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ENVIRONMENTAL CONSULTING , SOFTWARE & TRAINING

Flood Risk Assessment and Surface Water Drainage Strategy

Site Address
Land Between
60-66 Alwyne Road
Wimbledon
SW19 7AF

Client
GBSArchitectural

Report Reference
FRASW - 2022 - 00001

Prepared By
STM Environmental Consultants Ltd

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1 Document Control

Sustainable Drainage System Strategy

Site Address:	Land Between 60-66 Alwyne Road Wimbledon SW19 7AF
National Grid Reference:	524644, 170853
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3 Abbreviations

Abbreviation	Description
STM	STM Environmental Consultants Limited
BGS	British Geological Survey
EA	Environment Agency
OS	Ordnance Survey of Great Britain
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
FWD	Floodline Warning Direct
FRMS	Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
SWMP	Surface Water Management Plan
SFRA	Strategic Flood Risk Assessment
CDA	Critical Drainage Area
SuDS	Sustainable Drainage Systems
GWSPZ	Groundwater Source Protection Zone
TPH	Total Petroleum Hydrocarbons
BTEX	Benzene, Toluene, Ethylene, Xylene
PAH	Poly-Aromatic Hydrocarbons

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5 Executive Summary

BACKGROUND			
Location	Land Between 60-66 Alwyne Road, Wimbledon, SW19 7AF Grid reference: 524644, 170853		
Site Area	121m^2		
Proposed Development	The construction of a new 2-storey apartment building with a basement and bedrooms are proposed at basement level.		
Current Site and Surrounding Uses	The site is currently a disused infill plot which is believed to have previously formed part of one of the adjoining residential gardens. The main surrounding uses are residential with associated green space and scattered commercial uses. Wimbledon railway station is located approximately 235m southeast of the site.		
Flood Zone	The site is located in Flood Zone 1.		
Sequential and Exception Test	The Sequential and Exception Tests should not be required as the development is located in Flood Zone 1.		
Topography	The elevations range from 25.84mAOD (SW) to 27.06mAOD (NE).		
Hydrology	No watercourses within 250m of the site.		
Flood Defences	No EA Flood Defences identified in the vicinity of the site.		
Historic Flooding	8no. historic pluvial, 1no. historic sewer and 1no historic groundwater flooding incident in a 500m radius of the site. These all occurred between 1981 and 2011 - the site was not impacted.		
Fluvial (River) and Tidal (Sea) Flood Risk	Low – The site lies within EA Flood Zone 1.		
Pluvial (Surface Water) Flood Risk	Low – the site remains dry during the 1 in 100-year pluvial event. The southwest area of the site (including the proposed development area), would witness flood depths of up to 300mm in in the 1 in 1000-year pluvial event.		
Flood Risk from Artificial (Canals and Reservoirs) Sources	Low – No significant artificial sources identified.		
Groundwater Flood Risk	Medium - The EA indicates that the east of the site has potential for groundwater flooding to occur at the surface. According to the BGS, groundwater is likely to be less than 3mbgl for at least part of the year.		
Geology	BGS information indicates that the superficial deposits consist of Head (Clay, Silt, Sand and Gravel), while the bedrock is classified as belonging to the London Clay Formation (Clay and Silt).		
Hydrogeology	BGS information indicates that the site is situated upon a Secondary (undifferentiated) superficial aquifer and an Unproductive bedrock aquifer.		
Permeability	BGS information indicates that the superficial deposits are highly variable, and the bedrock is classified as poorly draining.		
Infiltration Potential	BGS information indicates that the site has very significant constraints indicated for the use of infiltration SuDS.		
	Ground Cover	**Existing (m^2)**	**Proposed (m^2)**

Existing and Proposed Site Layout			**(Without SuDS)**
	Buildings	18	110
	Driveways/Patio	17	10
	Gardens/ Soft landscaping	85	0
	Total Impermeable Area	**35**	**120**
Changes in Impermeable	Without SuDS, the proposed development would increase the impermeable area of the site by 85m^2 (71%) without the introduction of SuDS.		

PROPOSED SUDS				
Run-Off Rates	**IH24** Greenfield (GF) (l/s)	**MRM** Pre - Development (l/s)	**MRM** - Post Development Without SuDS (l/s)	**Modelled** - Post Development (l/s)
Qbar	0.02		0.06	
1 in 1	0.02	0.4	1.8	0.1
1 in 30	0.04	1.1	4.2	0.2
1 in 100	0.06	1.3	5.3	0.3
1 in 100 + CC (40%)	0.09	1.8	7.4	0.5
SuDS Target Requirement	As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply. The proposal should aim to achieve the greenfield Qbar runoff rate of 0.09 l/s for all storm events and never exceed the pre-development scenario of 1.8 l/s for all storm events.			
Storage Required to meet Planning Requirement	The total storage volume required to match pre-development rates was calculated to be 4.8 m^3.			
Site Investigation	The ground investigation works were carried out on the 15th of December 2022. 2no. boreholes (BH01 – BH02) were drilled to depths of 10mbg and 4mbgl respectively. Made Ground consisting of gravelly SILT with an abundance of brick fragments was encountered to a maximum depth of 1.2mbgl. The Made Ground was underlain by brown and grey CLAY (London Clay) to 10mbgl. Groundwater was not encountered in any of the boreholes. Due to the limited space available on the site, there is no feasible location that allows for a soakaway to be installed at least 5m from any existing or proposed foundation or 1 m from the boundary as recommended by BRE Digest 365. Infiltration testing was not undertaken.			
SuDS Strategy	The proposal will introduce a green roof and green wall to intercept and attenuate surface waters on site. A small section of permeable paving will be introduced (below the roof line) on the ground floor which will form ground floor amenity space. The excess surface water from the rooftop will discharge into the nearby sewer via the permeable paving sub-base, which will be lined.			

	The basement amenity space will be fitted with emergency pump and sump systems which will discharge any excess flows reaching the basement level to street level. The excess surface water runoff will be directed to the nearest Thames Water surface sewer located 5m south of the site. An investigation by Thames Water is required to determine the details of their assets. A new connection agreement is also likely to be required. The proposal will provide 4.7m^3 of attenuation storage and the proposed SuDS management train will reduce the discharge rates to the sewer.
Proposed Flood Risk Mitigation Measures	• The construction will utilise flood resistant materials and services will be placed as high as practicable to reduce impact of flooding; • The basement will be water proofed (i.e. tanked); • Pump and sumps will be installed at basement level to convey any excess flows to ground level; • The proposed building and retaining walls will form physical barriers to prevent the movement of surface water to basement level;
Conclusion	With the proposed SuDS mitigation measures in place, we believe that the proposed development will reduce local flood risk and therefore be in compliance with the LLFA's current planning policy and the NPPF.

6 Introduction

STM Environmental Consultants Limited have been appointed by GBS Architectural to undertake a Flood Risk Assessment (FRA) and Sustainable Drainage System (SuDS) Strategy for a proposed development at Land Between 60-66 Alwyne Road, Wimbledon, SW19 7AF.

6.1 Proposed Development

The report is required to support a planning application for the new 3-storey apartment building with a basement.

Copies of the development plans are presented in Appendix A1.

6.2 Report Aims and Objectives

This report sets out the proposed drainage strategy that will be employed in the designs to meet the requirements of the planning condition and the National Planning Policy Framework.

6.3 Legislative and Policy Context

6.3.1 National Planning Policy Framework (NPPF)

The NPPF (updated July 2021) sets out the government's planning policies for England and how these are expected to be applied. It also provides a set of guidelines and philosophy with which local planning authorities (LPAs) can build their own unique policies to appropriately regulate development within their jurisdictions.

Section 14 entitled "Meeting the challenge of climate change, flooding and coastal change" deals specifically with flood risk.

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

In addition, Paragraph 161 outlines that "All plans should apply a sequential, risk-based approach to the location of development – taking into account all sources of flood risk and the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by:

- applying the sequential test and then, if necessary, the exception test as set out below;
- safeguarding land from development that is required, or likely to be required, for current or future flood management;
- using opportunities provided by new development and improvements in green and other infrastructure to reduce the causes and impacts of flooding, (making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management);
- where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations".

The NPPF then states in Paragraph 163 that "if it is not possible for development to be located in areas with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification".

It further states that when determining any planning application, LPAs should "ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment[55]. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

- development is appropriately flood resilient and resistant;
- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Applications for minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments set out in footnote 55.

Footnote 55 states: “A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.”

The NPPF also lays out requirements for how LPAs should deal with planning applications in coastal areas. They should ensure that should they “reduce risk from coastal change by avoiding inappropriate development in vulnerable areas or adding to the impacts of physical changes to the coast.”

Developments in Coastal Change Management Areas should only be considered appropriate where it is demonstrated that:

6.3.2 Legislative Context

Section H3 of the Building Regulations 2010 requires that adequate provision is made for rainwater to be carried from the building roofs and paved areas. and be

preferentially discharged to soakaways or some other adequate infiltration system. Where that is not reasonably practicable, a watercourse; or sewer can be used.

The Flood and Water Management Act was introduced in 2010. The Act defines the role of lead local flood authority (LLFA) for an area. All LLFA are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area, called “local flood risk management strategy”.

Alongside the Act, Flood Risk Regulations (2009) outline the roles and responsibilities of the various authorities, which include preparing Flood Risk Management Plans and identifying how significant flood risks are to be mitigated.

6.3.3 Policy Context

The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental and social planning policies for England. The policies set out in this framework apply to the preparation of local and neighbourhood plans and to decisions on planning applications.

Paragraph 167 of the National Planning Policy Framework (NPPF) states that:

> When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment (See Note 1) Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:
>
> - within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location
> - the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Applications for some minor development and changes of use (See Note.2) should not be subject to the sequential or exception tests but should still meet the requirements for site-specific flood risk assessments set out in (See Note 1).

Paragraph 169 states that:

Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- take account of advice from the lead local flood authority;
- have appropriate proposed minimum operational standards;
- have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
- where possible, provide multifunctional benefits.

A major development is defined as:

- a residential development: 10 dwellings or more or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known
- a non-residential development: provision of a building or buildings where the total floor space to be created is 1000 square metres or more or where the floor area is not yet known, a site area of 1 hectare or more.

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

subject to other sources of flooding, where its development would introduce a more vulnerable use.

Note. 2 - This includes householder development, small non-residential extensions (with a footprint of less than 250m^2) and changes of use; except for changes of use to a caravan, camping or chalet site, or to a mobile home or park home site, where the sequential and exception tests should be applied as appropriate.

6.3.4 The London Plan

In addition, the requirements of this report are laid out in the London Plan [2] and the LBS Local Plan [3].

The Sustainable Drainage Hierarchy set out in Policy SI.13 of The London Plan GLA) London Plan (2011) [2] stipulates that developments should utilize Sustainable Drainage Systems (SuDS), unless there are particle reasons for not doing so; and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close as possible in line with the following drainage hierarchy:

- Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater in ponds or open water features for gradual release;
- Attenuate rainwater by storing in tanks or sealed water features for gradual release;
- Discharge directly to a water course;
- Discharge rainwater directly to a surface water sewer/drain;
- Discharge to a combined sewer.

- Major developments must implement SuDS to enable a reduction in peak run-off to greenfield rates for a 1 in 100 event + CC;

- Major developments will be required to provide a sustainable drainage strategy that demonstrates how SuDS will be integrated to reduce peak flow volumes and rates in line with the requirements of this policy;
- All other developments must maximize attenuation levels, achieving greenfield rates where possible;
- All new car parks and hard standing areas should be rainwater permeable with no run-off directed in to the sewer network;
- All flat roofs should be green or brown roofs to contribute to reducing surface water run-off.

The well-established Sustainable Drainage Hierarchy set out in Policy SI.13 of the Greater London Authority's (GLA) London Plan (2021) [3] stipulates those developments should utilize Sustainable Drainage Systems (SuDS), unless there are particle reasons for not doing so; and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close as possible in line with the following drainage hierarchy and there is a strong push to move towards green infrastructure away from grey features (impermeable).

6.3.5 Local Planning Policy – London Borough of Merton

In addition, the requirements of this report are laid out in the London Borough of Merton core strategy [4].

Policy

EP E6 Environmental protection

- In accordance with the London Plan policies 5.12 Flood Risk Management and 5.13 Sustainable Drainage and the supporting Design and Construction Supplementary Planning Guidance (SPG April 2014), the proposed development must aim to reduce post development runoff rates as close to greenfield rates as reasonably practicable.

- Development proposals must demonstrate how surface water runoff is being managed as high up the London Plan Policy 5.13 Sustainable Drainage hierarchy as possible.

- Sustainable Drainage Systems (SuDS) must be part of any major development proposals. Drainage and SuDS should be designed and implemented in ways that deliver other policy objectives for each of the following multi-functional benefits:

a. Blends in and enhances amenity, recreation and the public realm
b. Enhances biodiversity
c. Improves water quality and efficiency
d. Manages flood risk

- The development must be made safe from flooding, without increasing flood risk elsewhere for the lifetime of the development taking the latest climate change allowances into account. Potential surface water flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing surface water flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

6.4 Location and Area

The site is centred at national grid reference 524644, 170853 and has an area of 121m^2.

It falls within the jurisdiction of the London Borough of Merton in terms of the planning consultation process on flood risk and surface water management. The LLFA is also the London Borough of Merton.

Figure 1 provides the site location map and aerial imagery.

6.5 Current Site and Surrounding Uses

The site is currently a disused infill plot which is believed to have previously formed part of one of the adjoining residential gardens. It is fenced off and currently consists a small disused residential outbuilding and soft landscaping. Photos of the site are available in Appendix C3.

The surrounding uses are mainly residential with associated green space and scattered commercial buildings throughout. The Wimbledon railway station is southeast of the site.

6.6 Site Topography

The mapping provided in Appendix A2 shows the 1m elevation DTM LiDAR data.

The elevations within the site range from 25.84mAOD in the southwest, forming the hard standing which adjoins the site to Alwyne Road, to 27.06mAOD in the north east. The north east is the rear of the site and is made up of soft landscaping; it is predominately covered in grass and backs onto the gardens of 64 Woodside.

The proposal will cover the vast majority of the site and will involve lowering the ground level by approximately 2.5m to form the basement level.

6.7 Hydrology

There are no main watercourses within a 250m radius of the site.

Figure 1: Site location map and aerial photo

6.8 Geology and Hydrogeology

BGS mapping showing the geological and hydrogeological characteristics of the site are presented in Appendix A2.

The BGS information indicates that the superficial deposits consist of Head (Clay, Silt, Sand and Gravel), while the bedrock is classified as belonging to the London Clay Formation (Clay and Silt).

The permeability of the superficial geology is considered to be highly variable. The bedrock is classified as poorly draining.

The BGS infiltration potential map suggests that there are significant constraints indicated for infiltration methods at the site.

The maps also indicate that the groundwater table is less than 3mbgl.

The site lies upon an Unproductive bedrock aquifer and a Secondary (undifferentiated) superficial aquifer. The site does not lie within a groundwater Source Protection Zone.

7 The Sequential and Exception Tests

7.1 The Sequential Test

The Sequential Test aims to steer developments and redevelopments to areas of lower flood risk. The test compares the proposed development site with other available sites, in terms of flood risk, to aid the steering process. The Sequential Test is not required if the proposed development is a minor development or if it involves a change of use unless the development is a caravan, camping chalet, mobile home or park home site.

Based on Government Guidance, Minor Development means:

- minor non-residential extensions: industrial/commercial/leisure etc extensions with a footprint less than 250 square metre.
- alterations: development that does not increase the size of buildings eg alterations to external appearance.
- householder development: For example; sheds, garages, games rooms etc within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling eg subdivision of houses into flats.

With regard to residential and commercial developments, major development, as defined by the Town and Country Planning (Development Management Procedure) means one or more of the following:

- c(i) - the number of dwelling houses to be provided is 10 or more; or
- c(ii) - the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph (c)(i);
- the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more;
- or development carried out on a site having an area of 1 hectare or more.

The development is located in Flood Zone 1, meaning a Sequential Test will not be necessary.

7.2 The Exception Test

Where the Sequential Test is undertaken and alternative sites of lower flood risk are not available, then the proposed development may require an Exception Test in order to be granted planning permission. Where the exception test is required, it should be applied as soon as possible to all local development document allocations for developments and all planning applications other than for minor developments. All

three elements of the exception test have to be passed before development is allocated or permitted. For the exception test to be passed:

- It must demonstrate that the development provides wider sustainability benefits to the community that outweigh the flood risk, informed by an SFRA, where one has been prepared;
- The development should be on developed land or on previously developed land;
- A flood risk assessment must demonstrate that the development will be safe without increasing flood risk elsewhere, and where possible will reduce the overall flood risk.

The requirements for an Exception Test are given in Table 1 and are defined in terms of Flood Zone and development vulnerability classification.

Table 1: NPPF Flood Zone vulnerability compatibility (source: NPPF).

Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	✗	Exception Test required	✓	✓
Zone 3b	Exception Test required	✗	✗	✗	✓

Key:

✓ Development is appropriate

✗ Development should not be permitted.

An Exception Test will not be necessary.

8 Flood Risk

8.1 Fluvial (River) and Tidal (Sea) Flood Risk

Fluvial and tidal risk is assessed using flooding maps produced by the Environment Agency (EA). These maps use available historic data and hydraulic modelling to define zones of flood risk. The maps allow a site to be defined in terms of its Flood Zone (e.g. 1, 2, 3a or 3b) and in terms of the overall flood risk (very low, low, medium or high).

The EA Flood Zones are defined as:

- Flood Zone 1: Less than a 1 in 1000 annual probability of fluvial and/or tidal flooding;
- Flood Zone 2: Between 1 in 100 and 1 in 1000 annual probability of fluvial flooding and/or between 1 in 200 and 1 in 1000 annual probability of tidal flooding;
- Flood Zone 3a: Greater than 1 in 100 annual probability of fluvial flooding and/or greater than 1 in 200 annual probability of tidal flooding;
- Flood Zone 3b: functional flood plain (definition specific to the LLFA). Less than a 1 in 20 annual probability of fluvial and/or tidal flooding.

The site is designated as being within Flood Zone 1 and is therefore considered to have a low risk of flooding. This equates to a potential yearly risk of flooding of 0.1% Annual Expected Probability.

8.1.1 Main Potential Sources of Local Fluvial/Tidal Flooding

There are no watercourses within 250m of the site.

8.1.2 Records of Historic Fluvial/Tidal Flooding Incidents

The EA informed that they do not have any information on recorded flood incidents in the vicinity of the site.

8.1.3 Flood Defences

The EA's flood defence map which is available in Appendix B1 shows no indication of any flood defences in the vicinity of the site.

8.1.4 Climate Change - EA Modelled Predictions of Fluvial and Tidal Flood Levels and Extents

As the site is located in Flood Zone 1 EA modelled predictions were not available.

8.2 Pluvial (Surface Water) Flood Risk

Surface water flooding occurs when high intensity rainfall leads to run-off which flows over the ground surface, causing ponding in low-lying areas when the precipitation rate or overland flow rate is greater than the rate of infiltration, or return into watercourses. Surface water flooding can be exacerbated when the underlying soil and geology is saturated (as a result of prolonged precipitation or a high-water table) or when the drainage network has insufficient capacity.

The chief mechanisms for flooding can be divided into the following categories:

- Runoff from higher topography – the areas of greatest flood depths tend to be at the base of the steeper land;
- Localised surface water runoff – within the central parts of the borough, surface water flooding tends to be a result of localised ponding of surface water;
- Sewer Flooding – areas where extensive and deep surface water flooding is likely to be influenced by sewer flooding. Where the sewer network has reached capacity, and surcharged, this will exacerbate the flood risk in these areas.
- Low Lying Areas – areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Cuttings – leading to internal ponding and transport disruption;
- Railway Embankments – discrete surface water flooding locations along the up-stream side of the raised network rail embankments where water flows are interrupted and ponding can occur.

A map showing the site and the modelled prediction of surface water flood risk and depth provided by the EA is available in Appendix B2. This indicates that the site is at low risk of flooding.

8.2.1 Main Potential Sources of Local Pluvial Flooding

The main potential source of pluvial flooding to the site is considered to be surface water ponding and flooding associated with heavy rainfall in the area.

8.2.2 Records of Historic Pluvial Flooding Incidents

Examination of the LLFA's Level 1 SFRA revealed a cluster of 5 historic pluvial flooding incidents approximately 90m - 160m south of the site which mainly occurred in 2007, excluding one which occurred in 2011. Historic pluvial events were also recorded approximately 350m southwest, 390m northeast and 480m northeast of the site, all which were dated 2007.

There were also two historic flood incidents of unknown source which occurred approximately 320m northwest (dated 1999) and 350m northeast (date unknown) of the site.

A map showing the location of surface water flooding incidents is available in Appendix B2.

8.2.3 Climate Change - Modelled Predictions of Surface Water Run-off Flooding

Mapping of the predicted extent and depth of surface water flooding for the 1 in 100-year and 1 in 1000-year rainfall return periods provided by the EA are available in Appendix B2.

During the 1 in 100-year pluvial event the site remains dry. In the 1 in 1000-year pluvial event the site, including the proposed development, witnesses flood depths of up to 300mm in the southwest of the site.

8.2.4 Surface Water Flood Risk from Artificial Sources (Reservoirs and Canals)

An examination of OS mapping and the EA's mapping revealed no indications of significant reservoirs or canals in the area of the site.

The EA's reservoir flood risk map indicates that the site does not lie within an area that is at risk of reservoir flooding.

8.2.5 Sewer Flooding

Examination of the LLFA's Level 1 SFRA revealed evidence of one historic sewer flooding incident located approximately 150m southwest of the site, which occurred in the year 1981.

A map showing recorded incidents of sewer flooding is available in Appendix B2.

8.3 Groundwater Flood Risk

Groundwater flooding occurs when water rises from an underlying aquifer (i.e. at the location of a spring) to such a level where it intersects the ground surface and inundates the surrounding land. Groundwater flooding tends to occur after long periods of intense precipitation, in often low-lying areas where the water table is likely to be at a shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels. A high groundwater table also has the potential to exacerbate the risk of surface water and fluvial flooding by reducing rainfall infiltration capacity, and to increase the risk of sewer flooding through sewer/groundwater interactions.

8.3.1 Historic Records of Groundwater Flooding

Examination of the LLFA's Level 1 SFRA revealed one record of groundwater flooding 480m southeast of the site which occurred in the year 2006.

A map showing the locations of historic groundwater flooding incidents is available in Appendix B2.

8.3.2 Susceptibility to Groundwater Flooding

The Groundwater Flood Susceptibility Map provided by BGS and presented in Appendix B3 indicates that the site has potential for groundwater flooding to occur at the surface. The Groundwater Depth map also provided by BGS indicates that the groundwater level may be at approximately less than 3mbgl.

8.4 Risk of Flooding from Multiple Sources (ROFMS)

The Environment Agency provides a map which gives an indication of the overall flood risk to a site from fluvial, tidal and surface water sources after considering the presence of flood defences. This map indicates that there is less than 1% chance of flooding at the site in any year. A copy of the map is presented in Appendix B4.

8.5 Critical Drainage Area

A Critical Drainage Area (CDA) may be defined as “a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure”. A CDA is defined in the Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006 as “an area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency”.

The site is located within the Critical Drainage Area Group7_008.

8.6 Existing Drainage

No drainage features were present upon a site walk over apart from a disconnected downpipe off the existing derelict outbuilding.

A utility search was undertaken which identified Thames Water as the local sewage undertaker. The Asset map is available in Appendix C1.

Table 2: Asset Information

Asset ID	Flow Direction / Location	Asset Type	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)	Depth (m)
6805	Upstream 25m SW	SW	n/a	n/a	n/a
6803	Upstream 10m S	SW	25.71	n/a	n/a
6806	Downstream 25m NE	SW	n/a	n/a	n/a

n/a = unknown

Both surface water and foul sewers are located on Alywne Road.

The surface water drainage run flows past the Site from the southwest to northeast along Alwyne Road. The Thames Water Asset data does not include manhole cover and invert levels for this drainage run, so further investigation will be required to determine these.

The closest asset is 6803, however, joining at this location would be against the flow direction, so a direct connection would likely be required.

The proposal will require a new connection agreement with Thames Water.

9 Hydrological Run-off Assessment

To minimise the impact of the new development on local flood risk, the NPPF requires that post development surface water run-off volumes and peak flow rates are improved upon those of the existing conditions. The following section provides an assessment of greenfield as well as pre- and post-development run-off rates.

9.1 Existing and Proposed Ground Cover

A summary of the existing and proposed site ground cover is shown below in Table 3 and 4 below.

Table 3: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m2)
	m²	%	m²	%	
Buildings	18	15	110	92	92
Hard Standing	17	14	10	8	-7
Soft landscaping	85	71	0	0	85
Total	0	0	0		

Table 4: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m²	%	m²	%	m²
Existing Site	35	29	85	71	120
Proposed Site	120	100	0	0	120
Difference	85	71	-85	-71	

The introduction of the proposed building will increase the impermeable area of the site by 85m^2 (71%).

9.2 Impacts on Flood Risk, Flood Storage and Flood Flow Routes

As the development will increase the impermeable site area by a further 85m^2, it is considered possible that it could impact upon local flood storage, flood flows and surface water runoff rates.

The development will also increase the site's built-up area meaning it is could have an impact on flood flow pathways. However, it should be noted that as the site remains dry during the EA 1% AEP modelled pluvial and fluvial events, these risks are thought to be negligible.

10 SuDS Requirements

10.1 Peak Flow Control

With regard to peak flow control, the non-statutory technical standards for sustainable drainage systems state that:

- S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as

reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

The London Plan SI.13 states that development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. The London Plan Sustainable Design and Construction SPG (section 3.4.10) states that all developments on Greenfield sites must maintain Greenfield runoff rates. On previously developed sites, runoff rates should not be more than three times the calculated Greenfield rate.

10.2 Volume Control Requirements

With regard to volume control, the non-statutory technical standards for sustainable drainage systems state that:

- S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.
- S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

10.3 Run-off and Storage Calculations

The IH124 method was applied to calculate the Greenfield and post-development run-off rates that include the 40% allowances for climate change. The full results are presented in Appendix C2. Table 5 below give a summary of the results.

Table 5: Calculation of post-development run-off rates for the site.

	IH24 Greenfield (l/s)	MRM – Pre - Development (l/s)	MRM - Post Development (l/s) Without SuDS
Qbar	0.02		
1 in 1	0.02	0.4	1.8
1 in 30	0.04	1.1	4.2
1 in 100	0.06	1.3	5.3
1 in 100 + CC	0.09	1.8	7.4

As the development is taking place on a previously developed site S3 (peak flow) and S5 and S6 (volume controls) apply.

The proposal should aim to achieve the greenfield Qbar runoff rate of 0.09 l/s for all storm events and never exceed the pre-development scenario of 1.8 l/s for all storm events.

Without the introduction of SuDS, the proposal will significantly increase the runoff rates, as shown in Table 5 above. The Post Development Modified Rational Method calculations without SuDS indicate the rates would increase by more than three times during all scenarios.

Using the quick storage estimate tool in Microdrainage, the storage volume required to achieve greenfield rates and discharges was estimated to be up to 4.8m^3.

Screenshots of the quick storage estimate and variables are available in Appendix C2.

11 Flood Resilience

Flood resilient construction uses methods and materials that reduce the impact from a flood, ensuring that structural integrity is maintained, and the drying out and cleaning required, following inundation and before reoccupation, is minimised.

11.1 Finished Floor Levels

As the site is in Flood Zone 1 and is not impacted by flooding in any of the relevant modelled fluvial and pluvial scenarios, based on EA guidance, no action is required in relation to finished floor levels.

11.2 Compensatory Flood Storage (CFS)

As the site is located in Flood Zone 1 CFS is not required.

11.3 Flood Resilience Construction Measures

In terms of achieving resilience, there are two main strategies, whose applicability is dependent on the water depth the property is subjected to. These are:

- Water Exclusion (Flood Resistance) Strategy - should be employed where predicted flood depths are less than 0.3m and are likely to be for short duration. Emphasis is placed on minimising water entry and giving occupants time to relocate ground floor contents, maintaining structural integrity, and on using materials and construction techniques to facilitate drying and cleaning;
- Water Entry (Flood Resilience) Strategy - Flood resilience measures are designed to allow water in but to limit damage and allow rapid re-occupancy. Resilience measures should be employed where flood depths are greater than 0.6m and where it is likely that structural damage will occur due to excessive water pressure.

Given that flood depths less than 0.3m are predicted in extreme scenarios, the water exclusion is considered most applicable for this site.

Water Exclusion Strategy:

There are a range of flood protection devices/methods that can be used in the Water Exclusion Strategy including:

- Using materials and construction with low permeability;
- Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk elsewhere);
- Raising thresholds and finished floor levels (e.g. porches with higher thresholds than main entrance);

- Flood gates with waterproof seals;
- Sump and pump for floodwater to remove waste water faster than it enters, particularly in the basements;
- Door guards and airbrick covers.

Flood resilience design and measures that will be implemented are outlined below. Water-resistant and resilient materials will be utilized throughout the construction to minimize the flood risk and potential impacts.

Floor construction:

- Use of resilient flooring materials as ceramic tiles or stone floor finishes;
- Use of a concrete slab 150mm thick;
- Use of ceramic tiles or stone floor finishes is recommended;
- Maintain existing under floor ventilation by UPVC telescopic vents above 400 mm to external face of extension;
- Damp proof membrane of impermeable polythene at least 1200 gauge;
- Avoid the use of MDF carpentry.

Wall construction:

- Include in the external face of the extension a damp – proof course, 250 mm above ground level, to prevent damp rising through the wall;
- Use rigid closed – cell material for insulation above the DPC;
- Spread hardcore over the site within the external walls of the building to such thickness as required to raise the finished surface of the site concrete. The hardcore should be spread until it is roughly level and rammed until it forms a compact bed for the oversite concrete. This hardcore bed will be 100 mm thick and composed by well compacted inert material, blinded with fine inert material.

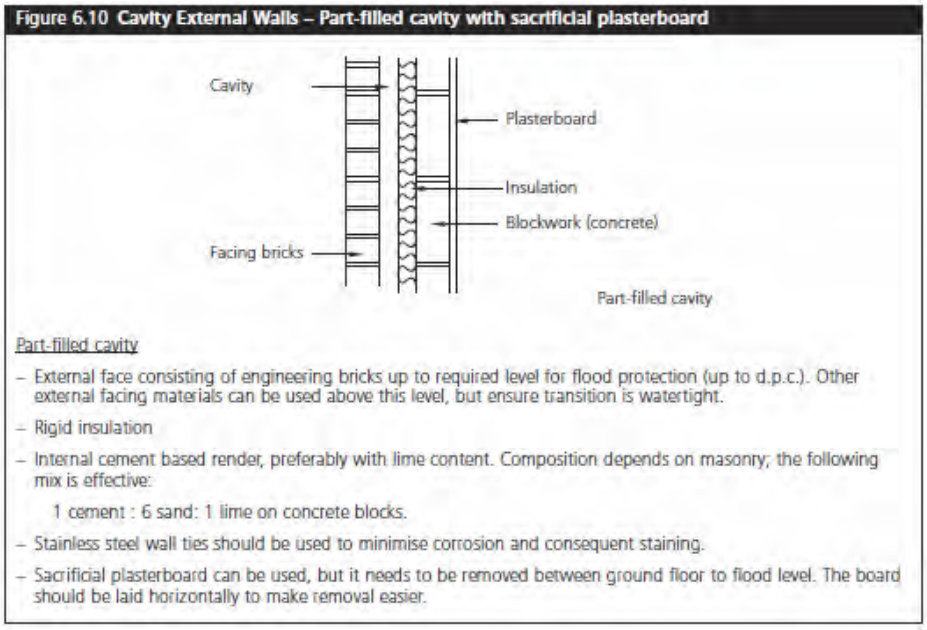
Doors:

- Seal doors around edges and openings. UPVC or composite material will be used with passive protection meaning that minimal intervention will be required in the event of flooding.

Underground drainage:

- Avoid use of metal for any underground piping;
- Use closed cell insulation for pipes that are below the predicted flood level;
- Provide non – return valves for the drainage system to prevent back water flow;
- Use UPVC or clay pipework for fouls and surface water drainage.

Figure 4: Cavity External Walls



As well as the above the following flood resilience features should be applied as part of the development:

- Electrical sockets should be installed above flood level for the ground floor;
- Utility services such as fuse boxes, meters, main cables, gas pipes, phone lines and sockets will be positioned as high as practicable;
- All external openings for pipes or vents below 400mm to be sealed around pipe or vent with expanding foam and mastic.

Basement

- The basement will be water proofed (i.e. tanked);
- Pump and sumps will be installed at basement level to convey any excess flows to ground level;
- The proposed building and retaining walls will form physical barriers to prevent the movement of surface water to basement level;

12 Emergency Plan

12.1.1 Assessment of Danger to People

The dangers associated with flood water to people are possible injury and/or death. This can occur as a result of drowning or being carried along by the waters into hard objects or vice versa. The risk to life is largely a function of the depth and velocity of the floodwater as it crosses the floodplain. Fast flowing deep water that contains debris would represent the greatest hazard.

The assessment of danger to people from walking in floodwater is described in the Flood Risks to People guidance documents (FD2321_TR1 and FD2321_TR2) by DEFRA/EA.

Danger can be estimated by the simple formula:

$$HR = d \times (v + 0.5) + DF$$

where, HR = (flood) hazard rating; d = depth of flooding (m); v = velocity of floodwaters (m/sec); and DF = debris factor.

The scoring methodology and calculation matrix for this is summarised in Appendix B5.

As the site is located in Flood Zone 1 and is not indicated to be impacted by any flood scenarios the Hazard Rating is 0.

12.1.2 Access and Safe Egress

Safe egress to Flood Zone 1 is available on site.

12.1.3 Safe Refuge

The proposed development will have internal connections to upper floors in the property which will act to provide sufficient safe refuge in the event of an extreme flood event.

13 Site Investigation

13.1.1 Site Investigation

The ground investigation works were carried out on the 15th of December 2022.

2no. boreholes (BH01 – BH02) were excavated at the site for the purpose of undertaking geotechnical in-situ testing and soil sampling using a dynamic windowless sampler rig. Borehole BH01 was advanced to a maximum depth of 10mbgl, while BH02 was advanced to 4mbgl. In-situ Standard Penetration Tests (SPT) were carried out at 1m intervals.

13.1.2 Ground Conditions Encountered

The investigation encountered ground conditions consistent with the published geological records of the area. Made Ground consisting of gravelly SILT with an abundance of brick fragments was encountered to a maximum depth of 1.2mbgl. The Made Ground in turn underlain by brown and grey CLAY to 10mbgl.

13.1.3 Ground Water

Groundwater was not encountered in any of the boreholes.

13.1.4 Infiltration Testing

Infiltration testing was not undertaken due to limited space.

14 SuDS Options

As mentioned above, planning policies require that SuDS strategies consider source control (i.e. disposal of runoff within the plot boundary), followed by site control (site wide disposal) and then regional control (appropriate for larger development with strategic drainage infrastructure). They also require that that those methods that give the most benefits in terms of sustainability are prioritised for employment (generally known as the SuDS Hierarchy) as further described below.

14.1 SuDS Hierarchy

The SuDS Hierarchy sets out the preferred method of selecting which Sustainable Drainage System should be used. Generally, 'soft SuDS' such as ponds and swales are the preferred drainage systems as they mimic natural drainage and provide a number of benefits including attenuation of surface water flows and flow rates as well as pollution.

Smaller developments which may not have the physical room for pond and swales would need to consider other options. In these cases, preference should be given to infiltration systems. However, care should be taken if implementing infiltration systems near aquifer protection zones, close to buildings or structural foundations or in areas where soils may be polluted.

The SuDS hierarchy is summarised in Figure 2 below.

Figure 2: SuDS Hierarchy

	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
Most Sustainable	Living roofs	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	Tanked systems - over-sized pipes/tanks - storms cells	✔		

14.2 Assessment of SuDS Options

An assessment was made of the suitability of a range of potential SuDS techniques that could be implemented as part of the development. The results of the assessment are summarised in Appendix C3 and are further discussed below.

14.2.1 Living Roofs

As buildings will cover more than 92% (110m^2) of the site, living roofs are considered to be a viable SuDS technique.

14.2.2 Rainwater Harvesting

The use of rainwater butts and/or harvesting tanks could be employed within each individual building and patios, although they would have a limited storage capacity and will be required to be an active system.

The rooftop is a suitable catchment area to provide an active rainwater harvesting system which is viable for storm water control. However, due to the limit available space, the volume of storage the system would be able to provide would be limited.

A print screen of the results is available in Appendix C1.

14.2.3 Basins, Ponds, Filter Strips and Swales

Basins, ponds, filters strips and swales are not considered suitable due to limited space.

14.2.4 Infiltration Devices

Infiltration techniques should be given priority in any SuDS design as they deal with discharge on the site by returning water to the aquifer and subsequently rivers via baseflow.

Mapping provided by the BGS showing the infiltration potential of the site is presented in Appendix A3. The map indicates that there are significant constrains for the use of infiltration SuDS in the area; the bedrock is also thought to be poorly draining.

However, given the limited space availability on the site, there is no feasible location that allows for a soakaway to be installed at least 5 m from any existing or proposed foundation or 1 m from the boundary as recommended by BRE Digest 365.

14.2.5 Permeable Surfaces and Filter Drains

Over 8% (10m^2) of the development will consist of lower ground floor amenity space, which will be at basement level, as such it is unlikely that it will suitable for permeable paving.

In addition to this, approximately 12m^2 of the ground floor will form pathways and amenity space to the front of the development. It is located below the overhanging roof and balconies, but would be suitable for the introduction of an impermeable lined paved sub-base.

14.2.6 Tanked Systems

A tanked system incorporating a restricted flow to the sewer would be a viable option if infiltration is not suitable. This option is ranked as being the least sustainable in the SuDS hierarchy, furthermore, there is very limit space.

14.2.7 Summary of results of SuDS Options Assessment

A summary of the results of the SuDS Options Assessment is presented in Table 6 below. Full details of the options assessment along with descriptions of the SuDS options are presented in Appendix C4 and Appendix C5.

Table 6: Summary of Results of SuDS Options Assessment

SuDS Technique	Potential Suitability
Rainwater Harvesting	Suitable – Small scale
Infiltration: Soakaways Infiltrations trenches and basins	Unsuitable - Space
Green/brown /blue roofs	Suitable
Rain Gardens	Unsuitable - Space
Permeable Pavements / Surfaces	Partially Suitable – lined.
Swales	Unsuitable - Space
Detention basin/ponds	Unsuitable - Space
Storage tanks/ Geocellular storage	Suitable – Limited space
Oversized piping	Suitable

15 SuDS Implementation

15.1 SuDS Constraints

The major constraints for implementing SuDS on site is the available space upon the ground floor upon completion. Over 90% of the development will form the building and therefore, roof level attenuation SUDS are more suited to this development.

15.2 Proposed SuDS

The proposal will introduce a green roof and green wall to intercept and attenuate surface waters on site. A small section of permeable paving will be introduced (below the roof line) on the ground floor as amenity space. The excess surface water from the rooftop will discharge via the permeable paving sub-base (which will be lined), into the nearby sewer.

The basement amenity space will be fitted with emergency pump and sump systems which will discharge any excess flows reaching the basement level to street level.

The proposed SuDS is further detailed below. A detailed drainage layout is available in Appendix C6.

15.2.1 Green Roof

The proposed buildings cover an area of 110m^2 which will be fitted with an extensive green roofing system. The green roof will cover a total area of 55m^2 and will be formed from a Sedum Green roof (or similar) along with 100mm drainage cells which will cover 20m^2 of the green roof; this will provide additional roof level attenuation.

The green roofs across the site will be constructed from vegetation ranging from sedum grasses and small flora. The vegetation will depend on the accessibility and depths and type of the underlying substrate. The substrates will be formed from a freely draining specifically designed roof growing medium - the depth of the substrate will vary depending on the growing medium it is intended to support (extensive, biodiverse or intensive).

Due to the size of the rooftop areas, shallow extensive green roof systems are most suitable.

The substrate provides water retention and is typically lain onto a filter fleece, drainage board and a waterproof membrane. The filter prevents fines from being drained out of the substrate and into the drainage system. The drainage board provides further waterproofing, allowing for continuous drainage and increases the storage capacity of the green roof.

The attenuation volume can be increased (or reduced) depending on the chosen materials and construction depth. The proposal has been designed with the 100mm drainage cells supporting the part of the green roof. Each cell provides 0.091m^3 of attenuation per square meter, across 20m^2 of the rooftop; it will provide 1.80m^3 of attenuation.

The green roof will provide approximately 2.8m^3 of attenuation within the substrate and drainage cells.

As well as allowing for storage, the substrate and planting will slow the runoff rate from the rooftop by up to 30 - 60 minutes depending on the level of saturation before the rainfall event. Excess will discharge into the permeable paving described below.

Examples of the proposed products are available in Appendix C5.

15.2.2 Permeable Paving (Lined)

The pathways and amenity space to the front of the proposed development account for 12m^2. This lies below the roofline and above the basement and as such any structure will be required to be impermeably lined.

Permeable Paving (Marshalls Prior or similar) combines hardstanding with SuDS and works in a very different way to traditional pavement. It is designed to allow rainfall to percolate immediately through the surface near to where the raindrop lands so surface ponding is completely eradicated without the need for an additional channel drainage system.

The construction will consist of 80mm interlocking concrete blocks with jointing, with a 50mm underlying bedding layer with a 300mm sub-base consisting of a graded aggregate (Marshalls Priora Aggregates or similar) with a porosity of 0.30. This construction over 12m^2 will provide approximately 1.1m^3 of interception and attenuation.

The water flows into a specially prepared sub-base, where the voids between the stones which make up the structure act as a temporary reservoir. During a rainstorm, the water is collected in the sub-base (‘attenuated‘) before it is slowly released directly into the surface manhole which connects into the sewer network.

15.2.3 Discharge Control Device

The proposed SuDS management train will be used to limit the discharge from the site into the Thames Water surface water sewer. Roof level flow control devices could potentially be implemented.

15.2.4 Microdrainage Modelling

Microdrainage Modelling was carried out to assess the performance of the proposed drainage system under a variety of modelled storm events. The designed system including the proposed attenuation storage provides a total storage of 4.7m^3 when including all pipes, manholes and storage structures.

All excess surface water was safely contained during all modelled scenarios, including and up to the 1 in 100 years plus 40% climate change.

Table 7: Modelled Post Development Runoff Rates - 6 hour storm event

Modelled Event	Modelled - Post Development (l/s)
1 in 1	0.1
1 in 30	0.2
1 in 100	0.3
1 in 100 + CC (40%)	0.5

Full results, drainage layout including the proposed discharge point and exceedance flows are available in Appendix C6.

15.2.5 Surface Water Discharge Points

As infiltration is not suitable and there are no nearby watercourses, any excess run-off from the development will be conveyed via 150mm diameter lateral drains to the surface water sewer on Alwyne Road (location).

A copy drainage asset search is available in Appendix C1.

A new connection agreement with Thame Water will be required.

15.2.6 Treatment of Run-off

Treatment of roof water runoff will be provided through the provision of trapped green roofs and permeable paving to intercept gross solids and sediment; guidance will be provided to householders on appropriate maintenance requirements.

15.2.7 Exceedance Flows

Upon completion the site will be fully developed upon with almost no ground floor. As such any exceedance flows would flow directly off site onto Alwyne Road.

It can be seen from the design proposals that the proposed system includes approximately 3.7m^3 of additional storage capacity (not including pipes and manholes). In addition, a safety factor of 2 was applied to the Microdrainage modelling, which gives a further degree of confidence that exceedance flows are unlikely to occur. Nonetheless, appropriate level design will be employed to ensure that flood waters are directed away from buildings in the unlikely event that an inundation of the proposed system results in overland flows.

A map displaying the exceedance flow is available in Appendix C6.

15.3 Maintenance and Adoption of SuDS

All SuDS features will be properly installed by competent persons. They will be maintained regularly to ensure that their design capacity and attenuation characteristics provide the required storage volume.

Landscaping and adjacent areas will be designed such that they do not cause soil, mulch and other materials to be washed onto the permeable surfaces and into drains causing clogging.

The maintenance will be carried out (under guarantee) by the drainage contractors responsible for installing it in the first 1 or 2 years of operation (dependent upon the contract specification) after which the responsibility will be transferred to the Property Management Company.

Owners of the properties/persons responsible for maintenance of SuDS components will be provided with operation and maintenance manuals which will include information such as:

- the location of SuDS components;
- an explanation of design intent and objective of the SuDS;
- the requirements for regular and occasional inspection and maintenance;
- visual indicators that may trigger maintenance.

An inspection checklist should be generated based on the maintenance strategy to facilitate consistent inspection of the condition of the system and as a method for recording inspections. Inspections should also be accompanied by photographic records to assist with the monitoring of the system. It is recommended that an annual maintenance report should be prepared and retained within the Operation and Maintenance Manual.

Regular maintenance of SuDS components is relatively straightforward with the main tasks consisting of:

- Regular visual inspections – checking inlets are not blocked and verifying that clogging has not occurred;
- Litter and debris removal;
- Grass cutting;
- Preventive sweeping;
- Weeding and invasive plant control;
- Oil and stain removal.

Occasional maintenance activities to ensure the long-term performance of the SuDS features include:

- Sediment removal
- Vegetation and plant replacement

These simple measures will ensure that the storage capacity of the system is maintained and that the need for reconstruction and replacement of components is minimised.

Further details on SuDS maintenance measures that will be employed at the site can be found in Appendix C7.

16 Conclusion and Recommendations

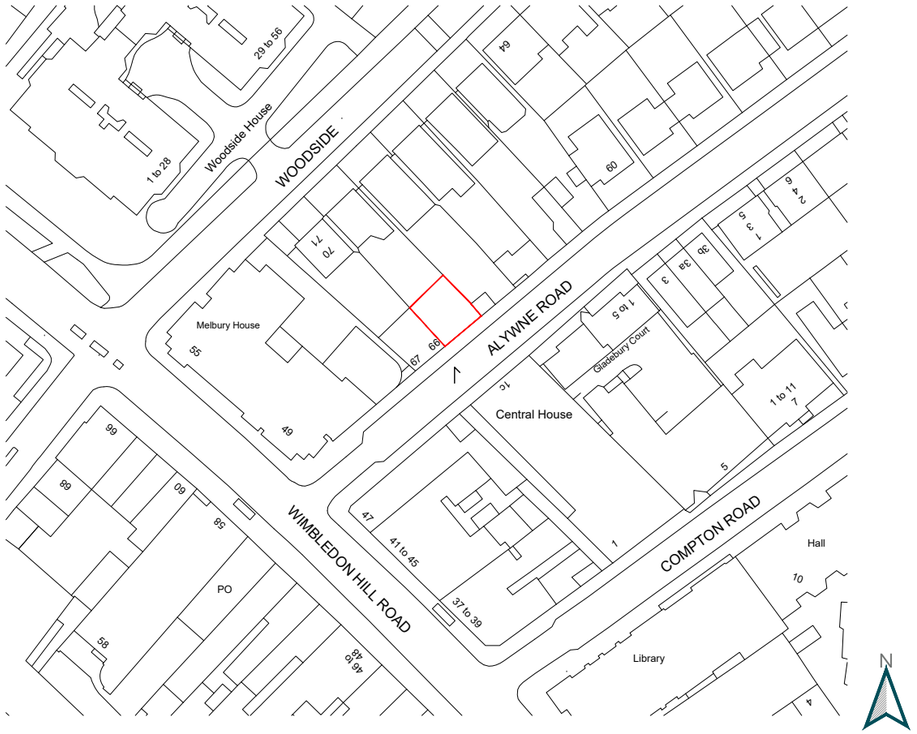
With the proposed SuDS mitigation measures in place, it is considered that the proposed development will reduce local flood risk and enhance the local environment and will therefore be in compliance with the LLFA's current planning policy and the NPPF.

17 References

1. Communities and Local Government - National Planning Policy Framework NPPF, 2019.
2. The London Plan – The Spatial Development Strategy for Greater London - March 2021
3. London Borough of Merton – London Borough of Merton Estates Local Plan, Adopted February 2018.
4. London Borough of Wandsworth and London Borough of Merton – Level 1 Strategic Flood Risk Assessment, November 2020

18 Appendices A – Site Characteristics

18.1 Appendix A1 – Development Plans



LOCATION PLAN
1:1250 @ A3

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Revisions

Rev	Date	Notes	Initial

Project

Client: Ernle Estates

Address: Land Between 60 & 66
Alwyne Road
London
SW19 7AE

Stage: Planning

Drawing

Title: LOCATION PLAN

Drawn By:

Date: JUN 22

Scale: 1:1250 @ A3

Dwg No.: 2022-026-LP Rev: -

PROPOSED SITE PLAN
1:50 @ A3

1:200
0m 4m 8m 12m 16m 20m

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Revisions

Rev	Date	Notes	Initial

Project

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London
SW19 7AE

Stage: Planning

Drawing

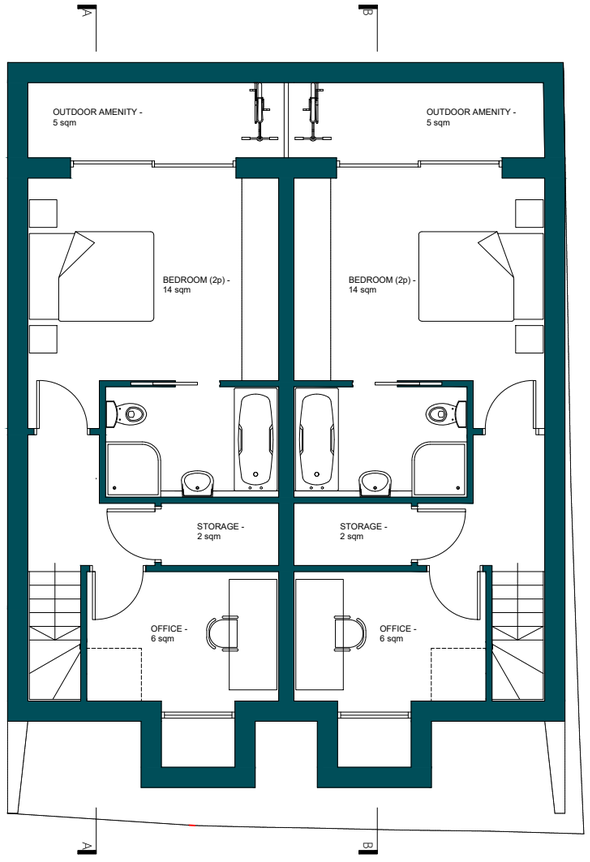
Title: SITE PLAN

Drawn By:

Date: JUN 22

Scale: 1:200 @ A3

Dwg No.: 2022-026-01 Rev: -



BASEMENT PLAN
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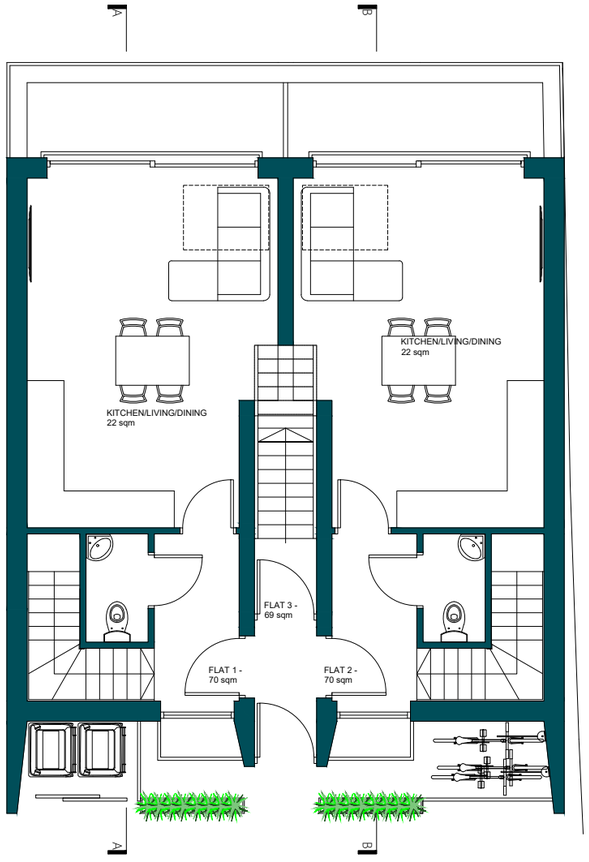

GROUND FLOOR PLAN
1:100 @ A3

1:100
0m 2m 4m 6m 8m 10m

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Stage: Planning

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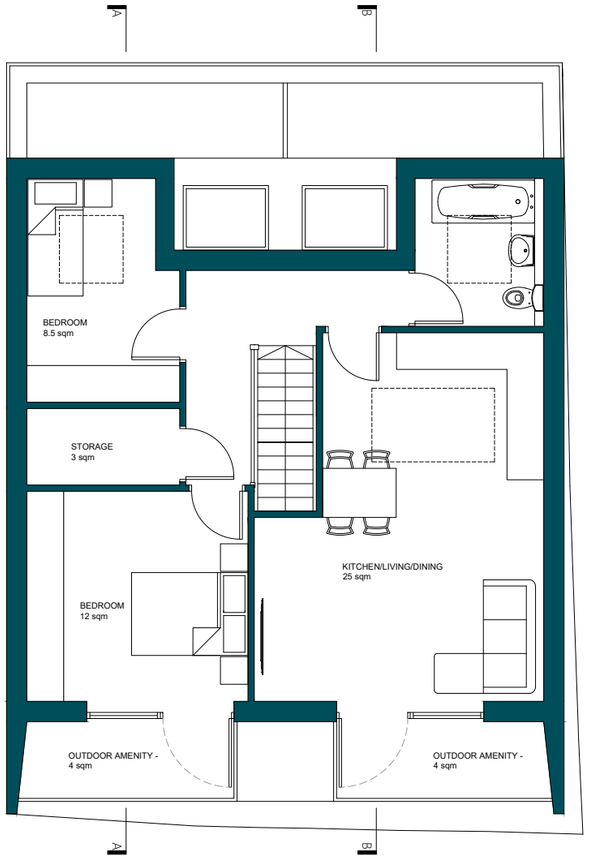
Title: FLOOR PLANS

Drawn By:

Date: JUN 22

Scale: 1:100 @ A3

Dwg No.: 2022-026-02 Rev: -



FIRST FLOOR PLAN
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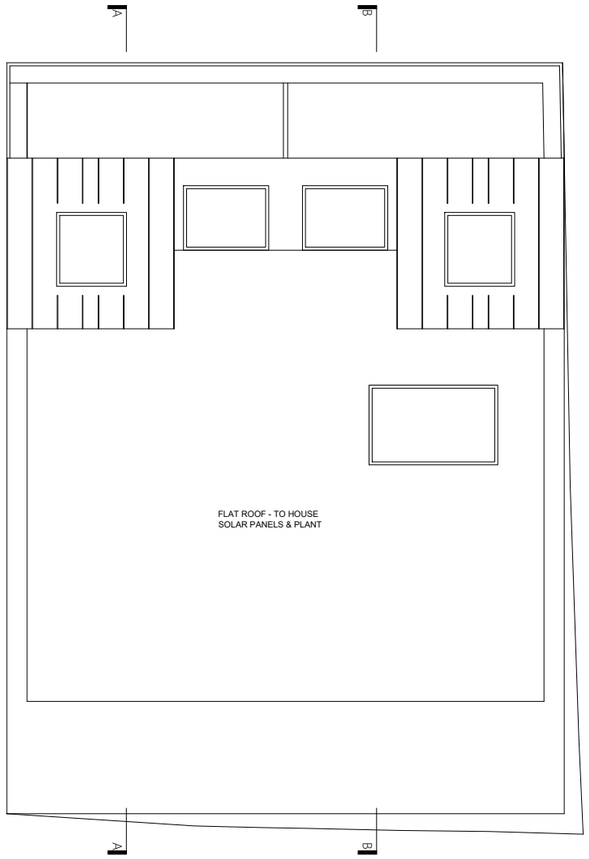

ROOF PLAN
1:100 @ A3

1:100
0m 2m 4m 6m 8m 10m

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Revisions

Rev	Date	Notes	Initial

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Alwyne Road
London
SW19 7AE

Stage: Planning

Drawing

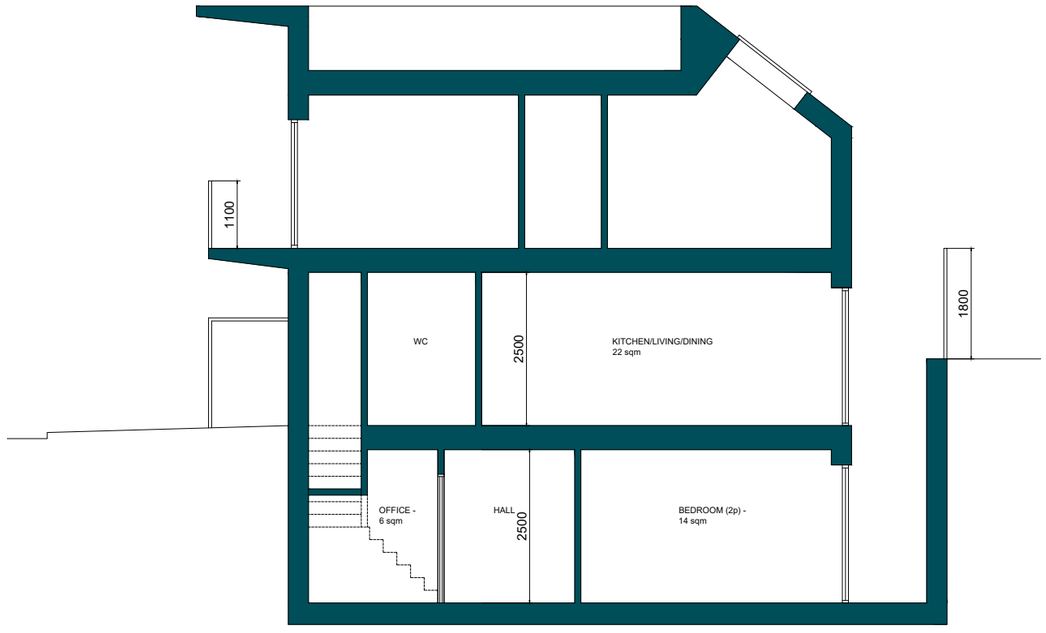
Title: FLOOR PLANS

Drawn By:

Date: JUN 22

Scale: 1:100 @ A3

Dwg No.: 2022-026-03 Rev: -



SECTION A-A
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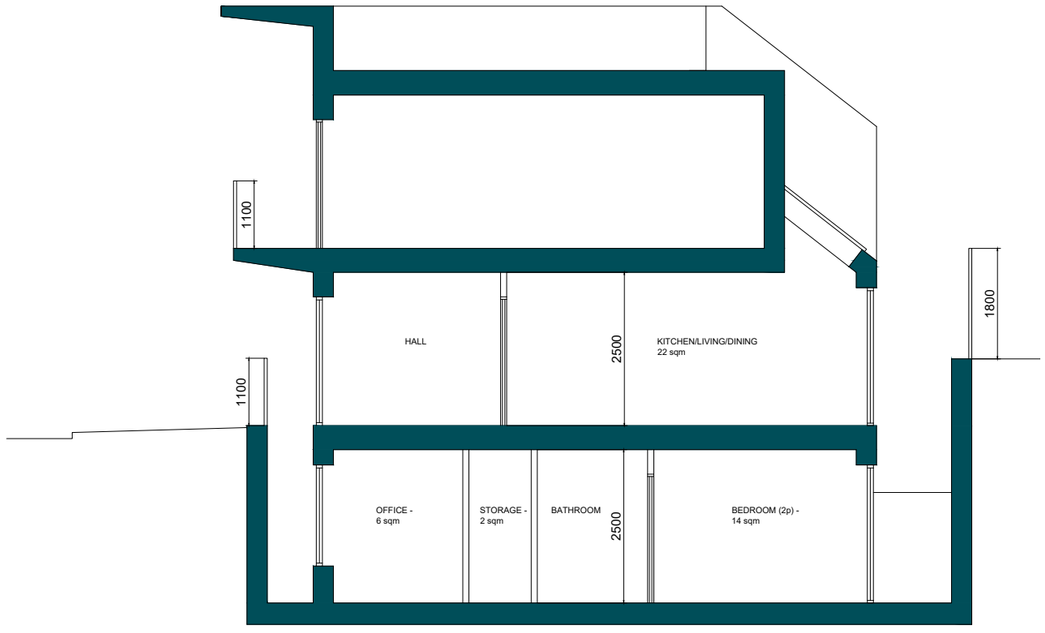

SECTION B-B
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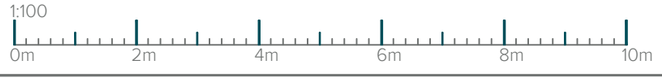


GBS ARCHITECTURAL
T: 020 3384 9464 / E: info@gbs.co.uk / W: gbs.co.uk

Important Note

Whilst due care and attention is taken to ensure all surveys, drawings, dimensions and details provided are accurate, it is the Builders responsibility to check and verify all dimensions, details, levels and sewer invert levels on site prior to ordering any materials or commencing works. Should any discrepancies be found these should be relayed to the Architect immediately for review. Should these drawings be used without adequate site investigations and subsequent issues arise, liability will lie solely with the Builder.Do not scale off this drawing, work to figured dimensions only.This drawing must be read and checked with all structural and relevant specialist drawings.The Builder is to comply in all respects with the current Building Regulations and latest Codes of Practice.

© Copyright

Revisions

Rev	Date	Notes	Initial

Project

Client: Ernle Estates

Address: Land Between 60 & 66
Alwyne Road
London
SW19 7AE

Stage: Planning

Drawing

Title: SECTIONS

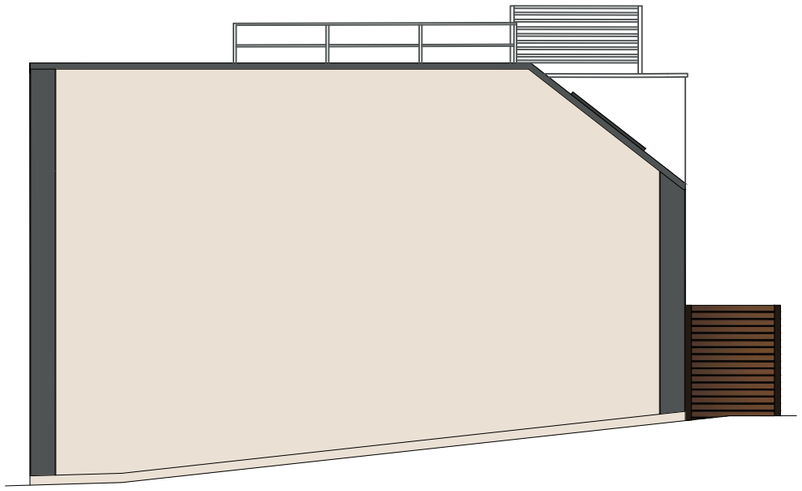
Drawn By:

Date: JUN 22

Scale: 1:100 @ A3

Dwg No.: 2022-026-04 Rev: A

FRONT ELEVATION
1:100 @ A3



SIDE ELEVATION
1:100 @ A3

REAR ELEVATION
1:100 @ A3

GBS ARCHITECTURAL

T: 020 3384 9464 / E: info@gbs.co.uk / W: gbs.co.uk

1:50
0m 1m 2m 3m 4m 5m

Important Note

Whilst due care and attention is taken to ensure all surveys, drawings, dimensions and details provided are accurate, it is the Builders responsibility to check and verify all dimensions, details, levels and sewer invert levels on site prior to ordering any materials or commencing works. Should any discrepancies be found these should be relayed to the Architect immediately for review. Should these drawings be used without adequate site investigations and subsequent issues arise, liability will lie solely with the Builder.Do not scale off this drawing, work to figured dimensions only.This drawing must be read and checked with all structural and relevant specialist drawings.The Builder is to comply in all respects with the current Building Regulations and latest Codes of Practice.

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Revisions

Rev	Date	Notes	Initial

Project

Client: Ernle Estates

Address: Land Between 60 & 66
Alwyne Road
London
SW19 7AE

Stage: Planning

Drawing

Title: ELEVATIONS

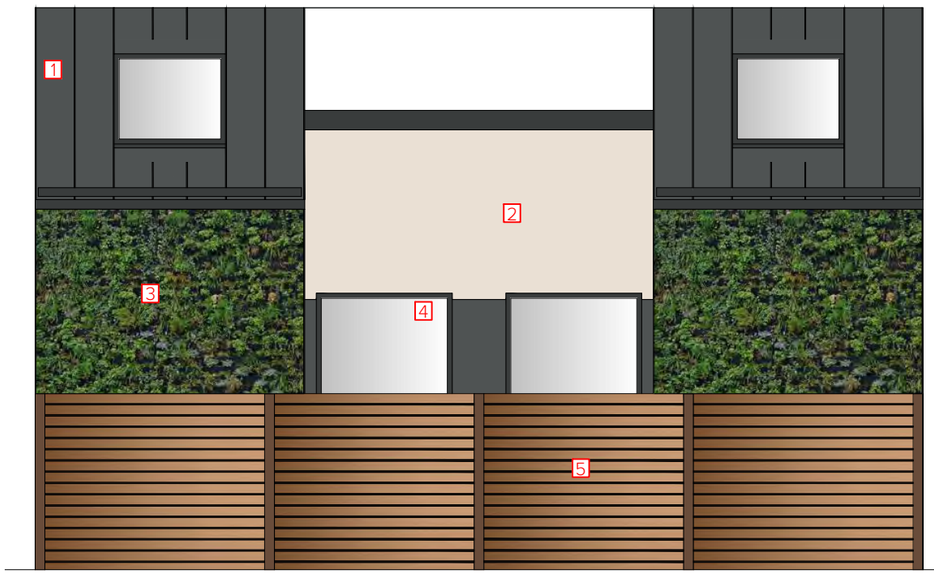
Drawn By:

Date: JUN 22

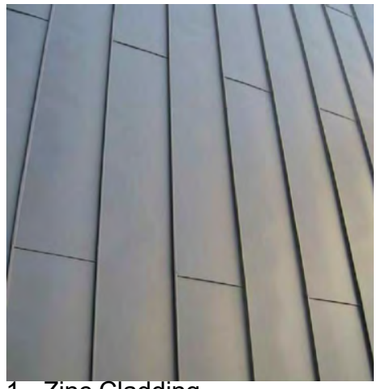
Scale: 1:100 @ A3

Dwg No.: 2022-026-06 Rev: -

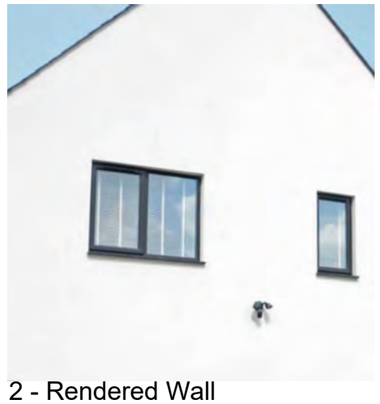
FRONT ELEVATION - MATERIAL STUDY
NOT TO SCALE



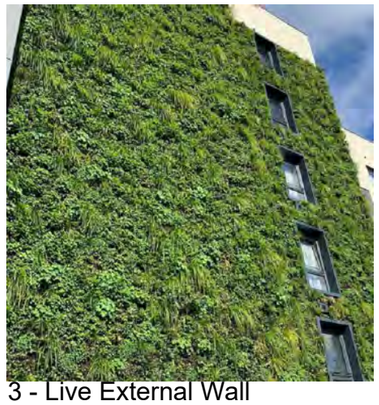
REAR ELEVATION - MATERIAL STUDY
NOT TO SCALE



1 - Zinc Cladding
Anthracite Grey or Similar

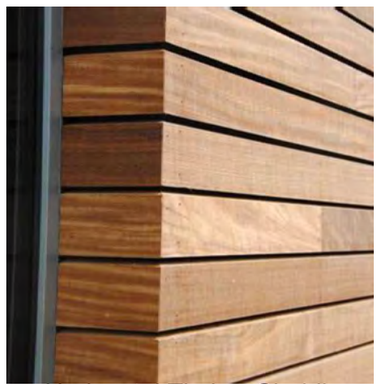


2 - Rendered Wall
White or Similar



3 - Live External Wall
Live Planting

4 - Powder Coated Aluminium Windows & Doors
Anthracite Grey or Similar



5 - Horizontal Timber Cladding
Western Red Cedar or Similar

GBS ARCHITECTURAL

T: 020 3384 9464 / E: info@gbs.co.uk / W: gbs.co.uk

Important Note

Whilst due care and attention is taken to ensure all surveys, drawings, dimensions and details provided are accurate, it is the Builders responsibility to check and verify all dimensions, details, levels and sewer invert levels on site prior to ordering any materials or commencing works. Should any discrepancies be found these should be relayed to the Architect immediately for review. Should these drawings be used without adequate site investigations and subsequent issues arise, liability will lie solely with the Builder.Do not scale off this drawing, work to figured dimensions only.This drawing must be read and checked with all structural and relevant specialist drawings.The Builder is to comply in all respects with the current Building Regulations and latest Codes of Practice.

Revisions

Rev	Date	Notes	Initial

Project

Client: Ernle Estates

Address: Land Between 60 & 66
Alwyne Road
London
SW19 7AE

Stage: Planning

Drawing

Title: ELEVATIONS

Drawn By:

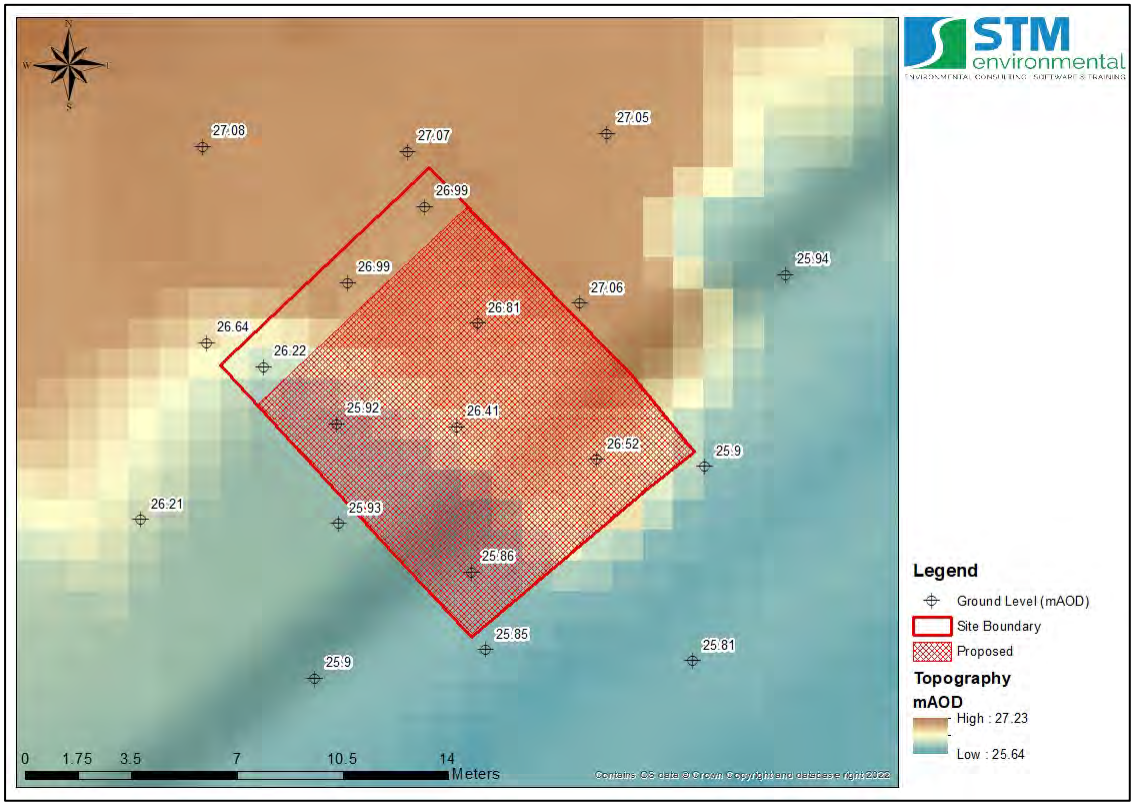
Date: JUN 22

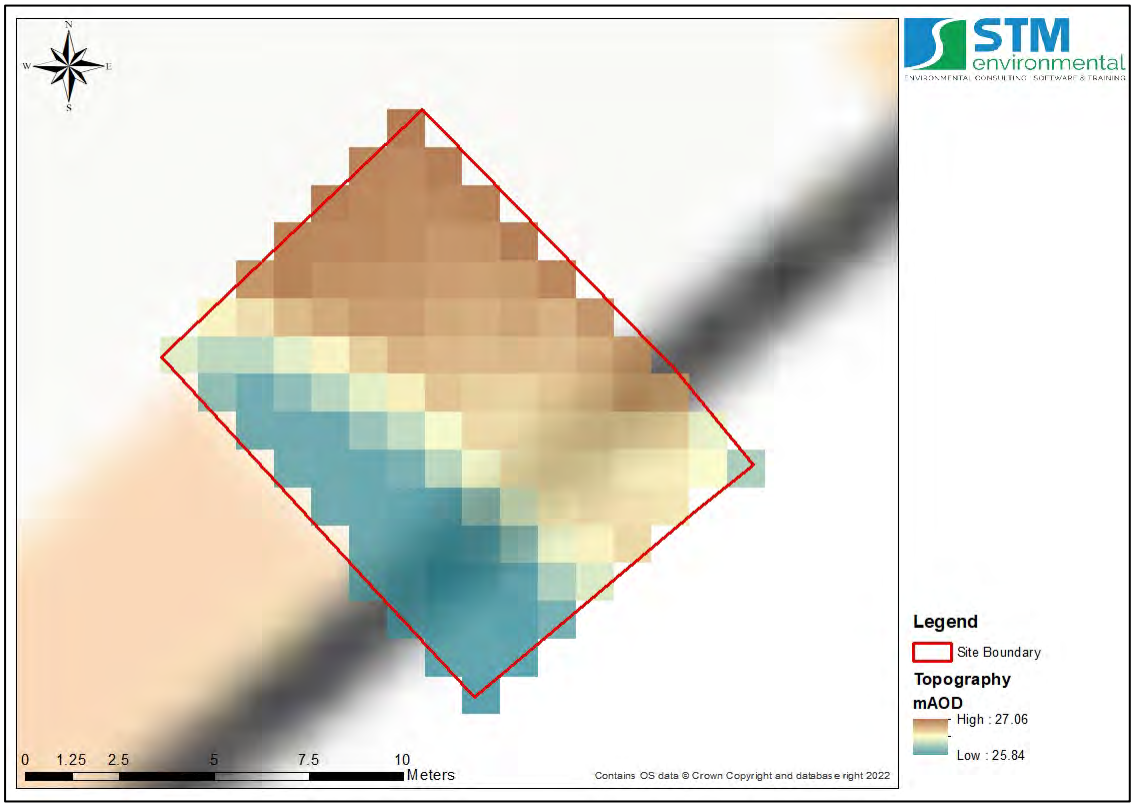
Scale: NTS @ A3

Dwg No.: 2022-026-07 Rev: -

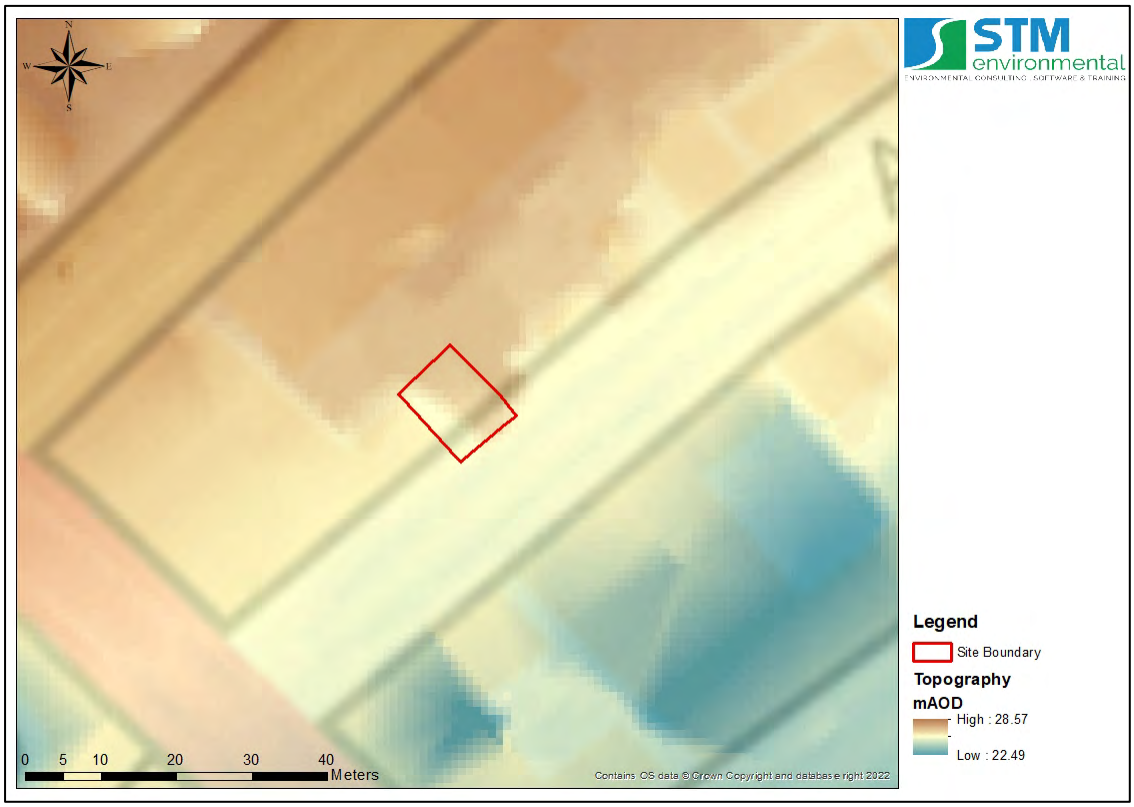
18.2 Appendix A2 – Site Topography and Drainage Characteristics

18.2.1 LIDAR Mapping showing Site Topography - (Source: OS 2017)

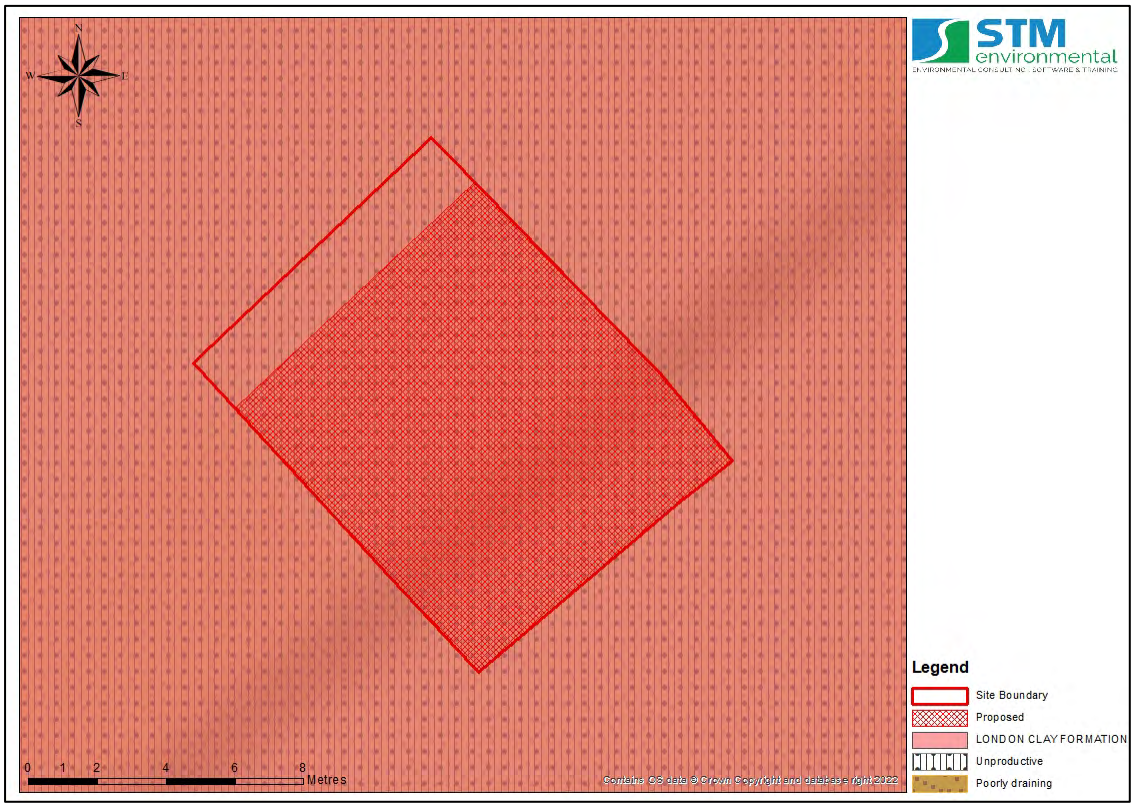




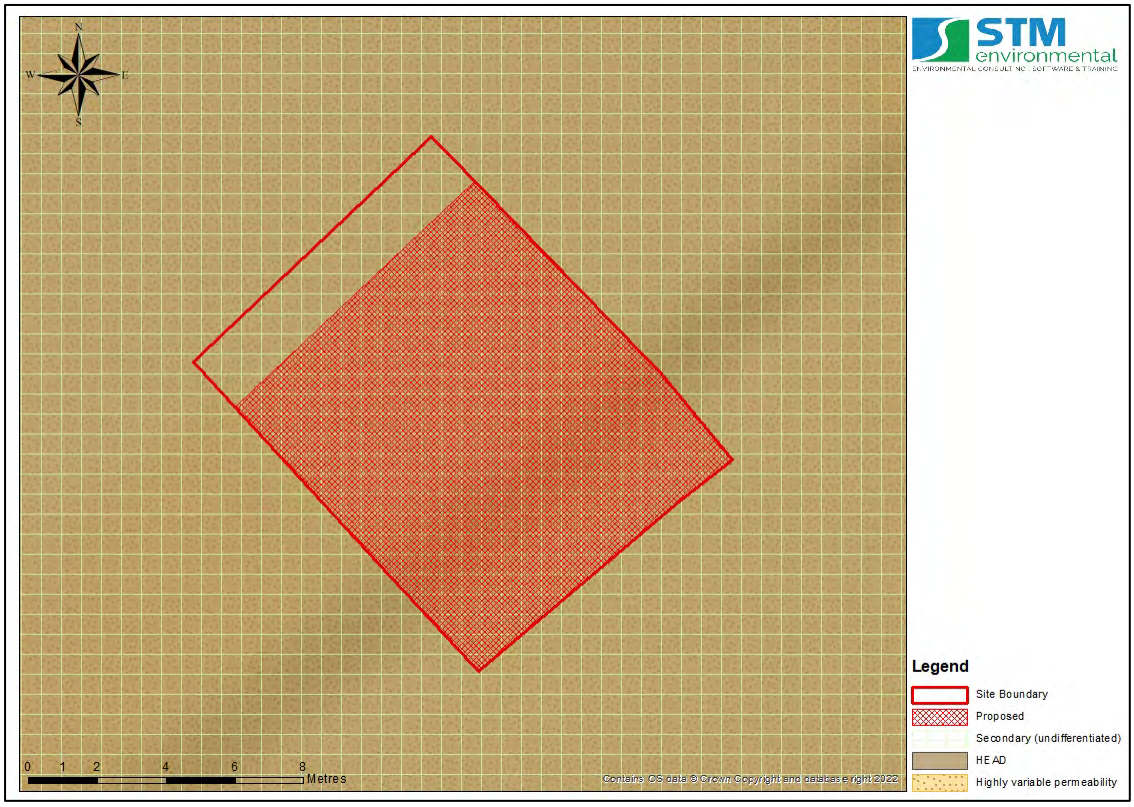
18.2.2 LIDAR Mapping showing Site Topography - (Source: OS 2017)



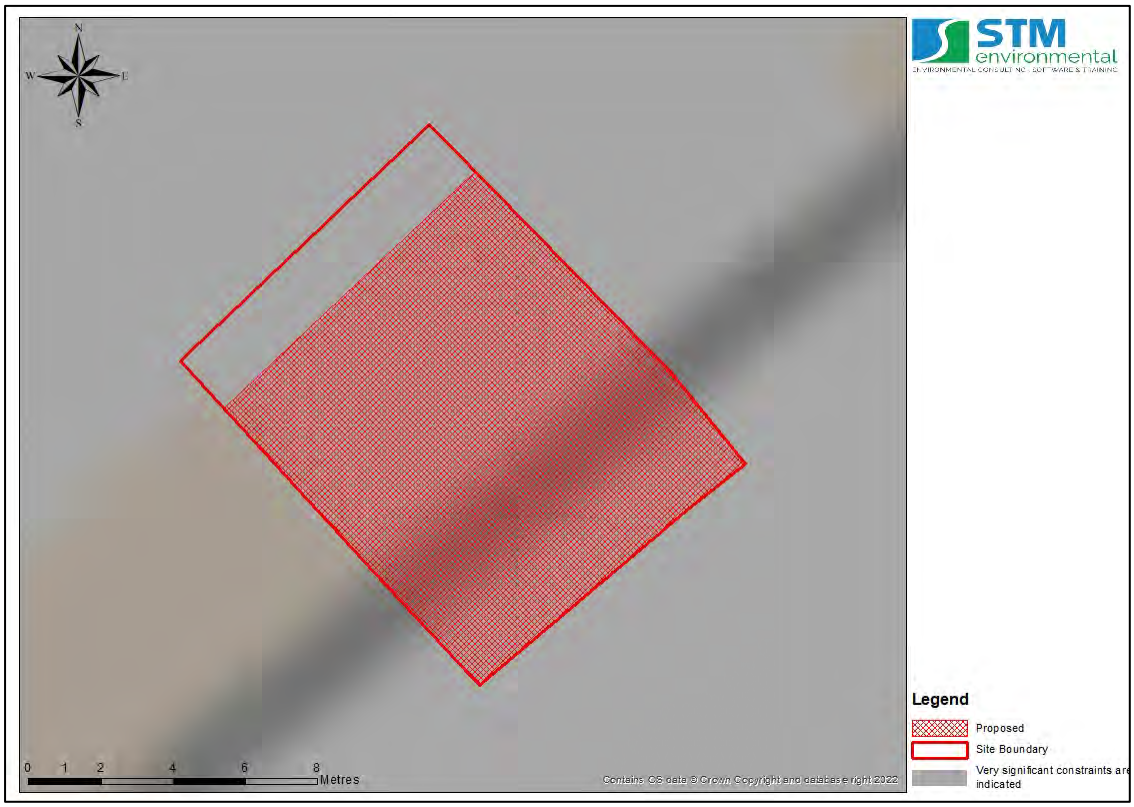
18.2.3 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



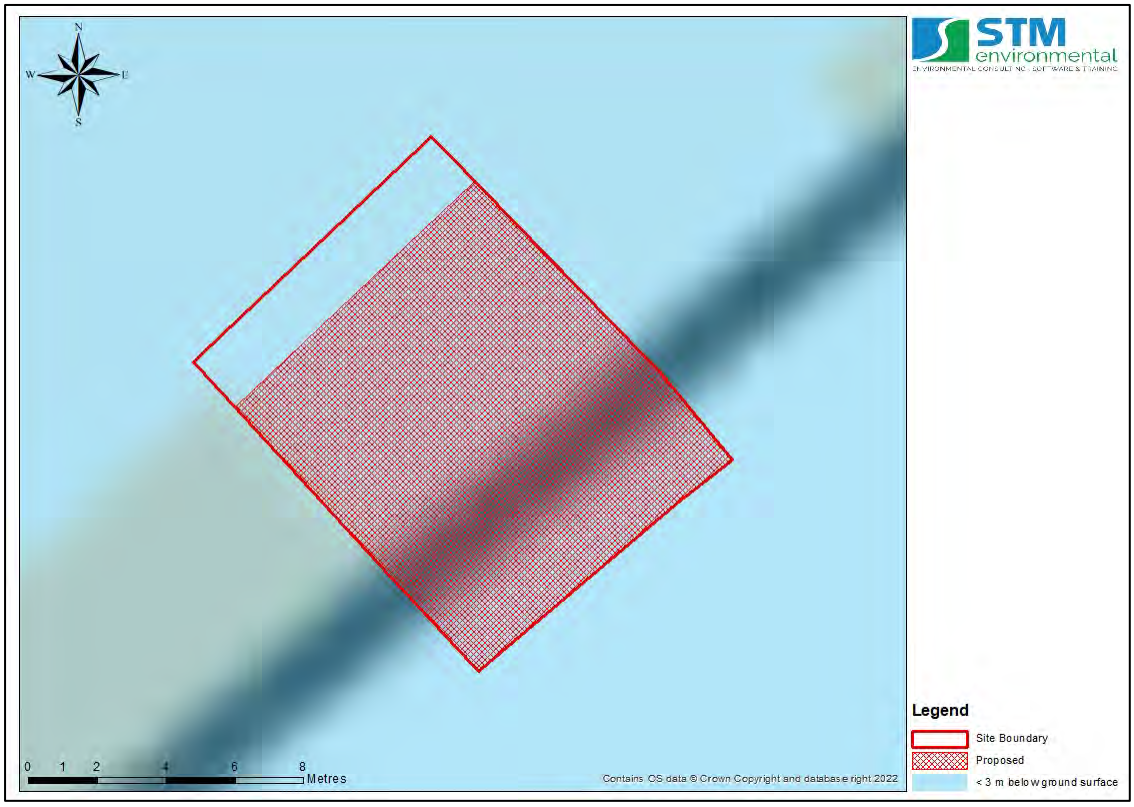
18.2.4 Superficial Hydrogeology & Permeability (Source: BGS, 2016)



18.2.5 Infiltration Drainage Potential (Source: BGS, 2016)



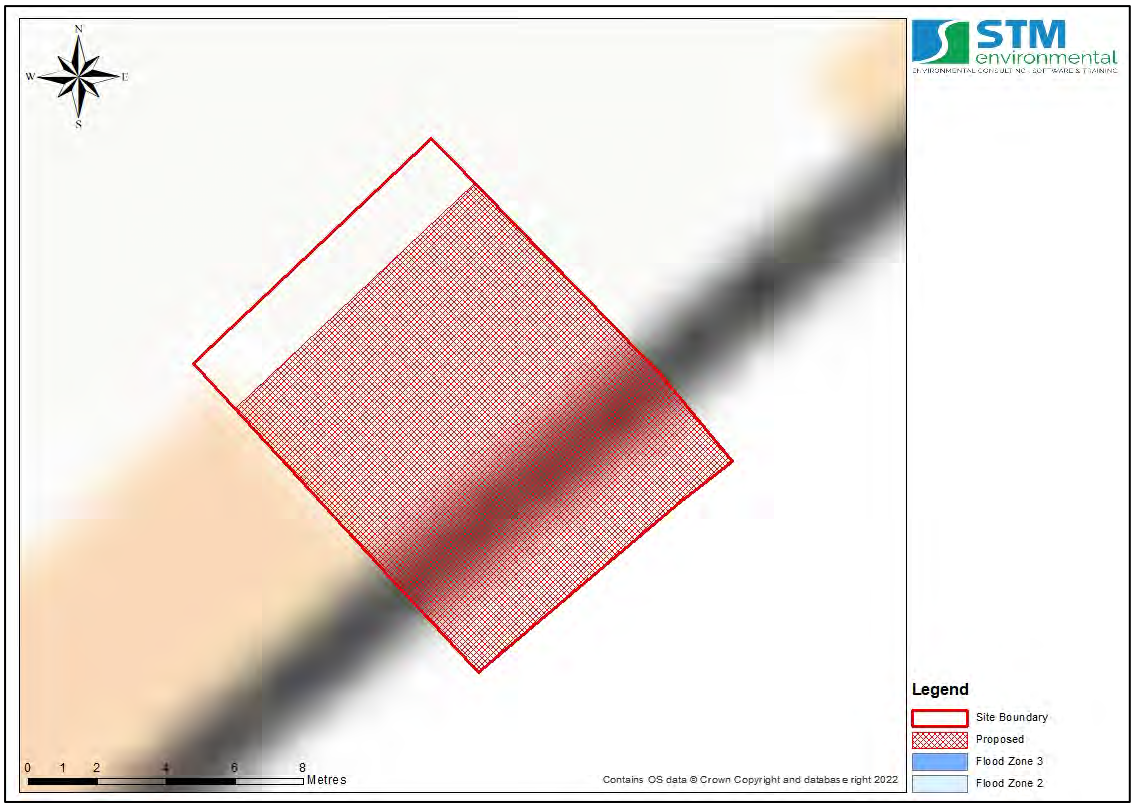
18.2.6 Groundwater Table Depth (Source: BGS 2016)



19 Appendices B – Flood Risk

19.1 Appendix B1 – Fluvial/Tidal Flood Risk Mapping

19.1.1 EA Flood Zone Map



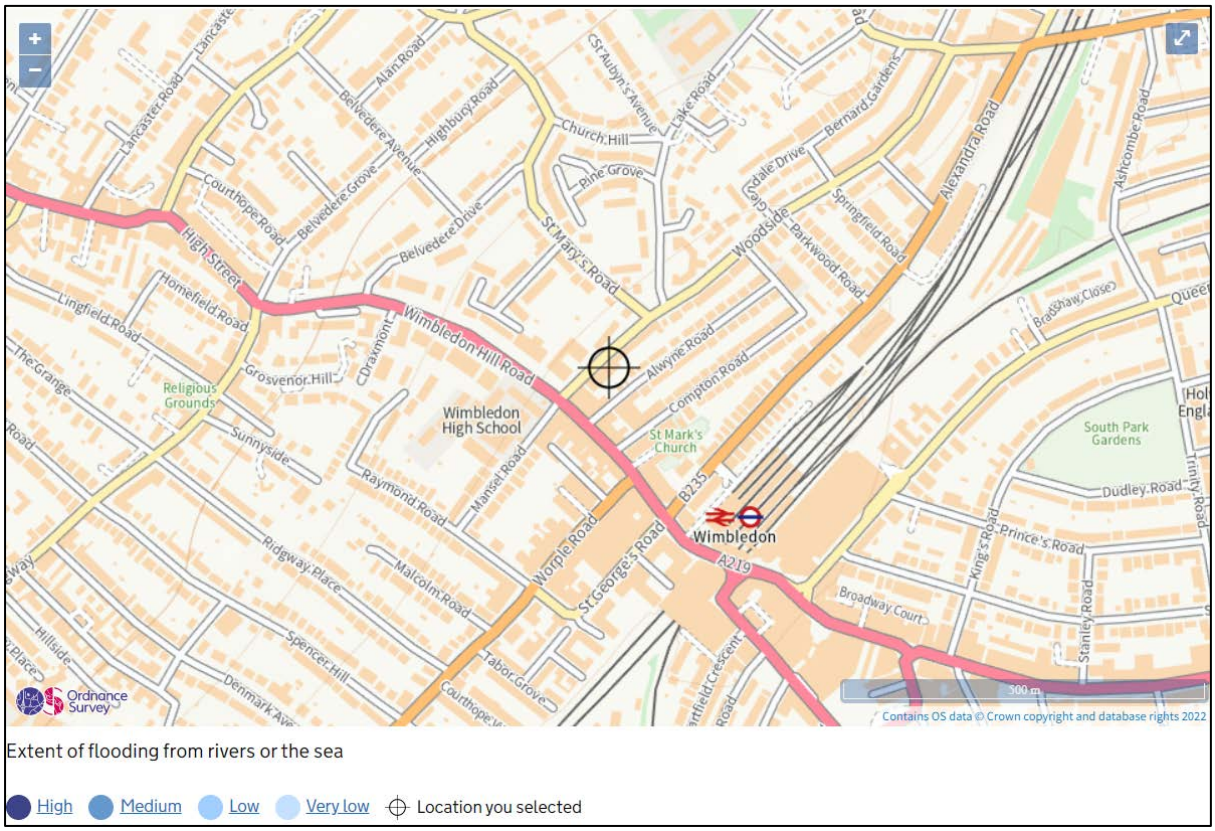
19.1.2 EA Historic and Recorded Flood Outlines

N.A. - No EA historic and recorded flooding identified in the vicinity of the site.

19.1.3 EA Flood Defence Map

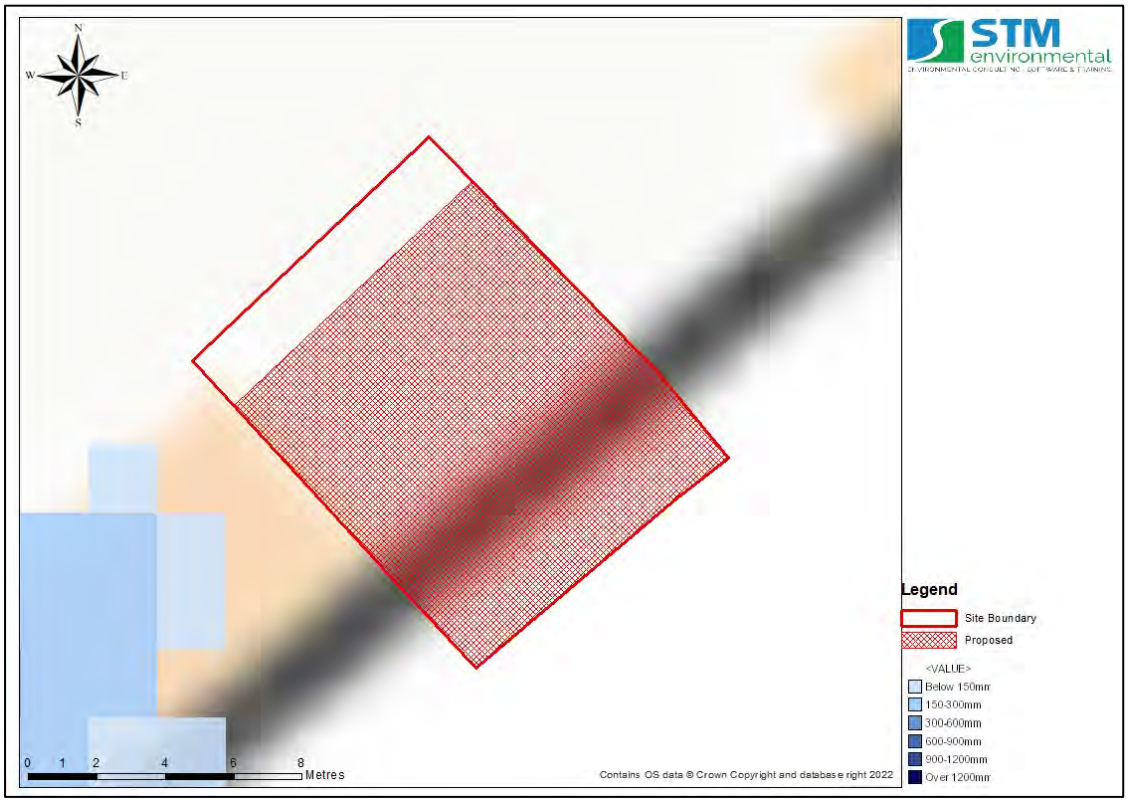
N.A. – No EA flood defences identified in the vicinity of the site.

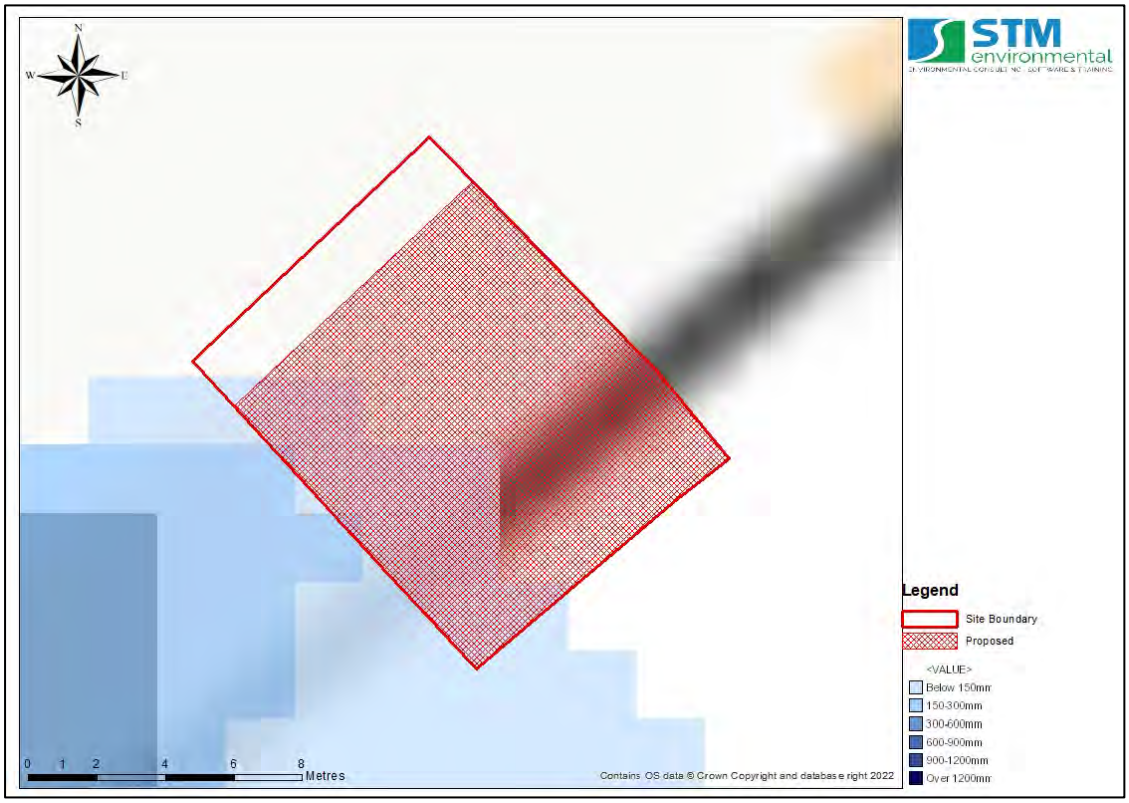
19.1.4 Long Term Fluvial Flood Risk Map (EA)



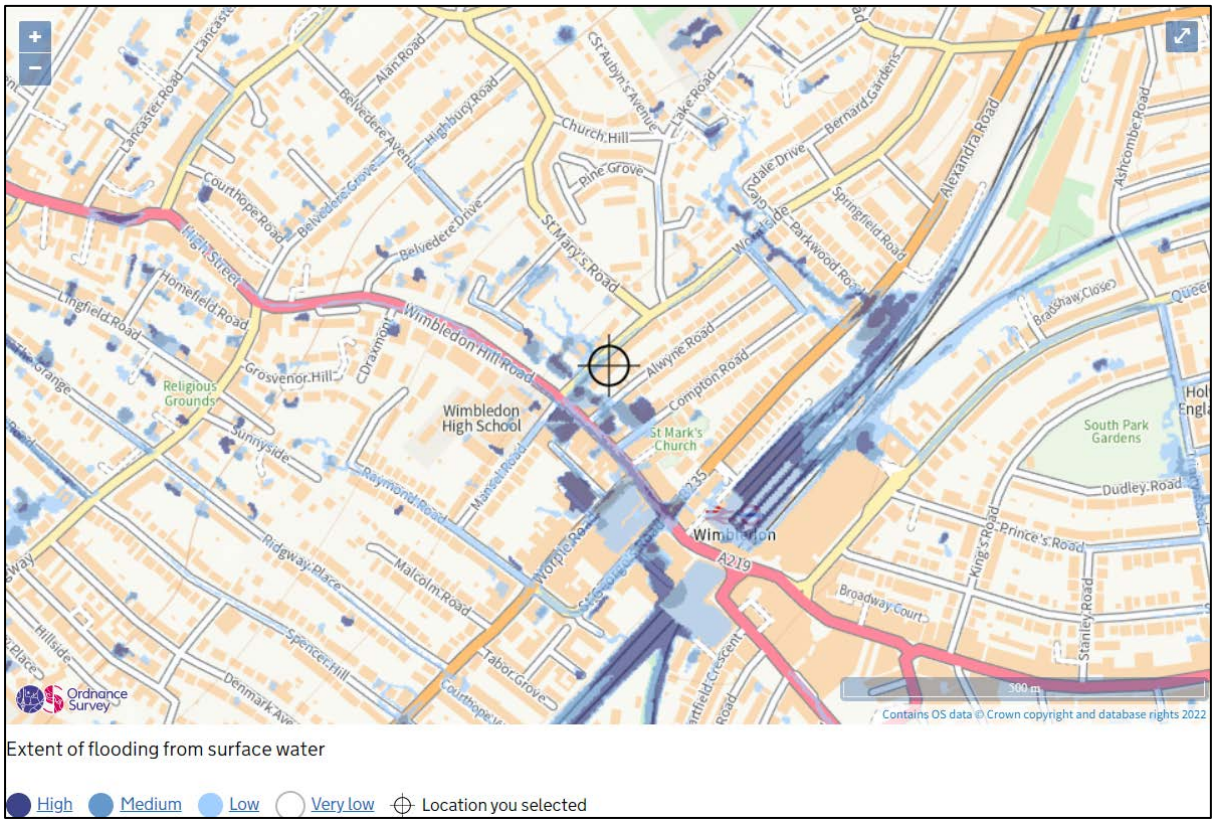
19.2 Appendix B2 – Pluvial Flood Risk Mapping

19.2.1 Surface water flood depth during the 1 in 100 and 1 in 1000-year rainfall return periods (Source: EA, 2016).





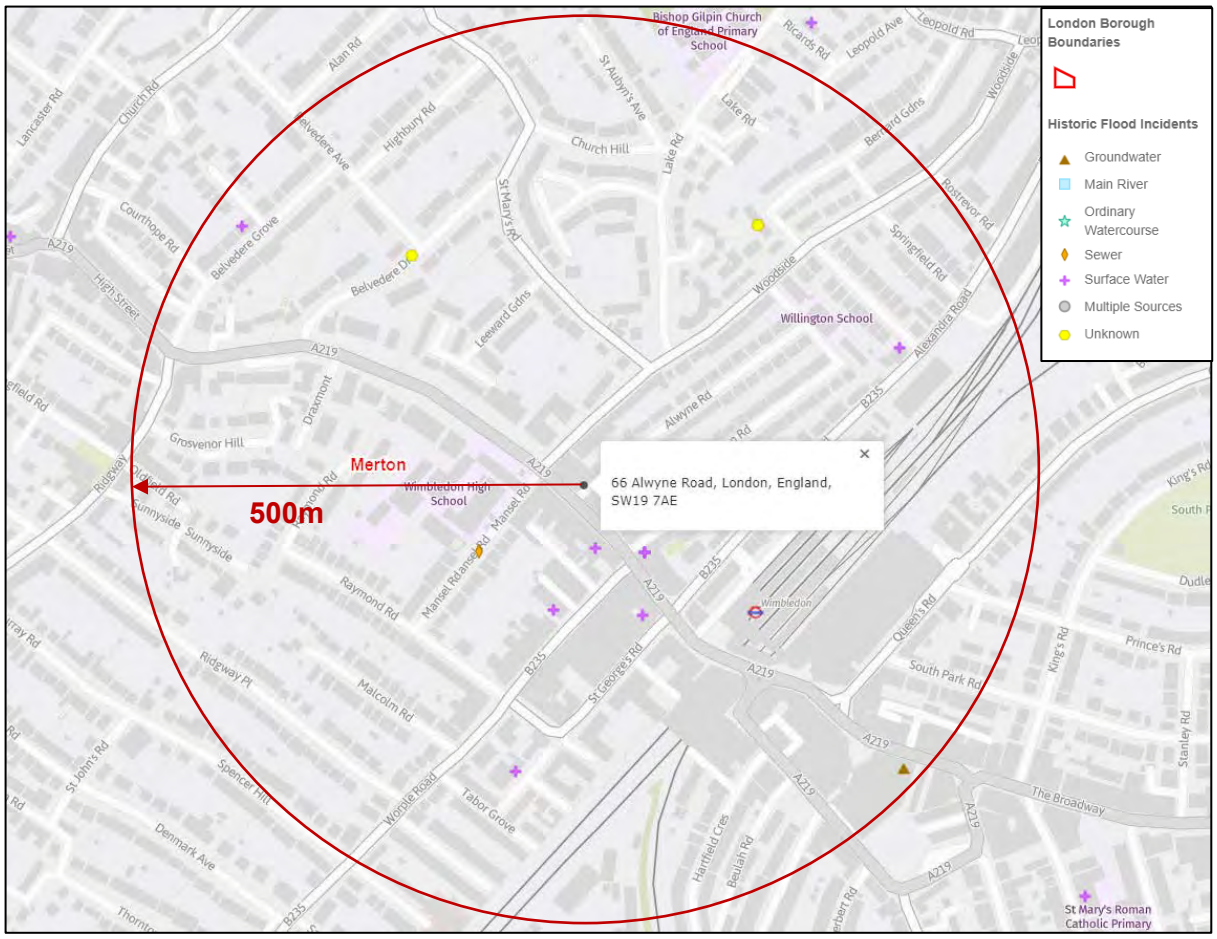
19.2.2 Long Term Pluvial Flood Risk Map (EA)



Extent of flooding from surface water

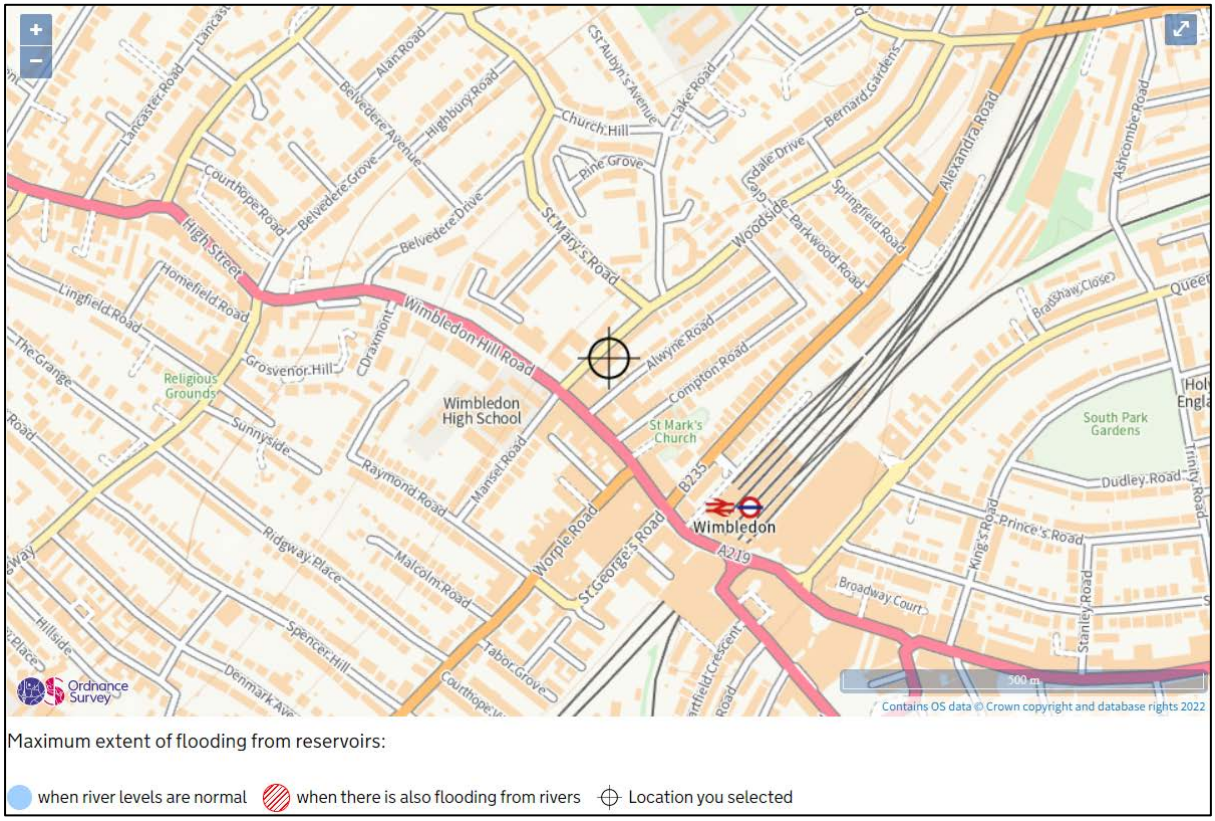
High Medium Low Very low Location you selected

19.2.3 Historic Flooding Incidents

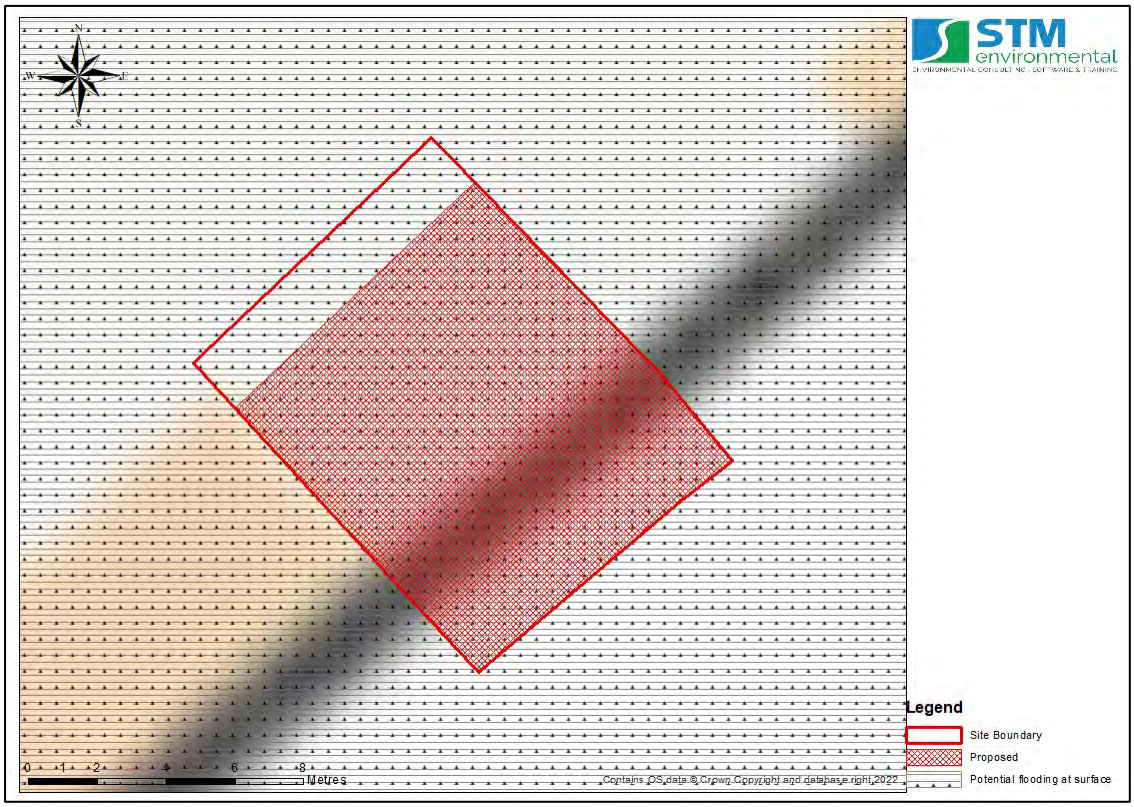


19.3 Appendix B3 – Artificial Sources, Groundwater and Sewer Flooding

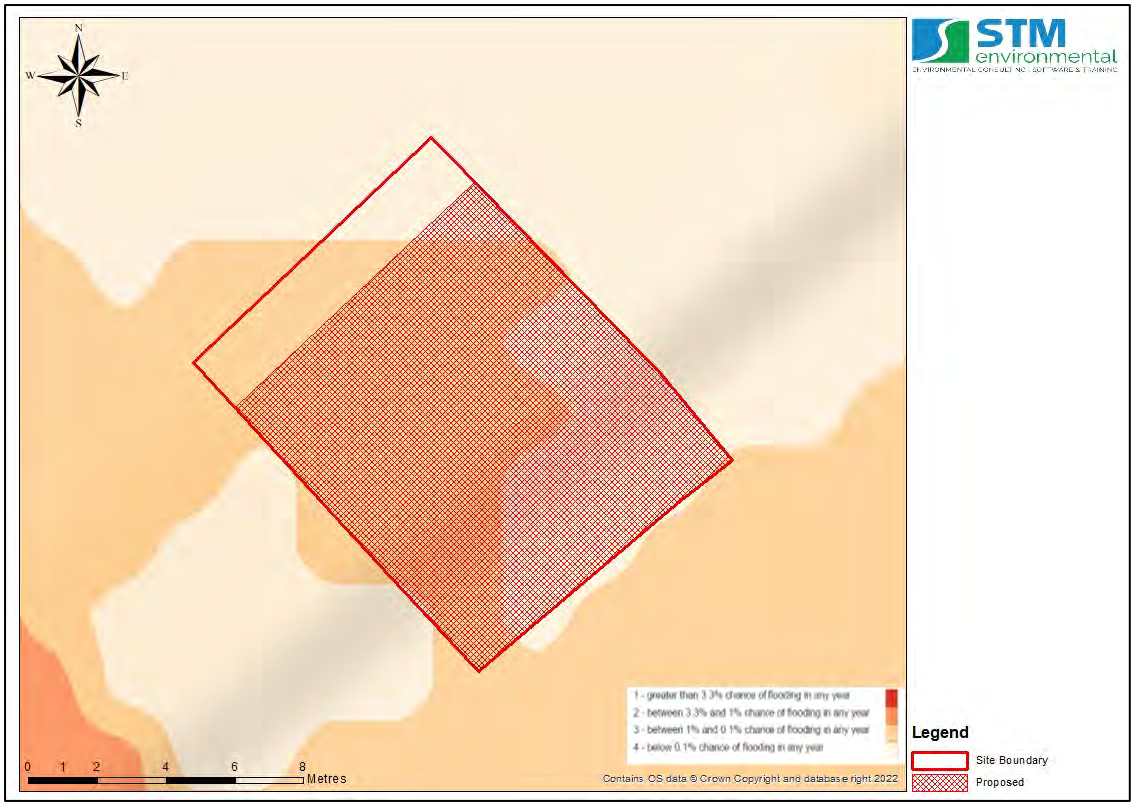
19.3.1 Long Term Reservoir Flood Risk Map (EA)



19.3.2 Groundwater Flooding Susceptibility (Source: BGS, 2016).



19.4 Appendix B4 – ROFFMS



19.5 Appendix B5 - Water Calculation of Flood Hazard Rating

Flood Hazard Rating Scores – based on DF score of 0

Velocity	Depth									
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.0**	**2.25**	**2.50**
0.0	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25
0.5	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
1.0	0.38	0.75	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75
1.5	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
2.0	0.63	1.25	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6.25
2.5	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50
3.0	0.88	1.75	2.63	3.50	4.38	5.25	6.13	7.00	7.88	8.75
3.5	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
4.0	1.13	2.25	3.38	4.50	5.63	6.75	7.88	9.00	10.13	11.25
4.5	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50
5.0	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38	13.75

Summary of Scores

	Score From	Score To	Flood Hazard	Description
	<0.75	0.75	Low	Exercise Caution
Class 1	0.75	1.5	Moderate	Danger for some
Class 2	1.5	2.5	Significant	Danger for most
Class 3	2.5	20.0	Extreme	Danger for all

Values for Debris Factor for different flood depths

Depths	Pasture/Arable Land	Woodland	Urban
0 to 0.25	0	0	0
0.25 to 0.75	0.5	1	1
d>0.75 and/or v > 2	0.5	1	1

20 Appendices C – Drainage

20.1 Appendix C1 – Thames Water / Asset Information

20.1.1 Asset Map

Asset location search

Property Searches

STM Environmental
TWICKENHAM
TW2 6RS

Search address supplied

66
Alwyne Road
London
SW19 7AE

Your reference 60-66 Alwyne Road

Our reference ALS/ALS Standard/2023_4783239

Search date 8 February 2023

Notification of Price Changes

From 1st April 2023 Thames water Property Searches will be increasing the prices of its CON29DW, CommercialDW Drainage & Water Enquiries and Asset Location Searches. Historically costs would rise in line with RPI but as this currently sits at 14.2%, we are capping it at 10%.

Customers will be emailed with the new prices by January 1st 2023.

Any orders received with a higher payment prior to the 1st April 2023 will be non-refundable. For further details on the price increase please visit our website at www.thameswater-propertysearches.co.uk

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

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

0800 009 4540

Asset location search

Property Searches

Search address supplied: 66, Alwyne Road, London, SW19 7AE

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

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

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

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

Asset location search

Thames Water Property Searches

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

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

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

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

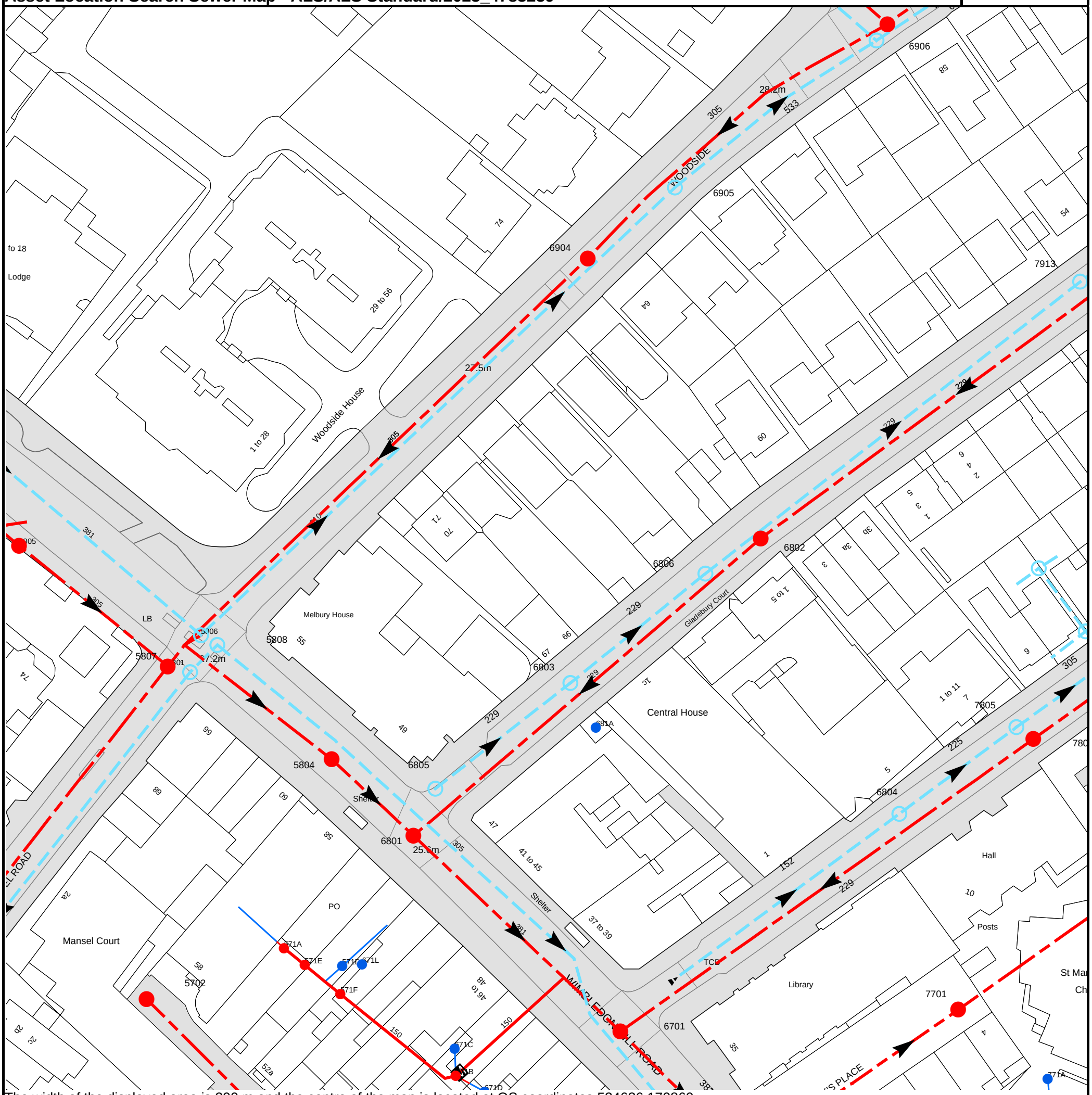
Clean Water queries

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

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

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

Asset Location Search Sewer Map - ALS/ALS Standard/2023_4783239



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 524636,170860

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
6904	27.67	24.47
6905	27.78	24.99
6802	25.84	22.85
6906	28.38	24.87
6901	28.48	24.73
7913	n/a	n/a
771A	n/a	n/a
6701	24.31	20.43
7701	24.04	18.38
6804	24.57	23.63
7803	24.75	21.1
7805	24.76	22.34
78AJ	n/a	n/a
6806	n/a	n/a
78AI	n/a	n/a
5807	26.93	25.69
5806	27.12	25.52
5808	26.88	25.89
571A	n/a	n/a
571E	n/a	n/a
5804	26.05	22.99
571F	n/a	n/a
571D	n/a	n/a
671L	n/a	n/a
6801	25.48	22.39
6805	n/a	n/a
671C	n/a	n/a
671B	n/a	n/a
6803	25.71	n/a
681A	n/a	n/a
5702	25.35	24.68
5801	27.12	23.87
5805	28.49	25.74

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

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

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

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

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

Sewer Fittings

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

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

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- Weir

End Items

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

- Inlet
- Outfall
- Undefined End

Other Symbols

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

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

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

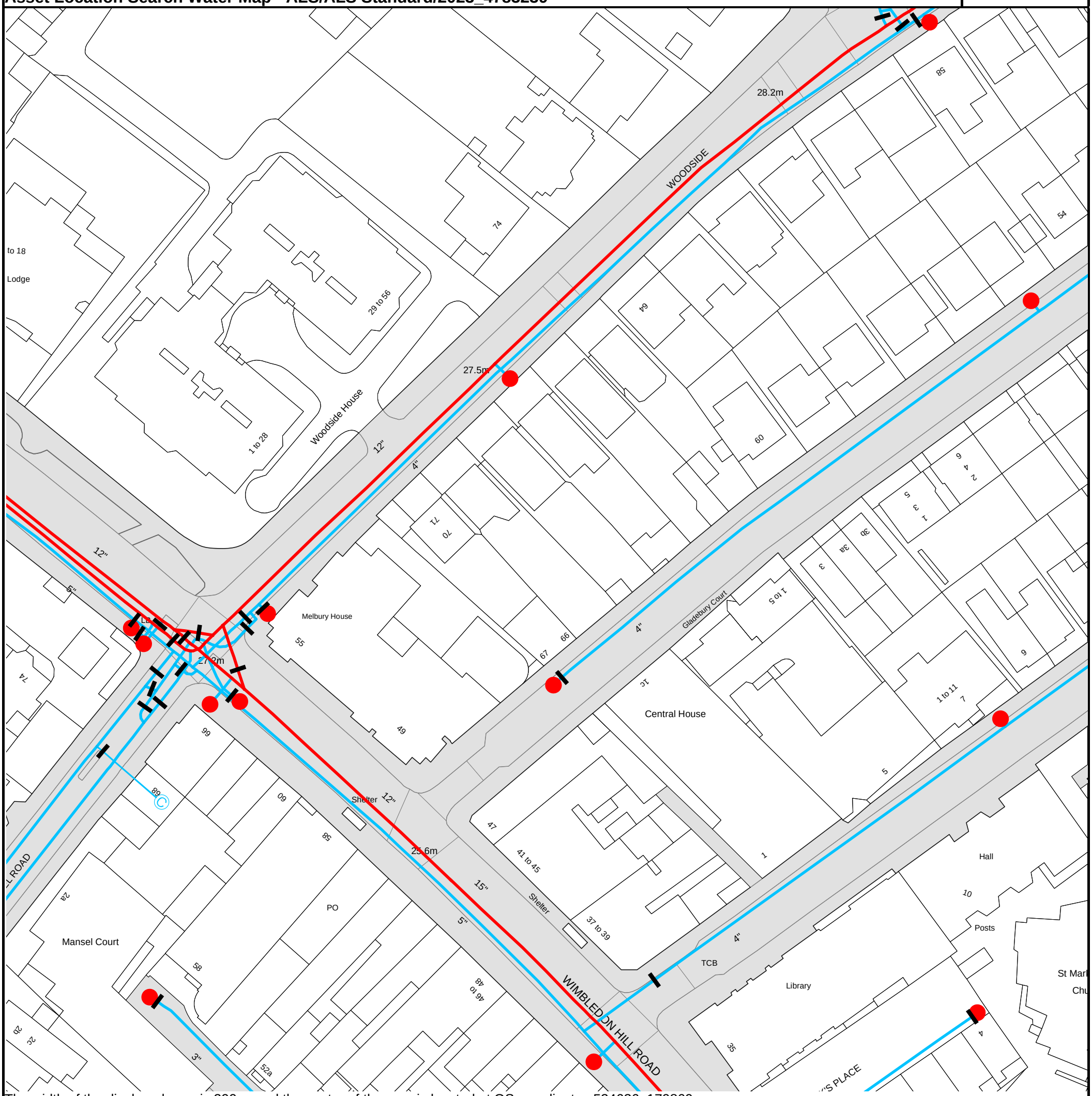
- Casement — Ducts may contain high voltage cables. Please check with Thames Water.
- Conduit Bridge
- Subway
- Tunnel

Notes:

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

If you are unsure about any text or symbology, please contact Property Searches on 0800 009 4540.

Asset Location Search Water Map - ALS/ALS Standard/2023_4783239



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 524636, 170860.

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

Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

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

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

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

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

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

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

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

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

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

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

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger
- **Casement:** Ducts may contain high voltage cables. Please check with Thames Water.

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

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

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

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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.

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

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

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Ways to pay your bill

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

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20.2 Appendix C2 – Run-Off Rate and Storage Calculations

20.2.1 UK SuDS

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Matthew Ashdown
Site name:	66 Alwyne Road
Site location:	SW19 7AF

This is an estimation of the storage volume requirements that are needed to meet normal
best practice criteria in line with Environment Agency guidance "Rainfall runoff management
for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and
the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design
of drainage systems. It is recommended that hydraulic modelling software is used to calculate
volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.42320° N
Longitude:	0.20826° W
Reference:	1090582460
Date:	Feb 08 2023 13:29

Site characteristics

Total site area (ha):	0.012
Significant public open space (ha):	0
Area positively drained (ha):	0.012
Impermeable area (ha):	0.012
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.02
Net impermable area for storage volume design (ha):	0.01
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.4
Urban creep allowance factor:	1.1
Volume control approach	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	101.64
FEH / FSR conversion factor:	1.32	1.32
SAAR (mm):	604	604
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.02	0.02
Q_{BAR} for net site area (l/s):	0.03	0.03

Site discharge rates	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes	Default	Edited
Attenuation storage 1/100 years (m^3):	1	1
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	1	1

Print | Close Report

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Georgia Travers
Site name:	Land Between 60-66
Site location:	Alwyne Road SW19 7AF

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.42302° N
Longitude:	0.20859° W
Reference:	3506270976
Date:	Dec 19 2022 15:34

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.0121

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	604	604
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

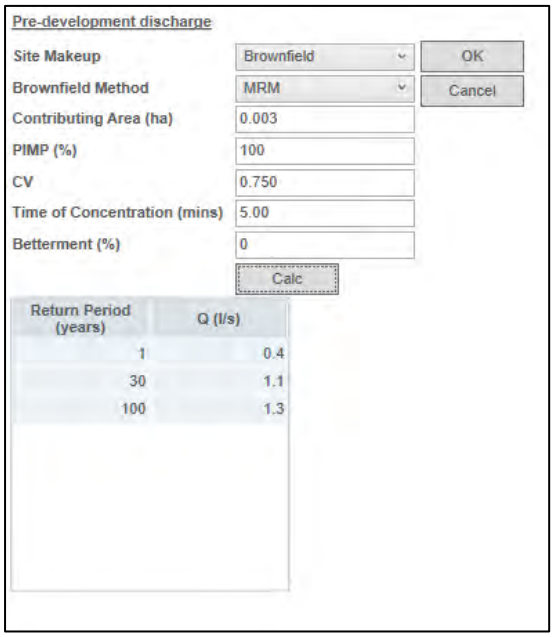
Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	0.02	0.02
1 in 1 year (l/s):	0.02	0.02
1 in 30 years (l/s):	0.04	0.04
1 in 100 year (l/s):	0.06	0.06
1 in 200 years (l/s):	0.07	0.07

20.2.2 IH124 method

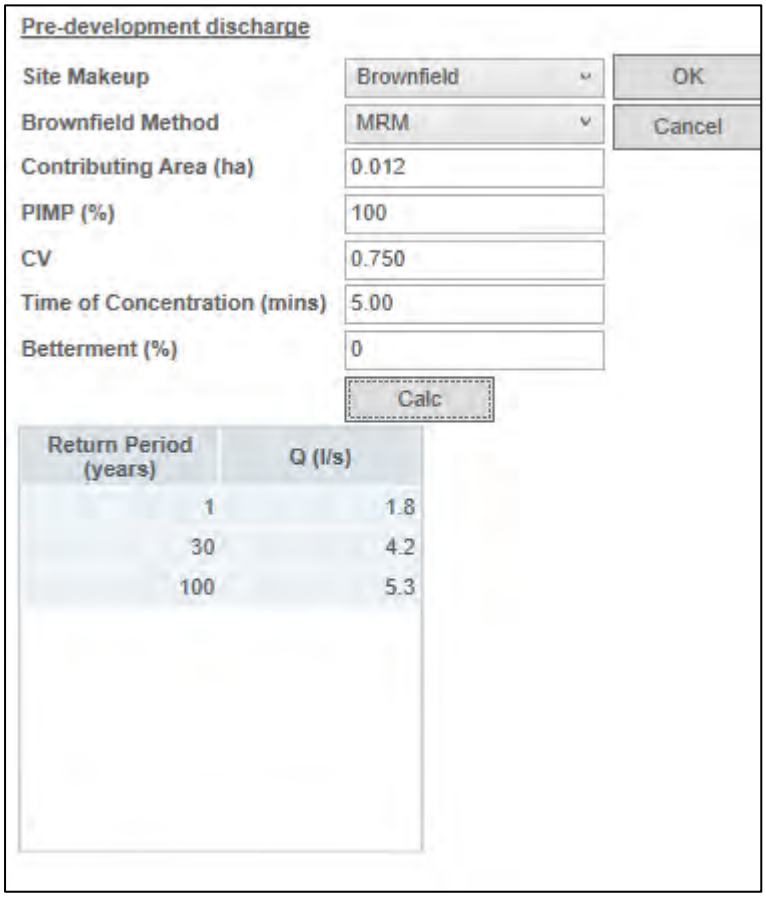
Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	0.0870	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	0.2992	
SAAR(mm) - Current	604.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.2122	
SAAR (mm) + CC	845.60		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	4.5831	
SPR (Greenfield)	0.30		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	0.0381	
SPR (Impermeable)	0.53		Volume of Storage Required to meet 3 * Greenfield Discharge - Difference between Proposed Development and 3 * Greenfield 1 in 100 +CC (m3)	0.8236	
Site Area (ha)	0.0120				
Impermable Area (Pre Development - ha)	0.00350				
Permeanble Area (Pre Development - ha))	0.0085000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermable Area (Post Development - ha)	0.0120000	Qbar	0.02	0.03	0.06
Permeanble Area (Post Development - ha)	0.0000000	1 in 1	0.02	0.03	0.05
GCF (1 in 1)	0.85	1 in 30	0.04	0.07	0.15
GCF (1 in 30)	2.30	1 in 100	0.06	0.10	0.20
GCF (1 in 100)	3.19	1 in 100 + CC	0.09	0.15	0.30
Hyrdological Region	6				
Soil Type	2				
Rainfall 100 Yrs 6 hours mm	63				

GREENFIELD RUN-OFF	QBAR50	Run-Off Rate l/s	l/s/ha (QBarA)	3 times greenfield (l/s)	Volume (6 hr) - Standard (m3)
Qbar	76.6785	0.0184	1.5336		
1 in 1		0.0156	1.3035	0.0469	0.3379
1 in 30		0.0423	3.5272	0.1270	0.9143
1 in 100		0.0587	4.8921	0.1761	1.2680
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	113.6693	0.0273	2.2734	0.0818	0.5893
1 in 1 +CC		0.0232	1.9324	0.0696	0.5009
1 in 30 + CC		0.0627	5.2288	0.1882	1.3553
1 in 100 + CC		0.0870	7.2521	0.2611	1.8797
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBarA)			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	263.6325	0.0185	5.2726	0.0554	0.3986
1 in 1		0.0157	4.4818	0.0471	0.3388
1 in 30		0.0424	12.1271	0.1273	0.9168
1 in 100		0.0589	16.8198	0.1766	1.2716
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	76.6785	0.0130	#DIV/0!	0.0391	
1 in 1		0.0111	#DIV/0!	0.0332	0.2393
1 in 30		0.0300	#DIV/0!	0.0899	0.6476
1 in 100		0.0416	#DIV/0!	0.1247	0.8982
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	340.3109	0.0315	#DIV/0!	0.0945	0.3986
1 in 1		0.0268	#DIV/0!	0.0803	0.5781
1 in 30		0.0724	#DIV/0!	0.2173	1.5644
1 in 100		0.1005	#DIV/0!	0.3014	2.1698
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	390.8127	0.0274	2.2797		0.5909
1 in 1 +CC		0.0233	1.9378		0.5023
1 in 30 + CC		0.0629	5.2434		1.3591
1 in 100 + CC		0.0873	7.2724		1.8850
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	113.6693	0.0193	#DIV/0!	0.0580	
1 in 1 +CC		0.0164	#DIV/0!	0.0493	0.3548
1 in 30 + CC		0.0444	#DIV/0!	0.1333	0.9600
1 in 100 + CC		0.0616	#DIV/0!	0.1849	1.3315
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	504.4820	0.0467	#DIV/0!	0.0580	0.5909
1 in 1 +CC		0.0397	#DIV/0!	0.0493	0.8571
1 in 30 + CC		0.1074	#DIV/0!	0.1333	2.3191
1 in 100 + CC		0.1489	#DIV/0!	0.1849	3.2165
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBarA)			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	263.6325	0.0633	5.2726	0.1898	
1 in 1		0.0538	4.4818	0.1613	1.1617
1 in 30		0.1455	12.1271	0.4366	3.1433
1 in 100		0.2018	16.8198	0.6055	4.3597
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	76.6785	0.0000	#DIV/0!	0.0000	
1 in 1		0.0000	#DIV/0!	0.0000	0.0000
1 in 30		0.0000	#DIV/0!	0.0000	0.0000
1 in 100		0.0000	#DIV/0!	0.0000	0.0000
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	340.3109	0.0633	#DIV/0!	0.1898	
1 in 1	0.0000	0.0538	#DIV/0!	0.1613	1.1617
1 in 30	0.0000	0.1455	#DIV/0!	0.4366	3.1433
1 in 100	0.0000	0.2018	#DIV/0!	0.6055	4.3597
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	390.8127	0.0938	7.8163		2.0260
1 in 1 +CC		0.0797	6.6438		1.7221
1 in 30 + CC		0.2157	17.9774		4.6597
1 in 100 + CC		0.2992	24.9339		6.4629
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	113.6693	0.0000	#DIV/0!	0.0000	
1 in 1 +CC		0.0000	#DIV/0!	0.0000	0.0000
1 in 30 + CC		0.0000	#DIV/0!	0.0000	0.0000
1 in 100 + CC		0.0000	#DIV/0!	0.0000	0.0000
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	504.4820	0.0938	#DIV/0!	0.0000	2.0260
1 in 1 +CC		0.0797	#DIV/0!	0.0000	1.7221
1 in 30 + CC		0.2157	#DIV/0!	0.0000	4.6597
1 in 100 + CC		0.2992	#DIV/0!	0.0000	6.4629

20.2.3 Modified Rational Calculation – Predevelopment Scenario



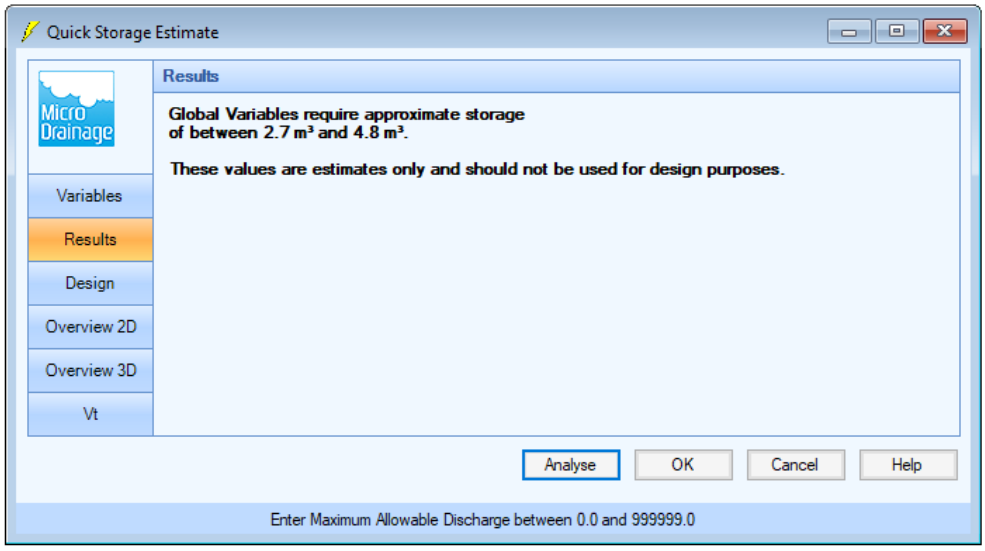
20.2.4 Modified Rational Calculation – Post - development Scenario

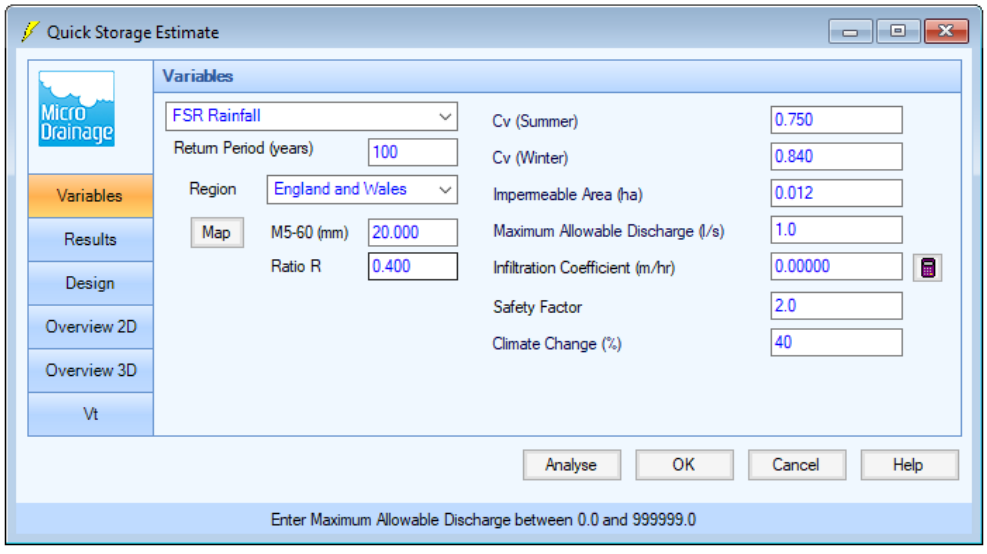


20.2.5 Attenuation Requirements

Pre-development discharge

Site Makeup	Brownfield	OK
Brownfield Method	MRM	Cancel
Contributing Area (ha)	0.012	
PIMP (%)	100	
CV	0.750	
Return Period (years)	100	
Climate Change (%)	40	
Storm Duration (mins)	360	
Betterment (%)	0	
	Calc	
PR	0.750	
Runoff Volume (m³)	8	





20.3 Appendix C3 - Site Investigation

20.3.1 Site Investigation Photos

20.4 Appendix C4 – SuDS Suitability Assessment

20.4.1 SuDS Suitability Table

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
Rainwater Harvesting	Capture of rainwater into a tank(s) for use (usually non-potable) such as irrigation, toilet flushing, vehicle or plant cleansing.	Care is needed to prevent the development of bacteria, algae and insect infestation.	Suitable on small scale for interception storage
Infiltration: Soakaways Infiltration Trenches and Basins	Infiltration components are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, into the groundwater.	Poorly draining clay bedrock. Potnetnial for geohazard. Maintenance	Unsuitable – Limited space.
Green/Brown /Blue Roofs	Used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater.	Maintenance - Ensuring safe access	Suitable
Rain Gardens	Creation of planted landscaped areas to allow the diversion of a portion of rainwater from either downpipes or surrounding paved surfaces. Raingardens can either allow infiltration into the ground or have tanked systems for water retention.	Require maintenance	Unsuitable
Permeable Pavements / Surfaces	Permeable hard surfaces that allow rainwater to pass through either into the ground or to tanked systems. Good as interception storage.	Potential impact of saturation on pavement stability to be considered. May require extensive use	Suitable

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
		of impermeable membranes and under-drainage. Maintenance required.	
Swales	Dry ditches used as landscape features to allow the storage and infiltration of rainwater. Often used as linear features alongside roads, footpaths or rail lines but capable of being integrated into the design of many open spaces.	Finding available space in proposed site layout	Unsuitable
Detention Basin/Ponds	Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.	Potential health and safety issues. Finding available space in proposed site layout	Unsuitable
Storage Tanks/ Geocellular Storage	Usually below ground level, they attenuate rainwater for later slow release back into the drainage system.	Pumping may sometimes be required to empty the tank into the drainage system	Suitable – limited space
Oversized Piping	Using larger than necessary pipework creates additional space to store rainwater.	Lacks the wider benefits of the green infrastructure-based techniques	Suitable

20.5 Appendix C5 – Descriptions Of SuDS Techniques

20.5.1 Living/Green Roofs

Green roofs are multi-layered vegetated systems, built on roof covers. These systems are designed to return the surface water runoff from a building to the sites pre-construction level, and can be built into new build or retrofitted and are suitable for any building with flat to gently sloping roofs providing the existing roof can take the required load.

Figure 3: Green roof at the Queen Elizabeth Olympic Park (University of East London)

The topographical variation is incorporated into the substrate depth. It varies between 75 and 200 mm to create varied microclimates and hydrological regimes increasing habitat heterogeneity.

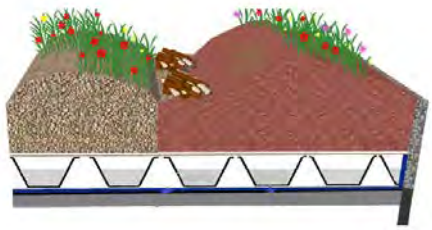


Figure 4: Biodiverse green roof diagram (University of East London)

Above the roof decking lies a standard waterproofing layer. The geocomposite drainage and water attenuation layers provide a water volume of 12 l/m^2. Geotextile filters are then places to act as root barriers and prevent sediments being released from the roof.

20.5.2 Living/Green Roofs - Product Example

Revision: 13/07/2018 – V1

PRODUCT DATA SHEET

Bauder SB Substrate Sedum Blanket

A British grown Sedum blanket produced on a fully bio-degradable coir mat carrier designed to be used over Bauder (FLL Compliant) Extensive Substrate.

Intended Use

Bauder SB Substrate Sedum Blanket is a mature vegetation blanket, sown with a broad variety of sedums. It is intended for application directly over Bauder FLL compliant, Extensive Substrate (see Product Data Sheet) as the underlying growing medium. The product is designed to enable rapid rooting to the substrate to speed up establishment times.

The SB Blanket is grown in the UK. Typically, it is not supplied until it is least one year old, this insures the root structure has developed, enabling it to cope with harvesting, transportation and relaying which can stress young sedum plants. The vegetation within this product is a broad mix of hardy sedum species.



PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	Unit	Value
Maximum saturated weight	kg/m²	≤ 24
Thickness	mm	30 to 40
Vegetation	Nos	Sown with 13 to 17 sedum species Species mixes are adjusted from time to time. Please contact Bauder Technical for more information.
Material		Substrate and sedum plants, grown on a Coir mat carrier. (100% Bio-degradable)
Typical supply size	m	1 x 2.4
Rolls per pallet	Rolls	Typically 20 rolls - Dependant on weight (40m²)
Pallets per articulated lorry	Pallets	26 pallets – Dependant on weight (1040m²)

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PRODUCT DATA SHEET

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany).
Recycled content	≥ 95% recycled material

INSTALLATION GUIDANCE

Normally installed directly onto the levelled substrate, it should be installed immediately on delivery, SB Blanket should only be layed by skilled operative. Care should be taken not to traffic the sedum during or after installation. See Bauder's Green Roof Installation Guide for full details.

The correct watering and aftercare is required for this product.

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Revision: 02/09/2019 – V2

PRODUCT DATA SHEET

Bauder (FLL Compliant) Extensive/Biodiverse/Intensive Substrate

Lightweight, free draining substrates designed as a growing medium for a range of different plant species.

Intended Use

This FLL/GRO compliant substrate provides a free draining, growing medium for green roof systems. It is a lightweight substrate designed for most vegetation (Sedum, Wildflower or Grass blankets, Specimen shrubs and trees, plug-plants or seed). Additionally, it provides aeration qualities with some inherent water retention.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE				
Characteristic	Unit	Extensive Value	Biodiverse Value	Intensive Value
Maximum saturated weight	kg/m³	≤1,200	≤1,200	≤1,250
Typical supply weight	kg/m³	c. 900	c. 950	c. 1,000
Water storage	By vol	35%	35%	35%
pH value	pH	6 - 8.5	6 - 8.5	6 - 8.5
Bulk bag size	m³	1.25	1.25	1.25
Small bag size	Litre	25	25	25
Material	Recycled crushed brick, expanded clay, shale, composted pine bark			

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	≥ 95% recycled material

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PRODUCT DATA SHEET

INSTALLATION GUIDANCE

Normally installed above a filter fleece and drainage board product. Substrates are raked out to give an even coverage of the required depth after settlement. See Bauder's Green Roof Installation Guide for full details.

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PRODUCT DATA SHEET

Bauder Filter Fleece

Fine mesh PP geotextile used in conjunction with Bauder substrates.

Intended Use

Bauder's Filter fleece is designed to separate and contain Bauder substrates from the drainage element of the green roof system. It prevents fine material from being washed out of the substrate layer.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	Test method	Unit	Value
Weight	DIN EN 1848-1	g/m²	125
Pore size	-	mm	0.13
Water storage	-	Litre/m²	0
Thickness	-	mm	1
Size (supplied in rolls)	-	m	1 or 2 x 100
Coverage	-	m²	100 or 200
Material	Polypropylene fleece		

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany).
Recycled content	Varied ≥10%

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PRODUCT DATA SHEET

INSTALLATION GUIDANCE

Normally installed to contain the substrate. The fleece should be taken up the sides of the substrate between the substrate and drainage trim or pebble margin. Fleece joints should be overlapped 150mm. Fleece should not be taken over the top of drainage outlets.

See Bauder's Green Roof Installation Guide for full details.

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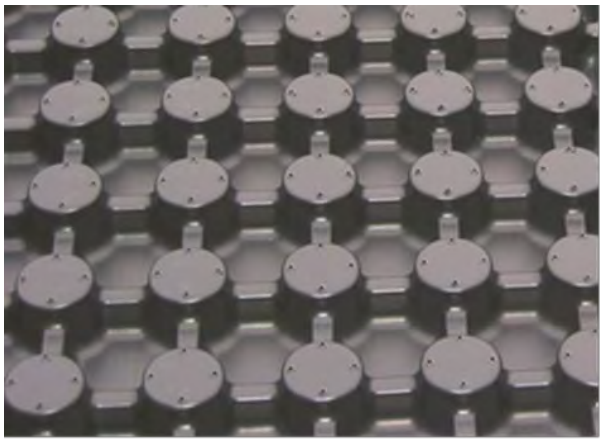
Revision: 30/08/2019 V2

PRODUCT DATA SHEET

Bauder DSE60 Drainage and Protection Layer

HDPE Water storage and multi-directional drainage layer. Used on roofs below 5⁰ pitch.



Intended Use

Provides a pressure resistant stable base for high loads or support for roof mounted equipment without compression to the drainage capacity. If DSE60 is filled with Bauder Mineral Drain, it provides a robust temporary finish able to accept site traffic, including vehicles.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	Test method	Unit	Value
Weight (dry)	EN 1848-1	Kg/m²	2
Weight (filled with mineral drain)		Kg/m²	51.9
Depth		mm	60
Capacity		l/m²	33
Water storage capacity		l/m²	17
Water Storage (when filled with mineral drain)		l/m²	10-12
Material			High density polyethylene
Board Size		m	0.975 x 1.975 (1.93 m²)
Coverage		m²	1.9

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% recycled high density polyethylene

INSTALLATION GUIDANCE

Normally installed over a protection layer, sheets are laid open cels down (as above) over entire areas. Butt up each sheet overlaping the lips. See Bauder's Green Roof Installation Guide for full details.

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Revision: 20/06/2019 – V5

PRODUCT DATA SHEET

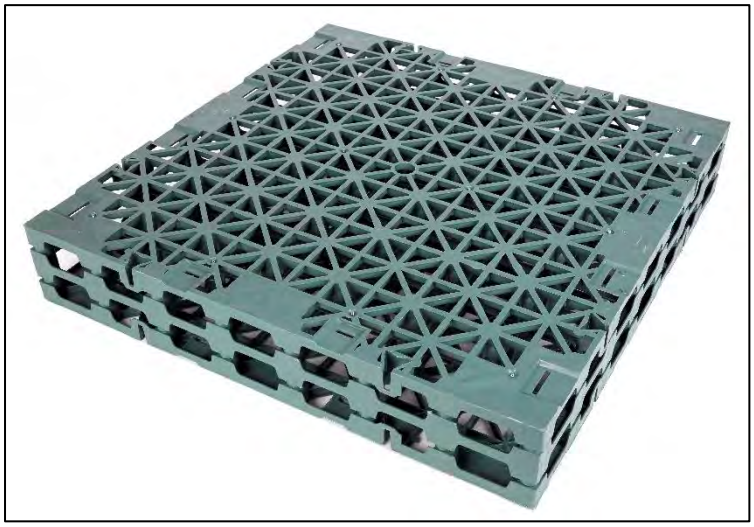
Bauder Attenuation Cell 100

Multi-directional drainage layer. Used primarily in Bauder Blue Roof Systems.

Intended Use

Designed to hold storm water during severe rain events. The product is over 95% void. It has excellent compressive strength for use under green roofs and hard landscaping surfaces. Attenuation Cell 100 is laid on a protection layer above the completed waterproofing to provide continuous drainage within hard and soft landscaping.

The Cross Connectors connect the cells together horizontally, the Shear connectors connect two layers of cells should they be required.



Attenuation Cell 100

Attenuation Cell Cross Connector - Deep

Attenuation Cell Shear Connector

ATTENUATION CELL PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	Test method	Unit	Value
Weight (dry)	-	Per piece	2.9
		kg/m²	8.05
Weight (saturated)	-	Per piece	2.9
		kg/m²	8.05
Water storage	-	m²	0.34 per piece (≥94.4%)
			Total capacity would be >91ltrs/m²
Compressive strength	EN ISO 10319	N/m²	≥400 KN/m² Vertically
			≥100 KN/m² Laterally
Depth	-	mm	100
Size	-	m	0.6 x 0.6
Approximate coverage	-	m²	0.36 (2.77 pieces per m²)

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Revision: 20/06/2019 – V5

PRODUCT DATA SHEET

ATTENUATION CELL CROSS CONNECTORS – DEEP / SHEAR CONNECTORS PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	Unit	Cross Connector – Deep Value	Shear Connector (vertical) Value
Weight	kg	0.1	0.08
Size	mm	40 x 25 x 23	40 x 25 diameter
Number per bag	Number	500	500
Minumum numbers of connectors per cell	N/m^2	2 (or as required)	1 (or as required)
Approximate coverage per bag	mm	$90m^2$ (based on 2 per cell)	$180m^2$ (based on 1 connector per cell)

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
DIBt DIN EN ISO 1183- 1 Plastic Density	0.95 g/cm^3 – 1.10 g/cm^3
RAL-GZ 994/11 Germany	RAL Deutsches Institut für Gütesicherung und Kennzeichnung e.V. and protected by registration with the German Patent and Trademark Office as a collective mark. Quality mark rainwater systems
Manufactured from	High Density Polypropylene (100% recycled material)

INSTALLATION GUIDANCE

Normally installed over a protection layer, cells are clipped together using cross conectors (ordered separately) to form a single layer over the entire blue roof area. If a second layer is required then shear connectors are required to connect the two layers.

See Bauder's Blue Roof Installation Guide for full details.

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Revision: January 2018

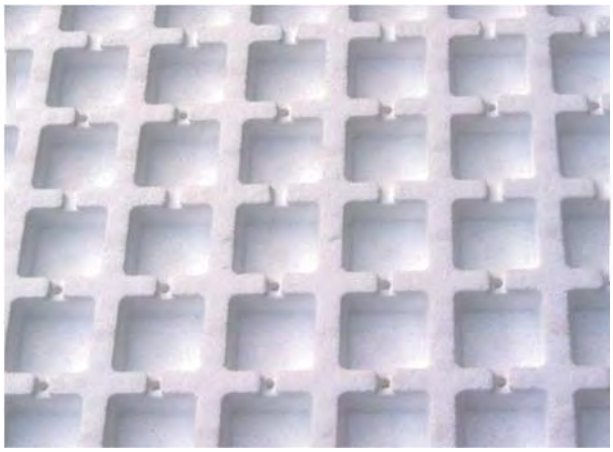
PRODUCT DATASHEET

Bauder Reservoir Board Drainage and Protection Layer

Water storage, multi-directional drainage layer. Used on roofs above 5º pitch.

Intended Use

Laid on to the completed waterproofing to provide continuous drainage and increased water capacity for the vegetation on pitched roofs. Also used in intensive roof systems.



PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	**Test method**	**Unit**	**Value**
Weight (dry)	DIN EN 1848-1	Kg/m²	0.65 or 0.95
Weight (saturated)		Kg/m²	10.65 or 22.45
Water Storage		Ltr	10 or 22.5
Depth		mm	50 or 75
Size		m	0.795 x 1,298 (rebated)
Coverage		m²	1

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany). ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany). ISO 50001: 2011 Energy Management Certificate 70499/03-15_c
Material	Expanded Polystyrene

INSTALLATION GUIDANCE
Normally installed with a protection layer, boards are laid over entire areas. Interlock each board. See Bauder's Green Roof Installation Guide for full details.

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Date: 10-11-2014

TECHNICAL DATA SHEET

Bauder Drainage Board

DESCRIPTION
Lightweight multidirectional drainage to allow for free dispersal of the water to the nearest outlet. Used within schemes where the growing medium is of sufficient depth to negate the need for additional water storage for the vegetation.

TECHNICAL DATA:
Composition

Material	expanded polystyrene – 15% recycled material

Weights and sizes

Standard width:	0.795 metre (rebated)
Standard length:	1.298 metres (rebated)
Coverage:	1m²
Thickness:	50mm
Weight:	ca. 0.65Kg/m²
Compressive strength	ca. 45kN/m²

Supply Form
Boards

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Revision: 02/09/2019 – V2

PRODUCT DATA SHEET

Bauder FSM 600 & FSM 1100 Protection Mat

Heavy duty protection layer made from polyester and polypropylene fibres. Supplied in two thicknesses.

Intended Use

Laid on the completed waterproofing to protect the completed waterproofing from mechanical damage.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE			
Characteristic	Unit	FSM 600 Value	FSM 1100 Value
Weight (dry)	kg/m²	0.6	1.1
Weight (saturated)	kg/m²	3.6	7.1
Water storage	Litre/m²	3	6
Thickness	mm	4	8
Size (supplied in rolls)	m	2 x 30	2 x 15
Coverage	m²	60	30
Material	-	Polyester and polypropylene fibre mix	

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
International Standards Organisation (ISO)	ISO 9001:2015 Quality Management Certificates EN1271 (UK) and 70499/03-15_e (Germany) ISO 14001:2015 Environmental Management Certificates A10552 (UK) and 70499/03-15_d (Germany) ISO 50001: 2011 Energy Management Certificate 70499/03-15_c (Germany)
Recycled content	100% - Polyester and polypropylene fibre mix

INSTALLATION GUIDANCE

Normally installed under the entire green roof are, but kept clear of all outlets and drainage trims. FSM mats should be lapped by 150mm at all joints.

See Bauder's Green Roof Installation Guide for full details.

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20.5.3 Permeable Paving

Various options are available for the type of permeable paving that can be installed. Permeable block paving allows for infiltration through gaps in the surface. This can be underlain by a geotextile membrane and fine gravel course followed by with a sub-base or geocellular crates as shown in the figures below.

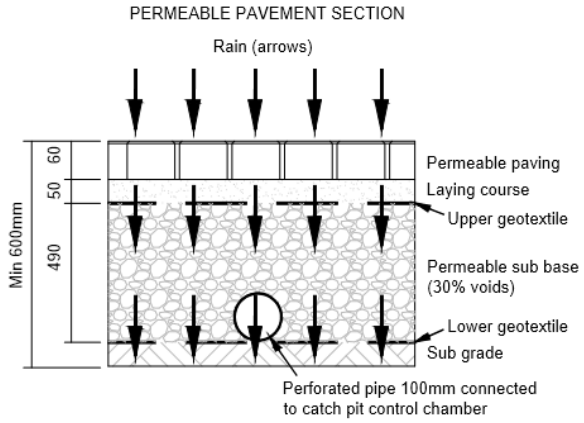


Figure 5: Block Permeable Paving with sub-base

The use of geocellular module storage provides structural strength (up to 400kN/m2) and high-water storage capacity with void space of 95%+.

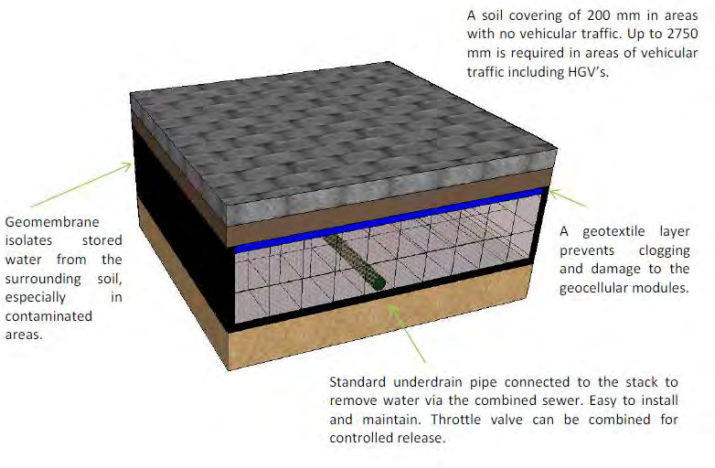


Figure 6: Block Permeable Paving with Geocellular Module

The plastic or concrete grid system is usually installed with a depth of 40 mm, with gaps between filled with an appropriate planting soil and seeded with a turf mix.

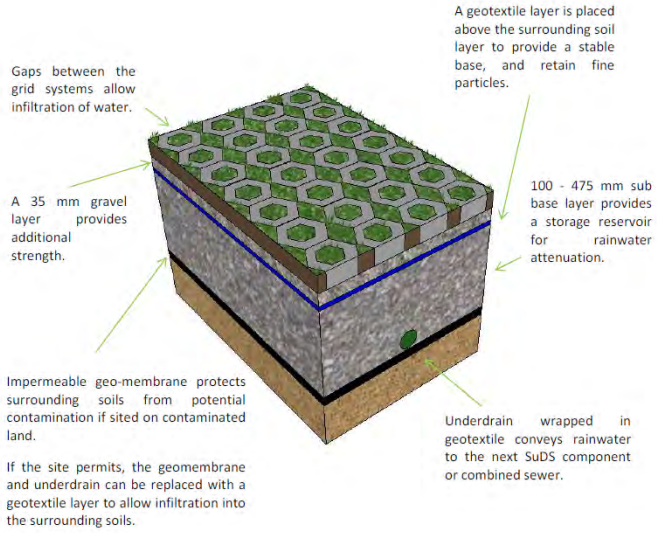


Figure 7: Plastic or Grid Permeable Paving with Sub-base

20.5.4 SuDs Planter Storage Volume/Rain water Harvesting Systems

SuDs planters are an innovative way of increasing the water attenuation, additionally providing an opportunity to green areas where is not practical to remove or break up permeable surfaces. With excellent retro-fit potential SuDs planters can be designed to receive rain water from a drainpipe or other inlet or simply used to receive rainwater falling on them. SuDS planters are best placed where they can be used in conjunction with other SuDS.

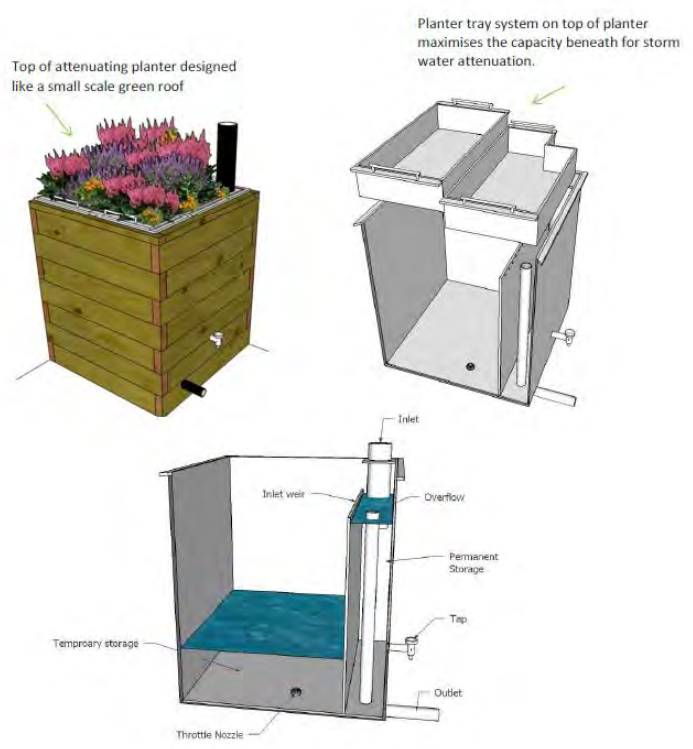


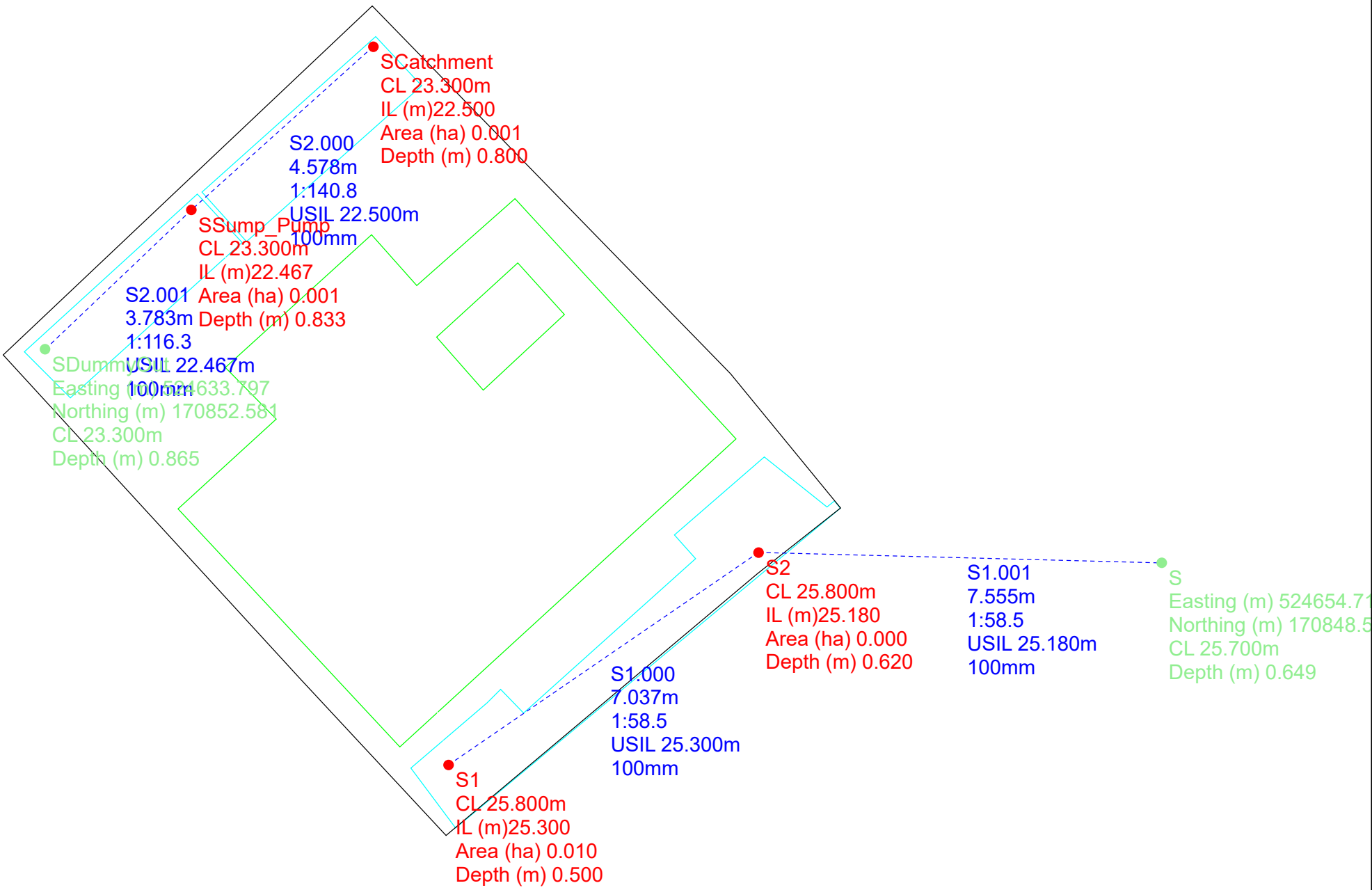
Figure 8: SuDS Planter with attenuation storage (Thames Water)

They offer multi-use benefits such as aesthetic improvements and biodiversity potential. Furthermore, with capacity for water storage, they are well situated in grow your own schemes, providing a substrate for plant growth and a water storage capacity, for use in watering other plants.

20.6 Appendix C6 - Microdrainage Modelling

20.6.1 Layout of Network

PDF to follow this page.


SCatchment
CL 23.300m
IL (m)22.500
Area (ha) 0.001
Depth (m) 0.800
S2.000
4.578m
1:140.8
USIL 22.500m
100mm
SSump_Pump
CL 23.300m
IL (m)22.467
Area (ha) 0.001
Depth (m) 0.833
S2.001
3.783m
1:116.3
USIL 22.467m
100mm
SDummy_1
Easting (m) 524633.797
Northing (m) 170852.581
CL 23.300m
Depth (m) 0.865
S2
CL 25.800m
IL (m)25.180
Area (ha) 0.000
Depth (m) 0.620
S1.001
7.555m
1:58.5
USIL 25.180m
100mm
S
Easting (m) 524654.71
Northing (m) 170848.5
CL 25.700m
Depth (m) 0.649
S1.000
7.037m
1:58.5
USIL 25.300m
100mm
S1
CL 25.800m
IL (m)25.300
Area (ha) 0.010
Depth (m) 0.500

20.6.2 Layout of Network - Features, Exceedance flows and Sewer Connection

PDF to follow this page.

524625.000000

524650.000000

170850.000000

Biointensive Green Roof
Total Coverage of 55m2
Example Construction
Bio Intensive Plant Seed Mix
=>150mm Biointensive substrate
Filter fleece
20mm Drainage Board
100mm attenuation cells across 20m2 of rooftop
Waterproof membrane

SCatchment
CL 23.300m
IL (m)22.500
Area (ha) 0.001
Depth (m) 0.800

SSump_Pump
CL 23.300m
IL (m)22.467
Area (ha) 0.001
Depth (m) 0.833

S2.000
4.578m
1:140.8
USIL 22.500m
100mm

SDummyOut
Easting (m) 524633.797
Northing (m) 170852.581
CL 23.300m
Depth (m) 0.865

S2.001
8.783m
1:116.3
USIL 22.467m
100mm

Lined Permeable Paving
Construction
Permeable Paving / Gravel or Block Paving
Permeable Aggregates sub-base; 300mm
Accepts excess from the rooftops;
Provides 1.1m3 attenuation and discharges to ground;
Excess flows into the Thames Water sewer connection manhole

Basement Level Sump and Pump
Emergency Sump and Pump Discharges surface waters received at basement level into gravity feed drainage network at ground level.

S
Easting (m) 524654.715
Northing (m) 170848.581
CL 25.700m
Depth (m) 0.649

S2
CL 25.800m
IL (m)25.180
Area (ha) 0.000
Depth (m) 0.620

S1.001
7.555m
1:58.5
USIL 25.180m
100mm

S1.000
7.037m
1:58.5
USIL 25.300m
100mm

S1
CL 25.300m
IL (m)25.300
Area (ha) 0.010
Depth (m) 0.500

Rooftop Discharge
Excess surface water runoff from rooftops, will discharge directly onto the surface of the permeable paving and percolate into the attenuation within the sub-base.

Thames Water Surface Water Sewer
New Connection Required;
Details of Thames Water Asset unknown; Detailed survey by Thames Water required;

System has been designed shallow to help ensure suitable connection;

Legend

- Site Shape File
- Proposed
- Continuous, 5, 25
- Loop (Pump Flow)
- Manhole
- Discharge Point
- Green Roof
- Concrete
- Pathways

0 2 4 8 12 16 20 Meters

20.6.3 Microdrainage results

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	20.000	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	0.400
Ratio R	0.400	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Time Area Diagram for Storm at outfall S (pipe S1.001)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.008	4-8	0.003

Total Area Contributing (ha) = 0.010

Total Pipe Volume (m³) = 0.115

Time Area Diagram at outfall SDummyOut (pipe S2.001)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.002	4-8	0.000

Total Area Contributing (ha) = 0.002

Total Pipe Volume (m³) = 0.066

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	7.037	0.120	58.5	0.010	5.00	0.0	0.600	o	100	Pipe/Conduit	
S1.001	7.555	0.129	58.5	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.12	25.300	0.010	0.0	0.0	0.0	1.01	7.9	1.4
S1.001	50.00	5.24	25.180	0.010	0.0	0.0	0.0	1.01	7.9	1.4

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.000	4.578	0.033	140.8	0.001	5.00	0.0	0.600	o	100	Pipe/Conduit	
S2.001	3.783	0.033	116.3	0.001	0.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	5.12	22.500	0.001	0.0	0.0	0.0	0.65	5.1	0.1
S2.001	50.00	5.21	22.467	0.002	0.0	0.0	0.0	0.71	5.6	0.3

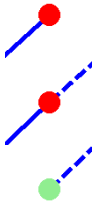
Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	25.800	0.500	Open Manhole	450	S1.000	25.300	100				
S2	25.800	0.620	Open Manhole	600	S1.001	25.180	100	S1.000	25.180	100	
S	25.700	0.649	Open Manhole	0		OUTFALL		S1.001	25.051	100	
SCatchment	23.300	0.800	Open Manhole	600	S2.000	22.500	100				
SSump_Pump	23.300	0.833	Open Manhole	600	S2.001	22.467	100	S2.000	22.467	100	
SDummyOut	23.300	0.865	Open Manhole	0		OUTFALL		S2.001	22.435	100	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	524641.356	170844.796	524641.356	170844.796	Required	
S2	524647.162	170848.772	524647.162	170848.772	Required	
S	524654.715	170848.581			No Entry	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SCatchment	524639.947	170858.244	524639.947	170858.244	Required	
SSump_Pump	524636.538	170855.189	524636.538	170855.189	Required	
SDummyOut	524633.797	170852.581			No Entry	



PIPELINE SCHEDULES for Storm

Upstream Manhole

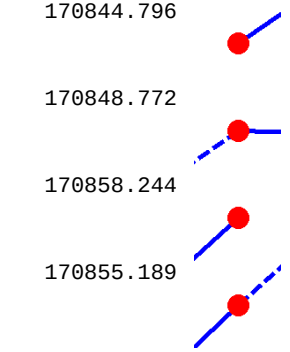
PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	100	S1	25.800	25.300	0.400	Open Manhole	450
S1.001	o	100	S2	25.800	25.180	0.520	Open Manhole	600
S2.000	o	100	SCatchment	23.300	22.500	0.700	Open Manhole	600
S2.001	o	100	SSump_Pump	23.300	22.467	0.733	Open Manhole	600

Downstream Manhole

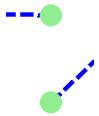
PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	7.037	58.5	S2	25.800	25.180	0.520	Open Manhole	600
S1.001	7.555	58.5	S	25.700	25.051	0.549	Open Manhole	0
S2.000	4.578	140.8	SSump_Pump	23.300	22.467	0.733	Open Manhole	600
S2.001	3.783	116.3	SDummyOut	23.300	22.435	0.765	Open Manhole	0

Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S1	450		524641.356	170844.796	524641.356	170844.796	
S1.001	S2	600		524647.162	170848.772	524647.162	170848.772	
S2.000	SCatchment	600		524639.947	170858.244	524639.947	170858.244	
S2.001	SSump_Pump	600		524636.538	170855.189	524636.538	170855.189	



PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.001	S	0		524654.715	170848.581	
S2.001	SDummyOut	0		524633.797	170852.581	



Setting Out Information - Site Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S1	450		524641.356	170844.796	524641.356	170844.796	
S1.001	S2	600		524647.162	170848.772	524647.162	170848.772	
S2.000	SCatchment	600		524639.947	170858.244	524639.947	170858.244	
S2.001	SSump_Pump	600		524636.538	170855.189	524636.538	170855.189	

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.001	S	0		524654.715	170848.581	
S2.001	SDummyOut	0		524633.797	170852.581	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.008	0.008	0.008
	User	-	100	0.002	0.002	0.010
1.001	-	-	100	0.000	0.000	0.000
2.000	User	-	100	0.001	0.001	0.001
2.001	User	-	100	0.001	0.001	0.001
				Total	Total	Total
				0.012	0.012	0.012

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.001	S	25.700	25.051	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S2.001	SDummyOut	23.300	22.435	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 1	Number of Time/Area Diagrams 1
Number of Online Controls 0	Number of Storage Structures 1	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	20.000	Cv (Summer)	0.750
Return Period (years)	100	Ratio R	0.400	Cv (Winter)	0.840
Region	England and Wales	Profile Type	Summer	Storm Duration (mins)	30

Offline Controls for Storm

Pump Manhole: SSump_Pump, DS/PN: S2.001, Loop to PN: S1.000

Invert Level (m) 22.467

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0000	0.600	10.0000	1.100	10.0000	1.600	10.0000	2.100	10.0000	2.600	10.0000
0.200	0.0000	0.700	10.0000	1.200	10.0000	1.700	10.0000	2.200	10.0000	2.700	10.0000
0.300	5.0000	0.800	10.0000	1.300	10.0000	1.800	10.0000	2.300	10.0000	2.800	10.0000
0.400	5.0000	0.900	10.0000	1.400	10.0000	1.900	10.0000	2.400	10.0000	2.900	10.0000
0.500	10.0000	1.000	10.0000	1.500	10.0000	2.000	10.0000	2.500	10.0000	3.000	10.0000

Storage Structures for Storm

Complex Manhole: S1, DS/PN: S1.000

Cellular Storage

Invert Level (m) 25.300 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	20.0	20.0	0.100	20.0	21.8	0.101	0.0	21.8

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.30	Slope (1:X)	0.0
Membrane Percolation (mm/hr)	1000	Invert Level (m)	25.401	Depression Storage (mm)	5
Max Percolation (l/s)	3.3	Width (m)	2.0	Evaporation (mm/day)	3
Safety Factor	2.0	Length (m)	6.0	Cap Volume Depth (m)	0.300

Time Area Diagram for Green Roof at Pipe Number S1.000 (Storm)

Area (m³) 50 Depression Storage (mm) 20 Evaporation (mm/day) 3 Decay Coefficient 0.050

Time Area Diagram for Green Roof at Pipe Number S1.000 (Storm)

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000909	20	24	0.000334	40	44	0.000123	60	64	0.000045	80	84	0.000017	100	104	0.000006
4	8	0.000744	24	28	0.000274	44	48	0.000101	64	68	0.000037	84	88	0.000014	104	108	0.000005
8	12	0.000609	28	32	0.000224	48	52	0.000082	68	72	0.000030	88	92	0.000011	108	112	0.000004
12	16	0.000499	32	36	0.000183	52	56	0.000067	72	76	0.000025	92	96	0.000009	112	116	0.000003
16	20	0.000408	36	40	0.000150	56	60	0.000055	76	80	0.000020	96	100	0.000007	116	120	0.000003

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
S1.000	S1	0.500
S1.001	S2	0.500
S2.000	SCatchment	0.500
S2.001	SSump_Pump	0.500

CASDeF Controller for Storm

PN	US/MH Name	Level Not Exceeded	Modify Control	Modify Pipe Size	Max Pipe Diameter	No. Pipe Failures	Add Storage	No. Storage Failures	Use CASDeF
S1.000	S1	25.800	Yes	No	350	0	Yes	0	Yes
S1.001	S2	25.800	Yes	No	470	0	Yes	0	Yes
S2.000	SCatchment	23.300	Yes	No	650	0	Yes	0	Yes
S2.001	SSump_Pump	23.300	Yes	No	683	0	Yes	0	Yes

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S1	0.080	0.055	2.986	3.121
S1.001	S2	0.175	0.059	0.000	0.235
S2.000	SCatchment	0.226	0.036	0.000	0.262
S2.001	SSump_Pump	0.235	0.030	0.000	0.265
Total		0.717	0.180	2.986	3.883

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
S1.000	S1	0.080	0.051	2.986	3.117
S1.001	S2	0.175	0.057	0.000	0.232
S2.000	SCatchment	0.226	0.031	0.000	0.257
S2.001	SSump_Pump	0.235	0.027	0.000	0.263
Total		0.717	0.167	2.986	3.870

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 1
Number of Online Controls 0 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.400 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
S1.000	S1	1440 Winter	1	+0%					25.301	-0.099	0.000	0.00		292

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.0	OK	

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
S1.001	S2	1440 Winter	1	+0%					25.180	-0.099	0.000	0.00		
S2.000	SCatchment	15 Winter	1	+0%					22.512	-0.088	0.000	0.03		
S2.001	SSump_Pump	15 Winter	1	+0%				0	22.483	-0.085	0.000	0.06	0.0	

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.0	OK	
S2.000	SCatchment	0.1	OK	
S2.001	SSump_Pump	0.3	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 1
Number of Online Controls 0 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.400 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S1.000	S1	120 Winter	30	+40%					25.314	-0.086	0.000	0.05		52	0.4

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S1.000	S1	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
S1.001	S2	120 Winter	30	+40%					25.194	-0.086	0.000	0.05		
S2.000	SCatchment	15 Winter	30	+40%					22.523	-0.077	0.000	0.12		
S2.001	SSump_Pump	15 Winter	30	+40%				0	22.499	-0.069	0.000	0.21	0.0	

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.4	OK	
S2.000	SCatchment	0.5	OK	
S2.001	SSump_Pump	1.0	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 1
Number of Online Controls 0 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 20.000 Cv (Summer) 0.750
Region England and Wales Ratio R 0.400 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)
S1.000	S1	120 Winter	100	+40%					25.319	-0.081	0.000	0.08		53	0.6

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Status	Level Exceeded
S1.000	S1	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)
S1.001	S2	120 Winter	100	+40%					25.199	-0.081	0.000	0.08		
S2.000	SCatchment	15 Winter	100	+40%					22.526	-0.074	0.000	0.15		
S2.001	SSump_Pump	15 Winter	100	+40%				0	22.503	-0.064	0.000	0.28	0.0	

PN	US/MH Name	Pipe Flow (l/s)	Status	Level Exceeded
S1.001	S2	0.6	OK	
S2.000	SCatchment	0.7	OK	
S2.001	SSump_Pump	1.3	OK	

20.7 Appendix C7 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer GBS Architectural. They will appoint a management company to undertake the general maintenance duties within the site and will join service agreements with the suppliers and manufactures of the SuDS/Pumps when required.

The cost of the services and management company will be funded through the service charge fee which will be paid and manged by home owners.

The information presented below is taken from the CIRIA SuDS Manual (Report c753) and SuDS. Further details on installation and maintenance can be found detailed below and online.

20.7.1 Pervious Pavements

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.	GBS Architectural will be responsible for setting up the management company.
Occasional maintenance	Stabilise and mow contributing and areas.	As required.	
	Removal of weeds or manage using weed killer applied directly into the weeds rather than spraying.	As required - once per year on less frequently used pavements.	
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving.	As required.	
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and lost material.	As required.	

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).	GBS Architectural will be responsible for setting up the management company.
Monitoring	Initial Inspection.	Monthly for three months after installation.	
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48h after large storms in first six months.	
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.	
	Monitor Inspection chambers.	Annually.	

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy). Therefore, if litter management is already required at the site, this should have marginal cost implications.

20.7.2 SuDS Planters Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components	Quarterly; As required.	GBS Architectural will be responsible for setting up the management company.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into rain gardens as required.	Quarterly; As required.	
	Remove, replace and maintain vegetation as required; Ensuring cuttings are removed to prevent debris build up; Weeding of flower bed to maintain the desired vegetation, density and biodiversity - Vegetation management	Monthly inspections during Spring / Summer Autumn / Winter - As required. .	
Remedial actions	Replace dead vegetation as required. Cut back vegetation as required.	As required.	
Monitoring	Inspect silt traps / discharge points and note rate of sediment accumulation and ensure no erosion pathways forming.	Monthly in the first year and then annually.	
	Check Planters are emptying as required following a storm event occurring.	After storms; When possible.	

Maintenance will be carried out manually. All monitoring and maintenance will be carried out by the appointed estate management company that undertakes the general landscaping maintenance.

20.7.3 Green & Blue Roof Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Preliminary Maintenance Procedures	Remove any dead vegetation and debris from the roof surface, ensure that any gutters, chute outlets and downpipes are free from blockages and that water can flow freely.	Bi-Annually - Spring and Autumn	GBS Architectural will be responsible for setting up the management company.
	Cleaning of gutters and any filters on downpipes.		
	Ensure that any new items of plant/equipment on the roof are mounted on suitable isolated slabs and that any fixings used to secure the plant/equipment in place do not penetrate the waterproofing. If in doubt, please contact Bauder for further advice.		
	Ensure that all protective metal flashings and termination bars remain securely fixed in place. Advise the client of the need to repair or renew as necessary.		
	Examine all mastic sealant and mortar pointing for signs of degradation. Advise the client of the need to repair or renew as necessary.		

General Horticultural Information	Any vegetation which has encroached into the vegetation barriers (pebbles) should be removed. If movement/settlement of the pebble vegetation barrier has occurred, additional washed 20/40 mm grade stone pebbles similar to the existing are to be added. Flint ballast with sharp edges is unsuitable and may damage the waterproofing.	As required	GBS Architectural will be responsible for setting up the management company.
	The cultivation of intensive green roof substrate may be carried out in the same way as with any normal horticultural growing medium. However, care must be taken not to mechanically damage the either the waterproofing system or any of the green roof components, as this would invalidate the guarantee. The use of fertilizers and weed killers will have no detrimental effect on either the waterproofing or the green roof system.	As required	GBS Architectural will be responsible for setting up the management company.
Remedial actions	The Building owner should keep a record of all inspections and maintenance carried out on the roof. Any signs of damage or degradation to either the waterproofing or the green roof installation should be reported to Bauder Ltd (or chosen provider) immediately, in order that arrangements can be made for remedial work to be carried out if necessary.	As required	GBS Architectural will be responsible for setting up the management company.

	Works to adjoining areas - When carrying out any maintenance to adjoining roof areas, care must be taken not to damage either the green roof landscaping or the waterproofing system. If it is considered that either element has been affected, then Bauder (or provider) should be contacted for advice. Any waterproofing damage caused after completion of the original installation may invalidate the guarantee.	As required.	

20.7.4 Flow Control Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris;	Quarterly; As required. Increase freq. to Monthly during Autumn;	GBS Architectural will be responsible for setting up the management company.
	Inspection & Cleaning of SuDS components upstream of flow control element.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Removal of debris and sediment;	Annually; Or as required.	
Remedial actions	Replacement of parts; Manhole cover, filters or components of flow control device;	As required;	
Monitoring	Ensure flow control device is function correctly during and after storm events; Check water levels up stream and downstream of flow control device	Monthly; During 1st year of installation or during and after storm event; When possible Reduce to Quarterly following the 1st year;	
	Check for damage to flow control components	Annually;	
	Check for securely fitting manhole lid; Ensures debris cannot enter the system unfiltered;	Annually;	

20.7.5 Surface Water Pump Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspection of pumping chamber for sediment and debris in inlet and outlet components; Inspection of pumping chamber for sediment and debris in inlet and outlet components; Grounds & Housekeeping: a clean and tidy pump station is a healthy pump station. Grass, trees and shrubs should be maintained for ease of access and to maintain a proper operating buffer from vegetation.	Monthly	GBS Architectural will be responsible for setting up the management company.

Regular maintenance	A typical service schedule will be included but is not limited to the following; Pump down sump on hand operation. Clean and check float level equipment. Check and adjust impeller/wear plate on pumps. Check oil bath lubrication if applicable. Check operation and wear of control panels/starters, including housing. Examine non-return and gate valves [if mounted in separate valve chamber and/or if accessible at time of service without undertaking a confined space entry]. Check pipework for leaks/wear/damage and report. Test run pumps and monitor performance leave running if possible and report if pumps not running and/or to correct characteristic. Replace or use parts/consumables necessary to bring station online, but only if within authorised limit. If necessary, report any defects/faults diagnosed. Our quotation for remedial repairs will automatically follow. Check motors and rotating elements of pumps for higher-than-normal temperature. Visually inspect pumps and motors for coating failure and oxidation and reapply protective coatings/paint as necessary. Inspection of electrical wiring and pumping station controllers Electrical Cables: Cables should be kept organized and tied-off in secure locations where available. Seals should be monitored to make sure they are in-tact. Contacts: Both the starter contacts and the alternator contacts should be inspected to make sure connections are good. Breakers: A failure to maintain the breakers can allow a simple surge to wipe out your controls or pumps.	Annual or bi-annual service.	GBS Architectural will be responsible for setting up the management company.
Remedial Actions	Replacement of parts, seals, wires, fuses; Lubricating moving parts; Pump replacement; Replace worn parts and ensure good operation of pumps through general maintenance; Grease / Lubricate / Replacing seals as required.	As required	GBS Architectural will be responsible for setting up the management company.

All maintenance and monitoring works will be scheduled and will follow the manufactures guidance and will be carried out by a qualified professional as required.