was identified to receptors associated with the proposed development. It is considered that contaminated land planning conditions will be included associated with the development and it is recommended that a ground investigation is undertaken to further quantify potential risks.
Geotechnical Considerations	Potential Geotechnical considerations identified including: <ul style="list-style-type: none"> • Presence of railway lines adjacent to the south and west of the site. The development will require further consultation with Network Rail following Fairhurst's initial meeting regarding potential for risk to their assets; • Noting that a basement is proposed in the northern and southern portions of the site, it is considered that a basement assessment will be required in accordance with LBRuT guidance, including assessment of land and structural stability; • It is noted that the site is within a National Grid safeguard zone and additional services are likely to be present associated with the development of the site. Existing services may require removal, capping and diversion associated with the development. Furthermore, it is recommended that full service plans are obtained in advance of any below ground investigation works; • Structural loads are unknown at this stage. Noting proposed development heights of between 4 and 9no storeys, it is considered that loads may exceed traditional shallow foundations (i.e. pads and strips) and foundations may need to be piled. Based on BGS borehole records, it is considered that a piled foundation solution would extend into the London Clay Formation. Foundation design will be subject to structural loads and ground investigation findings; and • The site is within a high risk area with respect to unexploded ordnance. It is recommended that a specialist is consulted prior to any below ground works.

CONTENTS

1.0	INTRODUCTION.....	2
2.0	SITE SETTING AND HISTORY	4
3.0	BACKGROUND INFORMATION AND ENVIRONMENTAL SETTING	9
4.0	PRELIMINARY CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT	17
5.0	GEOTECHNICAL CONSIDERATIONS	25
6.0	CONCLUSIONS AND RECOMMENDATIONS.....	27

FIGURES

FIGURE 1 – SITE LOCATION PLAN

FIGURE 2A – POTENTIAL SOURCES OF CONTAMINATION ON-SITE

FIGURE 2B – POTENTIAL SOURCES OF CONTAMINATION OFF-SITE

APPENDICES

APPENDIX A - DEVELOPMENT PLANS

APPENDIX B - ENVIROCHECK REPORT

APPENDIX C- DETAILED UNEXPLODED ORDNANCE (UXO) THREAT AND RISK ASSESSMENT

APPENDIX D - REGULATORY CONSULTATION

APPENDIX E - SITE WALKOVER PHOTOGRAPHIC RECORD

APPENDIX F - TOPOGRAPHIC SURVEY

APPENDIX G - PRINCIPLES OF GEO-ENVIRONMENTAL RISK ASSESSMENT

1.0 INTRODUCTION

1.1 Site Background and Understanding

Fairhurst have been appointed by Avanton Richmond Development Limited (Avanton), the Client, to undertake a Geo-Environmental and Geotechnical Preliminary Risk Assessment (PRA) for a site off Manor Road, Richmond, London, TW9 1YB (the site). The location of the site is shown on Figure 1.

It is understood that Avanton propose to redevelop the former Homebase site, to include a residential led development with commercial areas and associated car parking, soft landscaping and infrastructure. Development plans from Assael Architecture are included in Appendix A and detail:

- Basement parking / plant in the northern portion of the site;
- 4no blocks of between 4 and 9no storeys; and
- Associated landscaping.

1.2 Scope and Objectives

Pre-application discussions have been undertaken with the London Borough of Richmond Upon Thames (LBRuT) between July and December 2018 (ref.18/P0135/PREAPP), which identifies the site would be subject to the LBRuT local plan policy 10, which with respect to land contamination states '*The Council promotes, where necessary, the remediation of contaminated land where development comes forward. Potential contamination risks will need to be properly considered and adequately mitigated before development proceeds.*' Furthermore, the council state that their '*records indicate that the site and surrounding area has been subject to former potentially contaminative land uses and so a Land Contamination Assessment would be required.*'

The purpose of this assessment is to review available environmental, historical and geological data to identify potential geo-environmental and geotechnical constraints associated with the proposed development. This report includes the development of a preliminary conceptual site model and qualitative risk assessment assuming a proposed residential led end use in order to support the planning application and inform planning decision conditions.. This report has been undertaken in accordance with industry best practice document CLR11 'Model Procedures for the Management of Land Contamination' and BS10175:2011:A2:2017 in relation to the scope of a desk based study.

This report should be updated and refined should development plans change.

1.3 Sources of Information

The following sources of information have been reviewed and were utilised in the preparation of this report:

(i) Published Geological and Environmental Information

- British Geological Survey (BGS), South London, Geological Map Sheet 270 – Solid and Drift Edition, 1:50,000, 1998;
- BGS online map viewer and borehole records (bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html) (accessed 01/08/2018);
- Bomb Sight (bombsight.org version 1.0) (accessed 01/08/2018);
- Magic, DEFRA (magic.defra.gov.uk/MagicMap.aspx) accessed 01/08/2018);
- Public Health England UK Map of Radon Risk (ukradon.org/information/ukmaps) (accessed 01/08/2018);
- Long term flood risk information, (flood-warning-information.service.gov.uk/long-term-flood-risk/map) (accessed 01/08/2018); and,
- London Borough of Richmond Upon Thames Planning Portal (accessed 12/10/2017).

(ii) Envirocheck Information

Site Specific Envirocheck Report (Reference 142584674_1_1) dated October 2017. This report is included as Appendix B.

(iii) UXO Information

- Zetica Unexploded Bomb Risk Map (London, South-West), (zetica.com/, accessed 01/08/2018); and
- Landmark / Alpha Associates Detailed Unexploded Ordnance (UXO) Threat and Risk Assessment (References 190053937_1 and P7115 respectively), dated January 2019. This Report is included within Appendix C.

(iv) Consultations

The Environment Agency, the London Borough of Richmond Upon Thames, Network Rail, Transport for London and London Overground were contacted, with regards to any information they may hold in respect to the environmental setting of the site and surrounding area.

Where responses have been received from consultees, these have been summarised in Section 3.0 of this report. Records of the correspondence are included in Appendix D.

2.0 SITE SETTING AND HISTORY

2.1 Site Description

The site is located approximately 0.6km north-east of Richmond town centre, in south-west London and is centred on National Grid Reference 518890, 175430 (approximate post code TW9 1YB). The site is accessed via Manor Road, which bounds the site to the east.

The site is approximately triangular in shape, covering an area of approximately 1.8Ha and is currently occupied by a retail warehouse building (Homebase) in the central third, with associated car / bus parking in the north-eastern third and storage areas in the south-western third of the site.

The site is bound to the north west and south by railway lines and to the east by Manor Road, as detailed further below.

2.2 Site Survey Walkover

A site walkover was undertaken on 8th August 2018 by a Fairhurst Geo-Environmental Engineer. A photographic record and photograph location plan are included as Appendix D.

On-site

The following features were noted on-site:

- **Area 1: Car Parking and Bus Stand**

The northern portion of the site was occupied by car parking (Photo 1), with areas of soft landscaping and planters locally present across the car parking and along the western and eastern (Photo 2) boundaries, including mature trees, grass and shrubs. Vehicle access to the site was gained from Manor Road (Photo 3) to the north-east and pedestrian access can additionally be gained from this road to the south-east. A bus stand was noted to the north of the access road. Following amendments to the proposed development since the walkover was undertaken, it is understood that this area is now within the site boundary. No evidence of re-fuelling or tank storage was identified (Photo 16).

Ground level was typically laid to tarmac hardstanding or brick paving in car spaces; although an area in the north of the site was surfaced with paving slabs with drainage covers identified in a layout possibly indicative of an interceptor (Photo 4) and a vent pipe (Photo 5) was noted nearby, positioned within soft landscaping. Online aerial imagery¹ indicates that a car wash company operates within the car park at this location; however, a sign identified during the walkover, detailed that this company had moved to a new location.

Along the north-western boundary of the site (adjacent and south-west of the bus stand) was an electrical substation (Photo 3); however, this feature could not be assessed visually as it was surrounded by a visual screen, nor was there any information on the insulating materials used.

- **Area 2: Homebase and Pets at Home Shops**

The central portion of the site was occupied by a warehouse style structure, used by Homebase (a home and garden DIY store) and Pets at Home (pet store, grooming and veterinary). Homebase occupied the eastern two thirds of the store and included a mezzanine in the rear of the store and an outdoor garden centre in the south-eastern corner of the site. Pets at Home occupied the remaining western third of the structure.

To the west of the building was an access road trending from the car park to the delivery area in the south-western portion of the site (Photo 6).

In the south-eastern corner of the site was a small brick structure access from Manor Road to the east of the site (Photo 7). Based on signage, it is assumed that this structure is occupied by Southern Gas Networks; however, this could not be confirmed.

- **Area 3: Delivery Yard**

The south-western third of the site was occupied by the following land uses:

- The majority of this area was laid to tarmac hardstanding, with soft landscaping of grasses, shrubs and mature trees along the southern and north-western site boundaries (Photo 8);

¹ google.co.uk/maps accessed 09/08/2018

- To the rear of Pets at Home was a delivery yard; although no access was gained to this location. Air conditioning units and commercial waste bins were identified in this area;
- To the rear of Homebase was a delivery yard area laid to concrete hardstanding in good condition (Photo 9). Store goods were kept in this area in addition to propane and butane gas canister storage (Photo 10), assumed waste paint storage (Photo 11) and 3no storage containers, one of which was detailed as housing fireworks. Outside of the fenced off delivery area was an area of waste storage, storage containers, gas canisters and pallets (Photo 12); and
- In the south-western corner of the site was an area of soft landscaping raised c.0.5m from site level with rough shrub, grass and trees. Fly tipping of tyres, cushions, rubbish, plastics and turf was observed in this area (Photo 13).

Off-site

The following features were identified immediately adjacent to the site:

- **Manor Road**

Manor Road bounds the site to the east and is set at approximately 1m above existing site level in the southern portion and bisected from this by a gently sloped area of landscaping. Manor Road trends in a northerly and southerly direction from the site. To the north, it ramps up towards the Lower Richmond Road / A316 roundabout approximately 130m north of the site (Photo 14). At this location, the District / Overground railway line passes beneath the roundabout. Adjacent to the south-east of the site, it passes a level crossing and continues to trend in a southerly direction.

The following further features are identified along Manor Road:

- Beyond to the south-east and south (latter beyond the railway line) is residential housing, typically as identified as assumed traditional build 2-storey terraced housing (all of which identified c.15m from the site boundary);
- To the south-east of the site and south of the railway line is an area of allotment gardens (Photo 15) (c.50m from the site boundary);
- To the north-east of the site and east of Manor Road is a Sainsbury's supermarket and associated petrol station (c.50m from the site boundary). Additionally, is an area of assumed Southern Gas Network infrastructure (c.150m north-east from the site), which is assumed to be associated with the former Richmond Gas Works detailed further in Section 2.4;
- At the roundabout where Manor Road meets the Lower Richmond Road / A316 is a BP Petrol filling station and car dealership / workshop (c.170m north of the site).

- **National Rail (south)**

A railway line operated by National Rail bounds the site to the south (Photo 17), trending east to west at this location. This was visually identified as being at approximately 0.5-1.0m above existing site level and is bisected from the site by a gently sloped area of landscaping. Further features identified associated with this railway included:

- Adjacent to the south-east of the site was a footbridge, over the level crossing at Manor Road (Photo 18). The footprint of this bridge appeared to extend into the Homebase garden centre (Photo 19), causing a step in the otherwise straight site boundary; and
- Adjacent to the south-west of the site was National Rail infrastructure (Photo 20), which appeared to be accessible from the on-site delivery yard area and bisected from the site by a fence.

- **District / Overground Railway (west)**

A District / Overground railway line bounds the site to the west and is set at approximately 1.0m above existing site level and is bisected from the site by a gently sloped area of landscaping. West of this railway, land use was typically occupied by residential / office land use with the following additional industrial / commercial activities identified:

- F.A. Clover & Sons Ltd², an industrial painting contractors (positioned c.20m west of the site);

²cloverpainting.com/ (accessed 09/08/2018)

- Travis Perkins Trading Co. Ltd, a building materials supplier (positioned c.20m west of the site); and
- Big Yellow Self Storage, a storage facility (positioned c.40m west of the site).

2.3 Topography

A topographical survey was been conducted by Point Surveyors during August 2018 (LS2024/T) and is included within Appendix E. Based on this drawing and the site walkover, the site and surrounding area are noted to be relatively level (generally between 6.0-6.5mOD) with the exception of Manor Road, which increases in height to the north of the site and bridges over the railway line c.200m north of the site. Furthermore, as detailed in the site walkover, the existing railways to the north-west and the south of the site are noted to be set c.1m higher than existing site level.

Information included in the Envirocheck report details the site at approximately 10m AOD, remaining relatively level within 250m of the site. Approximately 1km south of the site, ground level increases to approximately 30m AOD; and decreases gently towards the River Thames at approximately 5m AOD, c.1km north of the site.

2.4 Site History

The historical land use of the site and immediate surroundings has been assessed using Envirocheck Report (Appendix B). Detailed maps for the site and surrounding area have been reviewed and the findings are summarised in Table 1. Features within 250m of the site considered to be potentially contaminative or significant have been detailed, with the exception of significant contamination sources (i.e. landfills / gas holder sites), which if within 500m have been noted.

Table 1 - Historical Map Summary

Dates and Map Scale	On site	Off site (surrounding area)
1867-1872 & 1872 1:1,056	<ul style="list-style-type: none"> • Site is undeveloped with possible area of trees in south-western portion. 	<ul style="list-style-type: none"> • Railway lines bound the site to south and north west in their current day location and evidence of an associated cutting along the western boundary of the site; • Richmond gas works is c.110m north-east, including 3no gasometers. • A militia barracks is c.160m north-west, with a drill ground c.200m north-west and nursery c.200m north-west. Militia barracks and drill ground are only present at this date.
1896-1879 1:2,500		
1871-1874 1:10,560		
1879-1894 1:2,500		
1896 & 1898-1899 1:10,560	<ul style="list-style-type: none"> • A timber yard is present on the southern portion. • A well close to the southern boundary) and unspecified structures are present in the south-eastern portion. • Unspecified structures and a crane are present in the northern portion. 	<ul style="list-style-type: none"> • Further development and expansion at the Richmond gas works, including possibly 2no additional gasometers, which has extended to within c.50m north-east. • A laundry is present c.200m south-west and corporation depot c.200m west. Laundry only identified at this date. • A nursery is present c.100m south, which was last identified in 1913. • A timber yard is present c.100m north and last identified in 1913.
1894-1895 & 1895 1:10,056		
1896 & 1898 1:2,500		
1913 1:2,500	<ul style="list-style-type: none"> • Unspecified development on-site, although it appears all associated with the timber yard, in addition to sidings along the southern and western boundaries and into the centre of the site. 	<ul style="list-style-type: none"> • Further development on the gas works site, including a smithy c.200m east and area of tanks c.150m east. The smithy is only identified at this date. • A tank is detailed on the nursery site c.200m north-west. The tank is last identified at this date and the nursery in the 1960s.
1920 1:10,560		

Dates and Map Scale	On site	Off site (surrounding area)
1934 – 1936 1:2,500 1933 & 1935 & 1938 1:10,560	<ul style="list-style-type: none"> No discernible changes. 	<ul style="list-style-type: none"> An additional gasometer is constructed on the gas works site c.200m east, as well as railway sidings extending onto this site c.150m north.
1946-1947 1:1,250 Aerial Imagery 1940-1950 & 1940-1958 1:10,000 1948 1:10,560	<ul style="list-style-type: none"> No discernible changes. 	<ul style="list-style-type: none"> Only 2no gasometers are identified on the gas works site.
1960 & 1960-1961 1:2,500 1960 & 1960-1972 & 1959-1960 & 1959-1980 & 1960-1974 & 1968-1983 1:1,250 1962-1966 & 1966-1967 1:10,000	<ul style="list-style-type: none"> The site is detailed as a depot. Railway cottages are detailed on the south-eastern corner. 	<ul style="list-style-type: none"> An area of ruins is detailed c.50m south. A goods depot and is present c.200m west adjacent to railway sidings. 3no garages are detailed just beyond c.250m south. 3no area of works are identified c.250m north-east. Warehouse buildings / works are detailed c.20m west beyond the railway line. An electrical substation is detailed c.200m north-west and last identified in the 1990s.
1975-1976 1:10,000 1973-1974 1:1,250 1960-1980 & 1968-1974 & 1973-1988 1:1,250	<ul style="list-style-type: none"> Railway sidings are no longer detailed on-site. Redevelopment of on-site structures, with possible warehouse style structure in central portion. A fuel depot, electrical substation, coal hoppers and timber yard are detailed on site. Of these only the electrical substation is identified beyond these maps and last identified in the early 1990s. 	<ul style="list-style-type: none"> The gas works is now identified as a depot. A works is present adjacent south-west and last identified in the 1990s. The goods depot c.200m west is no longer present and replaced by a coach repair works. No railway sidings are now identified in this area. Coal hoppers are detailed adjacent north and only identified at this date. An electrical substation and builders yard are detailed c.20m north-west. Furthermore, a tank is detailed c.50m north-west adjacent to a warehouse. A garage and works are detailed c.150m north.
1974-1991 & 1983-1989 & 1983 & 1989 & 1991 & 1992 & 1992-1994 1:1,250 1985 1:25,000 1988 & 1992 1:10,000	<ul style="list-style-type: none"> Only the timber yard use (and electricity substation) is detailed on-site from the mid-1980s. From the mid-1990s, car parking is detailed in the northern portion. 	<ul style="list-style-type: none"> Coach repair works c.200m west are now detailed as a 'Corporation Depot', which is last detailed at this location in the late 1990s and detailed as redeveloped in 1999. An electrical substation is detailed c.100m south. The works c.20m north-west is now detailed as a warehouse. A tank is detailed on the former gas works site c.110m north-east.

Dates and Map Scale	On site	Off site (surrounding area)
1999 Aerial Imagery 1999 1:10,000	<ul style="list-style-type: none">• The site is detailed in its current day layout.	<ul style="list-style-type: none">• The gasometers have been removed and much of the infrastructure on the former gas works site has been removed. An area of gas work infrastructure remains c.120 north-east of the site.
2006 & 2017 1:10,000	<ul style="list-style-type: none">• No discernible changes.	<ul style="list-style-type: none">• A petrol filling station, supermarket and car parking are detailed on the former gas works site. The petrol filling station is c.200m from the site boundary.

3.0 BACKGROUND INFORMATION AND ENVIRONMENTAL SETTING

3.1 Site Geology

The 1:50,000 British Geological Survey (BGS) map for South London (Survey Sheet Number 270, dated 1998) and BGS online map viewer, including borehole records, have been reviewed to provide information on the published underlying geology and ground conditions.

The site is reported to be underlain by superficial deposits comprising Kempton Park Gravel Member (comprising sand and gravel, locally with lenses of silt, clay or peat), which is shown to extend >100m laterally in all directions. This is underlain by bedrock comprising the London Clay Formation (silty sandy clay), which is shown to extend >1km laterally in all directions and is reported to be >50m vertical thickness.

The following BGS boreholes records were reviewed in the vicinity of the site:

- Record TQ17NE436, c.30m west, encountered Made Ground to 0.8m bgl, underlain predominantly by sands and gravels to 6.0m bgl, locally with lenses of soft sandy clay, considered to be indicative of the Kempton Park Gravel and further underlain by stiff clay, considered to be indicative of the London Clay to the base of the hole at 15m bgl. Groundwater was encountered at 3m bgl in superficial soils;
- Record TQ17NE62, c.100m east, encountered Made Ground to 0.9m bgl, underlain predominantly by gravels to 6.1m bgl, considered to be indicative of the Kempton Park Gravel and further underlain by stiff clay, considered to be indicative of the London Clay to the base of the hole at 15.2m bgl. Groundwater was encountered at c.1.5m bgl.

3.2 Mining and Mineral Extraction

The Envirocheck identifies no records of mining, mineral sites or natural cavities within 250m of the site.

3.3 Hydrology and Hydrogeology

The Envirocheck Report indicates that the nearest surface water feature within 500m of the site is a pond, located c.310m south of the site. The OS Water Network Map indicates the presence of possible field drains/ditches flowing in a southerly direction towards the pond, before trending to the east towards the River Thames. The River Thames is positioned approximately 1.4km to the north west and 1.3km to the south east at its closes positions, and generally flows in a easterly or south easterly direction at these locations.

The site is identified as being in a Flood Zone 1 (i.e. low probability of flooding); however, the EA reports a low to high flood risk from surface water locally across the site. It should be noted that this report does not purport to be making a flood risk assessment.

The Environment Agency classifies the Superficial Kempton Park Gravel Member as a Secondary A Aquifer and the London Clay Formation as an Unproductive Stratum. The site is not within a source protection zone, nor are there any groundwater abstractions within 1km of the site.

Groundwater is considered to be present within the Kempton Park Gravel Member based on historical borehole records and likely to be perched above the low permeability London Clay Formation. Regionally, groundwater is considered to flow in a north-easterly direction towards and in hydraulic connectivity with the River Thames, the dominant surface water feature in the vicinity of the site.

The following pollution incidents to controlled waters are detailed by the Envirocheck Report within 250m of the site:

- Category 2 significant incident positioned 210m north-east, dated May 1989. The pollutant is reported as unknown oils and no further information (including receiving water) is provided; and
- Category 3 minor incident positioned 250m north-east, dated December 1991. The pollutant is reported as unknown oils and no further information (including receiving water) is provided.

One discharge consent is present within 250m of the site, for discharge of groundwater to the River Terrace Gravels. This was issued in April 1998 and revoked in November 1999 and positioned 140m north-east of the site at the 'depot and former gas holder station'.

3.4 Landfilling and Waste Activities

No areas of registered or historical landfills are identified within the Envirocheck Report within 500m of the site, nor any licensed waste management facilities / transfer sites. Furthermore, no areas of infilled land are identified within 500m.

3.5 Radon

According to the Public Health England, the site is located in a lower probability radon area where <1% of homes are estimated to be at or above the action level and no radon protection measures are required.

3.6 Unexploded Ordnance Risk

Zetica regional unexploded bomb risk mapping (London – Southwest) indicated that the site is within a moderate risk with respect to unexploded ordnance in the vicinity of the site.

Online mapping indicates however that 4no high explosive bombs fell during WW2 within c.250m of the site, positioned between c.40 and 150m west of the site. It should be noted that only bombs during the Blitz (October 1940 – June 1941) are recorded on this mapping.

A Detailed Unexploded Ordnance (UXO)Threat and Risk Assessment undertaken by Alpha Associates (Ref P7115) on behalf of Landmark (190053937_1) identified high risk across the site and that further mitigation measures would be required during intrusive activities. It is therefore recommended that a specialist is consulted prior to any below ground works. A copy of the report is included within Appendix C.

3.7 Asbestos

This report does not purport to be providing an asbestos survey, for which an asbestos specialist should be consulted to provide an up to date survey prior to any building works on-site. However, it is noted that given the age of structures (pre 1999) and likely presence of Made Ground on-site, it is plausible that asbestos containing materials are present within both building fabrics and underlying Made Ground soils.

3.8 Invasive Species

An invasive species survey is outwith of the scope of this report and a specialist should be consulted. No invasive species were identified during the site walkover.

3.9 Sensitive Land Use

No Ramsar sites, sites of special scientific interest (SSSI), area of outstanding natural beauty or environmentally sensitive areas are identified at or within 500m of the site in the Envirocheck Report. The Royal Botanic Gardens Kew, are designated a World Heritage Site, positioned 350m north of the site.

Assessment of the archaeological and ecological setting of the site is outside the scope of this report.

3.10 Additional Environmental Information

Richmond Gas Works

The Envirocheck Report presents the following additional information pertaining to the former gas works:

- It is presented as a lower tier, active control of major accident hazard site;
- It has an inactive Notification of Installations Handling Hazardous Substances (NIHSS);
- It has previously been granted a planning hazardous substance consent for liquefied extremely flammable gas (including LPG) and natural gas (whether liquefied or not).

There are no gas holders remaining on the former gas works site, and the more recent ordnance survey maps indicate the site has been redeveloped. It is not clear if any British Gas/Transco/National Grid assets or infrastructure remains.

Pollution Prevention and Controls

There are 3no. Local Authority Pollution Prevention and Controls positioned within 250m of the site as detailed below:

- Positioned 170m north to a petrol filling station since December 1998;
- Positioned 210m north-east to a petrol filling station since August 2000; and

- Positioned 240m north-east for waste oil burners and dated from September 1993; although it is noted that the authorisation has been revoked.

The above stated activities may present a source of contamination; however, the LAPPC's seek to control and prevent contamination to the surrounding environment associated with industrial / commercial processes.

Contemporary Trade Directory Entries

There is one contemporary trade directory entry issued on-site for electrical goods sales, manufacturers and wholesalers; however, this is noted as being inactive. Further contemporary trade directory entries positioned within 250m of the site and considered to be potentially contaminative are detailed in Table 2 below.

Table 2 – Off-Site Contemporary Trade Directory Entries Considered to be Potentially Contaminative

Entry	Location	Status
Builders merchant	20m south-west	Inactive
2no Builders merchant	30m north	Inactive
Builders merchant	30m north	Active
Distribution services	30m south-west	Inactive
Carpet, curtain and upholstery cleaners	30m south-west	Active
Tank cleaning and repairing	30m north	Inactive
Printers	30m north	Inactive
Aerosols (M S George)	30m north	Inactive
Optical goods manufacturers	30m north	Inactive
Manufacturers (Fiberweb Plc)	30m north	Inactive
Manufacturers (Fiberweb Plc)	50m west	Inactive
Tyre dealers	70m north	Inactive
Powder coatings	80m north	Inactive
Domestic cleaning services	110m north-west	Inactive
Classic car specialists	130m north	Inactive
Petrol filling station	170m north	Inactive
Cable and wire equipment manufacturers	170m north	Inactive
Garage services	180m north	Active
Garage services	170m north	Inactive
Garage services	150m west	Active
Tyre dealers	170m west	Active
Car customizing specialists	180m west	Inactive
Distilleries	200m west	Active
Distilleries	200m west	Inactive

Pottery manufacturers and suppliers	200m north-west	Inactive
Dry cleaners	210m north-west	Active
Road haulage services	210m north-west	Inactive
Clothing and fabrics manufacturers	230m north-east	Active
2no Car dealers	240m north-east	Active
Dairies	240m east	Inactive

3.11 Planning Information

A search of planning applications was undertaken on the London Borough of Richmond Upon Thames Planning Portal for planning applications at and adjacent to the site based on a post code search. No information was identified pertaining to ground conditions; although the following applications were identified which identify the former land uses and dates on-site.

On-Site

- Application ref.91/2125/CON for the *provision of an electricity substation*, which was granted permission in January 1992;
- Application ref.91/0270/OUT for the *erection of two non-food retail warehouse units within use class A1, one with garden centre, new vehicle and pedestrian access and car parking and associated landscaping*. This was granted permission in September 1991; and
- Application ref.91/2243/FUL for the *change of use of site from open air car sales to car parking and part bus lay-by facility....* This was granted permission in May 1992.

No further information pertaining to ground conditions on-site, off-site or on the Richmond gas works site was identified for review.

3.12 Consultation

The London Borough of Richmond Upon Thames and the Environment Agency were contacted regarding information pertaining to ground conditions and contamination at the site. Responses received have been summarised below and the full responses included in Appendix C.

London Borough of Richmond Upon Thames

LBRuT reported the following additional information in their contaminated land enquiry:

- The site is not on the council's contaminated land register under the Environmental Protection Act 1990 and no notice has been served or has been resolved at the property. Furthermore, the site has not been designated for inspection;
- No information is held on the presence of tanks / decommissioning;
- No EA authorised of historic landfill sites are detailed within 250m;
- LBRuT identifies 3no abstractions, all of which are for irrigation purposes, positioned 920m west, 1170m west and 1440m north-west. The depth of the abstraction is unknown, but it is noted that these location is underlain by the Taplow Gravel Member and London Clay Formation;
- Former industrial land uses identified by LBRuT within 50m are detailed in Table 3 overleaf.

Table 3 – Former Industrial Land Uses Identified in Regulatory Correspondence

Land Use	Location
Electrical Substation, dated 1974 only. Part 2A risk rating: low medium <i>Fairhurst note that this was last identified on historical mapping in the 1990s.</i>	On-site (in the centre of the north-western boundary)
Power station (excluding nuclear power), dated 1974 only. Part 2A risk rating: medium <i>Fairhurst note that this feature was not identified on historical mapping and the council were asked for further information; however, note that they do not hold any. It is therefore considered likely this relates to the electrical substation entry noted above.</i>	On-site (site wide)
Electricity distribution, including transformer, dated 2004 only. Part 2A risk rating: medium <i>Fairhurst consider that this is the same as the existing substation identified during the site walkover.</i>	On-site (on position of existing electrical substation)
Railway land, no date identified. No part 2A risk rating detailed <i>Fairhurst note that this was as identified on historical mapping and site walkover.</i>	Off-site (at location of existing railway lines, possibly encroaching on-site)
Waste recycling, treatment & disposal: Metal recycling sites (scrap iron & metal merchants), dated 1969-1970. Part 2A risk rating: medium high	Off-site (adjacent west beyond railway line) Fairhurst note that all of these were identified on historical mapping c.20-50m west of the site
Metal manufacturing, iron and steelworks, dated 1971-1976. Part 2A risk rating: medium	
Factory or works (unspecified use), dated 1976-2004. Part 2A risk rating: low medium	
Oil refineries and bulk storage of crude oil and pet. Products, dated 1974 only. Part 2A risk rating: low medium	
Electricity distribution including large transformer, dated 2004 only. Part 2A risk rating: low medium	
Electricity distribution including large transformer, dated 1974 only. Part 2A risk rating: low medium	Off-site (adjacent south-west beyond railway line)
Factory or works (unspecified use), dated 1976-1994. Part 2A risk rating: low medium <i>Fairhurst note that this is positioned at the location of a works identified on historical maps.</i>	
Railway land, including: goods station and car park; road haulage contractor, dated 1890-2004. Part 2A risk rating: medium <i>Fairhurst note that this is positioned at the location of the corporation depot, goods depot, coach repair works and depot identified on historical maps.</i>	Off-site (50m south-west)
Gas works, coke works, coal carbonisation plants, gas works depot. Producing gas from coal, lignite, oil or other carbonaceous materials other than waste, dated 1874-2004. Road vehicles: transport and haulage centres; dismantling, repairing or maintenance of road transport or road haulage vehicles, dated 1980-1990. Part 2A risk rating: medium <i>Fairhurst note that this is positioned at the location of the Richmond Gas Works identified on historical maps.</i>	Off-site (from 50m north-east)
Warehouse (light industrial: engines, building and general industrial to manufacture component parts for electrical and motor industries), dated 1978-2002 Part 2A risk rating: medium <i>Fairhurst note that this wasn't identified on historical mapping.</i>	Off-site (adjacent south-west beyond railway line)

LBRuT presented records of three site investigations undertaken within 250m of the site as detailed below:

Ground Investigation 1 - Structa LLP, titled Land at Orchard Road, Richmond, ref.3374-GE001B and positioned c.220m east of the subject site

Scope of Report

The report was undertaken for assessment of Geo-Environmental and Geotechnical considerations associated with the demolition of the existing warehouse and construction of a 5no storey building with a doctors surgery at ground level and residential dwellings above.

Structa identify that the site was formerly occupied as a dairy depot and anecdotally recently was used for vehicle maintenance, with the Richmond Gas Works possibly extending onto the western portion of the site.

Ground Conditions Encountered

Fairhurst note that the BGS published ground conditions are reported to be the Kempton Park Gravel Member overlying the London Clay Formation.

Structa undertook the following ground investigation: 6no cable percussive boreholes to a maximum depth of 20.45m bgl; 6no windowless sample boreholes to a maximum depth of 5.7m bgl; ground gas monitoring and groundwater sampling; permeability testing in boreholes; and laboratory analysis.

Ground conditions encountered by Structa are detailed in Table 4 below.

Table 4 - Ground Conditions Encountered During Structa Investigation

Stratum & Description	Top Depth Range (m bgl)	Maximum Proven Thickness (m)	SPT N Value Range
Made Ground <i>As variable granular and cohesive elements with anthropogenic inclusions of brick, concrete, glass and clinker.</i>	0.15 - 0.26	3.74	1 - 7
Kempton Park Gravel <i>Variable granular and cohesive elements, frequently with gravel of flint.</i>	1.2 - 4.0	4.2	4 - >50 [^]
London Clay Formation <i>Firm becoming stiff silty CLAY.</i>	4.7 - 5.6	14.85 [*]	19 - 32 [#]

[^]One SPT N value of 4 recorded, remaining values were recorded between 14 and 50.

^{*}The base of the London Clay Formation was not proven.

[#]3no undrained triaxials were undertaken on this formation between 6.5 and 15.5m bgl, with recorded values of between 40 and 85kN/m².

During groundwater monitoring, Structa identified a resting groundwater level of between 2.2 and 2.9m bgl and was considered to be flowing in a south-easterly / easterly direction. Fairhurst note that no topographical assessment was undertaken of groundwater levels and therefore this cannot be verified.

Geotechnical Assessment

Limited Geotechnical conclusions were presented; however, the following is noted:

- Falling head permeability testing indicated an infiltration rate of between 3.96×10^{-5} and 5.96×10^{-8} m/s in the Kempton Park Gravel; and
- Structa noted that piles should be constructed to DS-4, AC-4 and pile caps to DS-5, AC-5 based on the buried sulphate classification.

Contamination Assessment

Fairhurst have briefly reviewed the Structa contamination assessment; however, it is noted that the site is considered to likely be down hydraulic gradient of the site and therefore no significant risks are considered to the subject site from this assessment. However, it is noted that given that this site is adjacent to the former gas works, this investigation may be indicative of the contamination associated with this historical source.

- During the ground investigation, visual / olfactory evidence of chemical and hydrocarbon odours and sheens were frequently noted in all exploratory hole locations, typically from c.1.5-2.0m bgl;
- Soil analysis of contamination was undertaken, which identified concentrations of arsenic, cyanide, petroleum hydrocarbons and polycyclic aromatic hydrocarbons in excess of their

assessment criteria assuming a residential end use without the consumption of homegrown produce. Asbestos was detected in 3 of 7no Made Ground soil samples analysed. Structa concluded that the provision of a capping layer and vapour resistant membrane would mitigate the risks to identified human health receptors;

- Structa undertook groundwater analysis and compared concentrations to Environmental Quality and Drinking Water Standards. Concentrations of arsenic, cyanide, petroleum hydrocarbons, BTEX, polycyclic aromatic hydrocarbons and phenols were recorded in excess of their assessment criteria and was considered to be attributable to the former gas works. Structa undertook a detailed groundwater assessment and concluded that based on the contaminants and conditions encountered, no remediation of soils and groundwater would be required to be protective of controlled waters;
- Three rounds of ground gas monitoring were undertaken with recorded methane <0.1%, carbon dioxide ranged between <0.1 and 16.2%, maximum peak flow of 0.3l/hr and maximum PID of 4,000ppm. Structa concluded that the site would be reflective of Characteristic Situation 2 (i.e. low hazard potential) and additionally would require a hydrocarbon vapour resistant membrane.

Ground Investigation 2 - Exploration Associates Limited, titled Manor Road Gas Works, Richmond, Factual Report on Ground Investigation, ref.145046, May 1995

Scope of Report

The report was undertaken to establish ground and groundwater conditions to enable a contamination assessment to support the proposed redevelopment of the site.

Ground Conditions Encountered

Fairhurst note that the BGS published ground conditions are reported to be the Kempton Park Gravel Member overlying the London Clay Formation.

Exploration Associates undertook the following ground investigation: 6no cable percussive boreholes to a maximum depth of 7m bgl; 30no trial pits to a maximum depth of 3.7m bgl; 17no probe holes to a maximum depth of 6.2m bgl; ground gas and groundwater monitoring; and laboratory analysis.

Made Ground was encountered in all exploratory holes and proven to a maximum depth of 3.5m bgl (base of the exploratory hole). This deposit was reported to be of variable composition ranging from gravelly clays to sands and gravels with flint, brick, ash, clinker, concrete, metal and ceramic.

'Terrace Deposits' were encountered in exploratory holes advanced to a sufficient depth and typically comprised gravelly SAND, sandy GRAVEL and sandy CLAY.

The London Clay Formation was encountered in 3no exploratory holes and proven to a maximum depth of 7m bgl (base of excavation) and typically comprised stiff silty CLAY.

Groundwater was typically encountered in exploratory holes between 2.0 and 3.5m bgl.

No exploratory hole records, nor details of laboratory testing has been presented for review.

Ground Investigation 3 - Peter Brett Associates LLP (PBA), titled Cliveden House, 19-22 Victoria Villas, Richmond, London ref.33222/3501 Phase 2 Issue 01, February 2015 and positioned c.80m west of the site

Scope of Report

The report was undertaken to support the discharge of contaminated land planning conditions associated with the conversion of an existing commercial building to residential with private gardens. PBA note that the site was historically occupied by terraced residential properties, 2no warehouse type structures, a works and office space.

Ground Conditions Encountered

Fairhurst note that the BGS published ground conditions are reported to be the Kempton Park Gravel Member overlying the London Clay Formation.

PBA undertook 5no hand excavated trial pits to 1.2m bgl, which encountered Made Ground in all excavations as gravelly silty CLAY with inclusions of concrete, brick, slate and clinker.

Geo-Environmental laboratory testing was undertaken for metals, polycyclic aromatic hydrocarbons, petroleum hydrocarbons and asbestos screen. Concentrations of lead were recorded in excess of their assessment criteria for residential setting with consumption of homegrown produce. PBA concluded that to mitigate identified risks, 600mm of clean capping should be placed to break the contaminant pathway to future site users in areas of proposed soft landscaping. PBA considered no risks to controlled waters given

that leachate tests undertaken as part of waste acceptance criteria analysis recorded concentrations beneath assessment criteria and noting that there are no potable groundwater abstractions were identified within 1km. Furthermore, no risks were reported from ground gases as the composition of Made Ground was considered to represent a very low gas generation potential and from vapours noting that no petroleum hydrocarbons in soil analysis. PBA noted that water supply pipes may come into contact with Made Ground and new water supply pipes will be required to be 'barrier pipes'.

Environment Agency (EA)

A response was received from the EA in September 2018 (as detailed within Appendix C). The following information was provided:

- No landfills were known to be located within 500m of the site (corroborating with information provided by the London Borough of Richmond and the Envirocheck Report);
- That they were not aware of any incidents relating to contaminated land within 500m of the site;
- That no sites designated under Part 2a were believed to be within close proximity of the site;
- That no groundwater level monitoring sites were positioned within 500m of the site and therefore neither information relating to local depth to groundwater nor flow direction was held;
- No records were held relating to water quality;
- A single groundwater abstraction borehole was noted in relation to spray irrigation use located at the Richmond Athletics Ground (c.970m to the north-west); and,
- In relation to the former Richmond Gas Works located adjacent and to the north-east of the site, no investigation records were held, however following note their database dated from 2001 detailed the following:

“Groundwater contaminated with TPH, BTEX compounds and PAHs. Hotspots of heavy metals and PAHs. Remedial measures included the installation of a bentonite wall on the East & South of the site, excavation of 1.5m from across the site and the removal of buried structures. Groundwater remediation measures also include the removal of LNAPL and disposal off-site, groundwater treatment ex-situ and reinjection, and a period of monitoring to EA satisfaction.”

Network Rail

Fairhurst contacted and met with representatives of Network Rail (30th August 2018) in order to discuss potential constraints to the site development posed by the railway lines to the north-west and the south of the site.

Network Rail confirmed their responsibility for the lines and also that they require access to the railway via the gate to the south-west of the site in order to reach signalling equipment. In relation to the proposed development, Network Rail was generally happy with the provisions for this access incorporated into the existing design. Although Network Rail would likely not have any objections to the scheme and were generally satisfied with the required distance from the proposed blocks to their boundary, it was considered that final site layout (particularly referencing blocks within the southern portion of the site) will require further consultation and approval with Network Rail.

Liaison with Network Rail is ongoing.

Transport for London

Transport for London have confirmed that the Overground route at this location is owned and managed by Network Rail and TfL only has running rights on this route. Furthermore, the District line is under TfL / London Underground ownership and management.

London Underground

London Underground have stated that their assets will not be affected by works on-site; although there are Network Rail assets close to the site.

London Overground

London Overground have stated that they have no assets within close proximity of the site.

4.0 PRELIMINARY CONCEPTUAL MODEL AND QUALITATIVE RISK ASSESSMENT

A preliminary conceptual model represents the characteristics of the site that show the possible relationship between contaminant sources, pathways and receptors. The following outline conceptual model is based on the findings of the PRA. The principles of environmental risk assessment are presented in Appendix F.

The significance of the presence of sources, pathways and receptors is considered by carrying out a risk assessment of all potential pollutant linkages. The assessment has been undertaken to inform on potential geo-environmental risks associated with the redevelopment of the site for a residential led end use development.

4.1 Source Characterisation

Potentially contaminative land uses (current and historic) identified as part of this PRA are detailed in Table 5 below.

It is considered that when the distance from a potential source to the site is more than 250m, the creation of a realistic source-pathway-receptor linkage (contaminant transfer) is unlikely. This is, unless the primary pathway of concern is the migration of ground gas (such as from a historic landfill site or backfilled quarry). Therefore, typically, potential sources more than 250m from the site are excluded from the risk assessment. Where sources are discounted for alternative reasons, due to the absence of a realistic source-pathway-receptor linkage, this is stated in Table 5.

Table 5 – Identified Potential Sources of Contamination

Source (Date first identified on historical mapping)	Location	Identified by	Discounted
<i>On-site</i>			
Made Ground	On-site	Borehole records	No, nature and composition of fill material is unknown.
Current use of site as Homebase and pet store	On-site	Site walkover	Yes, no potential sources of contamination were identified during site walkover and shop use not considered to pose risk of contamination. Fly tipping was limited and noted to be of tyres, cushions, rubbish, plastics and turf and no contamination is anticipated from these sources. Area of paint storage was noted to be limited and not considered to present contamination source.
Former site use as car wash	On-site	Site walkover / Online aerial imagery	No, potential for chemicals to have been used.
Current site use as car parking and bus stand	On-site	Site walkover	No, potential for localised hotspots of contamination from spillages, interceptors and venting pipes identified in this area.
Historical uses including timber yard, crane, railway sidings, fuel depot, coal hoppers, electrical substation and power station	On-site	Historical maps / Council correspondence	No, potential for contamination to remain from historical sources.
Electrical substation	On-site (north-western corner and	Historical maps / Site walkover / Council correspondence	No, potential for historic and ongoing contamination from source.

	centre of western boundary)		
Asbestos containing materials in building fabrics	On-site	Historical maps / building age	Yes, it is considered that asbestos in building fabrics is unlikely to impact soil / groundwater. It is considered that an up to date asbestos survey will be undertaken prior to the demolition of existing structures. Asbestos may be present in soil from historic structures / Made Ground; however, this is covered in the Made Ground source detailed above.
Contemporary trade directory entry for electrical goods sales, manufacturers and wholesalers	On-site	Envirocheck report	Yes, no potential sources of contamination considered to be present associated with shop use.
Off-site			
Railway lines (1867 - present)	Bounding site to south and west	Historical maps / Site walkover / Council correspondence	No, potential for contamination to be present from source.
Richmond gas works and associated activities, including railway sidings, gas holders, tank etc (1867 - present) Later detailed as works / depot (1975 - 1990s)	Historically from 50m NE Present day 120m NE	Historical maps / Council correspondence	No, whilst source is likely down hydraulic gradient, potential for gas/groundwater impact to have had a widespread impact on groundwater quality in the area. Further, ground investigation is required to confirm hydraulic gradient.
Militia barracks and drill ground (1867 - 1894)	150-200m NW	Historical maps	Yes, noting that the source is considered to be down hydraulic gradient and the time passed since its presence.
Nursery (1867 - 1960)	200m NW	Historical maps	Yes, noting that the source is considered to be down hydraulic gradient and considered unlikely to be significant;
Laundry (1896 - 1898)	200m SW	Historical maps	No, source is up assumed hydraulic gradient of the site and relic contamination may remain from source, although unlikely given >100 years and likely volatile vapour nature of contaminants. Some detergents can be pervasive in the groundwater environment.
Corporation depot (1896 - 2004) Goods depot (1960 - 1970s). Later coach repair works (1970s - 1980s) and depot (late 1980s)	200m W	Historical maps / Council correspondence	No, source is up hydraulic gradient of the site and relic contamination may remain from source.
Nursery (1896 - 1913)	100m S	Historical maps	No, source is up hydraulic gradient of the site and relic contamination may remain from source, although given time passed since its presence (>100 years), this is considered unlikely.

Timber yard (1896 - 1913)	100m N	Historical maps	Yes, noting that the source is considered to be down hydraulic gradient and the time since present; therefore allowing for natural attenuation of contamination.
Smithy (1913)	200m E	Historical maps	Yes, noting that the source is considered to be down hydraulic gradient and the time since present; therefore allowing for natural attenuation of contamination.
3no garages (1960 - 1990s)	250m S	Historical maps	No, source is up hydraulic gradient of the site and relic contamination may remain from source.
3no works (1960 - 1990s). One of which is considered to be the car dealership / garage identified during the walkover 2no active car dealers positioned here	240-250m NE	Historical maps / Site walkover / CTDE	Yes, noting that the source is considered to be down hydraulic gradient and the time since present; therefore allowing for natural attenuation of contamination.
Warehouse buildings / works (1970s - present) Electrical substation (1970s - unspecified) Builders yard, identified as Travis Perkins during walkover (1970s - present) and 3no CTDE positioned at this location Tank (1970s - unspecified). CTDE for inactive tank cleaning and repair positioned here Additional CTDE for printers, aerosols, 2no optical goods, tyre dealers, powder coatings and domestic cleaning services positioned here	20 - 50m W	Historical maps / Site walkover Council correspondence / CTDE	No, potential for contamination to be remain associated with sources. Although, limited contamination considered to be present associated with ongoing Travis Perkins / builder's warehouse use.
F.A. Clover & Sons Ltd and Big Yellow Self Storage	20 - 50m W	Site walkover	Yes, no potential sources of contamination are considered associated with shop use.
Electrical substation (1960 - 1990s)	200m NW	Historical maps	Yes, noting that the source is considered to be down hydraulic gradient of the site.
Works (1975 - 1990s) Identified CDTE as inactive builders merchant, inactive distribution services and active carpet, curtain and upholstery cleaners	Adjacent SW	Historical maps / CTDE / Council correspondence	No, potential for contamination to be remain associated with source.
Coal hoppers (1970s - 1980s)	Adjacent N	Historical maps	No, potential for contamination to be remain associated with source.
Garage (petrol filling station) and works (1970s -	150m N	Historical maps / Site walkover /	Yes, noting that the source is considered to be down hydraulic

present) CTDE for inactive petrol filling station, inactive cable and wire equipment manufacturers and active and inactive garage services positioned here		CTDE	gradient of the site.
Electrical substation (1990s - unknown)	100m S	Historical maps	No, potential contamination present from source and it is positioned up hydraulic gradient of the site.
Petrol filling station (2000s - present)	200m NE	Historical maps / site walkover	Yes, noting that the source is considered to be down hydraulic gradient of the site.
Warehouse (light industrial: engines, building and general industrial to manufacture component parts for electrical and motor industries) (1978-2002)	20m S	Council correspondence	No, potential for contamination to be remain associated with source.
Classic car specialists	130m N	CTDE	Yes, source considered to be down hydraulic gradient.
Active garage services, active tyre dealers, inactive car customizing specialists, inactive and active distilleries, inactive pottery manufacturers and suppliers, active dry cleaners and inactive road haulage services	150-210m W / NW	CTDE	No, source is potentially up hydraulic gradient of the site.
Active clothing and fabrics manufacturers and inactive dairies	230-240m NE	CTDE	Yes, sources are considered to be down hydraulic gradient
Category 2 significant incident positioned 210m north-east, dated May 1989. Pollutant was unknown oils and no further information is provided Category 3 minor incident positioned 250m north-east, dated December 1991. Pollutant was unknown oils and no further information is provided		Envirocheck report	Yes, noting that the source is considered to be down hydraulic gradient of the site.

Contaminants of concern associated with the sources outlined above are listed in Table 6 below. Whilst they have been withdrawn, Department of Environment (DoE) industry profiles have been utilised for reference, where available. Figure 2a and 2b presents potential sources of contamination (on and off-site respectively), which are carried forwards to the conceptual site model.

Table 6 – Contaminants of Concern

Source	Contaminants of Concern
On-site	
Made Ground	Metals, PAH, asbestos, TPH, ground gas
Former car wash	Metals, PAH, TPH, VOC, SVOC
Car parking	Metals, TPH, SVOC, VOC PAH

Historical uses including timber yard, crane, railway sidings, fuel depot, coal hoppers, electrical substation and power station	Metals, PAH, asbestos, TPH, PCB, VOC, SVOC, phenols, pesticides
Electrical substation	PCB, TPH, PAH, metals, VOC, SVOC
Off-site	
Railway lines (1867 - present)	DoE industry profiles note the following potential contaminants in the vicinity of tracks: metals, VOC, PAH, pesticides
Richmond gas works and associated activities, including railway sidings, gas holders, tank etc (1867 - present)	Metals, TPH, PCB, PAH, VOC, SVOC, ammonia, phenols, cyanide (total), sulphates
Later detailed as works / depot (1975 - 1990s)	
Laundry (1896 - 1898)	VOC, solvents
Corporation depot (1896 - 2004)	Metals, TPH, VOC, SVOC, and PAH
Goods depot (1960 - 1970s). Later coach repair works (1970s - 1980s) and depot (late 1980s)	
Nursery (1896 - 1913)	Metals, pesticides
3no garages (1960 - 1990s)	Metals, TPH, VOC, SVOC, and PAH
Warehouse buildings / works (1970s - present) Electrical substation (1970s - unspecified) Builders yard, identified as Travis Perkins during walkover (1970s - present) and 3no CTDE positioned at this location Tank (1970s - unspecified). CTDE for inactive tank cleaning and repair positioned here Additional CTDE for printers, aerosols, 2no optical goods, tyre dealers, powder coatings and domestic cleaning services positioned here	Metals, PCB, PAH, TPH, VOC, SVOC
Works (1975 - 1990s) Identified CDTE as inactive builders merchant, inactive distribution services and active carpet, curtain and upholstery cleaners	PAH, TPH, VOC, SVOC, metal
Coal hoppers (1970s - 1980s)	Metal, PAH
Electrical substation (1990s - unknown)	Polychlorinated biphenyls, petroleum hydrocarbons, metals
Warehouse (light industrial: engines, building and general industrial to manufacture component parts for electrical and motor industries) (1978-2002)	PCB, PAH, TPH, VOC, SVOC, metal
Active garage services, active tyre dealers, inactive car customizing specialists, inactive and active distilleries, inactive pottery manufacturers and suppliers, active dry cleaners and inactive road haulage services	PAH, TPH, VOC, SVOC, metal

Metals and inorganic compounds including but not limited to As, B, Cd, Cr total, Cr VI and III, Cu, Hg, Ni, Pb, Se, Zn/ phenols, cyanide (free and total), asbestos and sulphates / VOC: volatile organic compounds / SVOC: semi volatile organic compounds / PAH: polycyclic aromatic hydrocarbons / TPH CWG: total petroleum hydrocarbons / PCB: polychlorinated biphenyls / Ground gas including but not limited to CO₂, CH₄, CO, H₂S

4.2 Receptor Characterisation

The following receptors are identified at the site:

- Human health: future site workers and residents and off-site adjacent land users, including neighbours and members of the public;
- Building materials and below ground structures (foundations and services); and
- Controlled waters: the underlying Secondary A Aquifer (Kempton Park Gravel Member).

The River Thames is not considered a receptor to on-site contamination, noting the distance of this surface water feature to the site (>1.6km). Furthermore, the off-site pond positioned c.310m south is considered to likely be up hydraulic gradient and therefore not considered to be a receptor from on-site contamination. Three groundwater abstractions were identified during council liaison, and were noted to be positioned west and north-west of the site and at closest 920m from the site; therefore, these have been discounted as they are not considered to be in hydraulic connectivity with the site.

It is assumed that appropriate Health & Safety measures, based upon a qualitative environmental risk assessment of site conditions by the contractor will be adopted during any future below ground maintenance works. This is likely to include personal protective equipment (PPE). It is considered that these measures will adequately mitigate the risk to construction and future maintenance workers from potential sources of contamination. Therefore, future construction and maintenance workers are not discussed further as part of this risk assessment.

Pollution linkages have not been identified to ecology as a Part IIA and Non-Part IIA Receptor at this stage. However, this report does not purport to be making ecological recommendations, for which a specialist should be consulted.

4.3 Pathway Characterisation

The potential pathways by which receptors might be exposed to contaminants (sources) at the site can vary depending on the proposed or current land use (i.e. commercial or residential land use). The assessment has been based on a residential end use.

For humans, the following are considered plausible exposure pathways:

- Migration, accumulation and inhalation of soil gas / vapours via permeable soils and groundwater;
- Direct contact and ingestion / inhalation of contaminated soils in areas of soft landscaping; and
- Ingress of contaminants into conduits, contaminating drinking water supplies.

Noting that the proposed development is to include multi-storey apartment buildings and therefore assumed shared landscaping spaces, the consumption of home grown produce has been excluded from the assessment.

For building materials and below ground structures (including foundations and services), the following are considered plausible exposure pathways:

- Soil gas / vapour accumulation in confined spaces and voids within or beneath structures; and
- Direct contact of building fabric with contaminated soils.

For controlled waters, the following pathways may be present:

- Vertical leaching and migration of contaminants from the soil to groundwater; and
- Lateral migration of on-site groundwater off-site or from off-site groundwater on-site.

4.4 Pollutant Linkages

The significance of future potential pollutant linkages at the site is now qualitatively assessed by considering the magnitude of the hazard, and the possibility of the linkages occurring based on the observations made above and taking consideration of the continued commercial end use. Potential pollutant linkages are identified in Table 7.

Table 7 – Preliminary Qualitative Risk Assessment for Identified Sources of Contamination

Source	Potential contaminants	Potential Pathway (s)	Potential receptor (s)	Assessment	Potential Severity	Potential Probability	Risk Class
On-site sources	Metals, TPH, PAH, PCB, VOC, SVOC, sulphates, asbestos, pesticides	Direct contact with contaminated soils Direct ingestion / inhalation of contaminated soils Ingestion of contaminated water from drinking water supply pipes	Human health (on-site)	Development proposals include areas of soft landscaping. Residential end use is more sensitive than existing commercial. Possible that new drinking water supply pipes are to be laid.	Medium	Likely	Moderate
	Ground gases / VOC	Inhalation of accumulated soil ground gases or vapours Lateral migration of volatile compounds in groundwater	Human health (on and off site)	Potential for ground gases to be present attributable to Made Ground or the degradation of organic contamination. Furthermore, potential sources of VOC identified.	Severe	Low	Moderate
	Ground gases / VOC	Soil gas / vapour accumulation in confined spaces and voids within or beneath structures	Buildings and service conduits (on and off-site)	As above.	Severe	Low	Moderate
	Metals, TPH, PAH, PCB, VOC, SVOC, pesticides Sulphates in London Clay Formation	Direct contact of building fabric with contaminated soils	Buildings and service conduits (on and off-site)	Sources of contamination identified on-site and associated with historic uses which may result in aggressive chemical conditions within Made Ground. Soft landscaping associated with proposed development may increase vertical leaching of contamination. Plausible that proposed building foundations are positioned beneath the groundwater table.	Mild	Likely	Moderate / Low
	Metals, TPH, PAH, PCB, VOC, SVOC, asbestos, pesticides	Vertical leaching and migration of contaminants from the soil to groundwater Lateral migration of groundwater off-site	Secondary A Aquifer (on and off-site)	Soft landscaping associated with proposed development may increase vertical leaching of contamination. Whilst no abstractions / surface water features are identified, the resource potential of the Secondary A Aquifer should be considered. Shallow groundwater was encountered from 1.5m bgl within BGS borehole records in the Kempton Park Gravel Formation.	Medium	Likely	Moderate

Source	Potential contaminants	Potential Pathway (s)	Potential receptor (s)	Assessment	Potential Severity	Potential Probability	Risk Class
Off-site sources	Ground gases / VOC	Inhalation of accumulated soil ground gases or vapours Lateral migration of volatile compounds in groundwater	Human health (on-site)	Potential sources of ground gases identified and there is potential for these to migrate in the unsaturated zone onto site. Potential for VOCs to migrate in groundwater or via the unsaturated zone to beneath the site.	Severe	Low	Moderate
	Ground gases / VOC	Soil gas / vapour accumulation in confined spaces and voids within or beneath structures	Buildings and service conduits (on - site)	As above.	Severe	Low	Moderate
	Metals, TPH, PCB, PAH, VOC, SVOC, ammonia, cyanide (total), sulphates, pesticides	Contact with building structures and services with contaminated groundwater migrating onto site	Buildings and service conduits (on - site)	Plausible that proposed building foundations will be positioned beneath the groundwater table and therefore in contact with contaminated groundwater migrating onto site.	Mild	Likely	Moderate / Low
	Metals, TPH, PCB, PAH, VOC, SVOC, ammonia, cyanide (total), sulphates, pesticides	Vertical leaching and migration of contaminants from the soil to groundwater Lateral migration of off-site groundwater on-site	Secondary A Aquifer (on-site)	Potential for contaminated groundwater to be flowing onto site. No abstractions identified on-site; however, resource potential could be impacted.	Medium	Likely	Moderate

5.0 GEOTECHNICAL CONSIDERATIONS

The following geotechnical considerations are noted associated with the development.

Basement Development

- Consultation with LBRuT identifies that the basement development would be subject to Policy LP 11 from their local plan, which details: and
 - A. The Council will resist subterranean and basement development of more than one storey below the existing ground level to residential properties or those which were previously in residential use.
 - B. Proposals for subterranean and basement developments will be required to comply with the following:
 1. Extend to no more than a maximum of 50% of the existing garden land or more than half of any other undeveloped garden area (this excludes the footprint of the original building);
 2. Demonstrate the scheme safeguards the structural stability of the existing building, neighbouring buildings and other infrastructure, including related to the highway and transport; a Structural Impact Assessment will be required where a subterranean development or basement is added to, or adjacent to, a listed building.
 3. Use natural ventilation and lighting where habitable accommodation is provided;
 4. Include a minimum of 1 metre naturally draining permeable soil above any part of the basement beneath the garden area, together with a minimum 200mm drainage layer, and provide a satisfactory landscaping scheme;
 5. Demonstrate that the scheme will not increase or otherwise exacerbate flood risk on the site or beyond, in line with policy LP 21 Flood Risk and Sustainable Drainage;
 6. Demonstrate as part of a Construction Management Statement that the development will be designed and constructed so as to minimise the impact during construction and occupation stages (in line with the Local Environmental Impacts, Pollution and Land Contamination policy of this Plan);
 - C. Proposals for subterranean and basement developments, including extensions, as well as lightwells and railings, will be assessed against the advice set out in the Council's SPDs relating to character and design as well as the relevant Village Planning Guidance and the forthcoming SPD on Basements and Subterranean Developments. Applicants will be expected to follow the Council's Good Practice Guide on Basement Developments.
- Furthermore, the LBRuT planning advice note 'Good Practice Guide on Basement Developments', May 2015 Consultation with LBRuT identifies that the basement development would be subject to Policy LP 11 from their local plan, which details potential requirements including: contacting utilities, Network Rail and Transport for London to confirm that works will not interfere with their infrastructure; flood risk assessment taking consideration of groundwater and potential groundwater flooding; assessment of land stability; structural assessment taking consideration of ground conditions and groundwater, existing trees and infrastructure and drainage; site investigation; and assessment of ground movements.

On the basis of the foregoing, it is considered that a Basement Impact Assessment and/or Ground Movement Assessment may be required to confirm the absence of adverse impacts to existing offsite infrastructure assets or neighbouring structures, subject to the development details/design and liaison with TFL/LUL and/or Network Rail and the Local Planning Authority.

Below Ground Structures and Utilities

- Council correspondence notes that the site is within a National Grid safeguard zone (unknown if this relates to the former Richmond Gas Works) and a possible Southern Gas Network structure was identified in the south-eastern corner of the site. Furthermore, existing utilities are likely to be present on-site associated with the existing development, including the electrical substation. Existing services may require removal, capping and diversion associated with the development. Furthermore, it is recommended that full service plans are obtained in advance of any below ground investigation works;
- Relic foundations and structures may be present associated with the historic development of the site. Obstructions may need to be delineated and grubbed out as part of any future earthworks at the site; and

- As detailed in Section 3.6, the site is within a high risk area with respect to unexploded ordnance. It is recommended that a UXO specialist is contacted prior to any below ground works.

Foundation Appraisal

- There is the potential for aggressive sulphates in Made Ground and London Clay Formation, which may impact buried concrete and as such will require further consideration as part of any ground investigation;
- Trees are present bounding the site and pre-application consultation with LBRuT identifies that there are tree preservation orders at the site. It is considered probable that existing tree roots are present in the Kempton Park Gravel Formation and should this formation prove to be cohesive in nature the volume change potential should be considered where trees are to be removed or planted associated with the development;
- Structural loads are unknown at this stage. Noting proposed development heights of between 4 and 9no storeys, it is considered that loads may exceed traditional shallow foundations (i.e. pads and strips) and foundations may need to be piled. Following ground investigation consideration could be given to shallow foundations and raft basement slabs, dependent on settlement tolerances and the thickness and density of the Kempton Park Gravels;
- Based on BGS borehole records, it is considered that a piled foundation solution would extend into the London Clay Formation. Foundation design will be subject to structural loads and ground investigation findings.

Adjacent Railways

- District, Overground and National Rail tracks bound the site to the south and the west. It is likely that additional assessments will be required to confirm the potential impacts of development on these assets, including during ground investigation and future development.

Further Considerations

- Soakaways may be feasible within the granular Kempton Park Gravel Formation; however, given the potential for contamination identified, further risk assessments may be required to ensure that these do not result in increased mobilisation of potential contamination. Furthermore, BGS borehole logs have identified a groundwater table from c.1.5m bgl and the shallow depth to groundwater may preclude the use of soakaway drainage.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Geo-Environmental

This report has identified potential sources of contamination on-site, including those that predate the commercial building, including Made Ground, timber yards, electrical substations, car wash, coal hoppers, fuel depot, power station and car parking. Furthermore, off-site sources of contamination were identified, most notably the former Richmond Gas Works positioned to the north-east of the site beyond Manor Road.

Potential risks were assessed against sensitive receptors including human health, building structures and services and controlled waters as the underlying Kempton Park Gravel Member (Secondary A Aquifer).

Typically a moderate risk was identified to receptors associated with the proposed development. It is considered that contaminated land planning conditions will be included associated with the development and it is recommended that a ground investigation is undertaken to further quantify potential risks.

6.2 Geotechnical

Potential Geotechnical considerations identified including:

- Presence of railway lines adjacent to the south and west of the site. The development will require ongoing consultation with Network Rail following Fairhurst's initial meeting with regards to confirming absence of risk to their assets;
- It is noted that the site is within a National Grid safeguard zone and additional services are likely to be present associated with the development of the site. Existing services may require removal, capping and diversion associated with the development. Furthermore, it is recommended that full service plans are obtained in advance of any below ground investigation works;
- Structural loads are preliminary at this stage. Noting proposed development heights of between 4 and 9no storeys, it is considered that loads may exceed traditional shallow foundations (i.e. pads and strips) and foundations may need to be piled. Based on BGS borehole records, it is considered that a piled foundation solution would extend into the London Clay Formation. Foundation design will be subject to structural loads and ground investigation findings; and
- The site is within a high risk area with respect to unexploded ordnance. A detailed assessment is currently being undertaken and the findings should be referred to prior to any below ground / excavation works.

6.3 Recommendations

It is recommended that an intrusive ground investigation is undertaken to further quantify Geo-Environmental and Geotechnical risks associated with the development. The above assessment is based on the proposed development plans included in Appendix A and the assessment should be revised if these are amended.

Following a design freeze (November 2018), Appendix A has been updated for the revision of this report.

Figure 1
Site Location Plan





Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.

RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO.

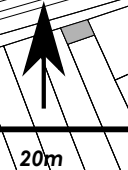
CONSTRUCTION

DEMOLITION

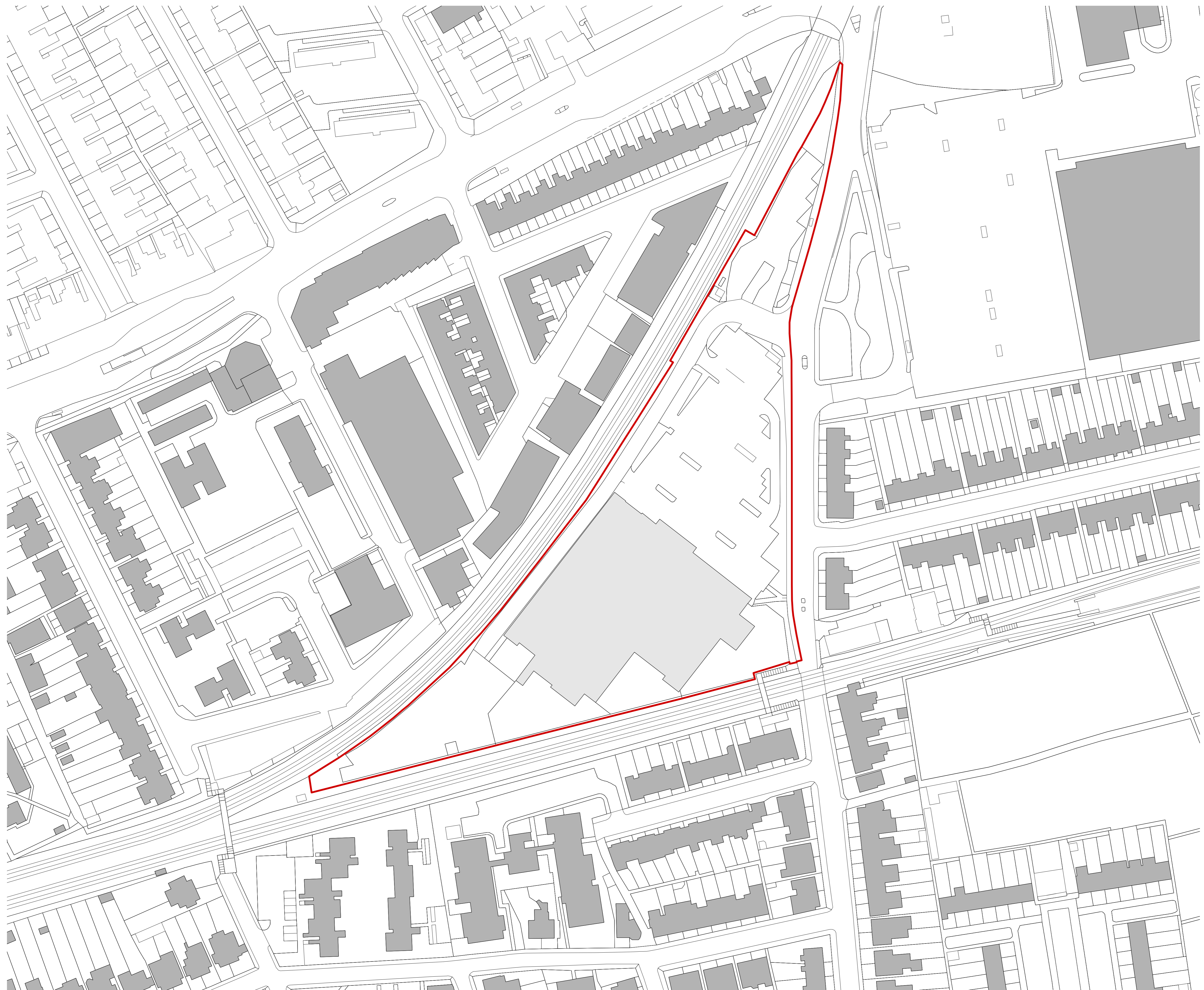
FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

Rev.	Date	Description	Drawn	Chkd.	Appd.																		
<table border="0"> <tr> <td colspan="2">FAIRHURST</td> <td>Client:</td> <td colspan="3">Avanton</td> </tr> <tr> <td colspan="6">135 Park Street LONDON SE1 9EA</td> </tr> <tr> <td colspan="6">Tel: 020 7828 8205 Fax: 084 4381 4412 Fairhurst.co.uk</td> </tr> </table>						FAIRHURST		Client:	Avanton			135 Park Street LONDON SE1 9EA						Tel: 020 7828 8205 Fax: 084 4381 4412 Fairhurst.co.uk					
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135 Park Street LONDON SE1 9EA																							
Tel: 020 7828 8205 Fax: 084 4381 4412 Fairhurst.co.uk																							
Project Title: Manor Road, Richmond																							
Drawing Title: Existing Site Layout From Assael Drawing A3004 100																							
Scale at A3: Not to Scale			Status: ISSUE																				
Drawn: EY		Checked: AS		Approved: AS																			
Date: 04/12/18		Date: 05/12/18		Date: 05/12/18																			
Drawing No.: 126782 Figure 1					Revision: A																		



20m



General notes

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Revision Status:
 P-Preliminary
 C-Contract

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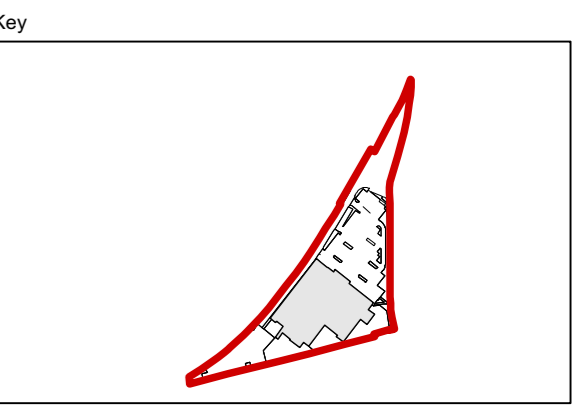
Drawing notes

Electronic file reference

Enter Source Filename ' Eg AA Title Block'

Status R:	Revision	Date	DRN	CHK	CDM
1	For Information	03/12/18	HB	JL	

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 - Comment
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Client Title Block

Client

Avanton

Project title

**A3004
 Manor Road Richmond**

Drawing title

Boundary Plan

Scale @ A1 size

1:500

Date

Dec '18

Drawing N°

A3004 100

Status & Revision

Existing site plan



Figure 2
Potential Sources of Contamination



Legend

Potential Sources of Contamination On-Site

- Former Car Wash
- Former Coal Hoppers
- Former Crane
- Former Depot
- Former Electrical Substation
- Former Fuel Depot
- Former Railway Sidings
- Made Ground, Former Timber Yard & Former Power Station (location unknown)
- Car Parking / Bus Stand
- Electrical Substation
- - - Site Boundary

FAIRHURST

135 Park Street
LONDON
SE1 9EA

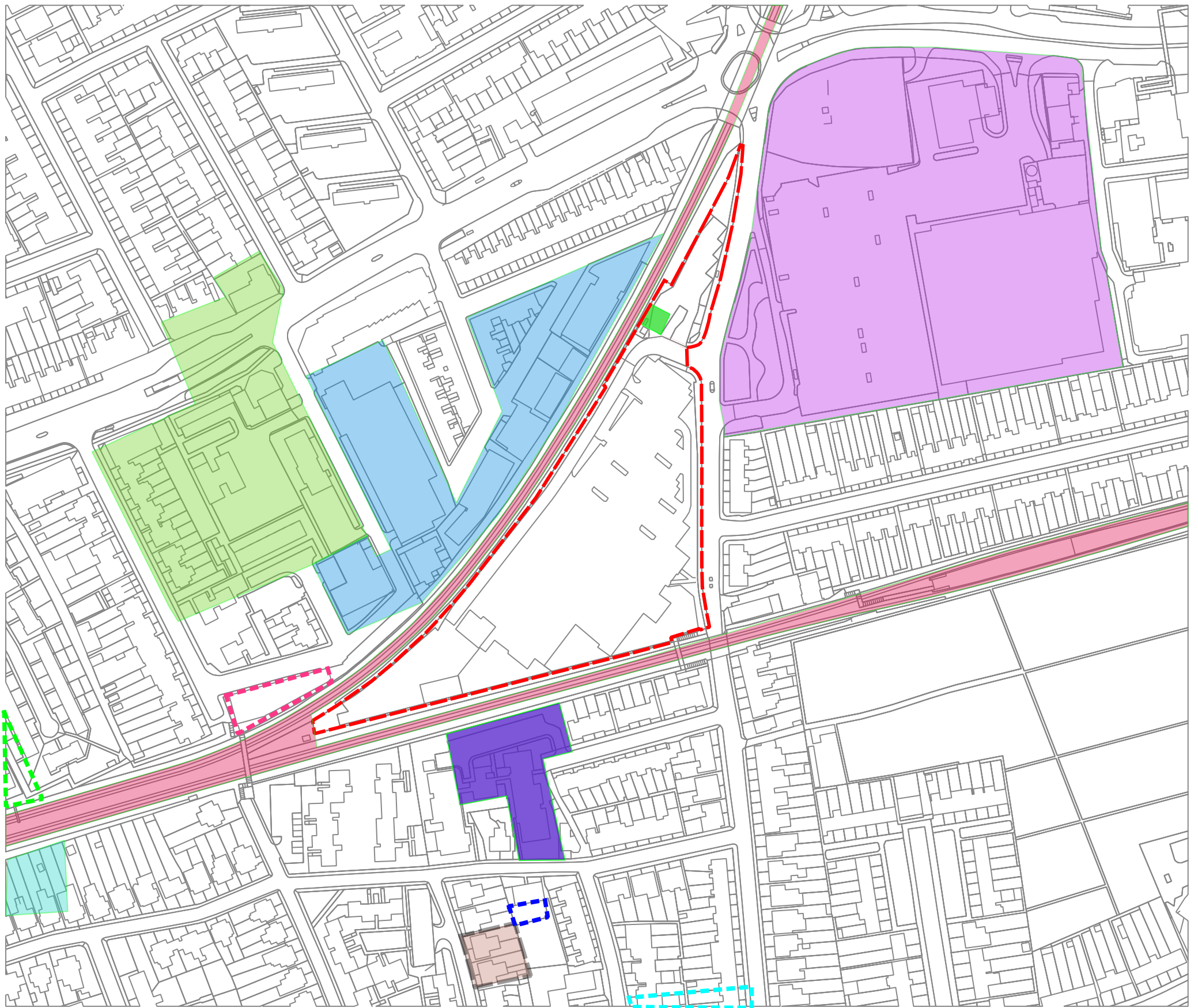
Tel: 020 7828 8205
Fairhurst.co.uk

Client:
Avanton Limited

Project Title:
Site off Manor Road, Richmond

Drawing Title:
**Potential Sources of Contamination On-Site
126782**

Scale at A1: NTS	Status: N/A	
Drawn: FS	Checked: CB	Approved: CB
Date: 10/08/2018	Date: 10/08/2018	Date: 10/08/2018
Drawing No.: Figure 2A		Revision: -



Legend

- - - Corporation & Goods Depots and Coach Repair Works
- - - Electrical Substation
- - - Former 3no Garages
- Former Coal Hoppers
- Former Laundry
- Former Light Industrial Warehouse
- Former Nursery
- Former Richmond Gas Works
- Former Warehouses, Works, Electrical Substation, Builders Yard, Tank and Various CTDE
- - - Former Works, Builders Merchant, Distribution Services & Carpet Cleaners
- Railway Lines
- Various CTDE
- - - Site Boundary

FAIRHURST

135 Park Street
LONDON
SE1 9EA

Tel: 020 7828 8205
Fairhurst.co.uk

Client:
Avanton Limited

Project Title:
Site off Manor Road, Richmond

Drawing Title:
**Potential Sources of Contamination Off-Site
126782**

Scale at A1: NTS	Status: N/A	
Drawn: FS	Checked: CB	Approved: CB
Date: 10/08/2018	Date: 10/08/2018	Date: 10/08/2018
Drawing No.: Figure 2B		Revision: -

APPENDIX A
Development Proposals





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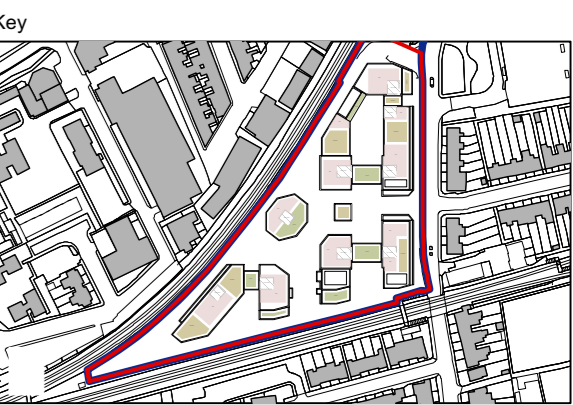
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3	For Information	26/7/18	HB	JL	
4	For Information	8/8/18	HB	JL	
5	For Information	23/8/18	AS	JL	
6	Not Issued	-			
7	For Information	29/08/18	AS	HB	
8	For Information	26/9/18	AS	HB	
9	For Information	17/10/18	AS	HB	
10	For Information	19/10/18	AS	HB	
11	For Information	21/11/18	AS	HB	

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Client
Avanton

Project title
A3004 Manor Road Richmond

Drawing title
GA Plans Roof Plan

Scale @ A1 size
1:500

Date
Nov '18

Drawing N°
A3004 210

Status & Revision
P12

Assael

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 London SW15 2TL

+44 (0)20 7736 7744
 info@assael.co.uk
 www.assael.co.uk



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Drawing notes

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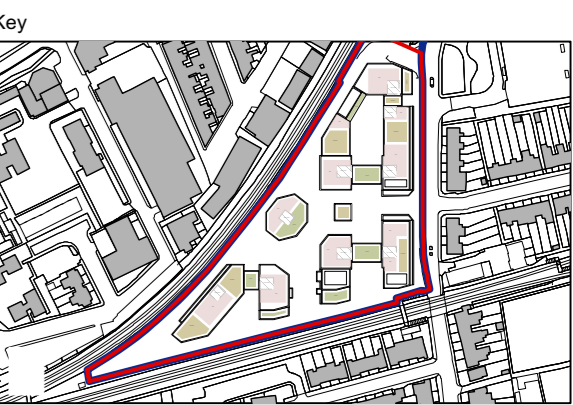
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2	For Information		7/6/18	HB	JL	
3	For Information		26/7/18	HB	JL	
4	For Information		8/8/18	HB	JL	
5	For Information		23/8/18	AS	JL	
6	Not Issued		-			
7	For Information		29/8/18	AS	HB	
8	For Information		26/9/18	AS	HB	
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10	For Information		19/10/18	AS	HB	
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Client
Avanton

Project title
**A3004
 Manor Road Richmond**

Drawing title
**GA Plans
 Eighth Floor**

Scale @ A1 size **Date**
1:500 **Nov '18**

Drawing N°
A3004 208

Status & Revision
P12