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9-12 New College Parade, Finchley Road

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Flood Risk Assessment and Sustainable Drainage Strategy

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1.0 INTRODUCTION

Conisbee have been appointed as Civil Engineering Consultants to undertake a Flood Risk and Sustainable Drainage Assessment for the proposed mixed use development at 9 to 12 New College Parade, Finchley Road, Camden in London.

This Flood Risk Assessment will be undertaken in accordance with the best practice guidance stated in National Planning Policy Framework (NPPF), PPS 25 – Development and Flood Risk pursuant to Local Authority approval and to informing the design. It is also a mandatory requirement for the Code for Sustainable Homes (CfSH). The proposed residential development has been set a minimum CfSH target of Level 4. This Flood Risk Assessment demonstrates how Credits under criteria Sur 1 and Sur 2 have been met.

In addition Credits can also be awarded under the BREEAM New Construction "Commercial" for the proposed commercial element of the development.

2.0 BACKGROUND

This flood risk assessment refers to the following documents.

2.1 General Documentation

2.1.1 National Planning Policy Framework (NPPF) (TSO, March 2012) and Planning Policy Statement 25 (PPS25) Development and Flood Risk (TSO, March 2010)

The National Planning Policy Framework and the PPS 25 set out government policy on development and flood risk. The aim is to ensure that flood risk is taken into account at all stages of the planning process and that inappropriate development is not undertaken within areas of flood risk.

2.1.2 The North London Boroughs Strategic Flood Risk Assessment (Mouchel, August 2008)

This Level 1 SFRA was prepared on behalf of the seven northern Boroughs of London consisting of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest. It defines the flood risks within the area and advises on flood risk management in accordance with the requirements of PPS 25.

2.1.3 Islington Core Strategy 2010 to 2025 (Islington Borough Council, February 2011)

The Core Strategy for the London Borough of Camden states that the Borough seeks to exceed its target for the construction of 1,170 new homes per annum during the period 2010 to year 2025. The Core Strategy also states that Islington Borough will seek to balance the demand for housing with the need to accommodate a growth in employment and tackle worklessness.

2.1.4 Code of Sustainable Homes (CfSH) (DCLG, December 2010)

This is an environmental assessment method for rating and certifying the design and construction of new residential houses with a view of encouraging continuous improvement in sustainable urban development, construction and use. It includes objectives for the management of surface water and flood risk.

2.1.5 BREEAM New Construction (BRE, December 2011)

This is an environmental assessment method for rating and certifying the design and construction of new commercial buildings with a view of encouraging continuous improvement in sustainable urban development, construction and use. It includes objectives for the management of surface water and flood risk.

2.2 Site Specific Documents

The following documents and drawings have been consulted for the preparation of this flood risk assessment.

- *Appendix A – Site Topographical Survey*
- *Appendix B – Geological Maps*
- *Appendix C – Thames Water Asset Location Plan*
- *Appendix D – SFRA Flood Maps*
- *Appendix E – Preliminary Drainage Layout & Site Proposals*
- *Appendix F – The SUDS Management Train*

3.0 EXISTING SITE

3.1 Location

The site is located at NGR 526584,184514 in Camden, London. The site forms a rectangular shape and is bound on its sides by the following:

- To the south of the site is immediately bound by the high street, Finchley Road.
- To the east and west of the site bound by commercial buildings situated on the high street; Finchley Road.
- To the north of the site is College Crescent with 39 College Crescent located further north, where a new residential development is being currently built.

3.2 Existing Site Description and Topography

The existing site consists of disused buildings that are to be demolished. The site area measures approximately 440m².

In terms of topography the site has a split level with the ground floor leading to Finchley Road, whilst the first floor leads directly onto College Crescent along the back of the property. The levels along the frontage of the site are around 53.610 m AOD whilst those at the back of the property are at a level of approximately 56.610m AOD. This is owing to the steep level rise between Finchley Road and College Crescent.

The existing topographical site survey is contained in Appendix A.

3.3 Ground Conditions

The Envirocheck BGS Geological maps indicate that the site is underlain by the following geological sequence; Superficial Geology comprises of Made Ground sitting on underlying Bedrock Geology of London Clay geology. An intrusive ground investigation is yet to be carried out, in order to confirm this geology.

Appendix B, contains details of the Envirocheck BGS Geological Maps.

Aquifer Designation

The Environment Agency has recently amended their aquifer designations so that they are consistent with the Water Framework Directive. The Superficial geology indicates that the site does not lie within any Aquifer. The Bedrock geology indicates that this site is not underlain by an Aquifer, at greater depths.

Source Protection Zone

Groundwater provides a third of our drinking water in England and Wales, and it also maintains the flow in many of our rivers. In some areas of Southern England, groundwater supplies up to 80% of the drinking water that you get through your taps. It is crucial that we look after these sources and ensure that your water is completely safe to drink.

The site does not lie within a Source Protection Zone.

3.4 Existing Site Drainage

Thames Water records show the existing combined sewer running outside the building within Finchley Road footway, to which the existing properties are currently discharging to. It is proposed to re-use this pipe; however a CCTV drainage survey is yet to be undertaken.
Thames Water records also indicate two possible connections from neighbouring properties, which may need to be diverted.

3.5 Existing Site Characteristics

The existing hydrological characteristics for the site are as follows:

- *Area of Development Site = 440m^2*
- *Total Existing Impermeable Area assessed to be 100% = 440m^2*
- *Existing run off rate QWR= 6,60l/s*
- *Infiltration rate = Unknown*

4.0 PROPOSED DEVELOPMENT

4.1 Description

The existing building comprises of two stories, housing various retails and office establishments. The redevelopment proposal seeks to provide a mix of private and residential and commercial premises suitable for A1/2/3 and 5 uses. The proposal comprises of ground floor and basement commercial space with 9 residential units sitting above the commercial space over four storeys. The new residential units will consist of the following accommodation mix:

- *4no. One bedroom apartments.*
- *4no. Two bedroom apartments.*
- *1no. Three bedroom apartment.*

4.2 Vulnerability Classification

Table D.2: Flood Risk Vulnerability Classification, Annex D of PPS 25 shows that the intended mix use has a Vulnerability Classification of "More Vulnerable". However the site lies in Flood Zone 1, of the EA River Flood maps.

Table D.2: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.[19] (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'[20]).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste.[21] • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.

4.3 Local Development Documents

The 9 – 12 College Parade, Finchley Road redevelopment site is located in the London Borough of Camden. The Core Strategy for the London Borough of Camden states that the Borough seeks to exceed its target for the construction of 1,170 new homes per annum during the period 2010 to year 2025. The Core Strategy also states that Islington Borough will seek to balance the demand for housing against the need to accommodate a growth in employment and tackle worklessness.

Through the implementation of the Core Strategy, Camden Borough Council will seek to address the clear need for more housing in the Borough and for more of this to be affordable. The following Core Strategy policies state the measures that are particularly applicable to this proposed development.

Policies CS6 to CS12 - Housing

Camden will meet its housing challenge, to provide more high quality, inclusive and affordable homes by seeking to meet and exceed the Borough housing target, which is set by the Mayor of London. The current annual target, which is in the process of being reviewed, requires Camden to build 595 additional homes each year, during the period 2007/8 to 2016/7.

4.4 Sequential Test

The Environment Agency Flood Plain map indicates that this site is located in Flood Zone 1. Flood Zone 1 comprises of land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). Table D.3: Flood Risk Vulnerability and Flood Zone 'Compatibility', Annex D of PPS25, shows that the development is appropriate for this zone and therefore the Exception Test is not required.

Table D.3[23]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Flood plain'	Exception Test required	✔	✗	✗	✗

Key:
✔ Development is appropriate
✗ Development should not be permitted

Secondly the site is a disused 'brownfield' commercial site which is being redeveloped into a new residential development. Therefore this redevelopment site passes the *'Sequential Test'*.

5.0 DEFINITION OF THE FLOOD HAZARD

5.1 Sources of Flooding

The North London Strategic Flood Risk Assessment (SFRA) was prepared for the 7 North London Boroughs of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest in order to identify the potential sources of flooding for this area, in accordance with Annex C of PPS25, which may affect the site. These sources are discussed below.

5.1.1 Fluvial Flooding

The North London SFRA states that Camden has no fluvial watercourses within its Borough boundaries. Camden is situated on higher ground in the central district of London. However River Fleet, which is formed from two springs on Hampstead Heath is the largest of London's subterranean rivers and historically drained the Camden area. The Fleet has long since been incorporated into the London sewer network although the traditional route of the Fleet and the large sewer in its place can still be traced in the south of the Borough as it passes into the City of London. Highgate and Hampstead Ponds were constructed to increase London's water supply. They are fed by the Fleet and are now used by the public for leisure activities.

Regents Canal runs from west to east and bisects Camden borough. The Regent's Canal was constructed in the early 1800's. British Waterways are charged with maintaining the Regents Canal. They actively operate a series of sluices and gates along the Canal for navigation and flood risk management purposes. The site is located 2.5km north of the nearest reaches of Regents Canal at a higher elevation; therefore this site can be considered to be at low risk from fluvial flooding.

5.1.2 Tidal Flooding

This site is remotely located from the Thames therefore it is not at risk from Tidal Flooding.

5.1.3 Overland Flooding

Overland flooding can occur when high intensity rainfall overwhelms man made drainage systems or cannot soak into the ground. Excess water can flow across the ground following the contour gradient and cause flooding downstream. It is exacerbated by steep topography. The site is located in South Hampstead an area that experienced flooding during the 1975 and 2002 flood events. The Camden Flood Risk Management Strategy states that both flooding events were extreme flood events with a 1 in 100 year return period.

The Camden Flood Risk Management Strategy states that excessive rainfall events experienced in both 2012 and 2013 have led to further flooding events in both West and South Hampstead, notwithstanding the flood alleviation works undertaken by Thames Water after the 2002 floods. It is noted only marginal reductions in flooding events have been achieved by the flood mitigation works. A further report with recommendations was expected from Thames Water, who have a legal obligation to address or mitigate these flooding events. The North London Strategic Flood Risk Assessment does not state this site is in an area susceptible overland flood. Therefore the site is not at risk from overland flooding.

5.1.4 Groundwater Flooding

For bedrock geology the groundwater profile through London shows relatively little change in elevation, however, the topography of the North London sub-region shows significant variation, with a general fall in an easterly direction from the higher ground in Barnet to the Lee Valley, where much of the area is only a few metres above sea level. As expected, groundwater levels are closest to the surface around watercourses, particularly in the low lying Lee Valley. The groundwater levels in the Lee catchment are significantly closer by approximately 30m to the surface, whilst those in South Hampstead, Camden are at depths between 80m and 90m beneath ground levels as shown in SFRA MAP 12 contained in Appendix C. GARDIT operate an ongoing abstraction scheme across London to maintain the level of the groundwater table in the Chalk Bedrock which is assisted by the London Clay impermeable geology. Therefore there is no risk of groundwater flooding from bedrock geology.

For the proposed development permanent waterproofing measures must be put in place to protect the proposed basement from the egress of perched groundwater. An intrusive ground investigation is yet to be carried out, this will help confirm the incidence of perched groundwater at the site. As a precaution dewatering apparatus should also be provided during the new basement extension works.

5.1.5 Sewer and Surface Water Flooding

Sewer Flooding

Sewer and surface water flooding generally results in localised short term flooding caused by extreme rainfall events which overload the capacity of sewers or run off adjacent land as surface flow. Flooding can also occur as a result of blockage, poor maintenance or structural failure. Sewer systems in London are often very old, particularly within the Boroughs of Camden, Islington and Hackney. Those older sewers, some of which were historically designed to convey storms of relatively low return periods such as a 1 in 10 year rainfall event. Current design standards require adoptable sewer networks to be designed to cope with storm events up to and including the 1 in 30 year storm event. If this storm event is exceeded surface

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water flooding would occur following the topography of the area subjected to the flooding event.

The North London SFRA states that following the 2002 flood event Thames Water made further funding cases to OFWAT to relieve more properties from flooding. Thames Water is mandated by regulation to identify and resolve any recurrent flooding issues on their network, therefore reducing the level of flood risk from sewers.

Surface Water Flooding

Surface water flooding has a recent history in Islington with the 2002 floods and other more localised flood events. The SFRA states that August 2002 was caused by excessive rainfall causing the main sewer system to become completely inundated. The surcharge pressure forced the water to back onto the streets through manholes and gully gratings and into residents' homes at basement and ground floor level. The SFRA Map 22 in Appendix C shows the roads affected by this 2002 flooding event. Thames Water sewer flood data during the 10 year period from August 1997 to August 2007 indicates that up to 90 sewer flooding events occurred during this period within the London Borough of Camden. These flooding events were mostly found in the following areas; West Hampstead, Cricklewood, South Hampstead and to the west of Church End. Transport for London (TFL) also collects flood data of reported flood incidents on transport routes within the M25. The SFRA states that there are numerous flood events recorded in south Barnet and south Hackney, however Islington and Camden have very few or no recorded TFL flood events.

The North London SFRA also states that up to 12 surface water flooding incidents recorded on Map 20 have historically occurred in Camden and were responded to by the Fire Brigade. The Overloaded sewers were to be the main course of the 1975 and 2002 flooding events. The Camden Flood Risk Management Strategy states that ongoing maintenance and routine upgrade of sewer networks by Thames Water would ensure the reduction of the number and severity of both sewer and surface water flooding incidents thus protecting the site.

5.1.6 Flooding from Artificial Sources

Regents Canal was constructed in 1820 to form the London arm of the Grand Union Canal. The Regents Canal stretches from Limehouse basin in Docklands to Paddington passing through Mile End, Hackney, Islington, King's Cross, Camden, Regents Park and Little Venice. Within this reach of the Regents Canal there are three tunnels; Islington Tunnel (886 meters) and Maida Hill Tunnel (251 meters) and the smaller Eyre's tunnel (48 meters).

As it is a statutory obligation for the British Waterways to maintain the Canal, this ensures that a robust flood risk management strategy is maintained along its length. However as the site is 2.5km, north of the Canal therefore it would not be susceptible to any flood risk caused by this feature.

5.2 Probability of Flooding

As discussed above the probability of flooding within this site from any source is minimal provided Thames Water undertakes flood mitigation works, and as long as the onsite drainage for the site is suitably designed. As previously stated in this flood risk is associated with inadequate sewer capacity, which the SFRA has indicated that Thames Water applied for funding to OFWAT to address this issue.

5.3 Flood Risk due to Climate Change

The effect of climate change will be to increase the intensity and duration of rainfall events, thus increasing the likelihood of localised flooding. It is current policy therefore to add 30% to design rainfall profiles when designing surface water drainage to accommodate Climate Change weather induced future increases. In this case the drainage will be designed to retain the 100 year + 30% for climate change return period storm event within the system.

6.0 PROPOSED SURFACE WATER DRAINAGE STRATEGY

6.1 Site Characteristics

The physical design and hydrological characteristics for the site are as follows;

- Total Catchment Area = 440m^2
- Total proposed Impermeable Area = 440m^2
- Existing Impermeable Area = 440m^2
- Net decrease of impermeable area after development = 0,0m^2
- Existing discharge rate = 6,60l/s
- The Policy requirement of the London Plan and PPS 25 guidance is to discharge surface water from both Greenfield and brownfield sites at Greenfield discharge rates. However the London Plan also states that the discharge rate can be reduced to 50% of the pre-existing discharge rate if there are site constraints that justify this reduction.

6.2 Proposed Surface Water Strategy

In accordance with best practice guidelines stipulated in PPS 25, it is proposed to provide attenuation up to and including the 1 in 100 year plus 30% for the Climate Change storm event for this site. In line with the London Plan and Code for Sustainable Homes the applicable discharge rated for this site is 50% of existing discharge rates of 6,60l/s; 3,30l/s. However the most hydraulically efficient hydrobrake that is also not prone to blockage would require a minimum discharge of 5,0l/s. Therefore the new development will have a controlled discharge rate of 5,0l/s. Owing to the constricted space available on this site there are only two options for surface water attenuation; blue roofs or an underground modular storage unit at basement floor level. The proposal is to discharge storm water run-off to the existing Thames Water sewers running along Finchley Road. The Preliminary Drainage Layout drawing can be found in Appendix E.

In terms of pollution control, site has no dedicated access road associated with it. The public highways along the frontage and back of the property; Finchley Road and College Crescent will be used for deliveries as the site is a ***'Car Free'*** development.

<u>Rate of Discharge & Proposed Outfall</u>

The Building Regulations recommend a hierarchy of methods of disposal of surface water. In order, these are disposal by infiltration, discharge to watercourses and if neither of these options are reasonably practical then discharge to a public surface water sewer. Chapter 6 of the Mayor's Draft Water Strategy (Rainwater in London) sets out a similar hierarchy. The objective is for surface water discharged from urban development's to replicate the predevelopment response of the site as far as possible.

Owing to the underlying geology and physical site constraints infiltration drainage techniques are precluded from this. The only viable means of disposal of surface water run-off is to the Thames Water public sewer network.

Therefore for this proposed development the applicable surface water discharge rate is 5,0l/s for all storm events up to and including the 1 in 100 year plus 30% for climate change storm event. The surface water attenuation required is $14.0m^3$.

6.3 Site Design Objectives and Constraints

The requirements for a sustainable surface water drainage strategy at this site are to:

- Limit the peak rate of surface water discharge into the public sewer to the predevelopment level,
- To attenuate all storm events up to and including the 1 in 100 year storm plus climate change event.
- Prevent pollution of the groundwater

6.4 Sustainable Drainage Systems (SUDS)

SUDS is a term used to describe the various approaches that can be used to manage surface water drainage in a way that mimics the natural environment. SUDS can improve the sustainable management of water for a site by:

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

The SUDS Manual, CIRIA C697, provides a hierarchy of techniques that which will incrementally reduce pollution, flow rates and volumes and this is called The SUDS Management Train. The methods are categorised depending on whether their primary use is considered to be pre-treatment, conveyance, source, site or regional controls, and they can be ranked based on their hydraulic and water quality performance potential. Table 6.1 categorises the capability of different SUDS techniques. Table 3.3 of the SUDS manual indicates how many components are recommended to deal with the runoff from differing land uses.

Further information describing the SUDS management train is attached at Appendix F.

Table 6.1 - Summary of SUDS Techniques

Technique	Description	Management Train Suitability						Water quantity				Water quality								Environmental benefits		
		Prevention	Conveyance	Pre-treatment	Source control	Site control	Regional control	Conveyance	Detention	Infiltration	Water	Sedimentation	Filtration	Adsorption	Biodegradation	volatilisation	precipitation	Uptake by plants	Nitrification	Aesthetics	Amenity	Ecology
Water butts, site layout & management	Good housekeeping and good design practices.	○	●		○			●	●	○	●	●	●	●	●	●	●	●	●	●	●	●
Pervious pavements	Allow inflow of rainwater into underlying construction/soil.	○			○	●			○	○	●	○	○	○	○	○				●	●	●
Filter drain	Linear drains/trenches filled with a permeable material, often with a perforated pipe in the base of the trench.		○		○	●		○	○				○ ○	○	○	○						
Filter strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and other articulates.			○	○			●	●	●		○	○	○	○					●	●	●
Swales	Shallow vegetated channels that conduct and/or retain water (and can permit infiltration when un-lined). The vegetation filters particulates.		○		○	○		○	○	●		○	○	○	○			●		●	●	●
Ponds	Depressions used for storing and treating water. They have a permanent pool and bank side emergent and aquatic vegetation.					○	○		○	●	○	○	○	○	○	○	○	○	○	○	○	○
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds.		●			○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	○	○
Detention basin	Dry depressions designed to store water fro a specified retention time.					○	○		○			○	●	●	○			●		●	●	●
Soakaways	Sub-surface structures that store and dispose of water via infiltration.				○					○			○	○	○							
Infiltration trenches	As filter drains, but allowing infiltration through trench base and sides.		●		○	○		●	○	○			○	○	○	○						
Infiltration basins	Depressions that's store and dispose of water via infiltration.					○	○		○	○			○	○	○	○				●	●	●
Green roofs	Vegetated roofs that reduce runoff volume and rate.	○		○	○				○				○	○	○	○	○	○	○	○	●	○
Bioretention areas	Vegetated areas for collecting and treating water before discharge downstream, or to the ground via infiltration.				○	○			○	○		○	○	○	○	○	○	○	○	○	○	○
Sand filters	Treatment devices using sand beds as filter media.			○		○	●		○	●			○	○	○	○	○					
Silt removal devices	Manhole and/or proprietary devices to remove silt.			○								○										
Pipes, subsurface storage	Conduits and their accessories as conveyance measures and/or storage. Water quality can be targeted using sedimentation and filter media.		○			○		○	○			●	●									

Key to symbols ● some opportunities, subject to design ○ High/primary process

6.5 SUDS Selection Criteria

The appropriate selection of a SUDS scheme for this development is dependent upon the factors listed in Table 6.2 below. These characteristics are then considered against the available techniques as illustrated in Table 6.3 so that an assessment of the suitability of each can be made.

Table 6.2 - Site Specific Characteristics

Category	**Site characteristics**
Proposed land use	Mixed Use
Soil type	Made Ground underlain by London Clay Formation.
Area draining to SUDS components	440m2
Minimum depth to water table	80m to 90m bgl. Perched water table maybe encountered during the Site Investigation.
Site slope	Split level construction front at ground levels with bath at first floor level.
Available head	TBC (minimum)
Available space	Limited.
Water quality treatment potential	Trapped gullies and trapped aco gullies.
Hydraulic control	The surface water will be discharged at a restricted discharge of 5,0l/s.
Maintenance	Desilting and emptying of gullies and aco channel every six months. Jet washing porous pavement every six months.
Community acceptability	High
Cost	Medium
Habitat creation potential	Low

SUDS GROUP	TECHNIQUE	Residential	Permeable soils	0-2 ha draining to single SUDS component	Min depth to water table 0-1m	Site slope 0-5%	Available head 0-1m	Available space low	Water Quality Treatment Potential					Hydraulic Control				Maintenance	Community acceptability	Cost	Habitat creation potential
									Total suspended solids removal	Heavy metals removal	Nutrient removal	Bacteria removal	Capacity to treat fine suspended sediments and dissolved pollutants	Runoff Volume Reduction	0.5 (1/2yr)	0.1-0.3 (10/30yr)	0.01 (100yr)				
Retention	Retention Pond	Y	Y	Y	Y	Y	Y	N	H	M	M	M	H	L	H	H	H	M	H	M	H
	Subsurface Storage	Y	Y	Y	Y	Y	Y	Y	L	L	L	L	L	L	H	H	H	L	H	M	L
Wetland	Shallow Wetland	Y	Y	Y	Y	Y	Y	N	H	M	H	M	H	L	H	M	L	H	H	H	H
	Extended detention wetland	Y	Y	Y	Y	Y	Y	N	H	M	H	M	H	L	H	M	L	H	H	H	H
	Pond/wetland	Y	Y	Y	Y	Y	Y	N	H	M	H	M	H	L	H	M	L	H	H	H	H
	Submerged gravel/wetland	Y	Y	Y	Y	Y	Y	N	H	M	H	M	H	L	H	M	L	M	L	H	M
	Wetland channel	Y	Y	Y	Y	Y	Y	N	H	M	H	M	H	L	H	M	L	H	H	H	H
Filtration	Surface sand filter	Y	Y	Y	Y	Y	N	N	H	H	H	M	H	L	H	M	L	M	L	H	M
	Sub-surface sand filter	Y	Y	Y	Y	Y	N	Y	H	H	H	M	H	L	H	M	L	M	L	H	L
	Perimeter sand filter	N	Y	Y	Y	Y	Y	Y	H	H	H	M	H	L	H	M	L	M	L	H	L
	Bioretention/ filter strip	Y	Y	Y	Y	Y	Y	N	H	H	H	M	H	L	H	M	L	H	H	M	H
	Filter trench	Y	Y	Y	Y	Y	Y	Y	H	H	H	M	H	L	H	M	L	M	M	M	L
Detentio	Detention basin	Y	Y	Y	Y	Y	N	N	M	M	L	L	L	L	H	H	H	L	H	L	M
Open channels	Conveyance swale	Y	Y	Y	Y	Y	Y	N	H	M	M	M	H	M	H	H	H	L	M	L	M
	Enhanced dry swale	Y	Y	Y	Y	Y	Y	N	H	H	H	M	H	M	H	H	H	L	M	M	M
	Enhanced wet swale	Y	Y	Y	Y	Y	Y	N	H	H	M	H	H	L	H	H	H	M	M	M	H
Source	Green / Blue roof	Y	Y	Y	Y	Y	Y	Y	NA	NA	NA	NA	H	H	H	H	L	H	H	H	H
	Porous pavements	Y	Y	Y	Y	Y	Y	Y	H	H	H	H	H	H	H	H	L	M	M	M	L

Table 6.3 - SUDS Selection Factors

6.6 Suitable SUDS Options

The SUDS systems chosen for this site will primarily be required to dispose of surface water runoff from hard surfaced areas; roofs, landscaped garden and footpaths. Therefore this site will not require pre-treatment before surface water runoff is discharged from the new proposed development. Therefore the applicable SUDS option for this site, which has been highlighted in Table 6.3 is the following:

- Subsurface Storage – Underground Modular Storage Units.
- Source Control – Green/Blue Roof.

These SUDS options have been assessed below in order to qualify its suitability for the proposed site. The proposed s attenuation options provide the most practical means of storing surface water runoff from this site.

6.6.1 Subsurface Storage

The subsurface storage will be provided by the following means:

- ***1.2m Underground Modular Storage units***

Key Design Criteria

- Design to meet site drainage standards – generally 1 in 100 year plus 30% increase in rainfall for the climate change design event
- Appropriate pre-treatment is required.

Table 6.4 below outlines the advantages and disadvantages of this technique. The proposed modular storage units will provide 14.0m^3 of rainwater attenuation volume.

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ADVANTAGES	PERFORMANCE
• Significant reduction in volume and rate of surface runoff • Suitable for installation in high density development. • No additional land take, allows dual use of space. • Low maintenance. • Good community acceptability. • Can also be incorporated into a rainwater harvesting system. **DISADVANTAGES** • No water quality treatment • No reduction in runoff volume	Peak flow reduction: Good Volume reduction: Poor Water quality treatment: Poor Amenity potential: Poor Ecology potential: Poor **TREATMENT TRAIN SUITABILITY** Source control: No Conveyance: Yes Site system: Yes Regional system: No **SITE SUITABILITY** Residential: Yes Commercial/industrial: Yes High density: Yes Retrofit: Yes Contaminated sites/sites above vulnerable groundwater (with liner) Yes **COST IMPLICATIONS** Land-take: Low Capital cost: Medium Maintenance cost: Medium **POLLUTANT REMOVAL** Total suspended solids: Low Nutrients: Low Heavy metals: Low
KEY MAINTENANCE REQUIREMENTS:	
• Occasional jetting and de-silting.	

6.6.2 Green / Blue Roofs

A green/blue roof is an alternative attenuation for this site. Green/Blue roofs can help to reduce both the pollution and surface runoff entering the drainage system. In this way, they are often, in dense urban areas, the only applicable source control mechanism in the Sustainable Drainage Systems (SUDS) management train.

A green/blue roof replicates what the landscape provides in terms of allowing infiltration into the vegetation, substrates and engineered drainage layers.

A green/blue roof will typically intercept the first 5mm and more of rainfall providing interception storage, the amount of which will be dependent on the depth and type of substrate in the green roof system.

In the summer a green roof can typically retain between 70% - 80% of the runoff.

In Germany between 40% - 100% of rainfall can be retained –dependent upon the season 75% of rain falling on extensive green roofs can be retained in the short term and up to 20% can be retained for up to 2 months

As the rainfall events become longer or more intense, the positive effect of a green roof remains as there is still a significant reduction in peak runoff rates.

This increase in the 'time of concentration' means that a green roof will be beneficial throughout a wide range of rainfall conditions.

The above benefits collectively mean that by incorporating a green roof into new development, there will be a reduction in the amount and cost of the overall drainage infrastructure required to serve that development.

<u>Key Design Criteria</u>

- Design for interception storage
- Minimum roof pitch of 1 in 80, maximum 1 in 3 (unless specific design features are included)
- Structural roof strength must provide for the full additional load of saturated green roof elements
- Hydraulic design should follow guidance in BS EN 12056-3 (BSI,2000)
- Multiple outlets to reduce risks from blockage
- Lightweight soil medium and appropriate vegetation

Table 6.5 below outlines the advantages and disadvantages of this technique.

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<table>
<tr><th>ADVANTAGES</th><th>PERFORMANCE</th></tr>
<tr><td>

Mimic predevelopment state of building footprint.
Good removal of atmospherically deposited urban pollutants
Can be applied in high density developments
Can sometimes be retrofitted
Ecological, aesthetic and amenity benefits
No additional land take
Improve air quality
Help retain higher humidity levels in city areas
Insulates buildings against temperature extremes
Reduces the expansion and contraction of roof membranes
Sound absorption

DISADVANTAGES

Cost (compared to conventional runoff).
Not appropriate for steep roofs
Opportunities for retrofitting may be limited
Maintenance of roof vegetation
Any damage to waterproof membrane likely to be more critical since water is encouraged to remain on the roof

</td><td>
Peak flow reduction: Medium
Volume reduction: Medium
Water quality treatment: Good
Amenity potential: Good
Ecology potential: Good

TREATMENT TRAIN SUITABILITY
Source control: Yes
Conveyance: No
Site system: No
Regional system: No

SITE SUITABILITY
Residential: Yes
Commercial/industrial: Yes
High density: Yes
Retrofit: Yes
Contaminated sites/sites above vulnerable groundwater (with liner) Yes

COST IMPLICATIONS
Land-take: None
Capital cost: Low-High (depending on roof type and capacity)
Maintenance cost: Medium

POLLUTANT REMOVAL
Total suspended solids: High
Nutrients: Low
Heavy metals: Medium
</td></tr>
<tr><th colspan="2">KEY MAINTENANCE REQUIREMENTS:</th></tr>
<tr><td colspan="2">

Irrigation during establishment of vegetation
Inspection for bare patches and replacement of plants
Litter removal (depending on setting and use)

</td></tr>
</table>

6.7 Assessment of Appropriate SUDS Technique

There is only one viable option available for the disposal of surface water from the site; discharging into the existing sewers. Owing to site constraints and the underlying geology it is recommended that the proposed underground modular storage units or a green/blue roof for rainwater attenuation are provided.

The developed drainage strategy will enable credits to be awarded under Code for Sustainable Homes and BREEAM New Construction 2011 - Commercial.

7.0 FOUL WATER DRAINAGE

In terms of the foul drainage strategy, it is anticipated that the combined sewer in Finchley Road would facilitate a gravity connection to be made from the proposed basement including the entire site. It is anticipated that 5,0l/s of foul water will be discharge via the combined outfall into the sewer in Finchley Road.

8.0 FLOOD RISK MANAGEMENT MEASURES

The proposed drainage system will be designed to ensure that the surface water generated by a 1 in 100 year plus 30% for climate change storm event will be attenuated by providing 14,0m^3 of attenuation storage. The surface water will discharge at a restricted rate of 5,00l/s.

Therefore there is no offsite surface water overflow for all storm events until this threshold is exceeded, thus providing a robust flood management regime.

9.0 OFFSITE IMPACTS

It is considered that the proposed drainage designs mean that the surface water and foul flows generated by the proposed development will not have any adverse effect off site.

10.0 RESIDUAL FLOOD RISKS

The only remaining risk following the construction of the proposed systems relates to exceedance of the design criteria. Design flows generated from excess rainfall events will be directed away from buildings. Therefore there is perceived to be a very low risk from the development.

11.0 COMPLIANCE WITH CODE FOR SUSTAINABLE HOMES REQUIREMENTS

It is proposed to achieve a level 4 compliance for the development.

11.1 Sur 1 - Management of Surface Water Run-off

11.1.1 Peak rate of runoff

The peak rate of runoff generated by the proposed development will not exceed that of the predevelopment site in as the Code for Sustainable Homes and London Plan requirements. The drainage will be less than the current discharge rate, to achieve the minimum hydrobrake size for operation efficiency. Therefore the applicable discharge rate is 5,0l/s. Mandatory requirement - achieved.

11.1.2 Volume of Runoff

The volumetric runoff generated by the proposed development will be less than that from the predevelopment of site. The required attenuation for this site for 1 in 100 year plus 30% Climate Change storm event has been provided. Mandatory requirement – achieved.

Attenuation Requirements = 14.0m^3 for the 1 in 100 plus 30% CC event

11.1.3 Water Quality

In terms of pollution control the development is to be a 'Car Free' development. However trapped gullies and trapped aco channels will be provided for the hard landscaped areas and footpaths. Additional Credit requirement – achieved.

11.2 Sur 2 – Flood Risk

11.2.1 The site is located in Flood Zone 1 and this Flood Risk Assessment shows that there is a very low risk of flooding from any source.

11.3 Points Achieved

The mandatory requirements can be achieved for the site. 2 credits will be achieved for complying with Sur 2.

12.0 COMPLIANCE WITH BREEAM COMMERCIAL REQUIREMENTS

It is proposed to achieve 'Excellent' level of compliance for this development.

12.1 Pol 5 – Flood Risk

12.1.1 To encourage developments in areas with low risk of flooding or if developments are situated in areas with a medium risk of flooding, that appropriate measures are taken to reduce the impact in an eventual case of flooding.

The site is located in Flood Zone 1, both this Flood Risk Assessment and the SFRA have also been found this site to be a low risk from flood from all other sources, with the exception of surface water flooding. The Camden Flood Risk Management Strategy states that the Thames Water are mandated to review the effectiveness of recently installed flood mitigation measures and undertake the necessary remedial works. Therefore this requirement has been met.

12.1.2 Points Achieved

2 credits will be achieved for complying with Pol 5.

12.2 Pol 6 – Minimising Watercourse Pollution

12.2.1 This site is a 'Car Fee' development therefore no pre-treatment is required prior to discharge. However trapped gullies and catchpits are proposed for the hard landscaped areas and footpaths. Additional Credit requirement – achieved.

12.2.2 Points Achieved

1 credit will be achieved for complying with Pol 6.

13.0 RECOMMENDATIONS

It is recommended that the proposed drainage network contained in Appendix E, be implemented for this site in order to ensure that a robust drainage solution is achieved for this site.

14.0 CONCLUSION

The site is located in Flood Zone 1 and is at minimal risk of fluvial flooding. Further, both the SFRA and the site specific flood risk assessment for this development has not identified potential flood risks for the site that cannot be managed, with the exception of surface water flooding. The following flood management measures are recommended:

Both the Camden Flood Risk Strategy and North London SFRA states that the Thames Water are obligated to actively investigate and remediate recurring flooding events within their catchment.

Secondly a proprietary waterproofing system be installed against the earth retaining wall. This provides protection against the possible perched water table within the existing ground. Dewatering apparatus should also be provided during deep and trench excavations.

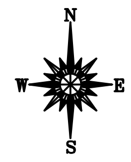
It is proposed that the proposed surface water drainage scheme be implemented in order to provide a robust and sustainable drainage regime to the proposed residential development.

It is considered that the development of this site will not increase flood risk elsewhere.

APPENDIX A

Survey Plan & Site Boundary Plan

Grid



LEGEND

BANKING (Top / Bottom)
SLOPING MASONRY
BUSHES & HEDGES
STILE
MARSH
WALL (Width drawn to scale)
TREES
3T / 0.2 / 6 (No of Trunks / Dia of Bole / Height of Tree)
BUILDING
NOTE:-
SPREADS AND HEIGHTS ARE INDICATIVE ONLY
OPEN SIDED BUILDING
GATES (Single / Double)
GLASS ROOFED
RETAINING WALL (RTW)
CONTOURS (25.50)

ABBREVIATIONS (WHERE APPLICABLE)

AIR VALVE	AV	LETTER BOX	LB
BED LEVEL	BL	MANHOLE	MH
BELISHA BEACON	BB	MARKER	MKR
BOLLARD	B	NOTICE BOARD	NB
BRITISH TELECOM BOX	BTB	NAME PLATE	NP
BRITISH TELECOM MANHOLE	BTMH	OVERHEAD WIRES	OHW
BRICKWORK	BKWK	PARKING METER	PM
BUS STOP	BS	RIDGE LEVEL	RID
CABLE TV	CATV	ROAD SIGN	RS
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CONCRETE POST	CP	SLUICE VALVE	SV
DOWN PIPE	DP	STOP COCK	SC
EAVES LEVEL	EAV	SOFFIT LEVEL	SOF
ELECTRICITY CABLE PIT	ELCP	STRUCTURAL SLAB LEVEL	SSL
ELECTRICITY CONTROL BOX	ECB	TREE STUMP	ST
ELECTRICITY POLE	EP	TELEGRAPH POLE	TP
EARTH ROD	ER	TELEPHONE CALL BOX	TCB
FIRE HYDRANT	FH	TOP OF KERB	TK
FLOWER BED	FB	TURNSTILE	TS
FOOTPATH	FP	TRAFFIC LIGHT	TL
FLOOR LEVEL	FL	TOP OF WALL	TW
FLAG STAFF	FS	UNDERGROUND	UG
GAS VALVE	GV	UNABLE TO LIFT	UTL
GULLY	G	UNABLE TO SURVEY	UTS
GULLY OUTLET	GO	VENT PIPE	VP
GATE STOP	GS	WATER METER	WM
INSPECTION COVER	IC	WATER LEVEL	WL
INVERT LEVEL	IL	WASH OUT	WO
LAMP POST	LP	WASTE PIPE	WP

BUILDING		BUILDING	
ACCESS HATCH	AH	WINDOW CILL LEVEL	WCL
ARCH HEAD HEIGHT	AHH	WINDOW HEAD LEVEL	WHL
ARCH HEAD LEVEL	AHL	STRUCTURAL CEILING HEIGHT	$\boxed{SC??}$
ARCH SPRINGER HEIGHT	ASH	SKYLIGHT	SL
ARCH SPRINGER LEVEL	ASL	SOIL AND VENT PIPE	SVP
BEAM	BE	WASH BASIN	WB
BEAM HEIGHT	BH	WATER TANK	WT
BEAM HEAD LEVEL	BHL	**FENCES**	
BEAM SOFFIT LEVEL	BSL		
COLUMN	Col	BARBED WIRE FENCE	BWF
CILL TO HEAD	C-H	CORRUGATED IRON FENCE	CIF
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DOOR HEAD LEVEL	DHL	CHESTNUT PALING FENCE	CPF
FIRE ALARM	FA	FENCE POST	FPO
FLOOR TO CILL	F-C	INTERWOVEN FENCE	IWF
FALSE CEILING	FC	IRON RAILING FENCE	IRF
FLOOR TO CEILING HEIGHT	$\boxed{1234}$	LARCH LAP FENCE	LLF
HOSE REEL	HR	MISCELLANEOUS FENCING	Misc.F
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RADIATOR	Rad	POST AND WIRE	PWF
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REV.	NOTES	DWN	DATE

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Notes:

Grid and levels relate to OS GPS Active Network.

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WebSite: http://www.maltbysurveys.com

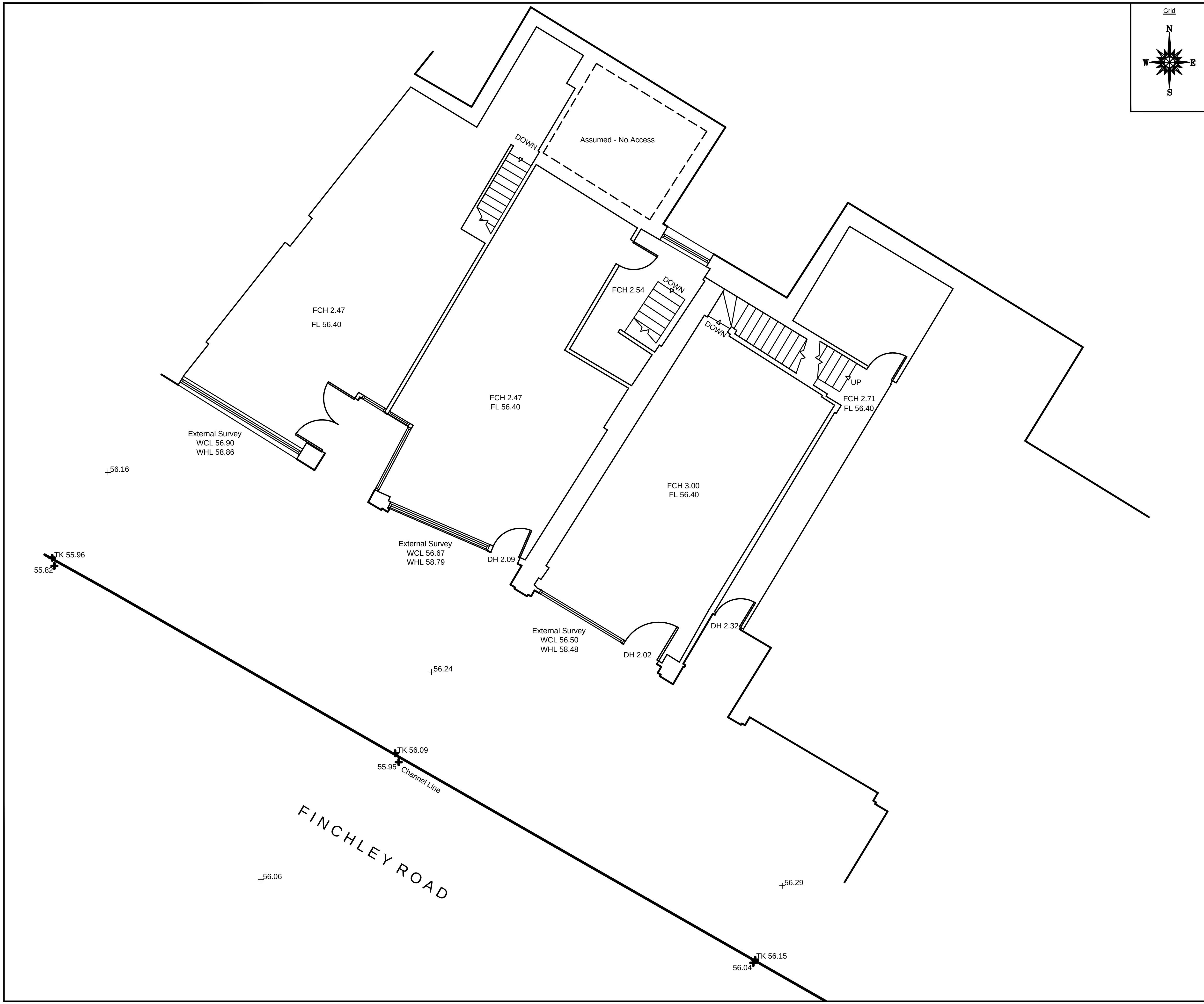
SURVEYED	MT	Koopmans
DRAWN	MT	
CHECKED	SJ	
RICS		SCALE: 1/100 (A3 Sheet)

9-12 New College Rd, Finchley Rd, NW3 5EP

BASEMENT FLOOR PLAN SURVEY

Job No	Rev	Drawing Number
12/268		12/268/200

Date : Nov 2012



LEGEND

BANKING	Top / Bottom	SLOPING MASONRY	
BUSHES & HEDGES		STILE	
MARSH		WALL (Width drawn to scale)	
TREES (3T / 0.2 / 6 — No of Trunks, Dia of Bole, Height of Tree)		BUILDING	
NOTE:- SPREADS AND HEIGHTS ARE INDICATIVE ONLY		OPEN SIDED BUILDING	
GATES	Single / Double	GLASS ROOFED	
RETAINING WALL	RTW	CONTOURS	25.50

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BUILDING		BUILDING	
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ROOF LEVEL	RL	POST AND RAIL FENCE	PRF
RADIATOR	Rad	POST AND WIRE	PWF
RAIN WATER PIPE	RWP	TUBULAR STEEL RAIL	TSRF

REV.	NOTES	DWN	DATE

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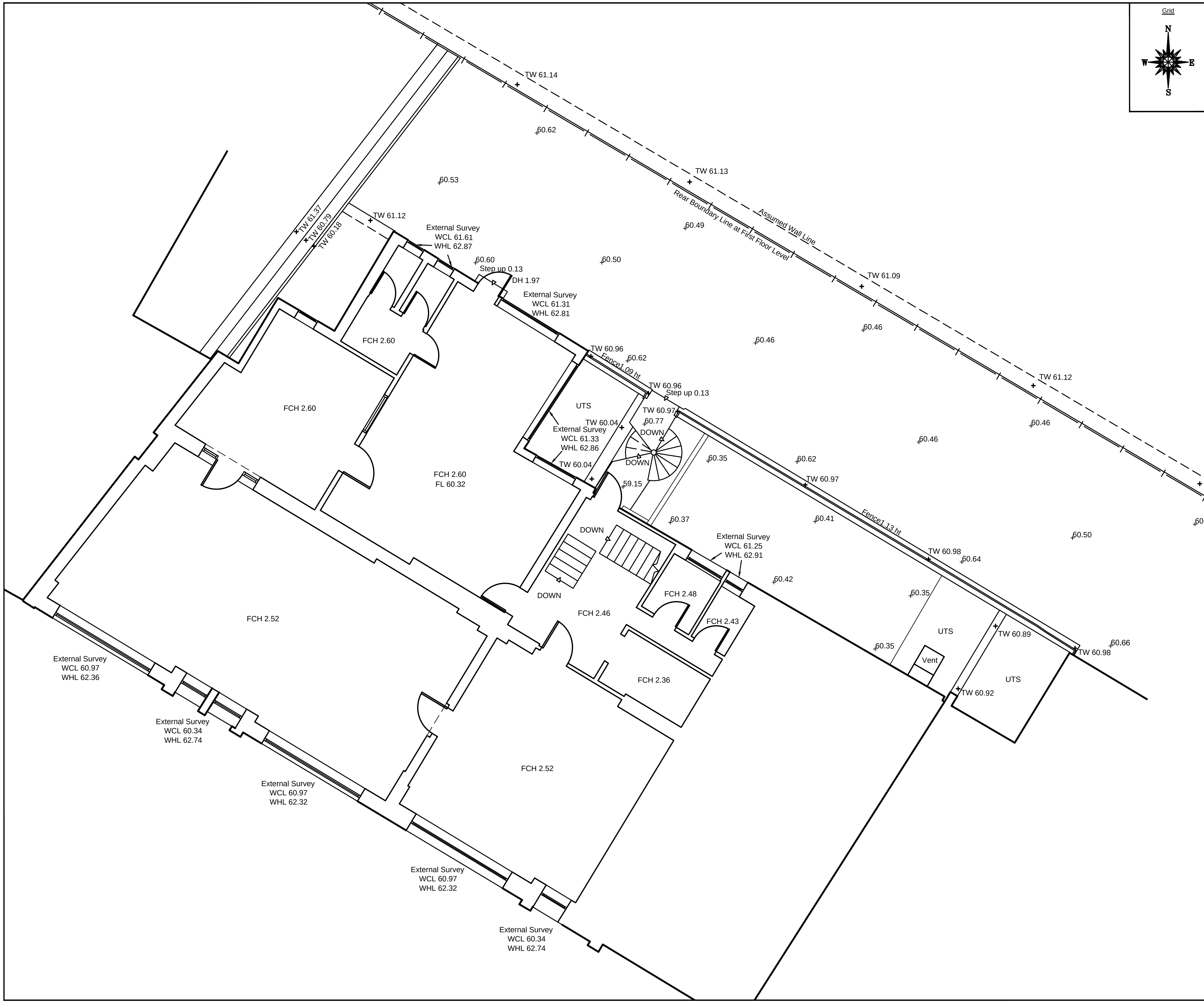
SURVEYED	MT	Koopmans
DRAWN	MT	
CHECKED	SJ	
RICS		SCALE: 1/100 (A3 Sheet)

9-12 New College Rd, Finchley Rd, NW3 5EP

GROUND FLOOR PLAN SURVEY

Job No	Rev	Drawing Number
12/268		12/268/201

Date : Nov 2012



LEGEND

BANKING — SLOPING MASONRY — BUSHES & HEDGES — STILE — MARSH — WALL — TREES — BUILDING — OPEN SIDED BUILDING — GATES — GLASS ROOFED — RETAINING WALL — CONTOURS

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DRAWN	MT	
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FIRST FLOOR PLAN SURVEY

Job No	Rev	Drawing Number
12/268		12/268/202

Date : Nov 2012

APPENDIX B

Geotechnical Maps

Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WGR	Worked Ground (Undivided)	Void	Holocene - Holocene
	MGR	Made Ground (Undivided)	Artificial Deposit	Holocene - Holocene

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	LC	London Clay Formation	Clay, Silt and Sand	Eocene - Eocene
	CLGB	Claygate Member	Clay, Silt and Sand	Eocene - Eocene
	BGS	Bagshot Formation	Sand	Eocene - Eocene

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Geology

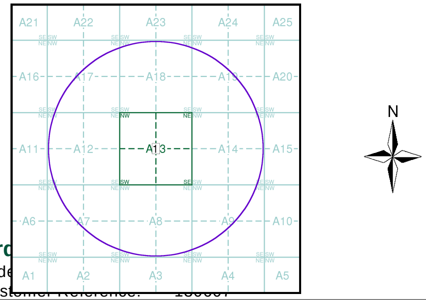
Geology 1:50,000 Maps

This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.
The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	1
Map Sheet No:	256
Map Name:	North London
Map Date:	2006
Bedrock Geology:	Available
Superficial Geology:	Available
Artificial Geology:	Available
Faults:	Not Available
Landslip:	Available
Rock Segments:	Not Available

Geology 1:50,000 Maps - Slice A



Ord

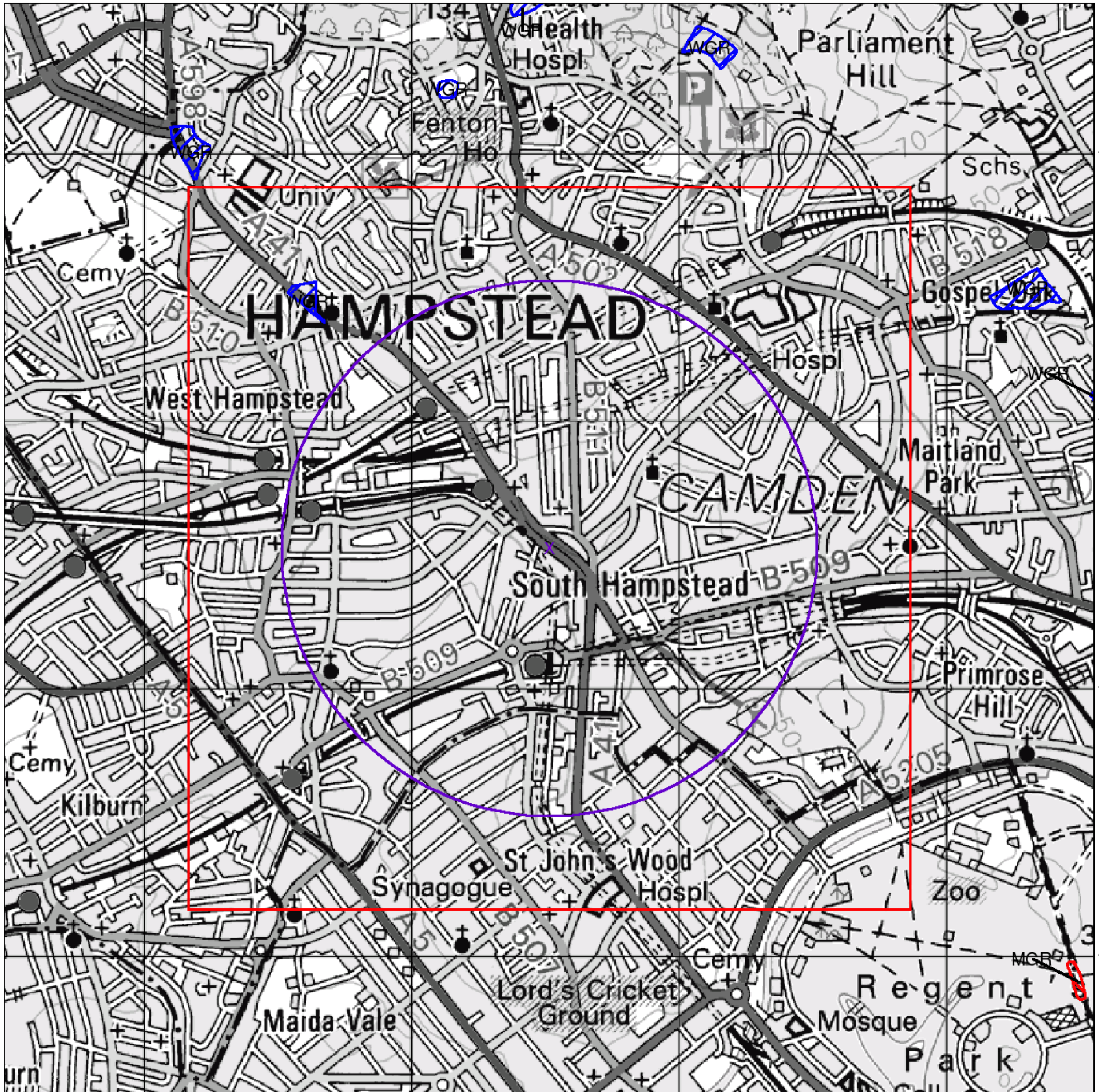
Orde
Cust

National Grid Reference:	526520, 184530
Slice:	A
Site Area (Ha):	0.01
Search Buffer (m):	1000

Site Details:

Site at 526600, 184500

Landmark®
Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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Geology

Artificial Ground and Landslip

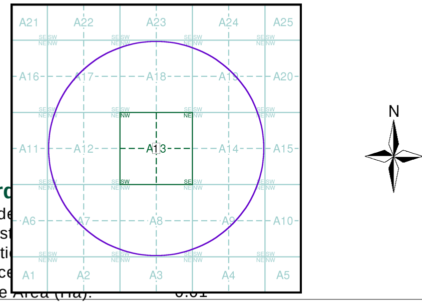
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A



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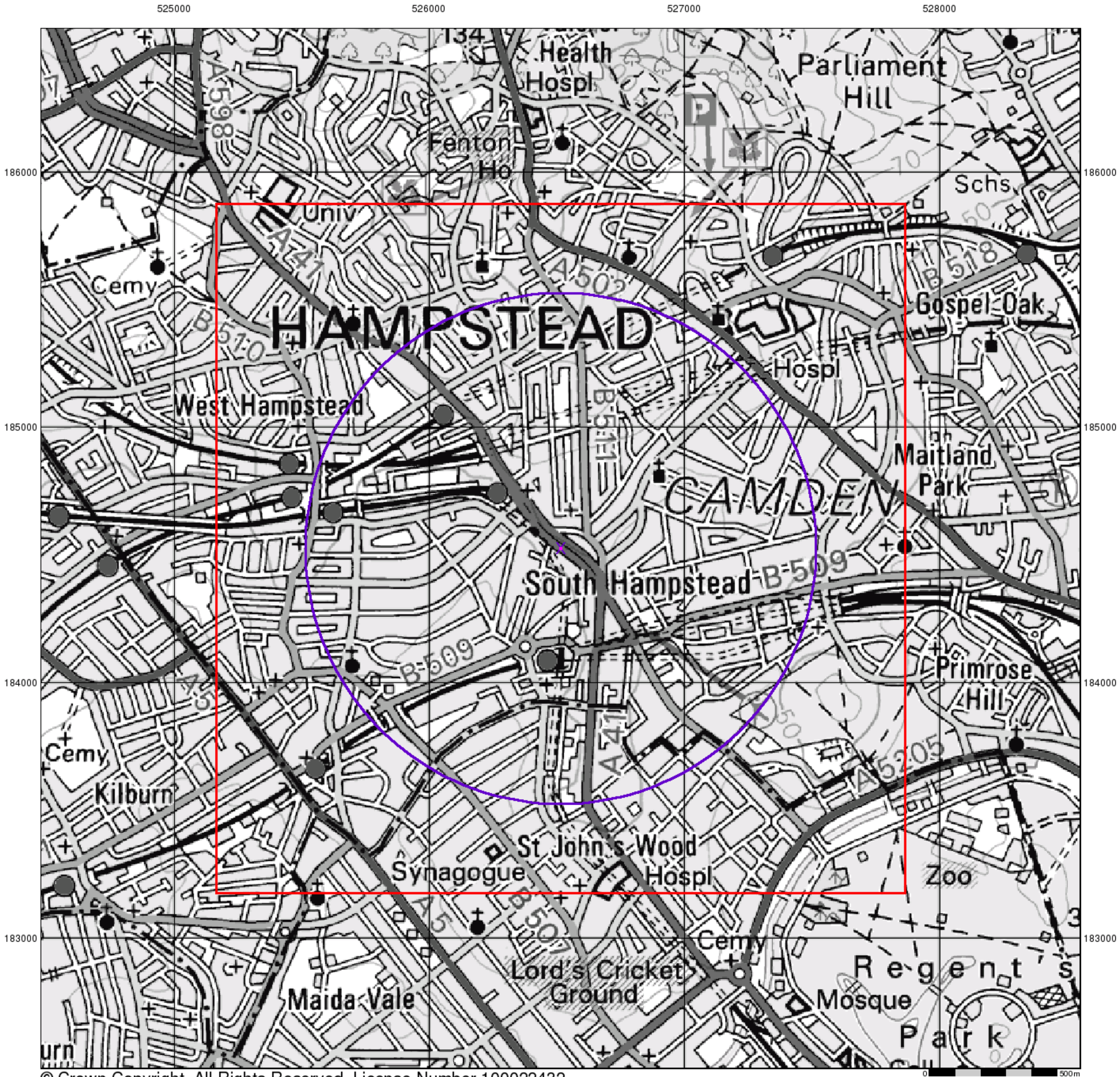
Slice
Site Area (Ha):
Search Buffer (m): 1000

Site Details:

Site at 526600, 184500



Envirocheck® Geology

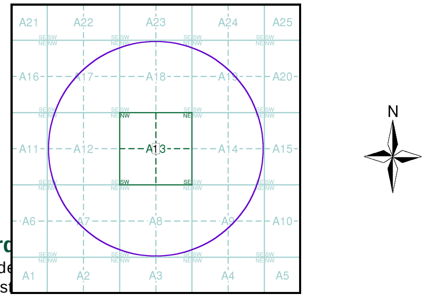
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



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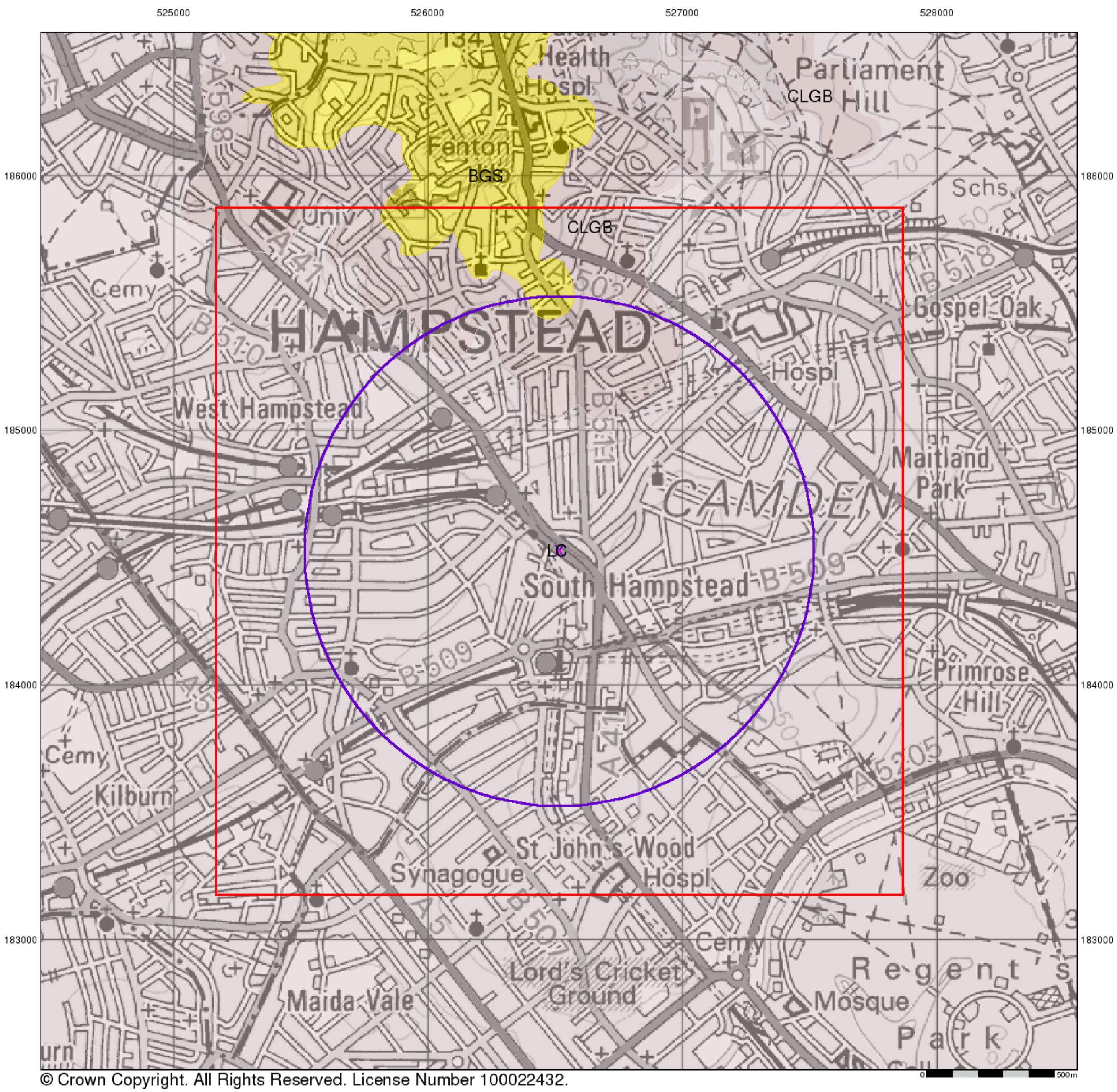
National Grid Reference: 526520, 184530
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details:

Site at 526600, 184500

Landmark® Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck® Geology

Bedrock and Faults

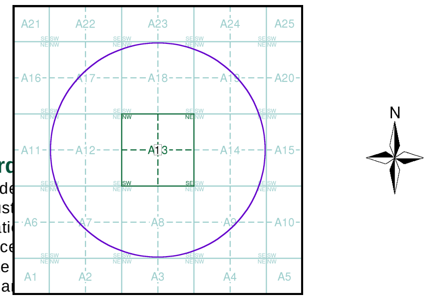
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



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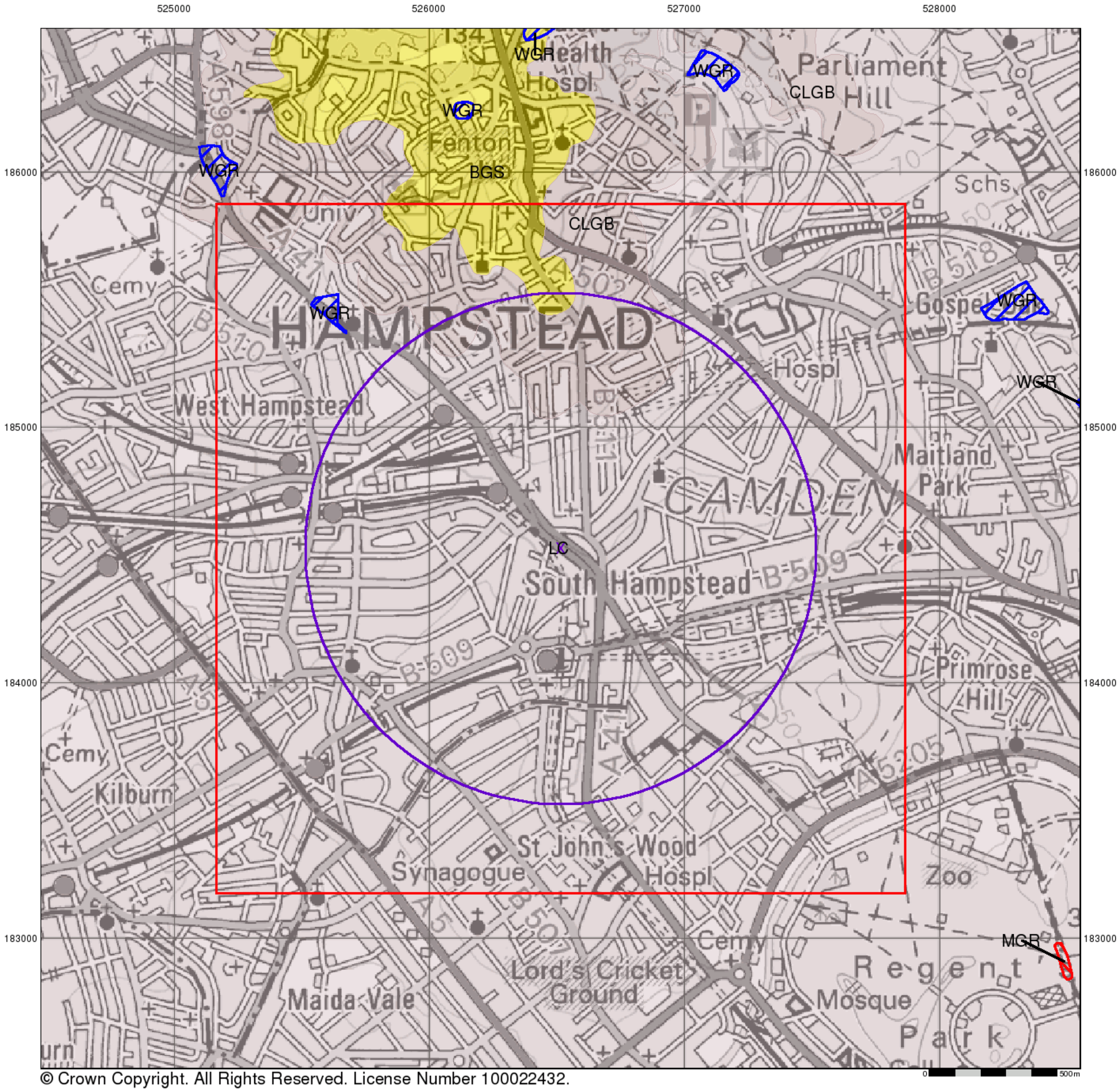
Site Details:

Site at 526600, 184500

Landmark® Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck® Geology

Combined Surface Geology

The Combined Surface Geology map combines all the previous maps into one combined geological overview of your site.

Please consult the legends to the previous maps to interpret the Combined "Surface Geology" map.

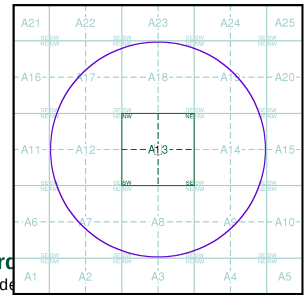
Additional Information

More information on 1:50,000 Geological mapping and explanations of rock classifications can be found on the BGS website. Using the LEX Codes in this report, further descriptions of rock types can be obtained by interrogating the 'BGS Lexicon of Named Rock Units'. This database can be accessed by following the 'Information and Data' link on the BGS website.

Contact

British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Telephone: 0115 936 3143
Fax: 0115 936 3276
email: enquiries@bgs.ac.uk
website: www.bgs.ac.uk

Combined Geology Map - Slice A



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Customer Reference: 130607
National Grid Reference: 526520, 184530
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details:

Site at 526600, 184500

APPENDIX C

Thames Water Asset Location Plan

Asset Location Search

Thames Water Property Searches
12Vastern Road
READING
RG1 8DB

Search address supplied	9 to 12 New College Parade 9 Finchley Road Hampstead London
Your reference	130607
Our reference	ALS/ALS Standard/2014_2678637
Search date	3 February 2014

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

Asset Location Search

Search address supplied: 9 to 12 New College Parade, 9, Finchley Road, Hampstead, London,

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

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

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

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0845 920 0800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Should you require any further information regarding budget estimates, diversions or stopping up notices then please contact:

DevCon Team
Asset Investment
Thames Water
Maple Lodge STW
Denham Way
Rickmansworth
Hertfordshire
WD3 9SQ

Tel: 01923 898 072
Email: devcon.team@thameswater.co.uk

Asset Location Search

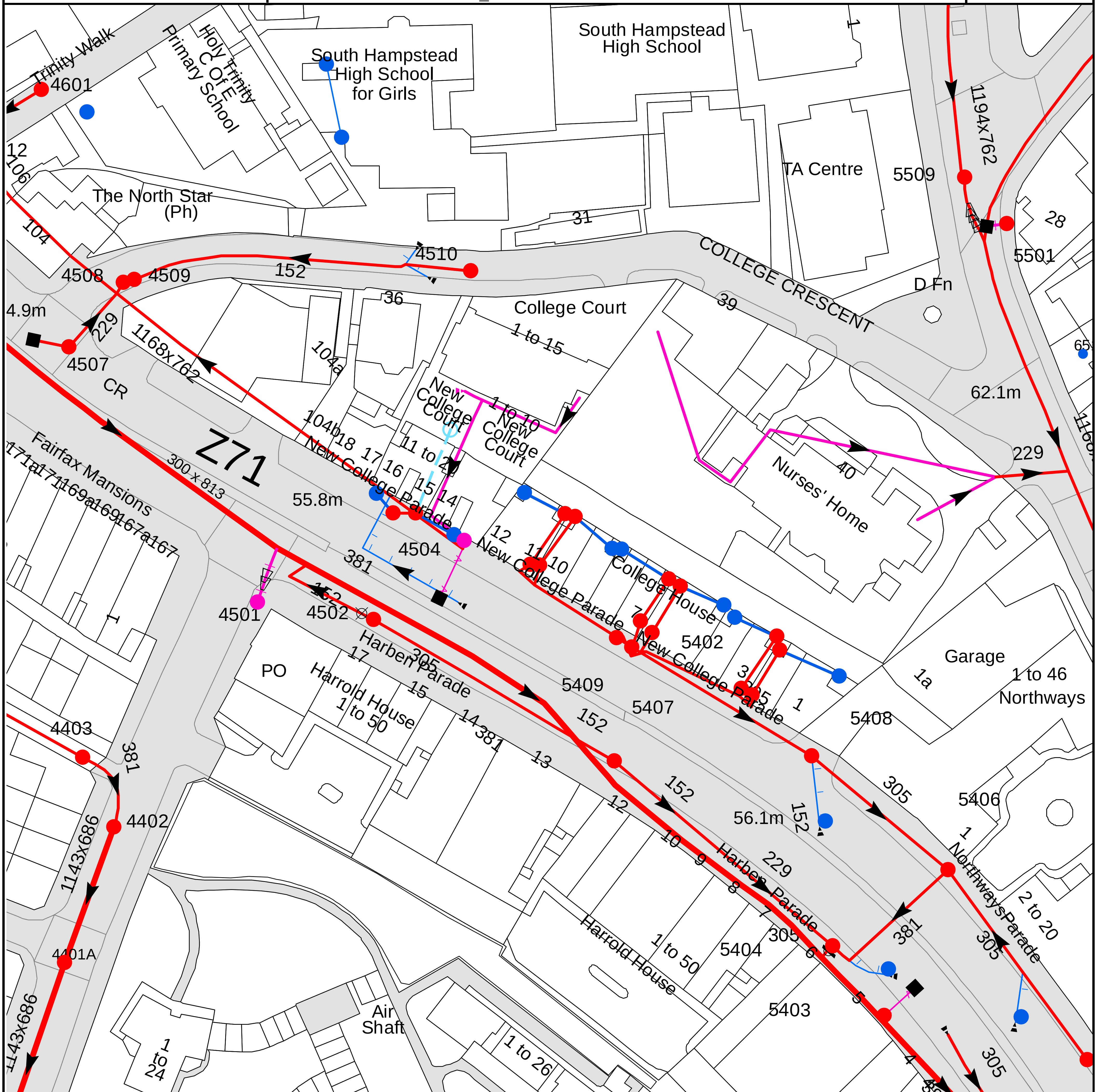
Clean Water queries

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

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

Tel: 01923 898 072
Email: devcon.team@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2014_2678637



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526514,184516

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
46AI	n/a	n/a
45EF	n/a	n/a
4601	58.43	57.79
4507	54.72	53.27
4403	n/a	n/a
4402	50.41	45.72
4508	56.38	53.21
4509	56.52	55.45
4501	54.71	n/a
45DG	n/a	n/a
4502	55.61	49.91
45DC	n/a	n/a
45DA	n/a	n/a
45CJ	n/a	n/a
45CI	n/a	n/a
45DB	n/a	n/a
4504	56.29	51.57
4510	61.48	n/a
55BF	n/a	n/a
55BH	n/a	n/a
55CB	n/a	n/a
55BG	n/a	n/a
55CA	n/a	n/a
55BJ	n/a	n/a
5407	56.07	49.98
5402	n/a	52.79
55CD	n/a	n/a
5409	56.19	51.97
55CF	n/a	n/a
55CH	n/a	n/a
55CE	n/a	n/a
55CG	n/a	n/a
55CI	n/a	n/a
55CJ	n/a	n/a
54DB	n/a	n/a
54DF	n/a	n/a
54DA	n/a	n/a
54DE	n/a	n/a
5408	56.66	51.46
54CC	n/a	n/a
54DD	n/a	n/a
5406	56.76	n/a
5509	63.22	58.03
5501	n/a	n/a
651B	n/a	n/a
4401	n/a	n/a
5404	56.38	48.51
5403	56.39	46.12
54CE	n/a	n/a
54CF	n/a	n/a
6403	56.96	54.83

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

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

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

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

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

Control Valve

Drop Pipe

Ancillary

Weir

End Items

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

Outfall

Undefined End

Inlet

Other Symbols

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

Public/Private Pumping Station

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

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

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

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

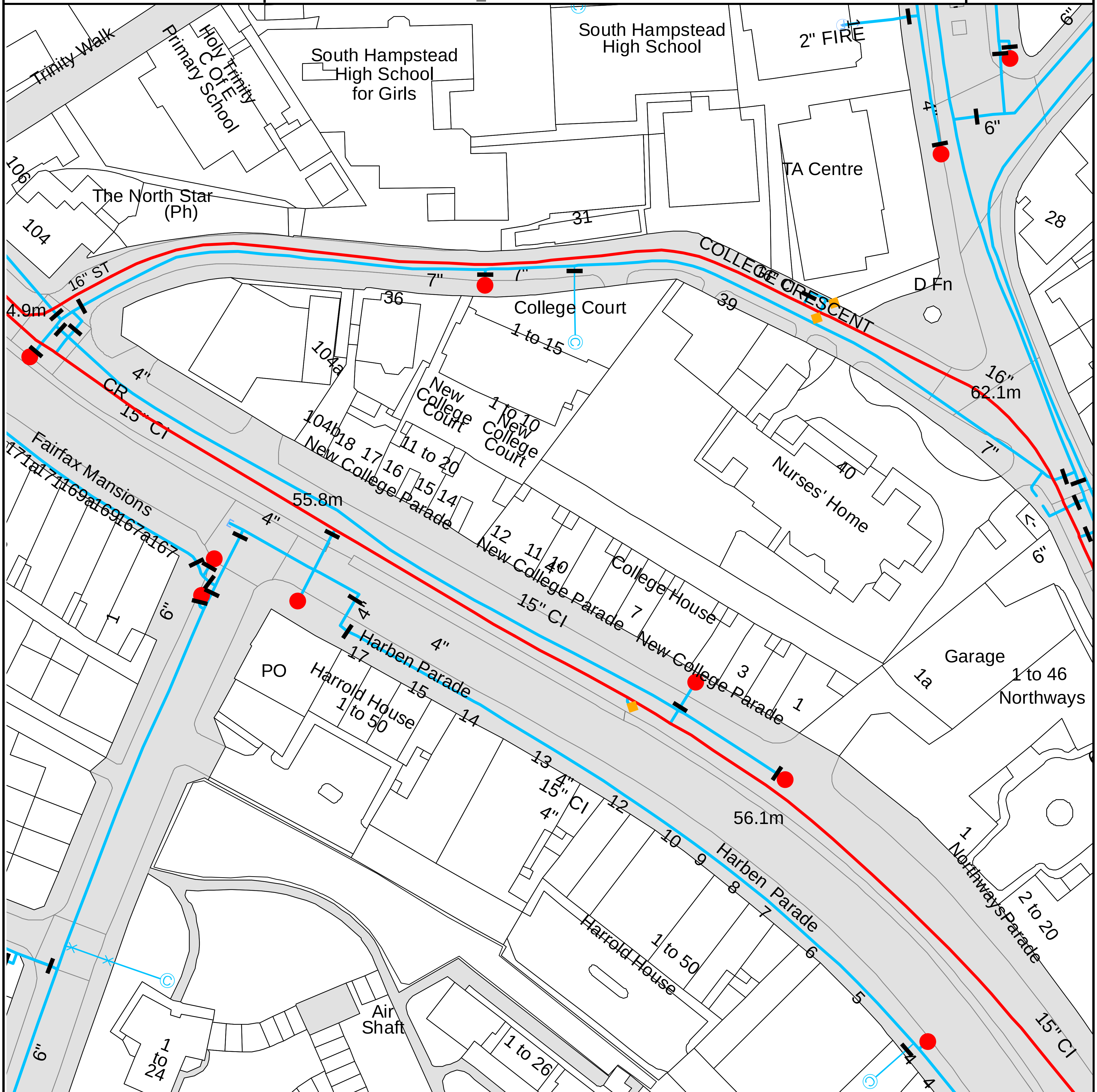
Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2014_2678637



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526514, 184516.

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

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

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

16"

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

3" SUPPLY

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

3" FIRE

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

3" METERED

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

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

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

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

Valves

General Purpose Valve

Air Valve

Pressure Control Valve

Customer Valve

Hydrants

Single Hydrant

Meters

Meter

End Items

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

Blank Flange

Capped End

Emptying Pit

Undefined End

Manifold

Customer Supply

Fire Supply

Operational Sites

Booster Station

Other

Other (Proposed)

Pumping Station

Service Reservoir

Shaft Inspection

Treatment Works

Unknown

Water Tower

Other Symbols

Data Logger

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

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

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

Terms and Conditions

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

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

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

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0845 9200 800.

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

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

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0845 070 9148** quoting your invoice number starting CBA or ADS.	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

Sewer Flooding
History Enquiry

Thames Water Property Searches

Vastern Road

Search address supplied	9 to 12 New College Parade 9 Finchley Road Hampstead London

Your reference	130607
Our reference	SFH/SFH Standard/2014_2678636
Received date	**3 February 2014**
Search date	**4 February 2014**

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Sewer Flooding
History Enquiry

Search address supplied: 9 to 12 New College Parade,9,Finchley Road,Hampstead,London

This search is recommended to check for any sewer flooding in a specific address or area

TWUL, trading as Property Searches, are responsible in respect of the following:-

(i) any negligent or incorrect entry in the records searched;

(ii) any negligent or incorrect interpretation of the records searched;

(iii) and any negligent or incorrect recording of that interpretation in the search report

(iv) compensation payments

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Sewer Flooding
History Enquiry

History of Sewer Flooding

Is the requested address or area at risk of flooding due to overloaded public sewers?

The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

For your guidance:

- A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
- "Internal flooding" from public sewers is defined as flooding, which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
- "At Risk" properties are those that the water company is required to include in the Regulatory Register that is presented annually to the Director General of Water Services. These are defined as properties that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company's reporting procedure.
- Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the At Risk Register.
- Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Company.
- Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
- It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Company. This report excludes flooding from private sewers and drains and the Company makes no comment upon this matter.
- For further information please contact Thames Water on Tel: 0845 9200 800 or website www.thameswater.co.uk

Thames Water Utilities Ltd

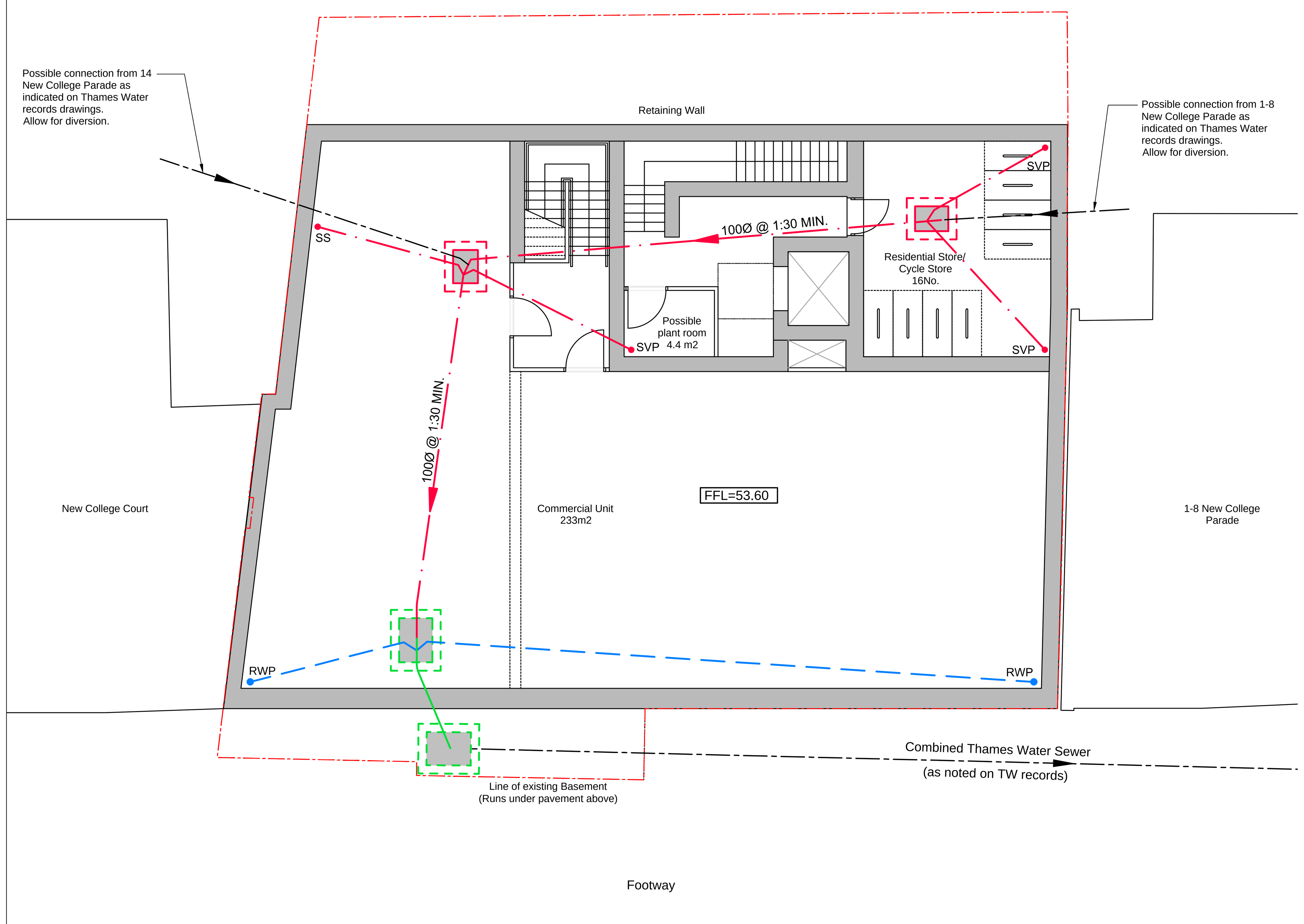
Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

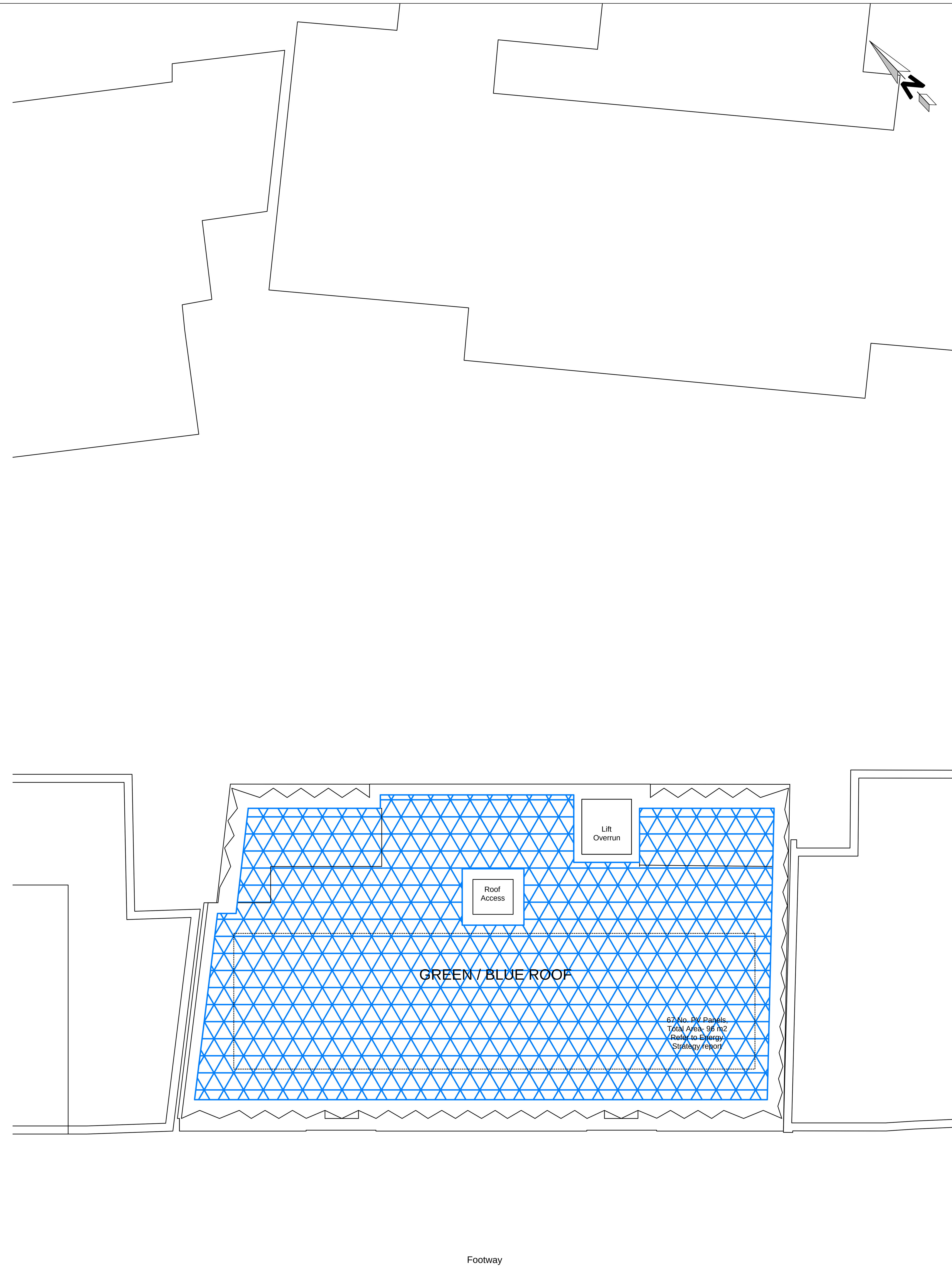
T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

APPENDIX E

Preliminary Drainage Layout & Site Proposals



BASEMENT PLAN



ROOF PLAN

THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE SPECIFICATION AND ALL OTHER RELEVANT DRAWINGS. DO NOT SCALE FROM THIS DRAWING.

NOTES

1. This drawing to be read in conjunction with all other relevant Conisbee civil engineering drawings.
2. Extent of the existing drainage within the site is not know.

LEGEND:

- Denotes Site Boundary
- FFL=53.60 — Denotes internal finished floor levels to Architects specification.
- Existing combined water sewer
- 100Ø 1:32 — Private surface water pipe, gradient and diameter indicated.
- 100Ø 1:32 — Private foul water pipe, gradient and diameter indicated.
- 100Ø 1:32 — Private combined water pipe, gradient and diameter indicated.
- Proposed RC Manhole
- RWP SVP — New private rainwater pipe/soil vent pipe/waste pipe (position to be confirmed by Architect).

FOR PLANNING ONLY

Design Notes :	
Existing Site Area:	440 m²
Total Impermeable Area:	440 m²
Proposed Site Area:	440 m²
Total Proposed Impermeable Area:	440 m²
Existing discharge rate:	6.6 l/s
Proposed Foul Water Peak Rate:	tbc
Proposed restricted Surface Water Discharge Rate:	5.0 l/s
Total Attenuation for 100YS + 30%CC:	14 m³

Attenuation Schedule

- Blue Roof (220m² x 0.075m deep attenuation crates): Vol = 15.7 m³

Rev	Date	Description	Drawn	Check
P2	06.02.14	Existing drainage added.	DN	TG
P1	04.02.14	Issued for Comment.	DN	TG

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Drawing Status: PRELIMINARY

Date: FEB 2014
Scale: 1:100 @ A1
Drawn: DN
Engineer: DN

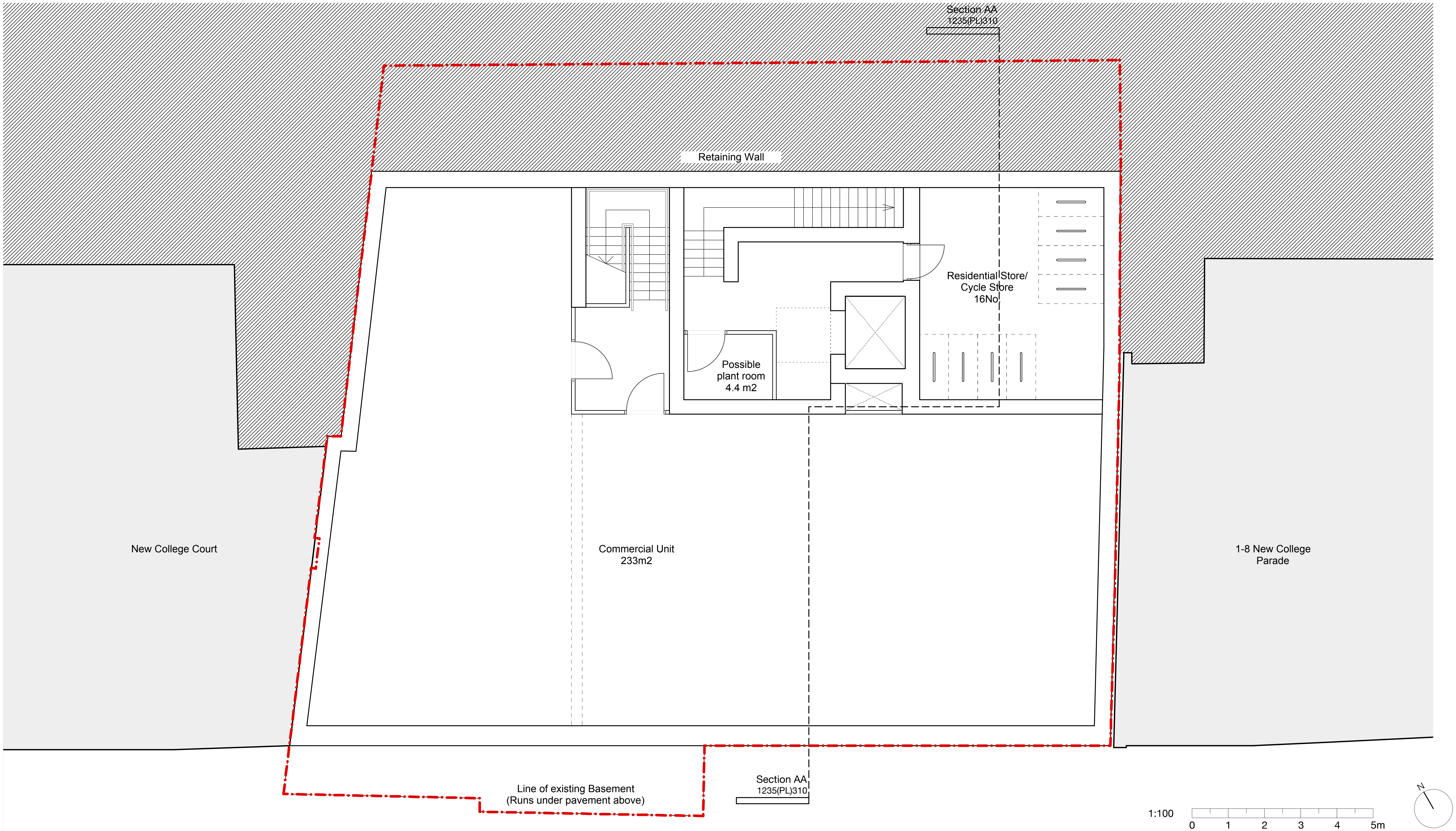
Project: 9-12 New College Parade Camden, London

Project No: 130607

Title: PRELIMINARY DRAINAGE LAYOUT

Drawing No: C100

Revision: P2



General Notes

These proposals are subject to the approval of all Statutory Building Control Requirements and the requirements of all Statutory Authorities and Service Providers.

The site boundaries and surroundings are based on a survey carried out by Maltby land surveys Ltd. The site boundaries are those described by the client.

These drawings are to be read in conjunction with all other relevant documentation produced by Stephen Davy Peter Smith Architects and other consultants employed by the client.

Do not scale the drawing.

Rev	Comment	By	Date
B	Section line added	LN	10.01.14
A	For comment - Basment layout revised	CM	15.11.13
-	Preliminary Issue - For comment	CM	08.11.13

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Client
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C/O Koopmans

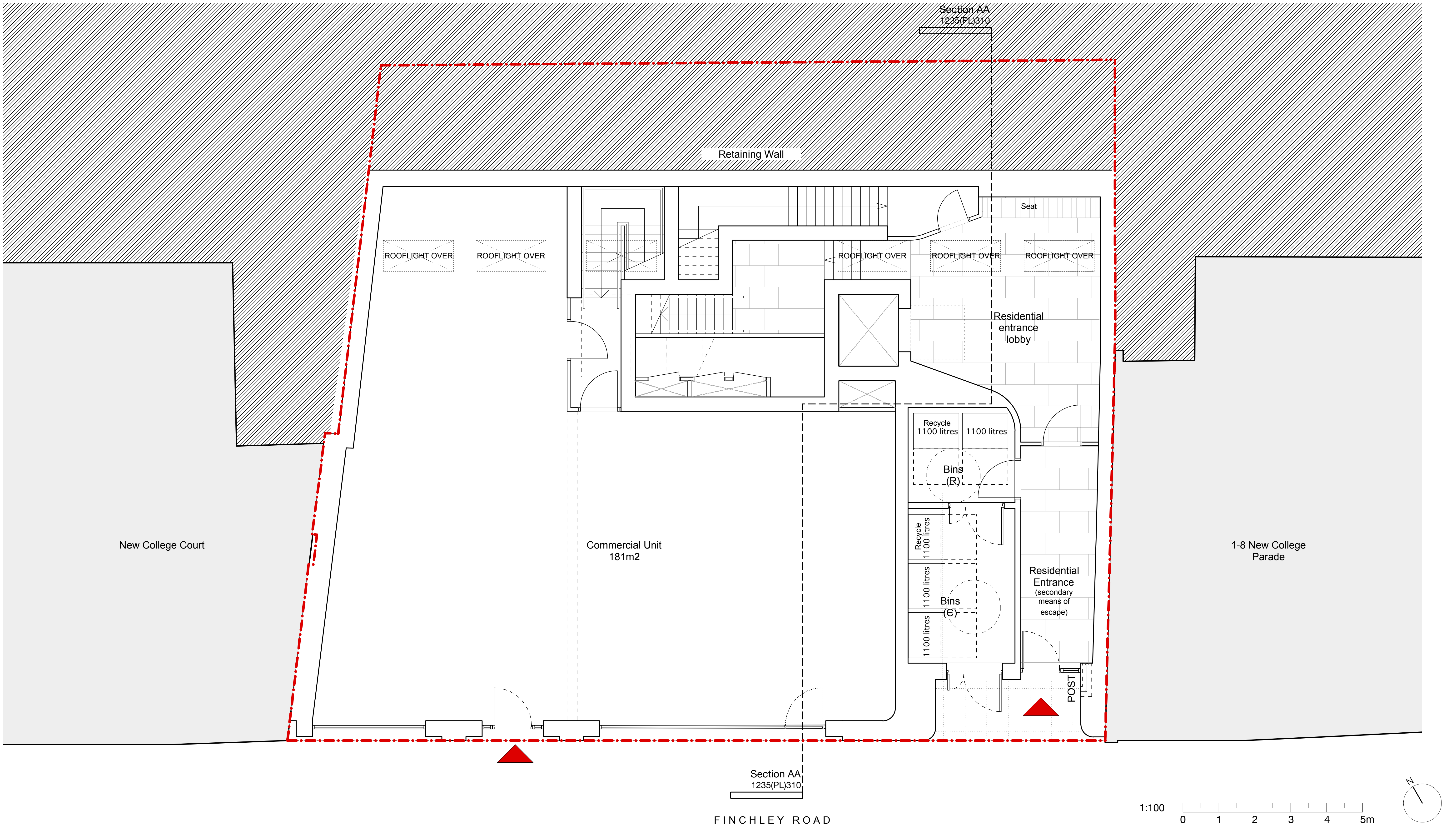
Project
9-12 New College Parade
Finchley Road
London, NW3

Drawing Title
Basement Plan

Job No.	Drawn By	Scale
1235	CM	1:100 @ A3
Date: Nov 2013	Checked By: GD	

Drawing No. 1235(PL)110

Revision B



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Do not scale the drawing.

Rev	Comment	By	Date
B	Section line added	LN	10.01.14
A	For comment - Basment stair layout revised	CM	15.11.13
-	Preilminary Issue - For comment	CM	08.11.13

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Project
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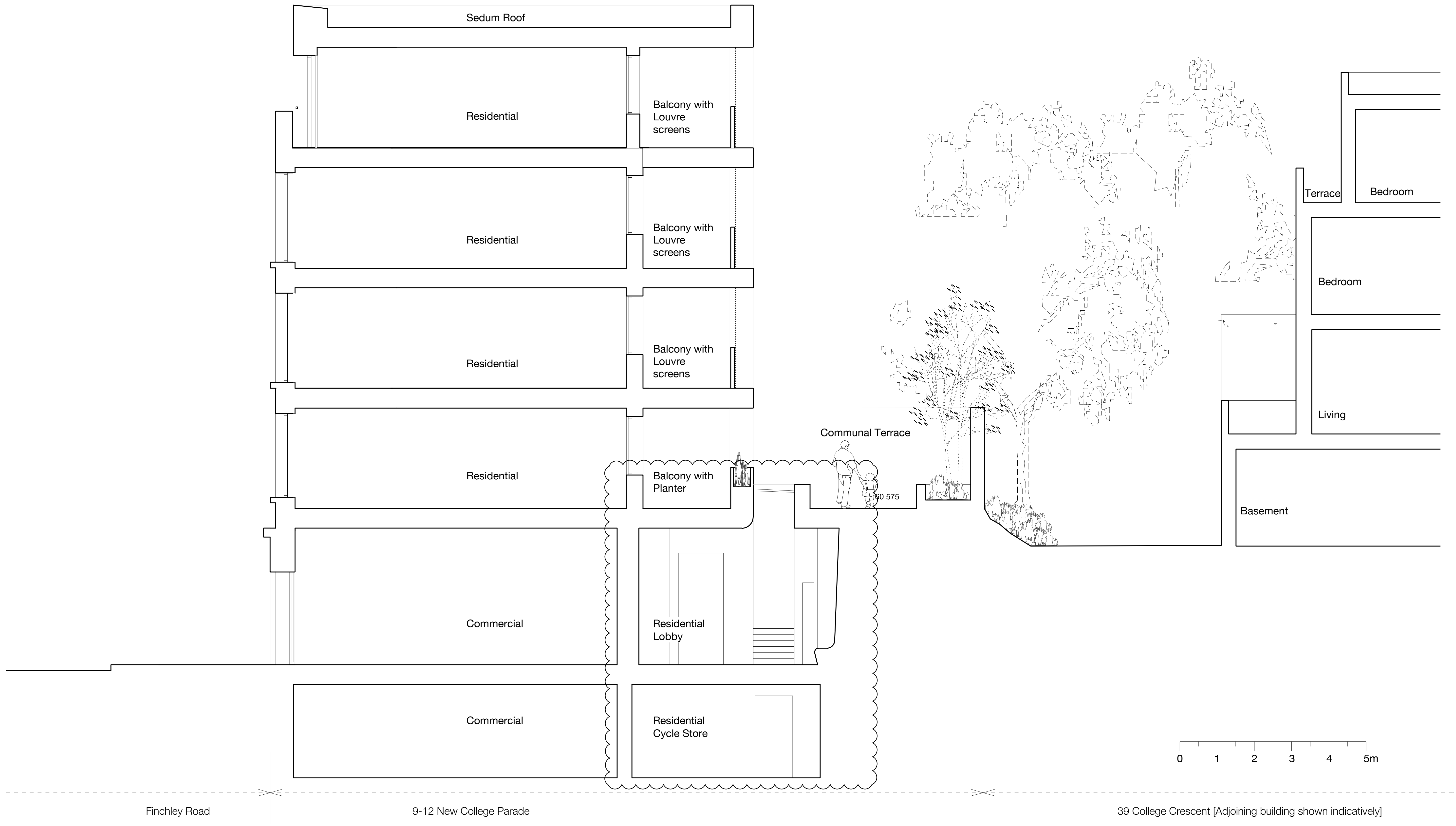
Drawing Title
Ground Floor Plan

Job No.	Drawn By	Scale
1235	CM	1:100 @ A3
Date	Checked By	
Nov 2013	GD	

Drawing No. 1235(PL)111 | Revision B



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Do not scale the drawing.

Rev	Comment	By	Date
A	Lobby and cycle store updated to suit plans	LN	08.01.14
-	Preliminary Issue - For comment	CM	08.11.13

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Drawing Title
Section AA

Project
9-12 New College Parade
Finchley Road
London, NW3

Job No.	Drawn By	Scale
1235	CM	1:100 @ A3
Date	Checked By	
Nov 2013	GD	

Drawing No. 1235(PL)310 Revision A

APPENDIX F

The SUDS Management Train

The SUDS Management Train

Prevention

The use of good site design and site housekeeping measures to prevent runoff and pollution (eg sweeping to remove surface dust and detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.

Source Control

Control of runoff at or very near its source (eg soakaways, other infiltration methods, green roofs, pervious pavements).

Site Control

Management of water in a local area or site (eg routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).

Regional Control

Management of runoff from a site or several sites, typically in a balancing pond or wetland.

Runoff Quality Control Processes

There is a range of natural water quality treatment processes that can be exploited within the design of a sustainable drainage system.

Sedimentation

Sedimentation is one of the primary removal mechanisms in SUDS. Most pollution in runoff is attached to sediment particles and therefore removal of sediment results in a significant reduction in pollutant loads. Sedimentation is achieved by reducing flow velocities to a level at which the sediment particles fall out of suspension. Care has to be taken in design to minimise the risk of re-suspension when extreme rainfall events occur.

Filtration and Biofiltration

Pollutants that are conveyed in association with sediment may be filtered from percolating waters. This may occur through trapping within the soil or aggregate matrix, on plants or on geotextile layers within the construction. The location of any filtration will depend upon the internal structure of the particular SUDS technique, for example whether a geotextile layer is near the surface or at the subgrade in a previous surface.

Adsorption

Adsorption occurs when pollutants attach or bind to the surface of soil or aggregate particles. The actual process is complex but tends to be a combination of surface reactions grouped as sorption processes:

Adsorption	Pollutants bind to surface of soil/aggregate
Cation exchange	Attraction between cations and clay minerals
Chemisorption	Solute is incorporated in the structure of a soil/aggregate
Absorption	The solute diffuses into the soil/aggregate/organic maters

Change in acidity of runoff can either increase or decrease the adsorption of pollutants by construction materials or soils. Eventually the materials onto which pollutants adsorb will become saturated and thus this method of treatment will stop.

Biodegration

In addition to the physical and chemical processes, which may occur on and within a SUDS technique, biological treatment may also occur. Microbial communities may be established within the ground, using the oxygen within the free-draining materials and the nutrients supplied with the inflows, to degrade organic pollutants such as oils and grease. The level of activity of such bioremediation will be affected by the environmental conditions such as temperature and the supply of oxygen and nutrients. It also depends on the physical conditions within the ground such as the suitability of the materials for colonisation.

Volatilisation

Volatilisation comprises the transfer of a compound from solution in water to the soil atmosphere and then to the general atmosphere. The conversion to a gas or vapour occurs due to heat, reducing pressure, chemical reaction or a combination of these processes. The rate of volatilisation of a compound is controlled by a number of its properties and those of the surrounding soil. In SUDS schemes volatilisation is primarily concerned with organic compounds in petroleum products and pesticides.

Precipitation

This process is the most common mechanism for removing soluble metals. Precipitation involves chemical reactions between pollutants and the soil or aggregate that transform dissolved constituents to form a suspension of particles of insoluble precipitates. Metals are precipitated as hydroxides, sulphides, and carbonates depending on which precipitants are present and the pH level. Precipitation can remove most metals (arsenic, cadmium, chromium III, copper, iron, lead, mercury, nickel, zinc) and many anionic species (phosphates, sulphates, fluorides).

Uptake By Plants

In ponds and wetlands, uptake by plants is an important removal mechanism for nutrients (phosphorous and nitrogen). Metals can also be removed in this manner (although intermittent maintenance is required to remove the plants otherwise the metals will be returned to the water when the plants die). Plants also create suitable conditions for deposition of metals, for example as sulphides the root zone.

Nitrification

Ammonia and ammonium ions can be oxidised by bacteria in the ground to form nitrate, which is a highly soluble form of nitrogen. Nitrate is readily used as a nutrient by plants

Photolysis

The breakdown of organic pollutants by exposure to ultra-violet light.

The removal mechanism appropriate for each pollutant category is presented in the Table below.

Table 3 - removal mechanism appropriate for each pollutant

Pollutant	**Removal mechanisms in SUDS**
Nutrients Phosphorous, nitrogen	Sedimentation, biodegradation, precipitation, de-nitrification
Sediments Total suspended solids	Sedimentation, filtration
Hydrocarbons TPH, PAH, VOC, MTBE	Biodegradation, photolysis, filtration and adsorption
Metals Lead, copper, cadmium, mercury, zinc, chromium, aluminium	Sedimentation, adsorption, filtration, precipitation, plant uptake
Pesticides	Biodegradation, adsorption, volatilisation
Chlorides	Prevention
Cyanides	Volatilisation, photolysis
Litter	Trapping, removal during routine maintenance
Organic matter, BOD	Filtration, sedimentation, biodegradation