Sustainable Drainage System Strategy

Site Address
441-447 Ewell Road
Surbiton
Surrey
KT6 7ES

Client
RAA Planning Ltd

Report Reference
SWDS - 2023 – 000025_B

Prepared By
STM Environmental Consultants Ltd

Date
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1 Document Control

Sustainable Drainage System Strategy

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2 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

3 Disclaimer

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4 Executive Summary

BACKGROUND			
Location	441-447 Ewell Road, Surbiton, Surrey, KT6 7ES Grid reference: 519748, 166100		
Site Area	1225m^2		
Proposed Development	Demolition of existing dance studio and erection of a three storey building housing No.11 3-bed flats with associated bins and cycle provision.		
Current Site and Surrounding Uses	The site is currently vacant. It was previously used as a Day Nursery and Dance Studio. The surrounding area supports a mixture of mainly residential and commercial land uses.		
Topography	The site is mostly flat, with a gentle slope ranging from 24.3mAOD (west) to 24.85mAOD (east).		
Hydrology	The nearest watercourse is the Hogsmill River approximately 1km to the east and south.		
Geology	BGS information indicates that there are no superficial deposits whilst the bedrock is classified as belonging to the London Clay formation (Clay, Silt and Sand).		
Hydrogeology	BGS information indicates that the site is situated upon an Unproductive bedrock aquifer.		
Permeability	BGS information indicates that the bedrock is classified as poorly draining.		
Infiltration Potential	BGS information indicates that there are potential opportunities for bespoke infiltration methods.		
Fluvial Flood Risk	Low – the site lies within EA Flood Zone 1.		
Surface Water Flood Risk	Low - the site is not impacted by the EA modelled surface water flood scenarios.		
Groundwater Flood Risk	Low - the EA do not indicate the potential for groundwater flooding on site however, groundwater is indicated likely to be less than 3mbgl for at least part of the year.		
Existing and Proposed Site Layout	**Ground Cover**	**Existing (m^2)**	**Proposed (m^2) (Without SuDS)**
	Buildings	368	346
	Driveways/Patio	533	155
	Gardens/ Soft landscaping	324	724
	Total Impermeable Area	**901**	**501**
Changes in Impermeable	Without SuDS, the proposed development would reduce the impermeable area of the site by 33% (i.e. 400m^2).		

PROPOSED SUDS				
Run-Off Rates	Greenfield (GF) (l/s)	IH24 Pre - Development (l/s)	IH24 Post Development Without SuDS (l/s)	Modelled Post Development With SuDS (l/s)
Qbar	0.30	0.57	0.45	-
1 in 1	0.26	0.48	0.38	1.3
1 in 30 / + CC	0.70	1.30	1.03	1.4
1 in 100 + CC	1.43	2.67	2.12	1.4
SuDS Target Requirement	As the development is taking place on a previously developed site the non-statutory technical standards for sustainable drainage systems S3 (peak flow) and S5 and S6 (volume controls) apply. The aim for the SuDS was that the post development run-off rate should meet the greenfield runoff rate of 1.4 l/s for the 1 in 100 year plus climate change event. At worst, it should never exceed three times this value.			
Storage Estimate	Using Causeway Flow, the minimum storage required was estimated to be 42m^3.			
Infiltration Testing	A site investigation was undertaken on the 7th and 8th of August 2023 for the purposes of assessing infiltration rates at the Site. 2no. trial pits (TP01 & TP02) were excavated on site. The geology encountered consisted of shallow topsoil, shallow Made Ground deposits and a bedrock of London Clay. Infiltration testing in line with BRE DG 365 guidance was undertaken in the trial pits. The pits failed to drain more than 50% of their volume during the 1nd drainage cycle run. Testing was therefore terminated and Infiltration SuDS methods concluded to be unsuitable for the Site.			
SuDS Strategy	The proposal will introduce a chain of SuDS features including extensive green roofs, rain gardens, permeable paving and geocellular storage. These features will work in combination, to intercept and reduce the velocity of the storm water runoff on site. Together these SuDS measures will provide 42.2m^3 of attenuation. Any excess surface water runoff will be directed to the nearest Thames Water combined sewer located on site. A Hydro-Break Optimum flow control will limit the surface water discharge into the Thames Water sewer to 1.4l/s during all storm events.			
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.			

5 Introduction

STM Environmental Consultants Limited have been appointed by RAA Planning Ltd to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at 441-447 Ewell Road, Surbiton, Surrey, KT6 7ES.

5.1 Proposed Development

The SuDS strategy is required to support a planning application for the demolition of existing dance studio and erection of a 4-storey building housing 11no. flats with associated bins and cycle provision.

Copies of the development plans are presented in Appendix 1.

5.2 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.

5.3 Legislative and Policy Context

5.3.1 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.

5.3.2 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.

5.3.3 The London Plan - Policy SI 13 Sustainable drainage

Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks.

Increases in surface water run-off outside these areas also need to be identified and addressed.

Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

- rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation);
- rainwater infiltration to ground at or close to source;
- rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens);
- rainwater discharge direct to a watercourse (unless not appropriate);
- controlled rainwater discharge to a surface water sewer or drain;
- controlled rainwater discharge to a combined sewer;

Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation (2).

5.3.4 The Royal Borough of Kingston upon Thames - Policy DM 4

- Require development to be designed to take account of the impacts of climate change including: water conservation, need for summer cooling and increase flood risk from fluvial and surface water flooding;
- Consider development proposals in accordance with PPS25, the Borough SFRA and related studies including the surface water management plans. The

Area Action Plan Policy K24 Flood Risk Management will be taken into consideration in the assessment of development proposals within Kingston Town Centre;

- Require a Flood Risk Assessment for major development proposals within Flood Zone 1 of one hectare or more and all new development in Flood Zones 2 and 3. It should address all sources of flooding, the future impact of climate change and take into account the findings of the SFRA, PPS25 and good practice guidance;
- Require development proposals to include Sustainable Urban Drainage Systems (SUDs) to manage and reduce surface water run-off unless is it can be demonstrated that such measures are not feasible;
- SUDs techniques include: rainwater recycling; soak-aways; porous surfacing and features to retain water on site (ponds and green spaces). Development proposals will need to be in line with the Mayor of London's drainage hierarchy. They should also demonstrate that there is adequate public sewerage capacity to serve their development and deal with surface water run-off;
- Development proposals will be required to demonstrate that there is no adverse impact on the quantity or quality of water resources and where possible they should seek to improve water quality;
- Encourage efficient water use and for water conservation measures to be included in development proposals.

6 Site Characteristics

6.1 Location and Area

The site is centred at national grid reference 519748, 166100 and has an area of 1225m^2. It is located upon a T junction, formed from Ewell Road and Fairmead Road. Figure 1 provides the site location map and aerial imagery.

It falls within the jurisdiction of Royal Borough of Kingston upon Thames (RBKT) in terms of the planning consultation process on flood risk and surface water management.

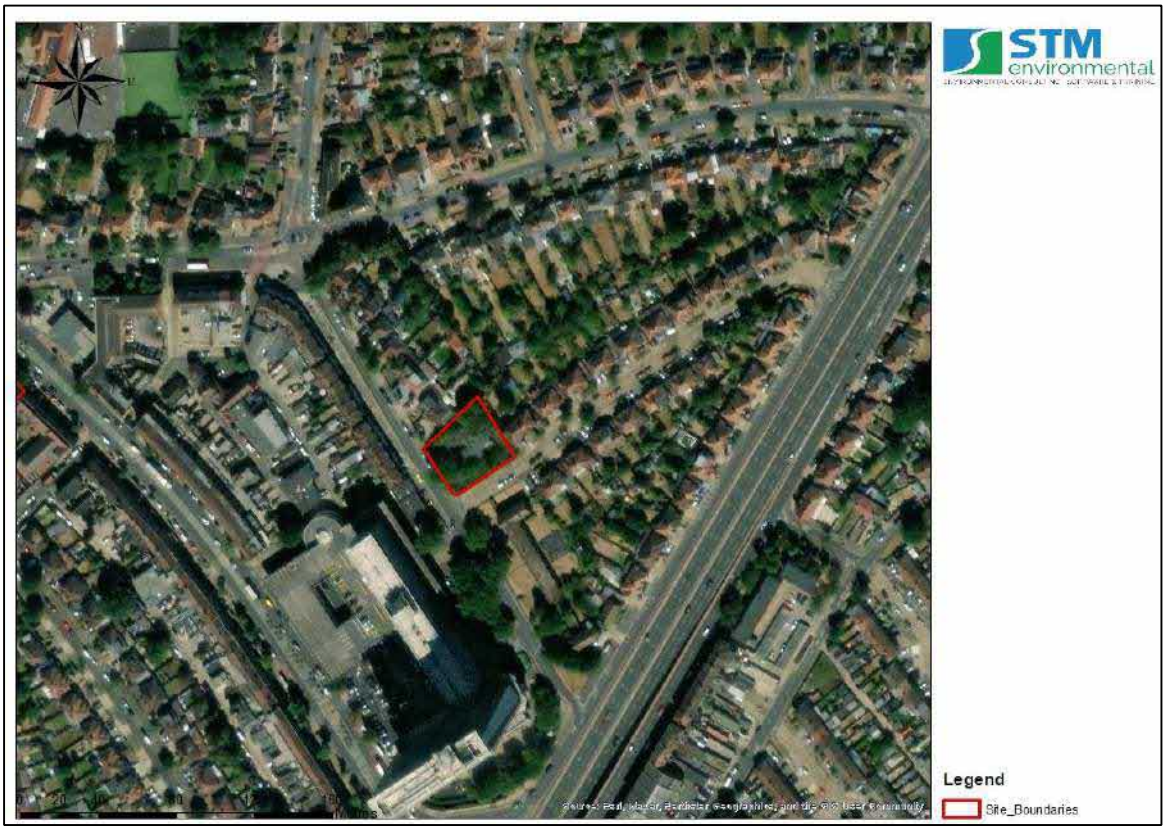


Figure 1: Site location map and aerial photo

6.2 Current Site and Surrounding Uses

The site is currently vacant. It was previously used as a Day Nursery and Dance Studio. It is located on outskirts of Tolworth and lies north of the train station and the A3 road which forms part of the wider suburban area of Surbiton. The surrounding area supports a mixture of residential and commercial land uses.

6.3 Site Topography

The LiDAR (1m DTM) and topographic survey maps provided in Appendix 2 show the elevations within the site. The topographic survey values have been used within this report.

The site is situated upon a gradual north facing slope. The site boundary forms an irregular rectangle orientated towards the north. The parcel of land is mostly flat, with a gentle slope ranging from 24.3mAOD (west) to 24.85mAOD (east).

6.4 Hydrology

The nearest watercourse is the Hogsmill River approximately 1km to the east and south. An unnamed tributary is also located 1km to the north of the site.

A discharge connection into a watercourse is not available.

6.5 Geology and Hydrogeology

BGS mapping showing the geological and hydrogeological characteristics of the site are presented in Appendix 2.

The BGS information indicates that there are no superficial deposits located on the site.

The bedrock is classified as belonging to London Clay (Silt, Sand and Clay). It forms an Unproductive bedrock aquifer. It's permeability is considered to be poorly draining.

The infiltration potential map indicates that there are opportunities for bespoke infiltration SuDS on site.

The maps also indicate that the groundwater table is likely to be at less than 3mbgl for at least part of the year.

The site does not lie within a groundwater Source Protection Zone.

6.6 Flood Risk

6.6.1 Fluvial 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 less than 0.1% Annual Expected Probability.

6.6.2 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 3. This indicates that the site is at very low risk of flooding.

The site remains dry during the 1 in 1000 year rainfall return period event.

6.6.3 Groundwater Flood Risk

Groundwater flooding occurs when water rises from the underlying aquifer at the location of a spring – where the underlying impermeable geology meets the ground surface. This tends to occur after much longer 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.

Groundwater susceptibility mapping provided by BGS is presented in Appendix 3. The available mapping does not indicate the potential for groundwater flooding to occur on the site. However, groundwater is indicated to be less than 3mBGL.

6.7 Existing Drainage

Drainage plans showing the existing surface water drainage system at the site were not available at the time of writing.

A utility search was undertaken which identified Thames Water as the local sewage undertaker. The Asset map is available in Appendix 4.

Table 1: Asset Information

Asset ID	Asset Type	Location / Distance (m)	Manhole Cover Level (mAOD)	Manhole Invert Level (mAOD)	Depth (m)
7069	SW	On Site	24.26	23.47	0.79
7071	SW	On Site	24.32	23.25	1.07
7170	SW	On Site	22.83	22.23	0.6
7174	SW	On Site	24.32	23.85	0.47
7073	SW	On Site	25.73	25.2	0.53
7155	SW	5m N	23.84	22.17	1.67
7051	SW	80m S	24.32	22.71	1.61
7176	FW	On Site	N/A	N/A	N.A
7010	FW	20 S	26	23.65	23.35

The asset information provided by Thames Water conflicts with the topography survey that was undertaken. The items highlighted in orange, indicate cover levels on assets greater or less than the range in topography witnessed within the topographical survey. Furthermore, the recently conducted survey did not identify the asset locations as identified on the Thames Water map.

A full CCTV drainage survey should be undertaken of the existing assets to confirm the drainage assets available on site in addition to a pre-application enquiry with Thames Water.

7 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.

7.1 Existing and Proposed Ground Cover

A summary of the existing and proposed site ground cover is shown below in Table 2 and Table 3 below. These tables assume all hardstanding will remain as impermeable surfaces.

Table 2: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m^2)
	m^2	%	m^2	%	
Buildings	368	30	346	28	-22
Hard Standing	533	44	155	13	-378
Soft landscaping	324	26	724	59	400
Total	1225	100	100	100	

Table 3: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m^2	%	m^2
Existing Site	901	74	324	26	1225
Proposed Site	501	41	724	59	1225
Difference	-400	-33	400	33	

The introduction of the permeable surface reduces the impermeable area of the site by 400m^2.

8 SuDS Requirements

8.1 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.

8.2 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.

8.3 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 5. Table 4 below provides a summary of the results.

Table 4: Calculation of post-development run-off rates for the site.

	IH24 Greenfield (l/s)	***IH24 Pre - Development (l/s)***	***IH24 Pre - Development (l/s)***
Qbar	0.30	0.57	0.45
1 in 1	0.26	0.48	0.38
1 in 30	0.70	1.30	1.03
1 in 100	**0.96**	**1.80**	**1.43**
1 in 100 + CC	**1.43**	**2.67**	**2.12**

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

Therefore, the proposal should aim to achieve the greenfield runoff rate of 1.4l/s for the post development during the 1 in 100 years critical storm plus climate change event.

Causeway Flow was used to estimate the storage. It was estimated that 23m^3 was required to achieve a discharge rate of 1.4 l/s when taking into account all the hard standing.

When taking into account the entire site, given the impermeable characteristics of the underlying geology (See section 11) when including the entire area of the site, of 0.125ha, the estimate storage increases up to 89m^3 during the 1% AEP plus 40% CC event. During the 1 in 30 year event, the storage volume is estimated at 42m^3.

As such, as a minimum, the proposal should aim to provide 42m^3 of attenuation below the flood risk level, to ensure there is no flooding during all the 1 in 30 year events.

All flooding during the 1% AEP plus 40% CC must be safely contained within the site.

Screenshots of the quick storage estimate and variables are available in Appendix 5.

9 Site Investigation

9.1 Site Investigation

The site investigation works were carried out on the 7th and 8th of August 2023. A total of 2no. trial pits were excavated to depths of 1.6mbgl for undertaking infiltration testing in accordance with BRE DG 365.

The site was very overgrown and there was limited access around the site because of this. Furthermore, the existing services on site limited the locations the testing could be undertaken.

9.2 Ground Conditions Encountered

The investigation encountered ground conditions that were generally consistent with the published geological records of the area. The shallow strata consisted turf underlain by dark brown pebbly, clayey, SILT to a depth of 0.3mblg. This was underlain by reddish brown, very silty CLAY to a depth of 1mbgl, in turn was underlain by slightly gravelly, very silty, clayey SAND to 1.55mbgl.

9.3 Infiltration Testing

Infiltration testing in general accordance with the methodology outlined in BRE Digest 365 was conducted in the two trial pits. The trial pits were rapidly filled with water from a 1.2m^3 water bowser.

The trial pits were left to drain for a 24 hour period. The water levels were continuously monitored using a water level logger. The water level failed to drain more than 50% of its original volume and as such, the testing was therefore abandoned in both locations.

Based on these findings, infiltration SuDS methods are considered unsuitable as a means of managing surface run-off from the Site.

Full details including photos, graphs, location map and results of the infiltration testing are available in Appendix 6.

10 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.

10.1 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.

	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	✓		

Figure 2: SuDS Hierarchy

10.2 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 7 and are further discussed below.

10.2.1 Living Roofs

As buildings will cover 28% (346m^2) of the site, living roofs are considered to be a viable SuDS technique.

10.2.2 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 rainwater harvesting calculator tool in Microdrainage was run to establish the suitability of installed an active rainwater harvesting system. The rooftop area is not a suitable catchment area to provide an active rainwater harvesting system as the rainfall yield will not meet demand when incorporating a green roof and the intended inhabitants. An active system allows for water attenuation and water reuse storage.

A print screen of the results is available in Appendix 4.

10.2.3 Basins, Ponds, Filter Strips and Swales

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

10.2.4 Infiltration Devices

As discussed in Section 10, infiltration SuDS are a not suitable method to use at the site due to the low infiltration rate calculated.

10.2.5 Permeable Surfaces and Filter Drains

Over 13% (155m^2) of the development will consist of pathways and amenity space, which could be designed to be permeable.

10.2.6 Tanked Systems

A tanked system incorporating a restricting flow to the public sewer is a viable option as infiltration is not suitable.

10.2.7 Summary of results of SuDS Options Assessment

A summary of the results of the SuDS Options Assessment is presented in Table 5 below. Full details of the options assessment along with descriptions of the SuDS options are presented in Appendix 7 and Appendix 8.

Table 5: Summary of Results of SuDS Options Assessment

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

11 SuDS Implementation

11.1 SuDS Constraints

The site is situated upon an impermeable bedrock of London Clay and as such, discharging surface water to ground is not possible.

11.2 Proposed SuDS

Flat roofs will be formed from biointensive green roofing, providing a significant reduction in the runoff rates, water retention and helping increase the biodiversity of the site. The excess storm water will discharge via rainwater butts, and onto the permeable paving or into rain gardens situated around the site. Together, these SuDS measures will provide a total storm water attenuation volume of 25.4m^3.

The void area (planting area) within the rain gardens will provide a further 10.8m^3 attenuation at ground level.

A geocellular storage tank will installed to provide the additional attenuation below the flood risk level, providing an 6m^3 of dedicated attenuation.

In total the scheme provides 42.2m^3 of attenuation storage.

A Hydro-Break Optimum will limit the discharge rate to 1.4l/s into the Thames Water Surface water sewer on Ewell Road.

The proposed SuDS is further detailed below. A detailed drainage layout is available in Appendix 9.

11.2.1 Green Roof

The proposed buildings cover an area of 344m^2 which will be fitted with a biodiverse brown roofing system.

The roofs will cover a total area of 77m^2 across the rooftop in three sections. It will be formed from a Bauder Biointensive Green roof (or similar) along with 40mm drainage

boards, which provide roof level attenuation alongside the substrate and encourage flow.

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, location and extent of the development being undertaken on site, biodiverse 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.

Table 6: Extensive Green Roofs

Building	Roof Type	Roof (m^2)	Green Roof Coverage (m2)	Detailed	Roof Level Attenuation Cell(m^3)
1	Green/Brown		77	Biodiverse Extensive Green roof 150mm => Substrate & 40mm – Drainage Board	3.1
	Total	**344**			**3.1**

As well as allowing for storage, the substrate and modular planting trays will slow the runoff rate from the rooftop by up to 30 - 60 minutes, depending on the level of saturation before the rainfall event.

The downpipes from the green roof will discharge onto the rain gardens or permeable paving which are described in more detail below.

11.2.2 Rainwater Butt

4no. Rainwater harvesting Butts (200 litre) will be fitted to the downpipes to allow for rainwater re-use within the garden. Once at capacity the excess will discharge into the rain gardens or permeable paving.

11.2.3 Permeable Block Paving

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 270mm sub-base consisting of a graded aggregate (Marshalls Priora Aggregates or similar) with a porosity of 0.30. This construction over 180m^2 (formed from multiple sections) will provide approximately 15.1m^3 of interception, attenuation, and treatment storage. As infiltration on site was poor, an excess from these areas will be conveyed via perforated pipe into the drainage network.

11.2.4 Rain Garden

2no. rain gardens will be formed in the north and south of the site which will accept all excess storm water before discharging into the Thames Water sewer.

The rain gardens will be position to accept all surface water from all hard standing areas including the permeable paved areas mentioned above.

The rain gardens will be 30m^2 each, providing 1.8m^3 attenuation within the sub-base based on an average porosity of 0.3. The well-draining substrate will have a porosity of 0.15 providing a further 1.8m^3 of attenuation. The surface will be formed from shallow depression forming a void filled with suitable planting and decorative stone, which will provide a further 5.4m^3 of attenuation at ground level.

The 2No. Rain gardens provide a total of 7.2m^3 below the flood risk level.

A rain garden is a shallow area of ground which receives run-off from roofs and other hard surfaces. A rain garden is planted with plants that can stand waterlogging for up to 48 hours at a time, but would typically drain completely within 12 - 24 hours. This would depend on the drainage capacity of the shallow soils, given onsite geology was shown to have a poor infiltration rate, the excess will discharge into a flow control chamber.

A range of different plants can be included within the garden, as more drought-tolerant plants will be suitable towards the edges. During a storm water fills the depression and then drains.

11.2.5 Geocellular Attenuation

The geocellular storage will be placed below the car parking area and soft landscaping to the west. The structure will cover a total area of 11m^2 with a thickness of 0.6m. The geocellular storage crates (AquaCell Drainage Crates or similar) will have a porosity of 90% and will be stacked together to create the desired storage volume of 6.0m^3.

11.2.6 Discharge Control Device

A Hydro-Brake Optimum flow control will be used to limit the discharge from the site into the Thames Water surface water sewer to 1.4l/s. Details and examples of product specification sheets are available in Appendix 8.

11.2.7 Drainage Modelling

Modelling using Causeway Flow 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 42.2m^3 when including all storage structures.

No flooding was indicated during any of the modelled scenarios, including the 1 in 100 year plus 40% climate change.

Table 7: Modelled Discharge Rates (Critical)

	Flow Modelled Post - Development (l/s)
1 in 1	1.3
1 in 30 + 40% CC	1.4
1 in 100 + 40% CC	1.4

Full results, drainage layout including the proposed discharge point and exceedance flows of this are available in Appendix 9.

11.2.8 Surface Water Discharge Points

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

As there are existing Thames Water assets located onsite a discussion with Thames Water should be undertaken.

11.2.9 Treatment of Run-off

Treatment of roof water runoff will be provided through the provision of trapped green roofs, permeable paving, rain gardens and or water butts to intercept gross solids and sediment. Guidance will be provided to householders on appropriate maintenance requirements.

11.2.10 Exceedance Flows

Upon completion the site will have a gentle fall of approximately 0.5m from the east to the west (i.e. from 24.3mAOD to 24.7mAOD respectively).

In the event of exceedance on the site, overland flows would pool within the voids of the proposed rain gardens and within the surrounding soft landscaping.

It can be seen from the design proposals that the proposed system includes approximately 42.1m^3 of storm water attenuation (not including pipes and manholes). In addition, a safety factor of 2 was applied to the 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 9.

11.3 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.

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 10.

12 Timetable for Implementation

An indicative timetable for implementation of the SuDS and other elements of the development are outlined in Appendix 11.

13 Water Efficiency

13.1.1 Water Consumption

The average UK daily consumption of water is 140 litres per day [5].

The developer will implement some or all of the following:

- Water-efficient showerhead - Reduces water consumption to 8 / 9 litres per minute
- Dual Flush Toilets or High Efficiency Toilet (HET);
- Taps - inexpensive aerators add air into the water – using less and the flow feels the same
- Garden - Drought resistance plant
- Appliances - choose energy and water efficient washing machines and dishwashers
- Greywater or rainwater harvesting; both these can generate water to flush the loo, wash the car or water the garden. They are much more efficient and cost effective when installed during construction.

14 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.

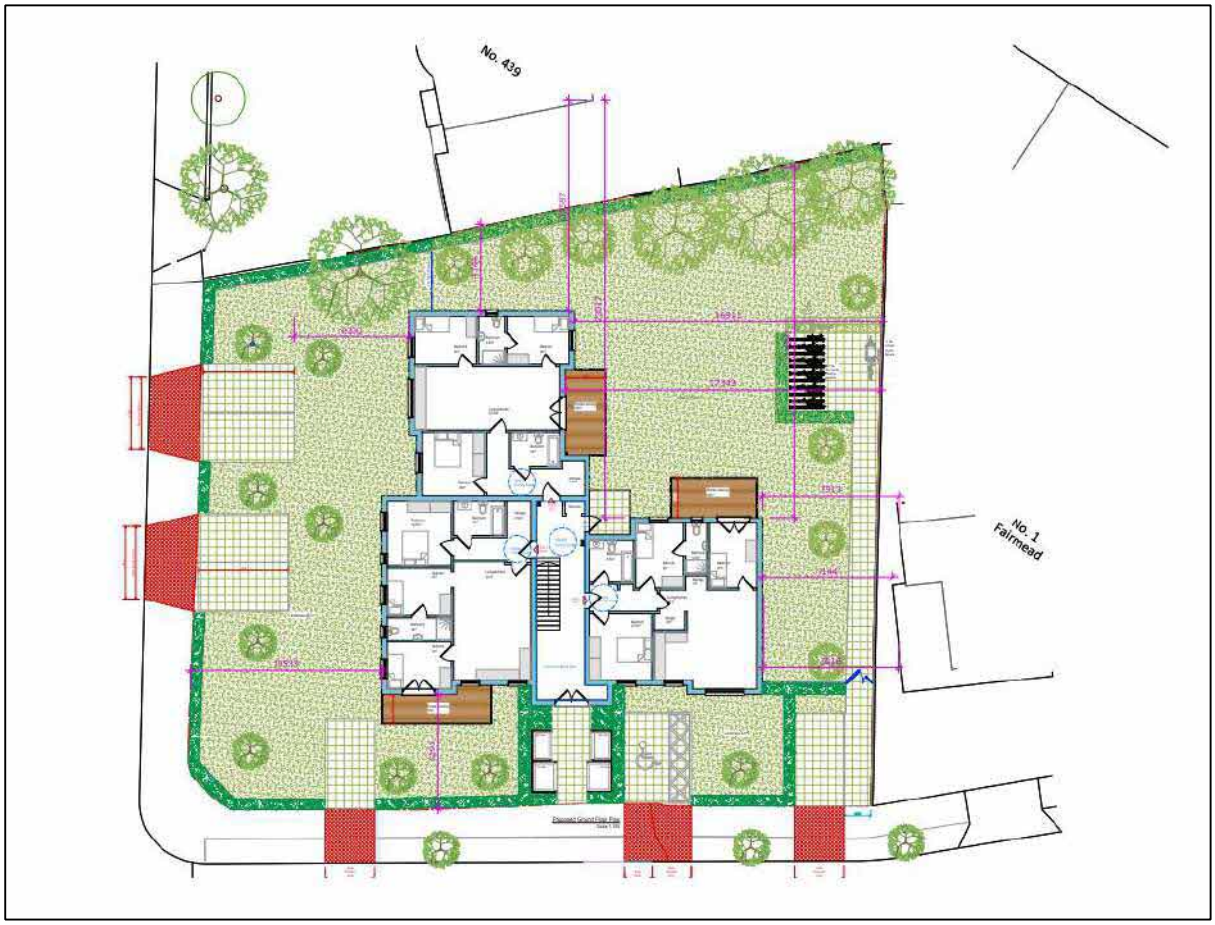
15 References

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. CIRIA, Defra, Environment Agency – UK SuDS Manual, 2015.
4. Core Strategy Royal Borough of Kingston Upon Thames – London Sustainable Drainage Action Plan, 2012.

16 Appendices

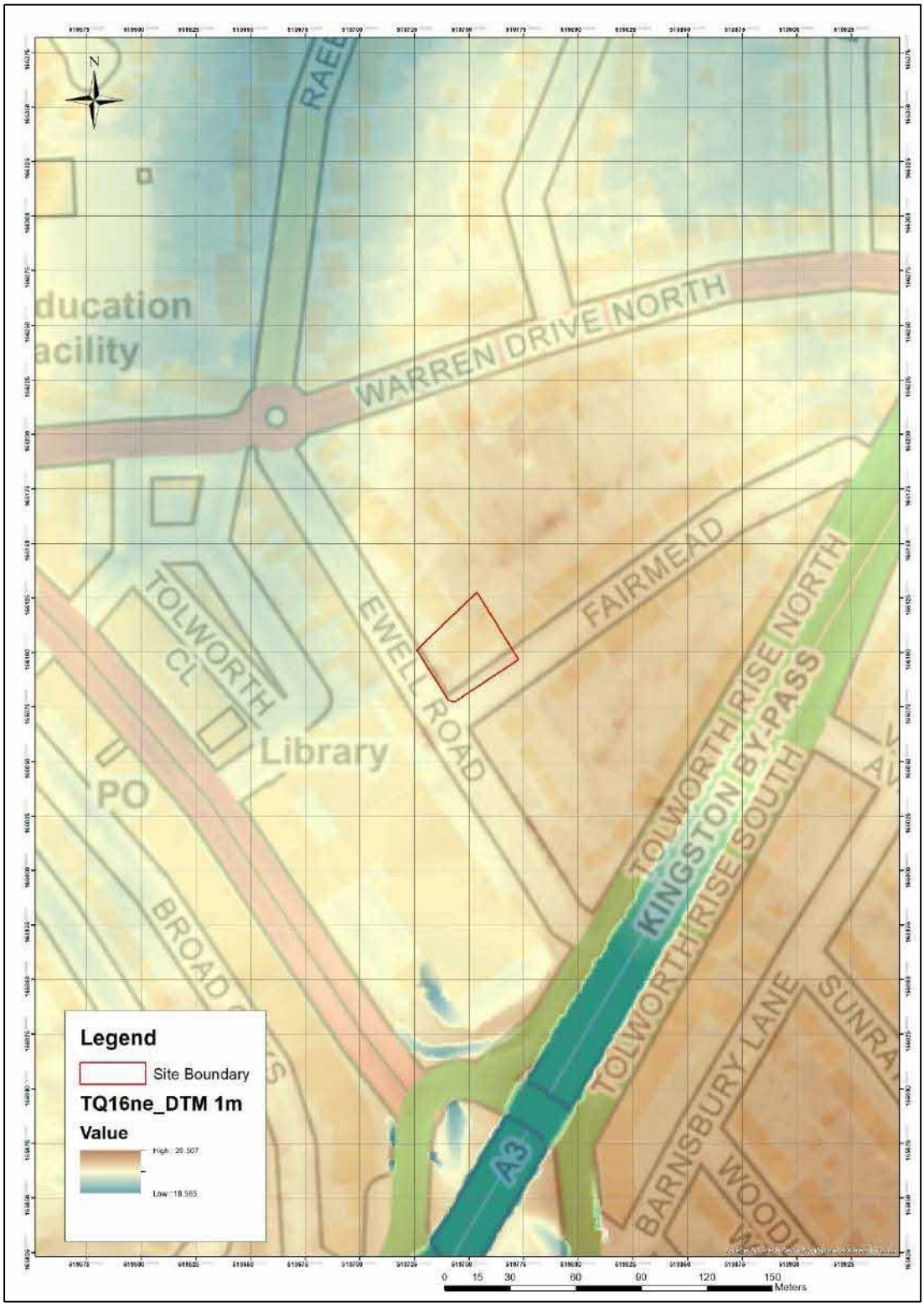
16.1 Appendix 1 – Development Plans

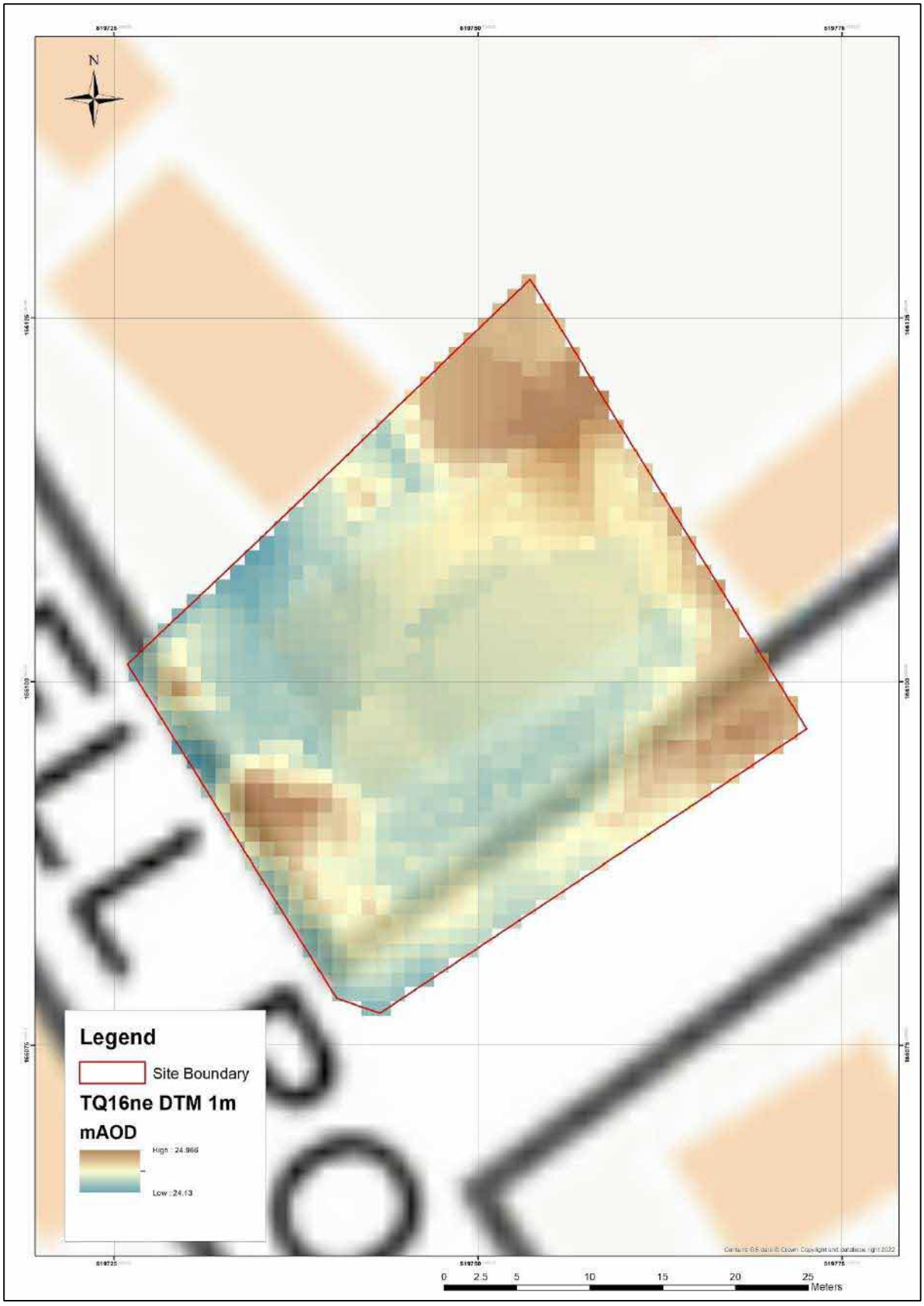
16.1.1 Ground Floor Plan



16.2 Appendix 2– Site Topography and Drainage Characteristics

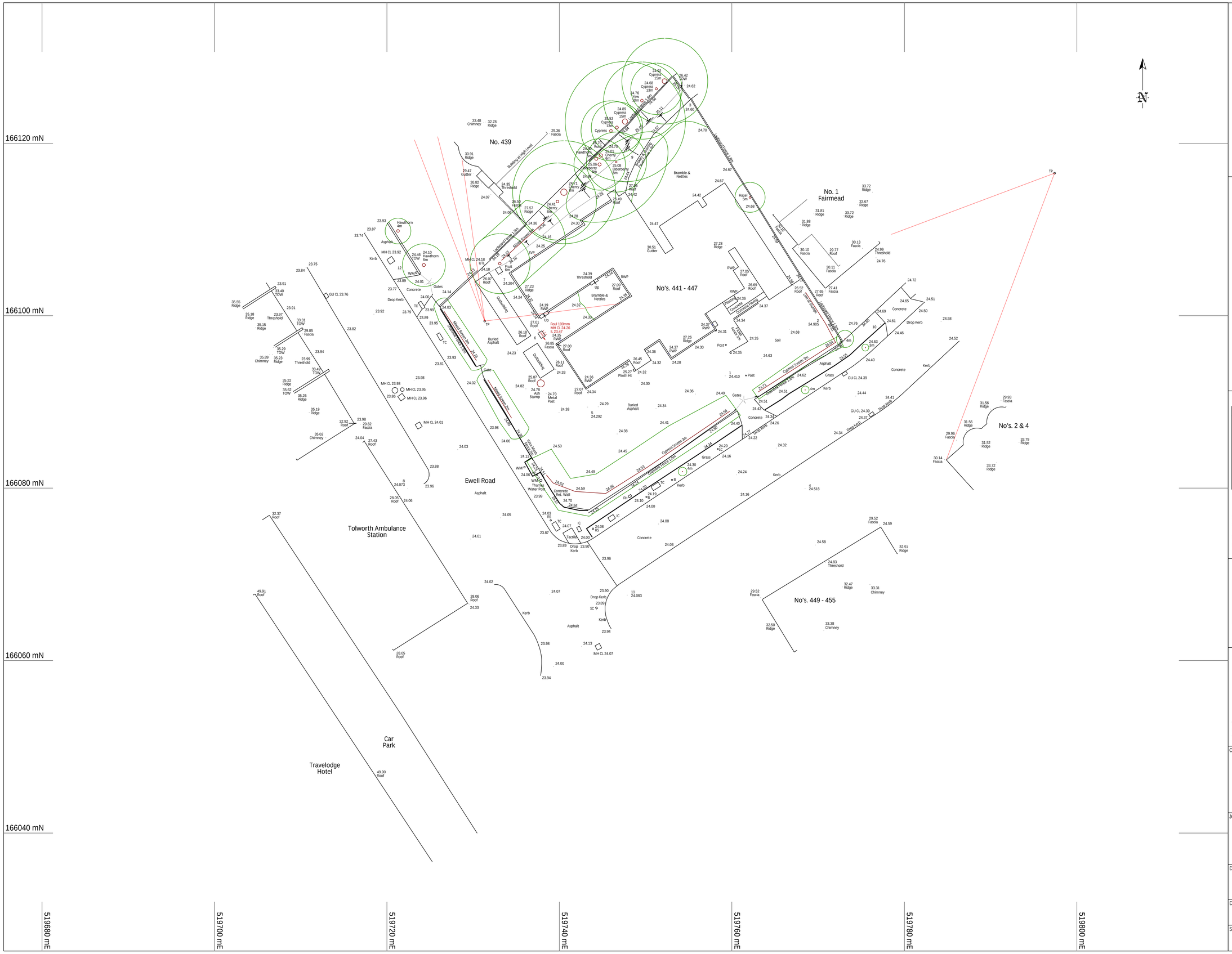
16.2.1 LIDAR Mapping showing Site Topography - (Source: OS 2017)




N
Legend
Site Boundary
TQ16ne DTM 1m
mAOD
High : 24.966
Low : 24.13
0 2.5 5 10 15 20 25
Meters

16.2.2 Topographic Survey

See next page.



NOTES

1. LEVELS ARE RELATED TO ORDNANCE SURVEY BY GPS OBSERVATION.
2. SURVEY ORIENTATED NORTH BY GPS OBSERVATION.
3. GIRTH, SPREADS, HEIGHTS AND SPECIES OF TRESS ARE INDICATIVE ONLY.
4. SURVEY HAS BEEN CARRIED OUT TO AN ACCURACY COMMENSURATE WITH A 1:200 SCALE DRAWING.
5. DETAILS IN ADJACENT PROPERTIES ARE APPROXIMATE WHERE WE HAVE NO ACCESS.
6. LEVELS SHOWN ON KERB LINES ARE ROAD (CHANNEL) LEVELS.
7. ALL CRITICAL DIMENSIONS AND LEVELS SHOULD BE CHECKED PRIOR TO DESIGN AND/OR CONSTRUCTION.

ABBREVIATION LIST

AV	AIR VALVE
B	BOLLARD
CL	COVER LEVEL
DK	DROP KERB
DPC	DAMP PROOF COURSE
ECB	ELECTRIC CABLE CABINET
ECP	ELECTRIC CABLE PIT
EP	ELECTICITY POLE
ER	EARTH ROD
FAI	FRESH AIR INLET
FH	FIRE HYDRANT
GC	GAS COCK
GU	GULLY
GUS	GULLY SURROUND
IC	INSPECTION COVER
IL	INVERT LEVEL
LC	LAMP COLUMN
M	SERVICE MARKER
MH	MANHOLE COVER
NPV	NO PIPES VISIBLE
OHC	OVERHEAD CABLES
RS	ROAD SIGN
RWP	RAIN WATER PIPE
SC	STOP COCK
SV	STOP VALVE
SVP	SOIL AND VENT PIPE
TBM	TEMPORARY BENCH MARK
TCB	TELEPHONE CABLE CABINET
TC	TELEPHONE CABLE PIT
TP	TELEPHONE POLE
TOS	TOP OF SILT
TOP	TOP OF PILLAR
TOW	TOP OF WALL
TV	CABLE TV PIT
UTL	UNABLE TO LIFT
VP	VENT PIPE
WL	WATER LEVEL
WM	WATER METER
WO	WASH OUT

STATION CO-ORDINATES

NO.	EASTING	NORTHING	LEVEL
1	519759.219	166093.024	24.407
2	519770.254	166099.873	24.905
3	519754.891	166124.905	24.841
4	519768.468	166079.964	24.518
5	519743.266	166089.399	24.292
6	519737.742	166097.508	24.256
7	519733.287	166104.770	24.204
8	519722.401	166079.934	24.073
9	519748.127	166117.865	24.881
10	519777.211	166098.992	24.616
11	519747.853	166067.588	24.083
12	519722.053	166105.180	23.928

2 / 122.11 SURVEY STATION

STATIONS IN HARD SURFACES ARE CROSS HEAD GALVANISED BOLTS.

STATIONS IN SOFT GROUND ARE PEGS AT GROUND LEVEL WITH CROSS HEAD GALVANIZED SCREWS.

NO.	DATE	DETAILS

REVISIONS

KND SURVEYS LTD
74 WATCHET LANE
HOLMER GREEN
HIGH WYCOMBE
BUCKINGHAMSHIRE
HP15 6UG
Tel: 01494 718453
Fax: 01494 717576
e-mail: admin.office@kndsurveys.com

CLIENT

JOB TITLE

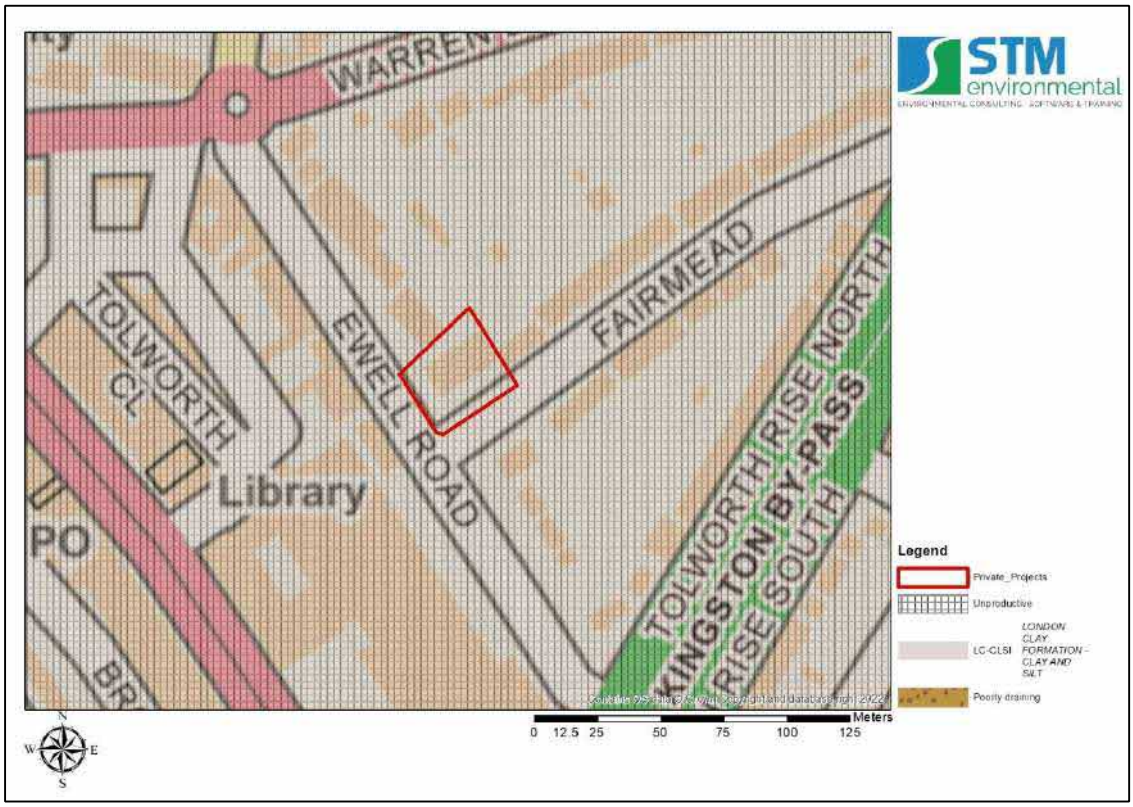
441-447 EWELL ROAD
SURBITON

DRAWING TITLE

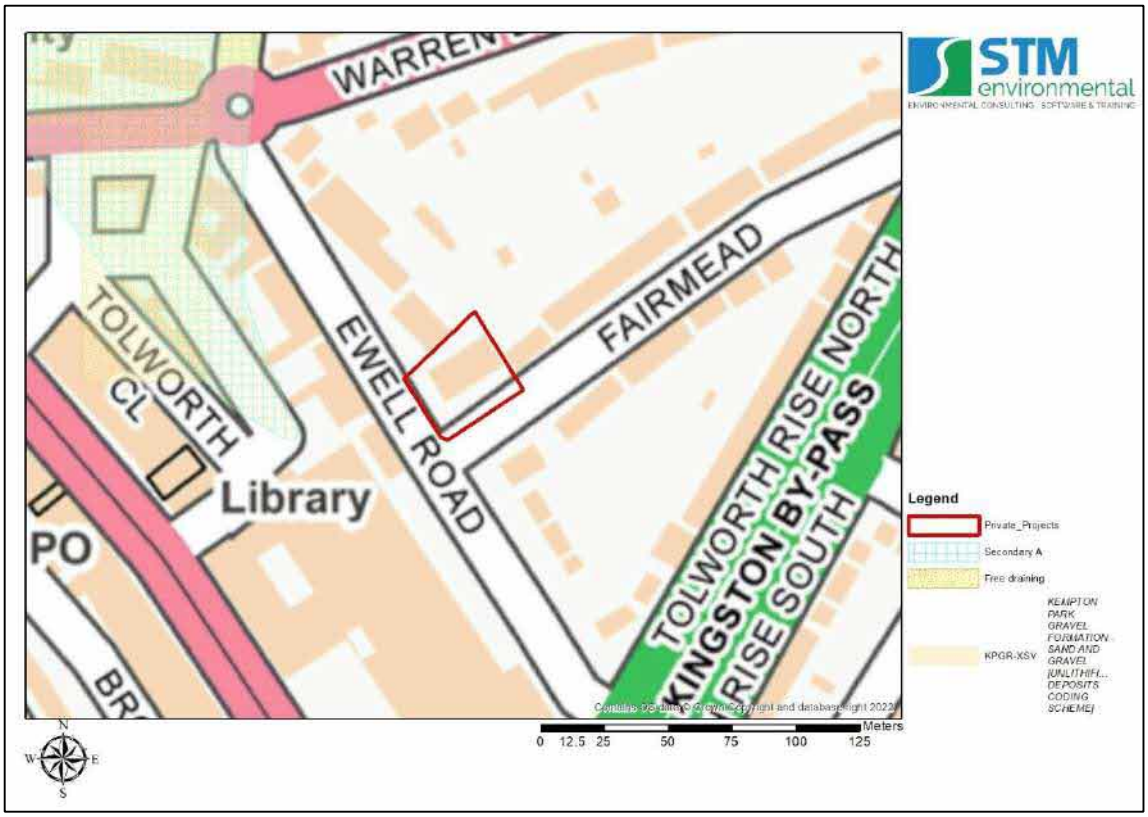
SITE SURVEY

DRAWING No.	DRAWN BY	DATE
L 06 22 - T	JD / MTP	08.12.2022
SURVEYED BY		SCALE
DJH / ML		1:200 A1 Sheet

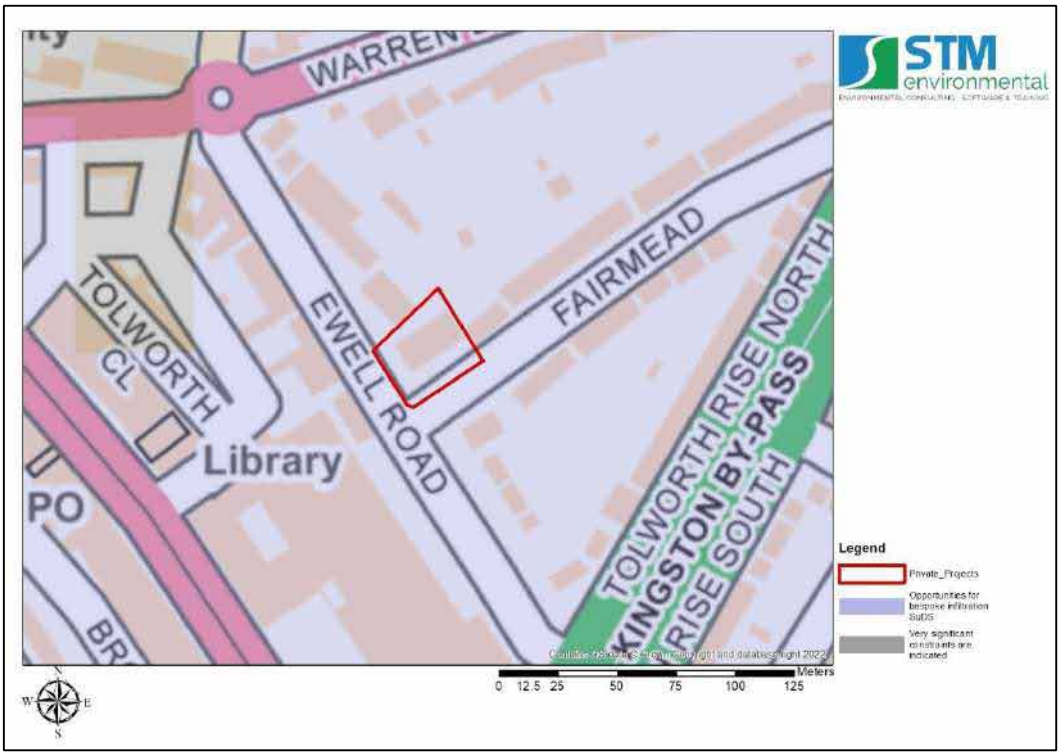
16.2.3 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



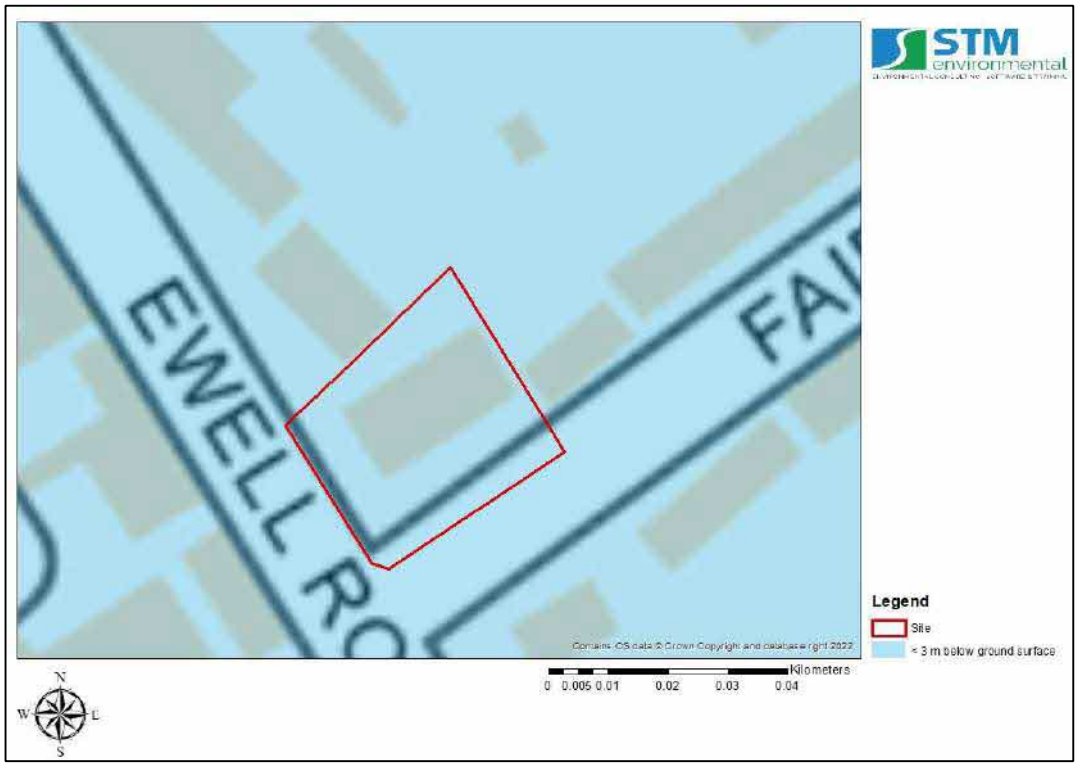
16.2.4 Superficial Hydrogeology & Permeability (Source: BGS, 2016)



16.2.5 Infiltration Drainage Potential (Source: BGS, 2016)

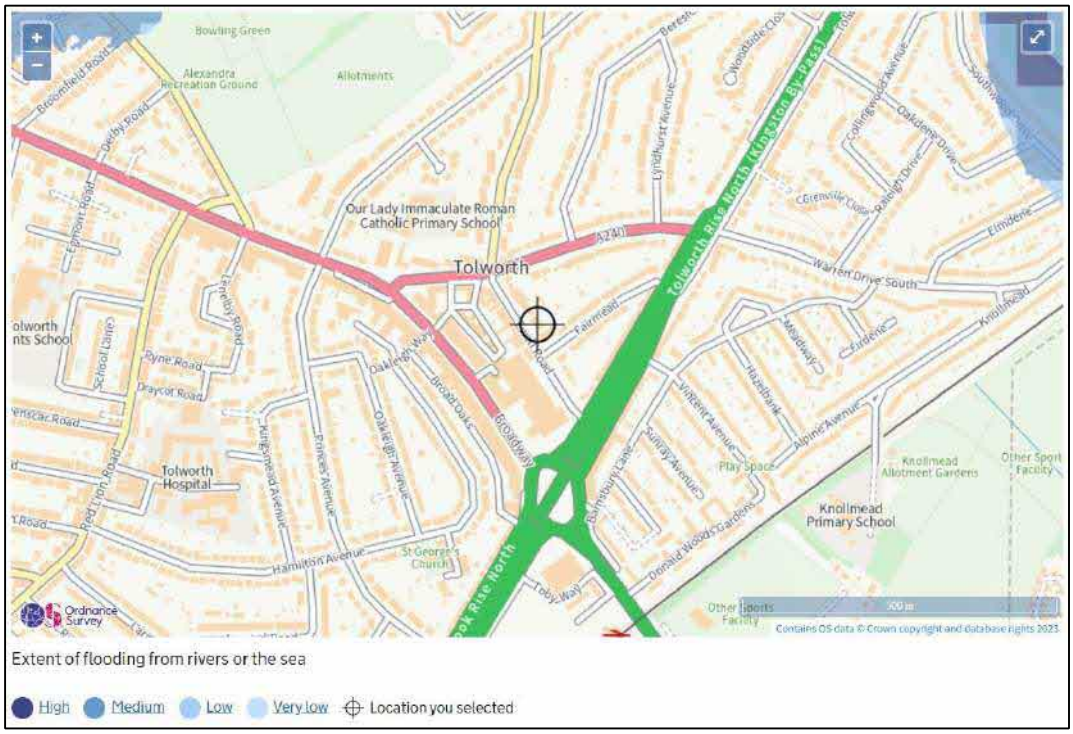


16.2.6 Groundwater Table Depth (Source: BGS 2016)



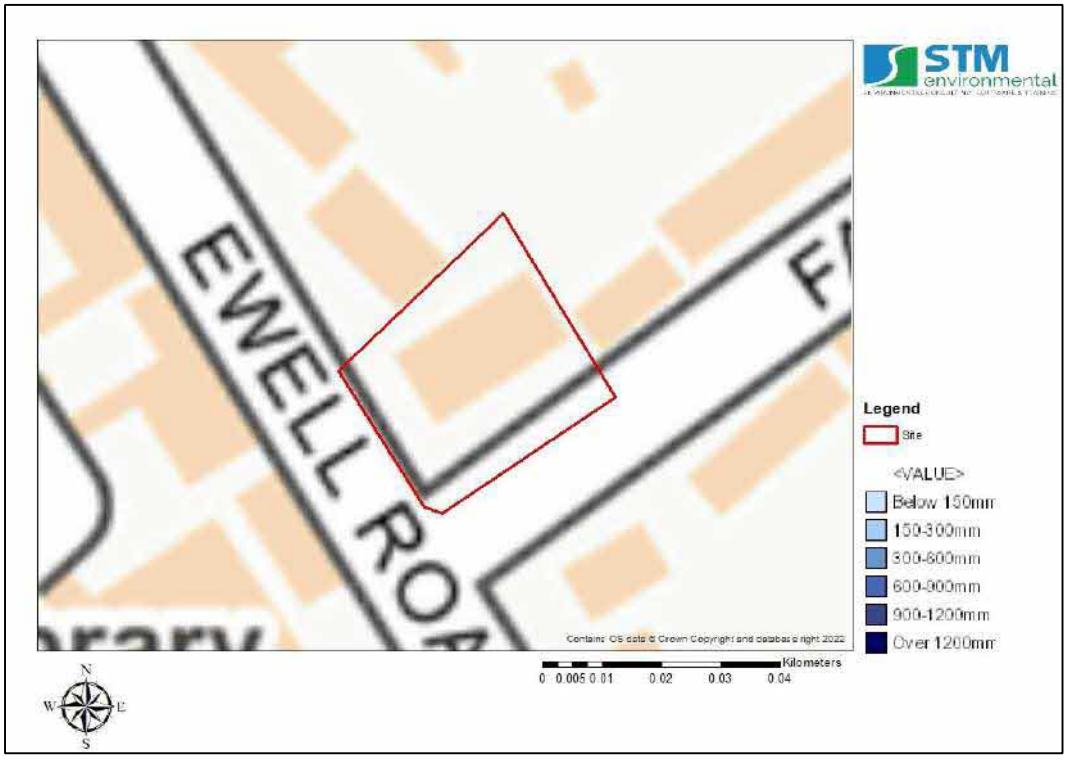
16.3 Appendix 3 – Flood Risk Mapping

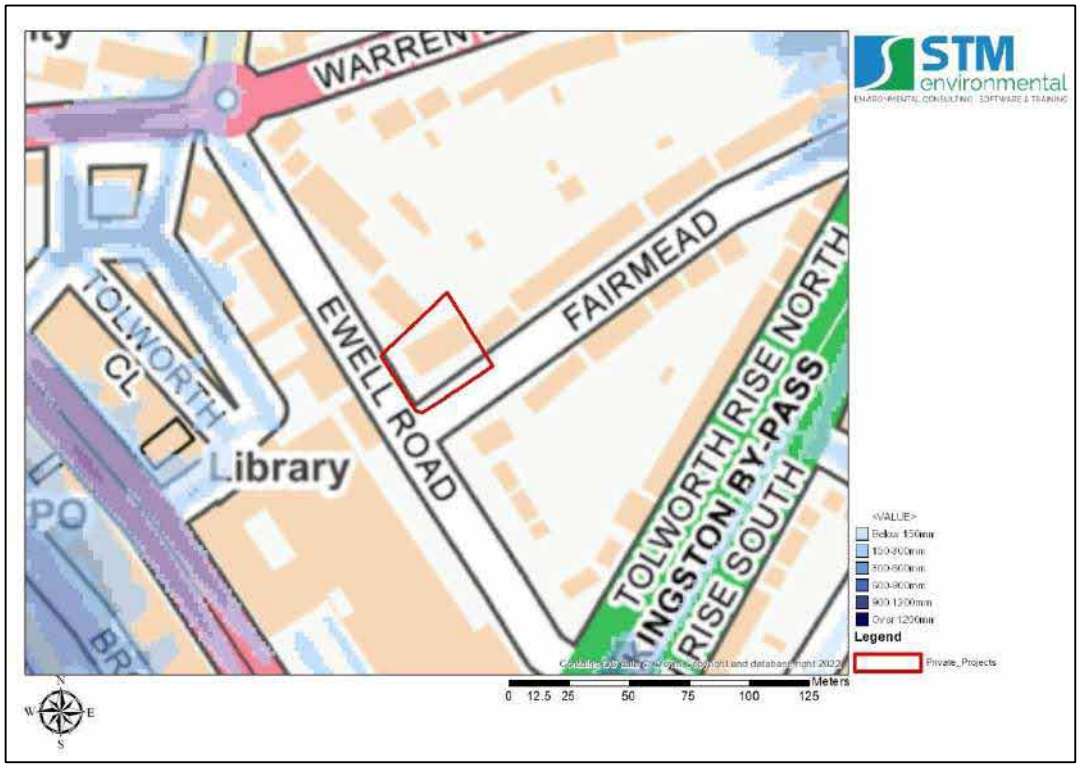
16.3.1 Long Term Fluvial Flood Risk Map (EA)



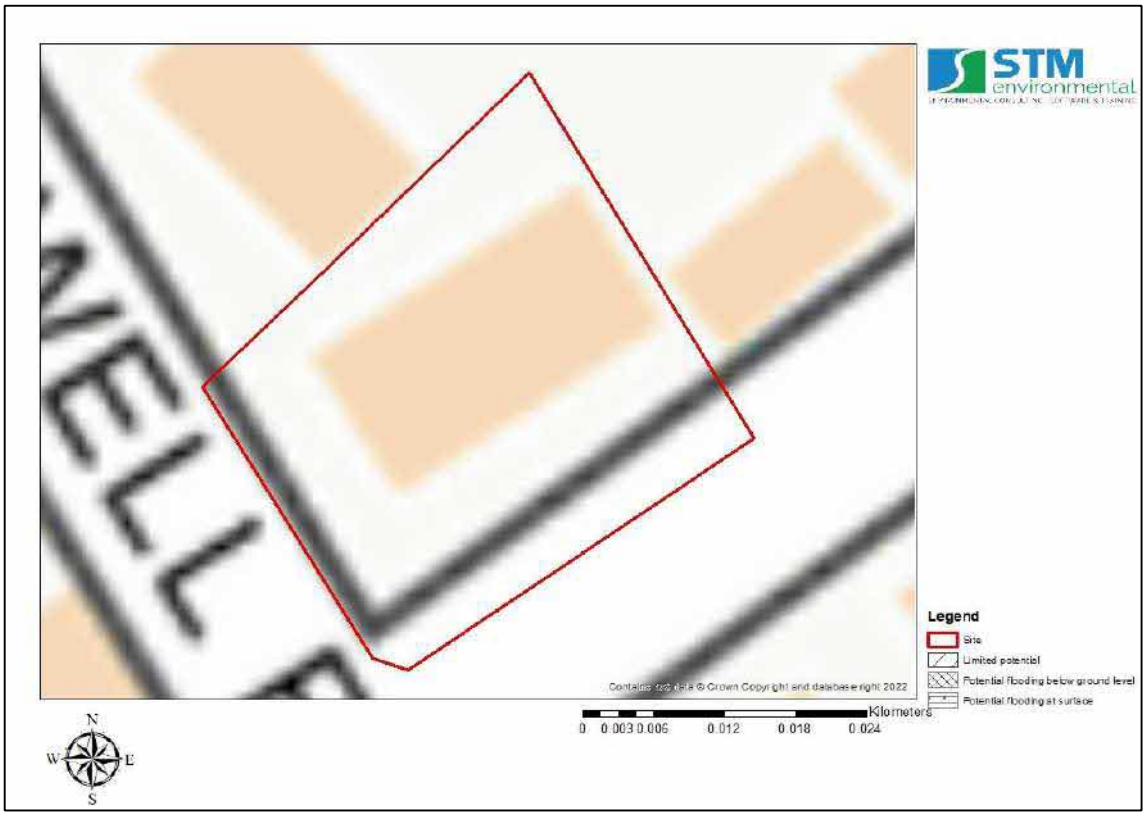
16.3.2 Long Term Pluvial Flood Risk Map (EA)

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





16.3.4 Groundwater flooding susceptibility (Source: BGS, 2016).



16.4 Appendix 4 – Thames Water / Asset Information

16.4.1 Asset Map

16.5 Appendix 5 – Run-Off Rate and Storage Calculations

16.5.1 UK SuDS

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	[redacted]
Site name:	441-447 Ewell Road,
Site location:	Surbiton, Surrey, KT6 7E

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:	51.38120° N
Longitude:	0.28077° W
Reference:	2879578262
Date:	Aug 25 2023 10:14

Runoff estimation approach

IH124

Site characteristics

Total site area (ha):	0.1225

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):	615	615
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):	0.19	0.19
1 in 1 year (l/s):	0.16	0.16
1 in 30 years (l/s):	0.44	0.44
1 in 100 year (l/s):	0.61	0.61
1 in 200 years (l/s):	0.72	0.72

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	[redacted]
Site name:	441-447 Ewell Road,
Site location:	Surbiton, Surrey, KT6 7ES

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:	51.38128° N
Longitude:	0.28073° W
Reference:	33215219
Date:	Aug 25 2023 10:17

Site characteristics

Total site area (ha):	0.1225
Significant public open space (ha):	0.0660
Area positively drained (ha):	0.056499999999999995
Impermeable area (ha):	0.0564
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):	0.06
Net impermable area for storage volume design (ha):	0.06
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.

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:	--	102.41
FEH / FSR conversion factor:	1.33	1.33
SAAR (mm):	615	615
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

Design criteria

Climate change allowance factor:	1.4		Growth curve factor 30 year:	2.3	2.3
Urban creep allowance factor:	1.1		Growth curve factor 100 years:	3.19	3.19
Volume control approach	Use long term storage		Q_{BAR} for total site area (l/s):	0.19	0.19
Interception rainfall depth (mm):	5		Q_{BAR} for net site area (l/s):	0.09	0.09
Minimum flow rate (l/s):	2				

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):	27	27
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	27	27

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

16.5.2 IH124 method

Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	1.4303	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	2.1212	
SAAR(mm) - Current	615.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.6909	
SAAR (mm) + CC	861.00		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	14.9234	
SPR (Greenfield)	0.37		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-2.1696	
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)	-46.8639	
Site Area (ha)	0.1225				
Impermable Area (Pre Development - ha)	0.09010				
Permeanble Area (Pre Development - ha))	0.0324000		Greenfield (l/s)	Pre - Development (l/s)	Post Development (l/s)
Impermable Area (Post Development - ha)	0.0501000	Qbar	0.30	0.57	0.45
Permeanble Area (Post Development - ha)	0.0724000	1 in 1	0.26	0.48	0.38
GCF (1 in 1)	0.85	1 in 30	0.70	1.30	1.03
GCF (1 in 30)	2.30	1 in 100	0.96	1.80	1.43
GCF (1 in 100)	3.19	1 in 100 + CC	1.43	2.67	2.12
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	123.4493	0.3025	2.4690		
1 in 1		0.2571	2.0986	0.7712	5.5530
1 in 30		0.6956	5.6787	2.0869	15.0258
1 in 100		0.9648	7.8761	2.8945	20.8401
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	183.0031	0.4484	3.6601	1.3451	9.6845
1 in 1 +CC		0.3811	3.1111	1.1433	8.2318
1 in 30 + CC		1.0312	8.4181	3.0937	22.2744
1 in 100 + CC		1.4303	11.6756	4.2908	30.8936
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBarA)			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	269.2586	0.4852	5.3852	1.4556	10.4804
1 in 1		0.4124	4.5774	1.2373	8.9083
1 in 30		1.1160	12.3859	3.3479	24.1049
1 in 100		1.5478	17.1787	4.6434	33.4325
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	123.4493	0.0800	1.1049	0.2400	
1 in 1		0.0680	0.9392	0.2040	1.4687
1 in 30		0.1840	2.5413	0.5520	3.9742
1 in 100		0.2552	3.5246	0.7656	5.5120
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	392.7079	0.5652	6.4901	1.6956	10.4804
1 in 1		0.4804	5.5166	1.4413	10.3771
1 in 30		1.3000	14.9272	3.8999	28.0791
1 in 100		1.8030	20.7033	5.4090	38.9445
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	399.1530	0.7193	14.3568		15.5363
1 in 1 +CC		0.6114	12.2032		13.2059
1 in 30 + CC		1.6543	33.0205		35.7335
1 in 100 + CC		2.2945	45.7981		49.5608
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	183.0031	0.1186	1.6379	0.3558	
1 in 1 +CC		0.1008	1.3922	0.3024	2.1772
1 in 30 + CC		0.2727	3.7672	0.8182	5.8914
1 in 100 + CC		0.3783	5.2250	1.1349	8.1711
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	582.1561	0.8379	15.9947	0.3558	15.5363
1 in 1 +CC		0.7122	13.5955	0.3024	15.3831
1 in 30 + CC		1.9271	36.7878	0.8182	41.6249
1 in 100 + CC		2.6728	51.0231	1.1349	57.7319
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		Impermeable Surface Run-Off (l/s/ha (QBarA)			Volume (6 hr)
Impermeable Surface Calculation					
Qbar Impermeable	269.2586	0.2698	5.3852	0.8094	
1 in 1		0.2293	4.5774	0.6880	4.9535
1 in 30		0.6205	12.3859	1.8616	13.4035
1 in 100		0.8607	17.1787	2.5820	18.5901
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	123.4493	0.1788	2.4690	0.5363	
1 in 1		0.1519	2.0986	0.4558	3.2819
1 in 30		0.4111	5.6787	1.2334	8.8805
1 in 100		0.5702	7.8761	1.7107	12.3169
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	392.7079	0.4486	7.8542	1.3457	
1 in 1	0.0000	0.3813	6.6760	1.1438	8.2354
1 in 30	0.0000	1.0317	18.0646	3.0950	22.2840
1 in 100	0.0000	1.4309	25.0548	4.2926	30.9070
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		Impermeable Surface Run-Off (l/s)			
Impermeable Surface Calculation					
Qbar Impermeable	399.1530	0.4000	7.9831		8.6389
1 in 1 +CC		0.3400	6.7856		7.3431
1 in 30 + CC		0.9199	18.3610		19.8696
1 in 100 + CC		1.2758	25.4660		27.5582
Permeable Surface Calculation		Permeable Surface Run-off (l/s)			
Qbar Permeable	183.0031	0.2650	3.6601	0.7950	
1 in 1 +CC		0.2252	3.1111	0.6757	4.8652
1 in 30 + CC		0.6095	8.4181	1.8284	13.1646
1 in 100 + CC		0.8453	11.6756	2.5359	18.2588
Impermeable Surface Calculation + Permeable Surface Calculation					
Qbar	582.1561	0.6649	11.6431	0.7950	8.6389
1 in 1 +CC		0.5652	9.8967	0.6757	12.2083
1 in 30 + CC		1.5294	26.7792	1.8284	33.0342
1 in 100 + CC		2.1212	37.1416	2.5359	45.8170

16.5.3 Storage Estimates – MRM

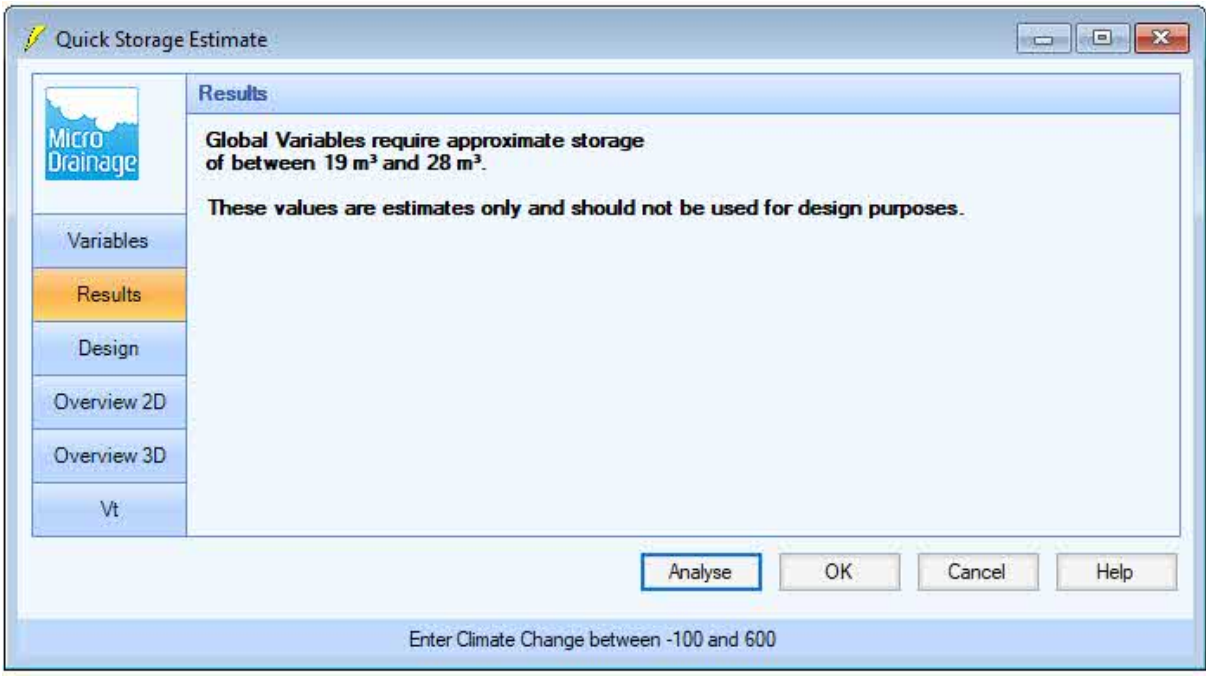
Pre-development discharge

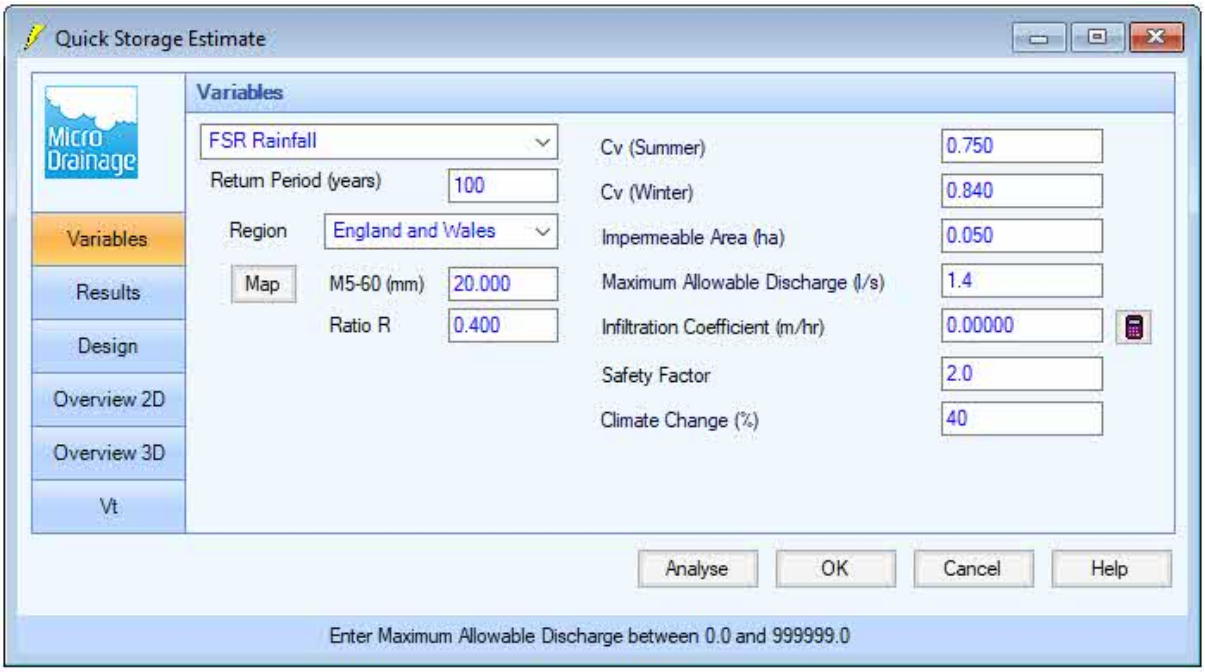
Site Makeup	Brownfield	OK
Brownfield Method	MRM	Cancel
Contributing Area (ha)	0.050	
PIMP (%)	100	
CV	0.750	
Return Period (years)	100	
Climate Change (%)	0	
Storm Duration (mins)	360	
Betterment (%)	0	
	Calc	
PR	0.750	
Runoff Volume (m³)	23	

16.5.4 Storage Estimates – Entire Site 0.125ha.

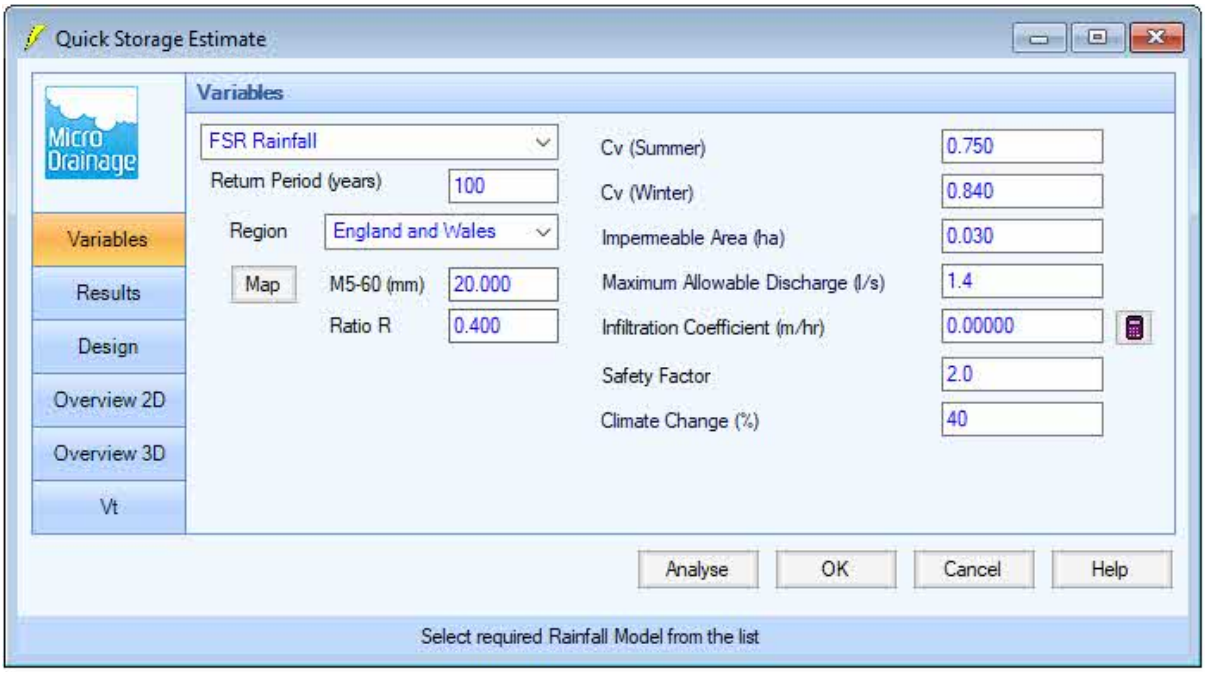
Site Makeup	Brownfield	OK
Brownfield Method	MRM	Cancel
Contributing Area (ha)	0.125	
PIMP (%)	100	
CV	0.750	
Return Period (years)	100	
Climate Change (%)	0	
Storm Duration (mins)	360	
Betterment (%)	0	
	Calc	
PR	0.750	
Runoff Volume (m³)	59	

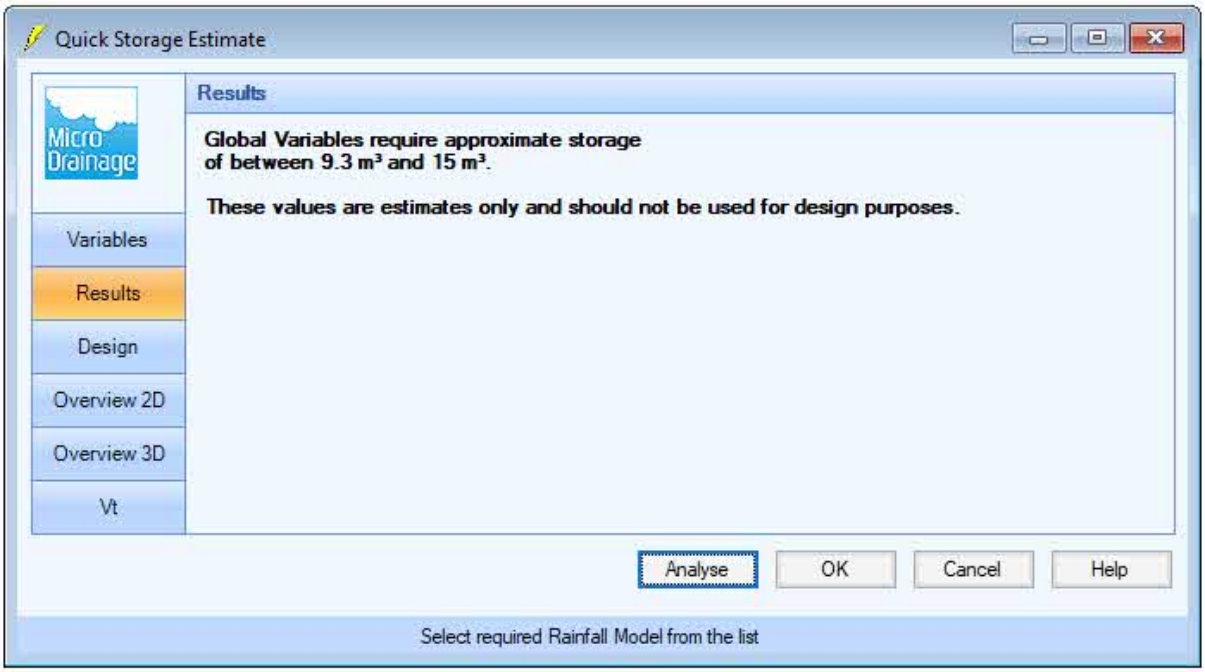
16.5.5 Post Development 0.05ha Impermeable



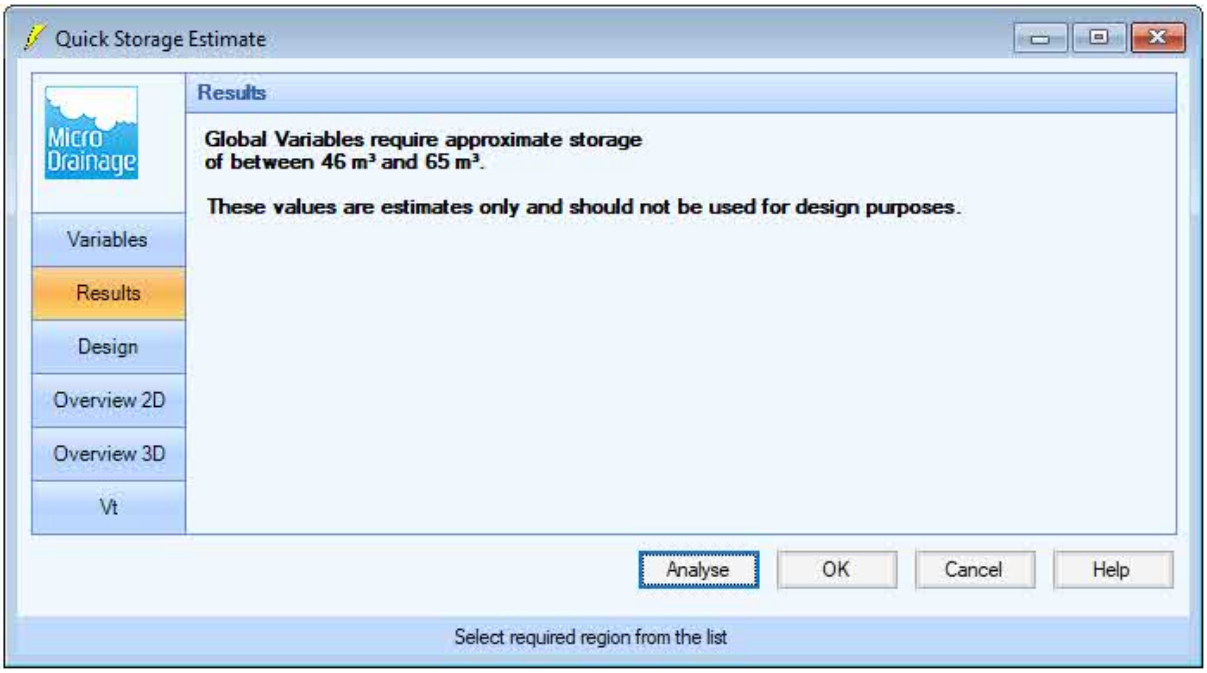


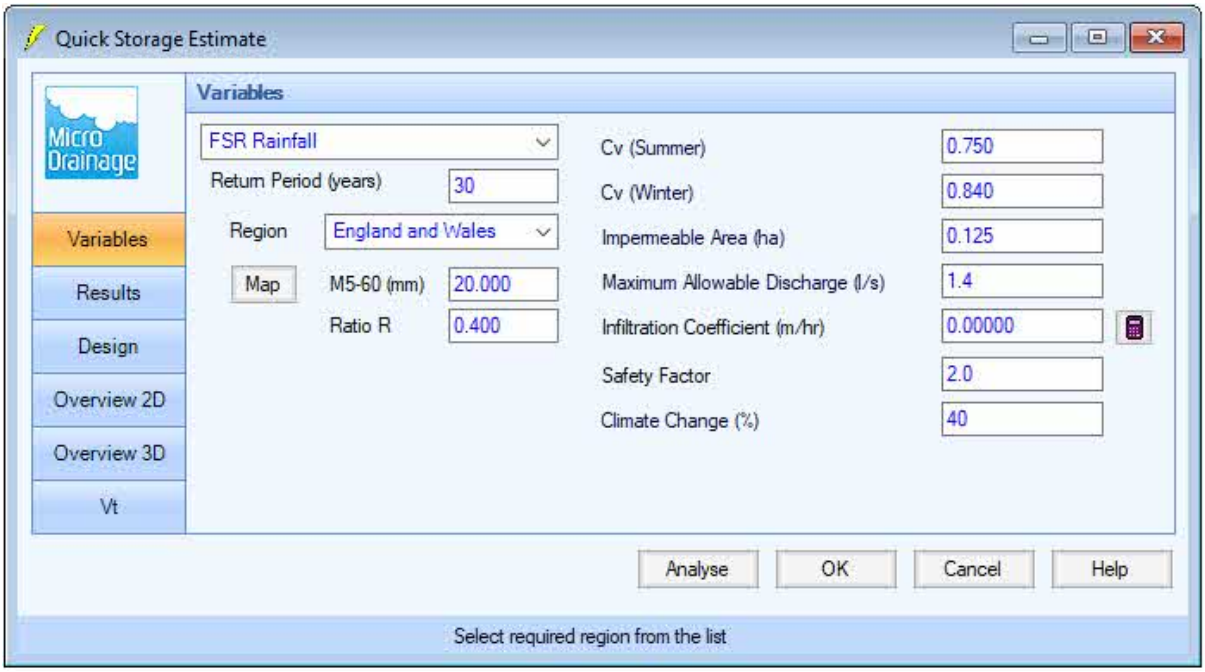
16.5.6 Post Development 0.03ha Impermeable (with SuDS)



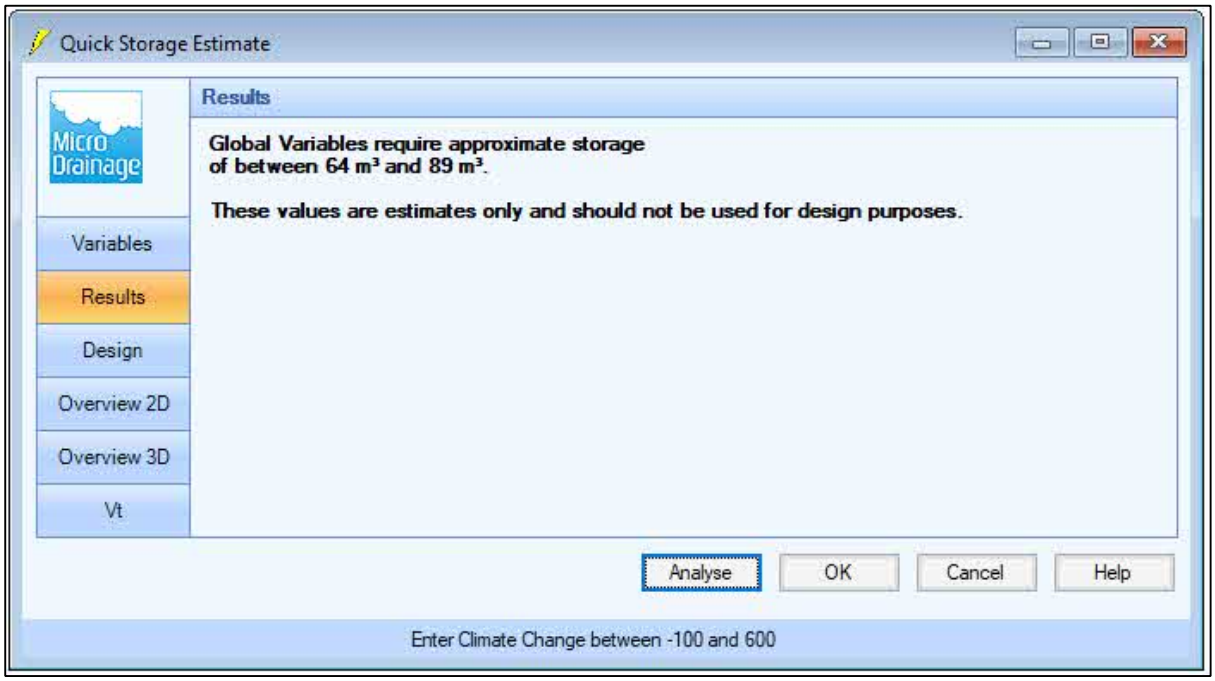


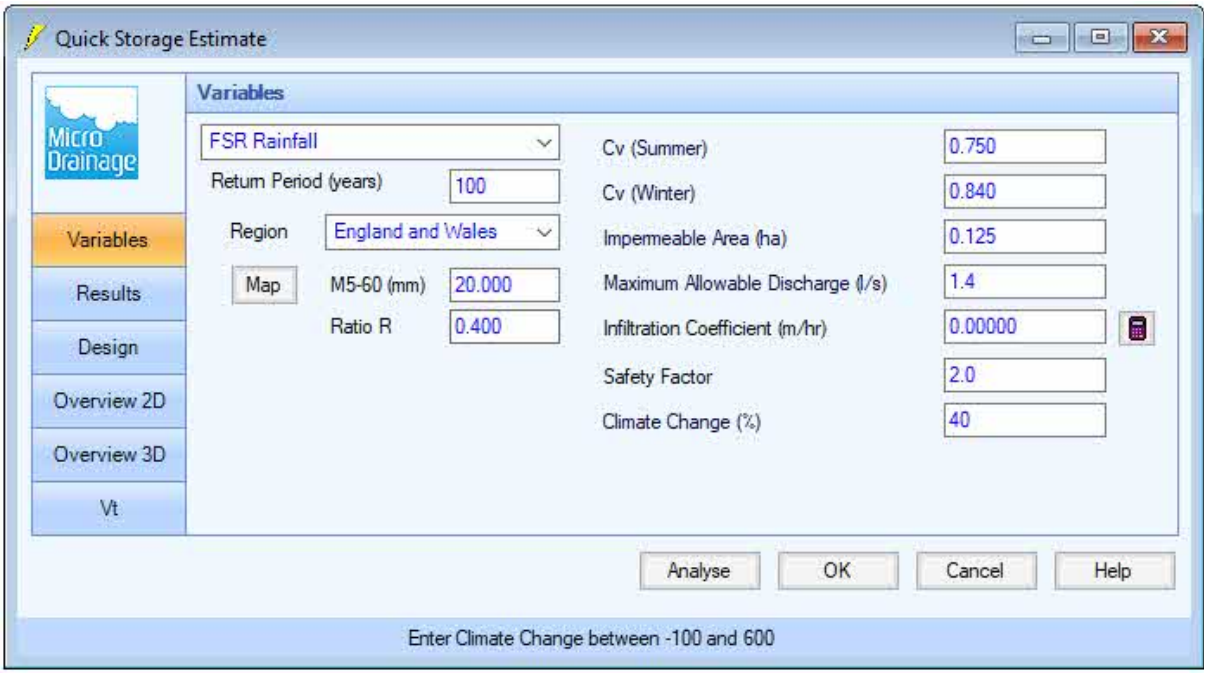
16.5.7 Post Development 0.125ha Impermeable – 0.33 % AEP Plus 40% CC





16.5.8 Post Development 0.125ha Impermeable - 1% AEP Plus 40% CC





16.6 Appendix 6 - Site Investigation

16.6.1 Site Investigation Photos

16.6.2 Infiltration Testing Graph – TP01

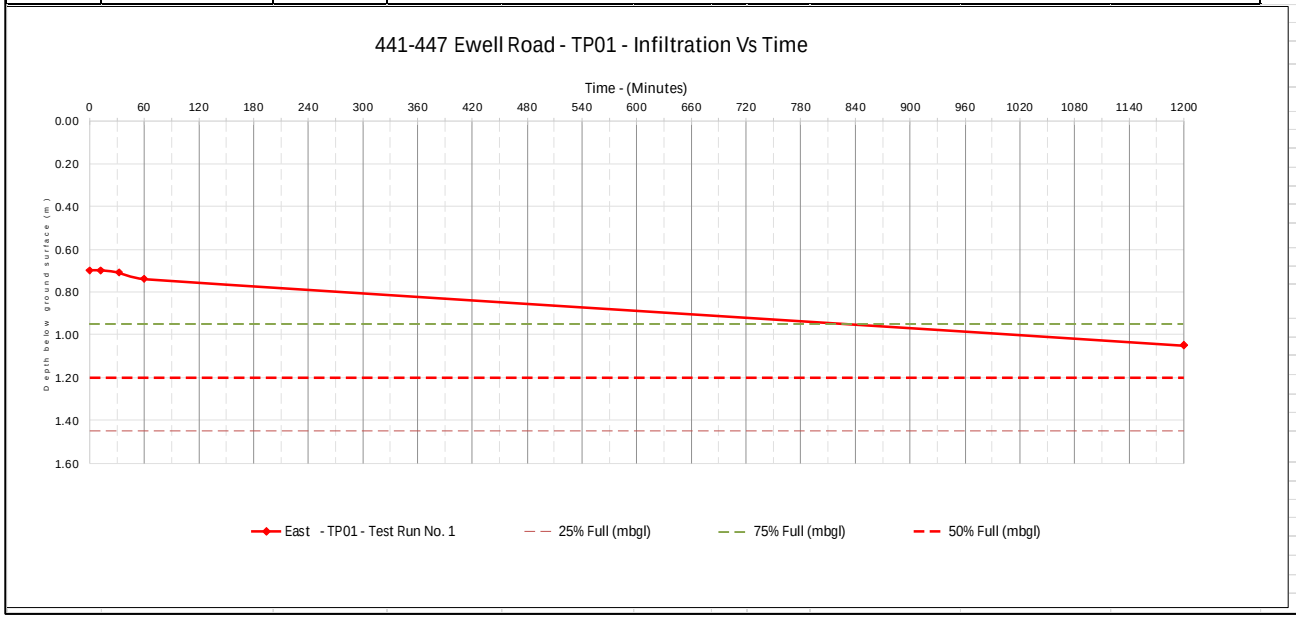
Site Location	441-447 Ewell Road		
Area	East		
Trial Pit ID	TP01		
Test Run	1	2	3

East - TP01 - Test Run No. 1

insert time according to the measured units

Dip Readng	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)	Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
	1.00	0.70	0.00	0	0	0:00 11:22:00	1.45	1.20	0.95
	1.00	0.70	0.20	12	720.00	0:12 11:34:00	1.45	1.20	0.95
	0.99	0.71	0.53	32	1920.00	0:32 11:54:00	1.45	1.20	0.95
	0.96	0.74	1.00	60	3600.00	1:00 12:22:00	1.45	1.20	0.95
	0.65	1.05	20.00	1200	72000.00	20:00 07:22:00	1.45	1.20	0.95

Failed to reach 50% within 24 hours. Second run not undertaken.



$f = V_{p75-25} * 0.3 / a_{s50} * t_{p75-25}$

Infiltration Coef. Calculations		
Width	0.30	m
Depth	1.70	m
Length	1.80	m
Total Volume	0.92	m3
Effective Storage Depth	1.00	m
25% Full	1.45	mbgl
50% Full	1.20	mbgl
75% Full	0.95	mbgl
Pipe Depth	1.85	
a_{s50}	2.88	m^2
V_{p75-25}	0.27	m^3
t_{p75-25} (read from graph)	N/A	mins
f	#VALUE!	m/s
f	#VALUE!	mm/hr
f	#VALUE!	m/hr

Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR VARIOUS SOIL

Soil type	Basic infiltration rate (mm/hour)
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

16.6.3 Infiltration Testing Graph – TP02

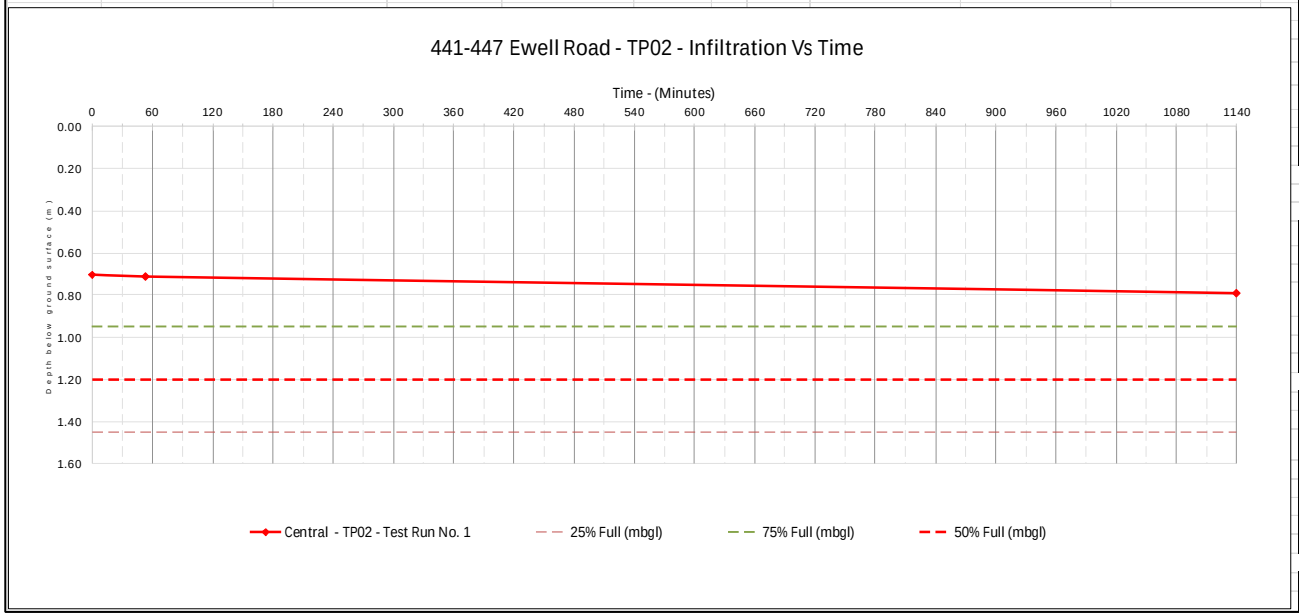
Site Location	441-447 Ewell Road		
Area	Central		
Trial Pit ID	TP02		
Test Run	1	2	3

Central - TP02 - Test Run No. 1

insert time according to the measured units

Dip Readng	Water Level Above Base	Depth (mbgl)	Time (hours)	Time (minutes)	Time (s)		Time	25% Full (mbgl)	50% Full (mbgl)	75% Full (mbgl)
	1.00	0.70	0.00	0	0	0:00	12:11:00	1.45	1.20	0.95
	0.99	0.71	0.88	53	3180.00	0:53	13:04:00	1.45	1.20	0.95
	0.91	0.79	19.00	1140	68400.00	19:00	11:54:00	1.45	1.20	0.95

Failed to reach 50% within 24 hours. Second run not undertaken.



$f = V_{p75-25} * 0.3 / a_{s50} * t_{p75-25}$

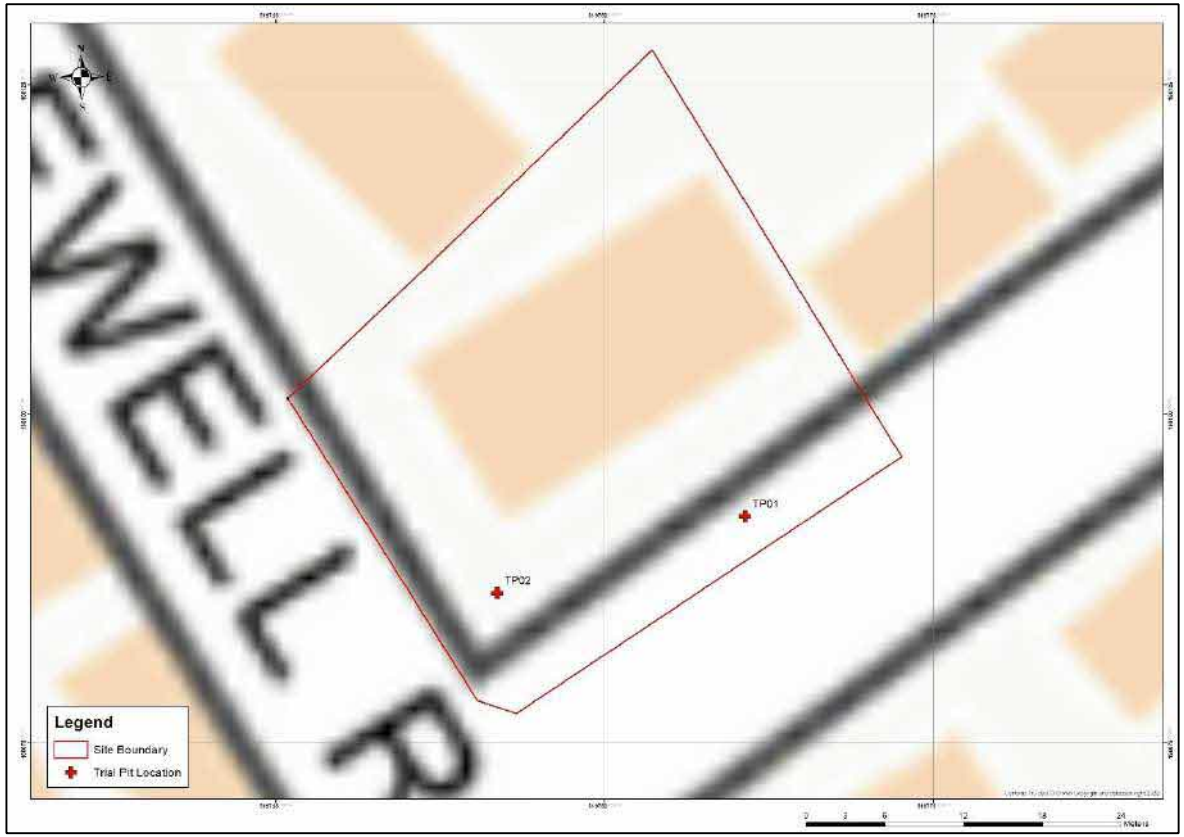
Infiltration Coef. Calculations		
Width	0.30	m
Depth	1.70	m
Length	1.60	m
Total Volume	0.82	m3
Effective Storage Depth	1.00	m
25% Full	1.45	mbgl
50% Full	1.20	mbgl
75% Full	0.95	mbgl
Pipe Depth		
a_{s50}	2.56	m^2
V_{p75-25}	0.24	m^3
t_{p75-25} (read from graph)	N/A	mins
f	#VALUE!	m/s
f	#VALUE!	mm/hr
f	#VALUE!	m/hr

Infiltration Rate (mm/hr)	
IR < 0.036	IMPERMEABLE
0.036 < IR < 0.38	VERY SLOW
0.38 < IR < 3.7	MODERATELY SLOW
3.7 < IR < 37	MODERATE
37 < IR < 370	MODERATELY RAPID
IR > 370	RAPID

BASIC INFILTRATION RATES FOR VARIOUS SOIL	
Soil type	Basic infiltration rate (mm/hour)
sand	less than 30
sandy loam	20 - 30
loam	10 - 20
clay loam	5 - 10
clay	1 - 5

Water level = Pipe Depth - Dip

16.6.4 Soakaway Test Location Map



16.7 Appendix 7 – SuDS Suitability Assessment

16.7.1 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 – Rain water butts
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 London Clay bedrock geology and groundwater table is potentially < 3m below surface. Could increase flood risk. Maintenance	Unsuitable – On site testing confirmed.
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	Suitable – limited infiltration
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 of impermeable membranes and under-drainage. Maintenance required.	Suitable – limited infiltration
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 - Space

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
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	Unsuitable
Oversized Piping	Using larger than necessary pipework creates additional space to store rainwater.	Lacks the wider benefits of the green infrastructure-based techniques	Suitable

16.8 Appendix 8 – Descriptions Of SuDS Techniques

16.8.1 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.

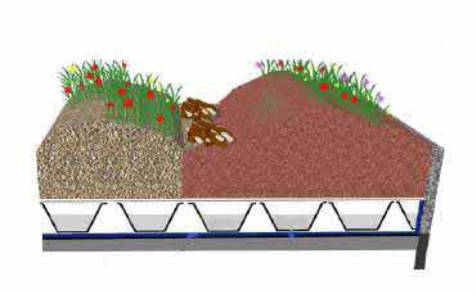


Figure 4: Biodiverse green roof diagram (University of East London)

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.

The outlet will be sized appropriately in order to cope with storm events.

16.8.2 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.

Bauder reserves the right to amend information and product specifications without prior notice. All reasonable care has been taken to ensure that all data is current at the time of print, however because Bauder pursues a policy of constant development we recommend ensuring that your copy of this information is current by contacting out Technical Department at technical@bauder.co.uk.

Recommendations for use should be verified as to the suitability and compliance with actual requirements, specifications, installation techniques and any applicable laws and regulations.

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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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Revision: 02/09/2019 – V2

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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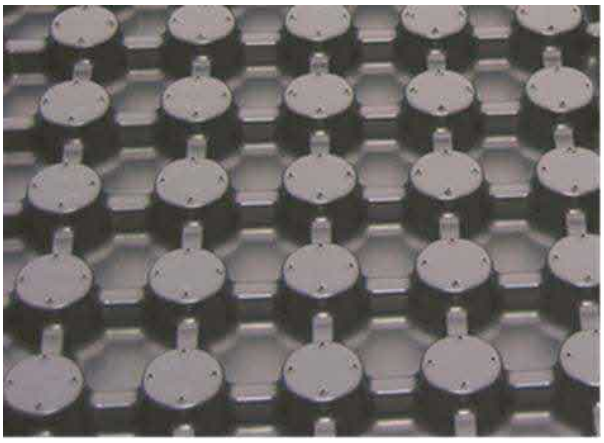
Revision: 30/08/2019 V2

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

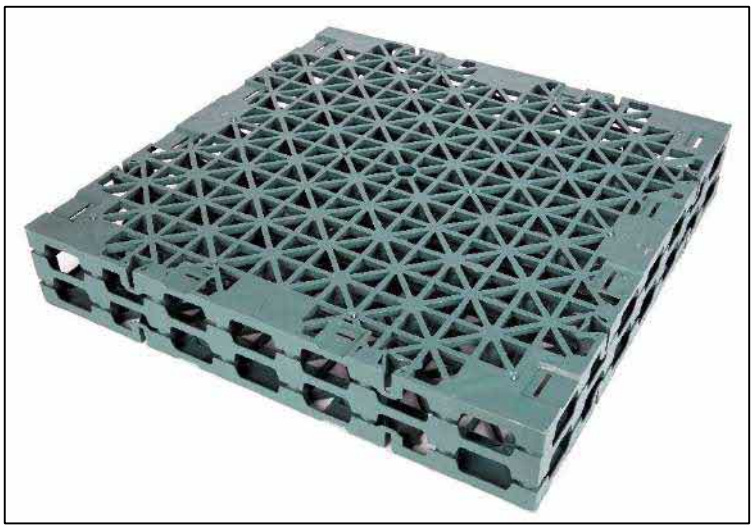
Bauder Attenuation Cell 100

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

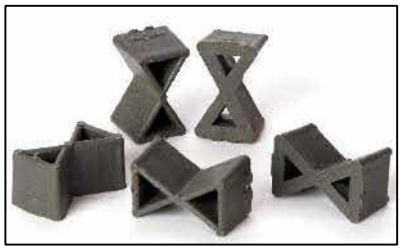
Intended Use

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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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/m²	2 (or as required)	1 (or as required)
Approximate coverage per bag	mm	90m² (based on 2 per cell)	180m² (based on 1 connector per cell)

CERTIFICATION AND ENVIRONMENTAL INFORMATION

DIBt DIN EN ISO 1183- 1 Plastic Density	0.95 g/cm³ – 1.10 g/cm³
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

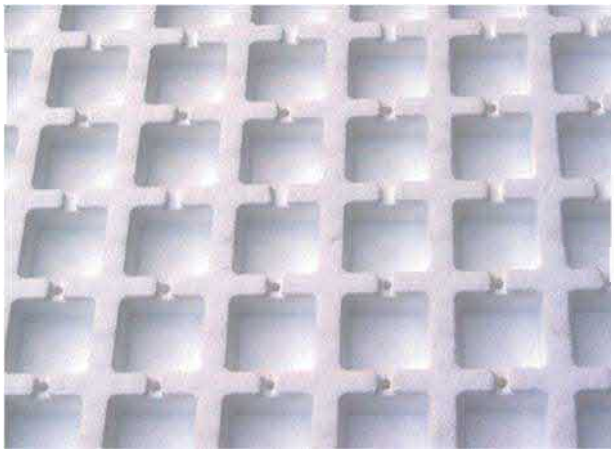
PRODUCT DATASHEET

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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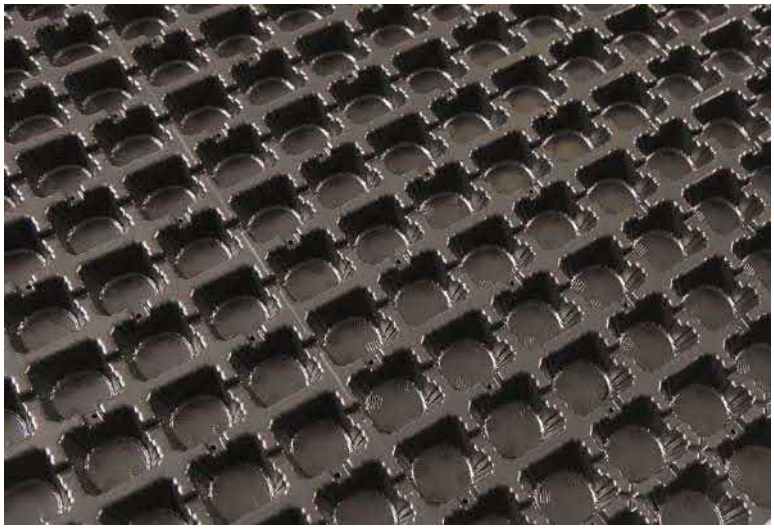
Revision: V3 22/11/2022

TECHNICAL DATA SHEET

BauderGREEN DSE 20 drainage board

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



Intended Use

Laid on to the completed waterproofing to provide continuous drainage within hard and soft landscaping. It is primarily used where the load is moderate, such as extensive green roofs, beneath paving laid on sand/cement or gravel bedding or within planter beds.

[redacted]

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE

Characteristic	Test method	Unit	Value
Weight (dry)	EN 1848-1	kg/m²	1.2
Weight (saturated)		kg/m²	8.6
Water Storage		Ltr	7.4
Material			recycled high density polyethylene
Nominal Thickness		mm	2
Depth		mm	20
Board Size		m	1.06 x 2.36 (2.5 m²)
Approx. Coverage		m²	2

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 up) over entire areas. Overlap each sheet by one full cup. See Bauder's Green Roof Installation Guide for full details.

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Revision: V1 01/09/2022

PRODUCT DATA SHEET

BauderBLUE ST-B adjustable flow restrictor (bitumen)

The BauderBLUE ST-B adjustable flow restrictor is fitted into the RWO and is used to control the flow of water from a blue roof, it is part of the Bauder blue roof system. It is comprised of four parts: baseplate with stainless steel slide control, overflow pipe, baseplate inner and outer seal. The polyamide baseplate fits within the 70mm vertical outlet, with the EPDM outer seal creating a watertight fit. The HDPE Overflow slots into the central hole of the baseplate with an inner EPDM seal preventing any leaks.

Intended Use

The BauderBLUE ST adjustable flow restrictor is designed to be fitted into a standard Bauder Bitumen Blue Roof Vertical Outlet DN70 as part of a Bauder Blue Roof system.

There are two versions of the restrictor, one for use with Bauder's hot melt system and the other used with Bauder's differing total roofing system.

The baseplate has a stainless-steel slide plate which can be set to 6 positions to control the flow rate for the outlet. The correct position for the plate will be shown on the Bauder Blue Roof Calculation Sheet.

PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**Baseplate**
Material		Polyamide + stainless-steel Slide Control
Height	mm	30 (42mm including Slide Control)
Diameter (c)	mm	196
Overflow External Diameter (a)	mm	75
Supply Form		As part of a 4-part set
		Overflow Pipe
Material		HDPE
Height	mm	250 maximum as Std (cut down to H-Max)
Overflow Inner Diameter	mm	69
Supply Form		As part of a 4-part set
Note: this product requires additional blue roof products to complete the system		

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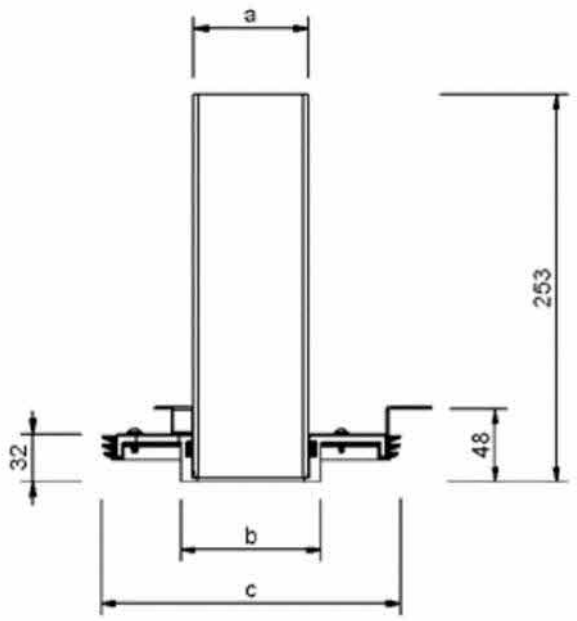
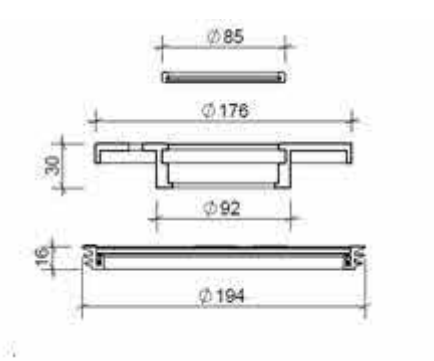
PRODUCT DATA SHEET





PRODUCT INFORMATION AND TECHNICAL PERFORMANCE		
Characteristic	**Unit**	**Inner & Outer Seal**
Material		EPDM
Diameter	mm	85 (inner seal) 194 (outer seal)
Supply Form		As part of a 4-part set
Note: this product requires additional blue roof products to complete the system		

MAIN CHARACTERISTICS

Robust, low maintenance design

Overflow pipe is cut to a bespoke length for individual project

UV/IR radiation resistant

Flow Rate can be adjusted via 6 position slide plate to match that required for a particular roof/site.

Follows the NFRC (National Federation of Roofing Contractors) Technical Guidance Notes for the Construction and Design of Blue Roofs & CIRIA Blue Roof Guidance (Construction Industry Research and Information Association)

Packaging: Supplied in PE plastic bag including installation guide within a cardboard box.

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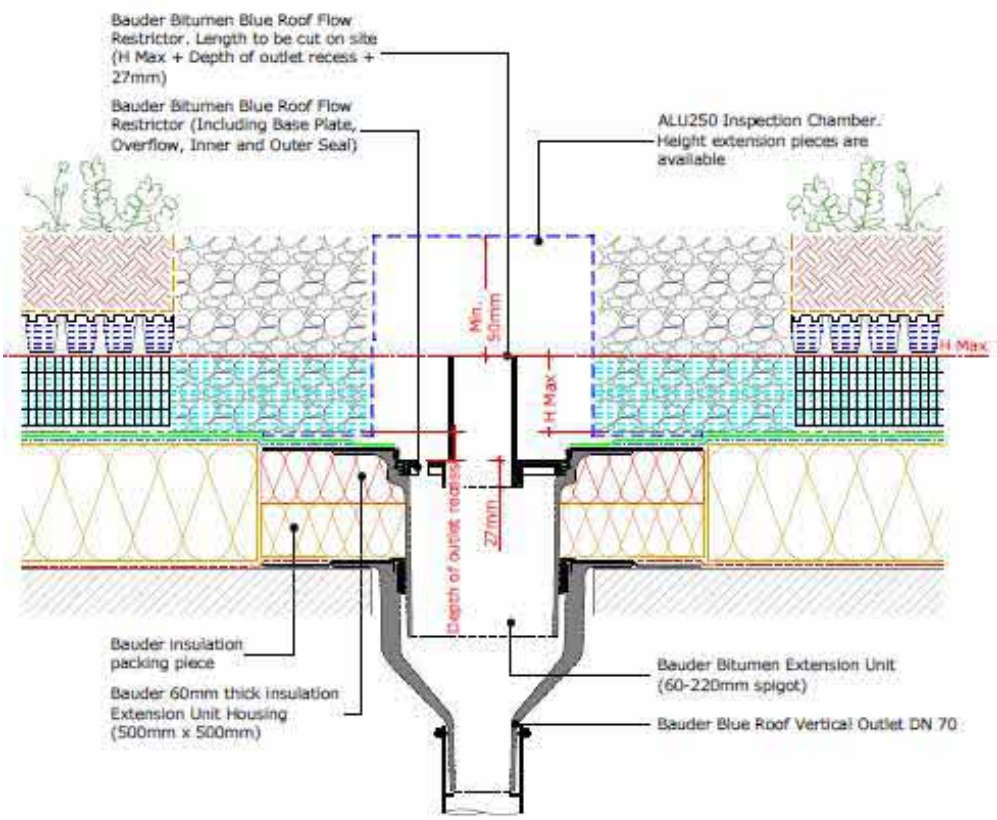
PRODUCT DATA SHEET

Section Detail



Discharge rate in l/s - Bauder Adjustable Flow Restrictor - Bitumen																				
	Head of water in mm																			
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Position 1	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1
Position 2	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0
Position 3	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0	3.1	3.2
Position 4	1.2	1.9	2.1	2.4	2.5	2.7	2.8	3.0	3.1	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.1	4.2	4.3	4.4
Position 5	1.6	2.6	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.2	4.4	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.5	5.7
Position 6	1.4	3.0	3.4	3.7	3.9	4.2	4.4	4.6	4.9	5.1	5.3	5.5	5.6	5.8	6.0	6.1	6.3	6.5	6.7	6.8

BLUE ROOF SURFACE FINISHES

Blue Roofs should have a surface finish above the water attenuation layers. This surface finish can be constructed from any suitable permeable surface, to provide visual masking, protection of the system, filtration of airborne debris to prevent blockages and ballasting preventing wind uplift and floatation of the components. An impermeable surface can be used but adequate measures should be taken to ensure the water can filter into the Blue Roof attenuation void.

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PRODUCT DATA SHEET

BLUE ROOF DESIGN GUIDANCE

A Blue Roof should not be considered as a water storage solution.
No British or European standard covers this type of application at the present time.
The Blue Roof must be designed to attenuate the predicted rainfall volume, required to prevent ponding or flooding on the roof surface. The surfacing should drain by direct permeability or drainage channels linking into the Blue Roof system.
Emergency drainage must be provided within the primary outlet or by a secondary method of drainage to facilitate the removal of excess rainfall, if the designed capacity is exceeded. This should be placed at the top of the water attenuation layer.
The Blue Roof, void forming components, thermal insulation and waterproofing must have the correct structural capacity to resist permanent (dead) load of the required finishes and any temporary (live) loading produced by maintenance/emergency vehicles or other elements. The components should be designed to accommodate the full capacity of the predicted storm water for a 24-hour period.
All components must have chemical resistance to all potential hazardous material e.g., Fertilisers, petrochemicals and water bound pollutants carried in by rainfall typically from 4-9PH.
An electronic or suitable integrity test should take place, by an independent and competent person, on the completed waterproofing prior to the installation of any Blue Roof void forming or landscaping components. The satisfactory waterproofing integrity certification must be retained.
See Bauder's Blue Roof Design Considerations for more information.

BLUE ROOF MAINTENANCE GUIDANCE

When maintaining a blue roof, the following considerations should apply:

Regularly clear all debris from the roof surface, rainwater outlets, chutes, gutters etc. Debris must be removed from the roof and not simply flushed down rainwater pipes.
Annually inspect the waterproofing system visible at all upstands, to ensure it is firmly adhered to the detail that it is waterproofing.
Cut back tree limbs that overhang the roof to give a one metre clearance outside the roof edge. This will significantly reduce blockage of drainage ways due to fallen leaves.
Ensure that all rainwater pipes are free from blockages and that water flows freely through them.
For full details see Bauder's Blue Roof Maintenance Guide.

CERTIFICATION AND ENVIRONMENTAL INFORMATION	
Environmental Accreditation	Interseroh Climate Protection Certificate
Third Party Accreditation	TUV (Germany)
International Standards Organisation (ISO) Product testing	ISO 9001:2015 Quality Management Certificates EN1253-2 ISO 14001:2015 Environmental Management Certificates EN1253-2 All components comply with EN 1253-2 Regulated Building Products
Supply Form	Boxed on pallet (circa 60 per pallet)
Packaging	Transparent Plastic Bag (80my - 0.029Kg LDPE) within Cardboard box 0.311 Kg (FSC Certified)
Recycled content of packaging	none

INSTALLATION GUIDANCE
This Adjustable Flow Restrictor is designed to fit into the Bauder DN70 Compact Outlet. It is recommended that the restrictor is NOT fitted until the roof is completed finished and rainwater run-off is flowing clear. The base plate and overflow have seals which must be fitted to ensure the restrictor is watertight, a lubricant is supplied. The flow position on the slide control should be selected and locked into place using a Torx 2 screwdriver prior to fitting.

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PRODUCT DATA SHEET

Bauder reserves the right to update this data set without prior notice and this document is uncontrolled if printed or stored. Always confirm the latest version is used for the adoption of this product, available from our website: bauder.co.uk/technical-centre.

Intended use of this product should be verified with Bauder to ensure suitability and compliance with applicable guidance, regulations, legislations, project requirements, specifications, and installation techniques.

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Revision: V3 22/11/2022

TECHNICAL DATA SHEET

BauderGREEN FSM 600 protection mat

Heavy duty protection layer made from polyester and polypropylene fibres.

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
Weight (dry)	kg/m²	0.6
Weight (saturated)	kg/m²	3.6
Water storage	Litre/m²	3
Thickness	mm	4
Size (supplied in rolls)	m	2 x 30
Coverage	m²	60
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.

Bauder reserves the right to amend information and product specifications without prior notice. All reasonable care has been taken to ensure that all data is current at the time of print, however because Bauder pursues a policy of constant development we recommend ensuring that your copy of this information is current by contacting our Technical Department at technical@bauder.co.uk

Recommendations for use should be verified as to the suitability and compliance with actual requirements, specifications, installation techniques and any applicable laws and regulations.

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16.8.4 Rain Garden

A rain garden is a shallow depression, with absorbent, yet free draining soil and plants that can withstand occasional temporary flooding. Rain gardens are designed to mimic the natural water retention of undeveloped land and to reduce the volume of rainwater running off into drains from impervious areas and treat low level pollution.

Rain gardens usually absorb all the rainwater that flows into them, but when they do fill up following particularly heavy rainfall, any excess water is redirected to the existing drains. These simple rain gardens do not require any redesign of the existing drainage system and can be installed wherever space permits (see Planning and Design below) and in most soil types.

Figure 5: Rain Garden Cross Sections Examples

Rain gardens are usually situated some distance from buildings or site boundaries, although the exact location will depend on the local topography and available space. In order to reduce the likelihood of property damage to insignificant levels, it is recommended that rain gardens are situated at least 3m (10 feet) from any building, or be impermeable lined to protect foundations.

A rain garden 150mm deep and 20% of the area of the area of the roof that it serves will be able to intercept all of the run-off from a typical summer storm where 10-15mm of rain might fall. Rain gardens on more permeable soils will be even more effective. Over the course of an average year, a rain garden of this size will intercept most of the rainfall that it receives, only overflowing after several days of persistent rainfall.

16.8.5 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.

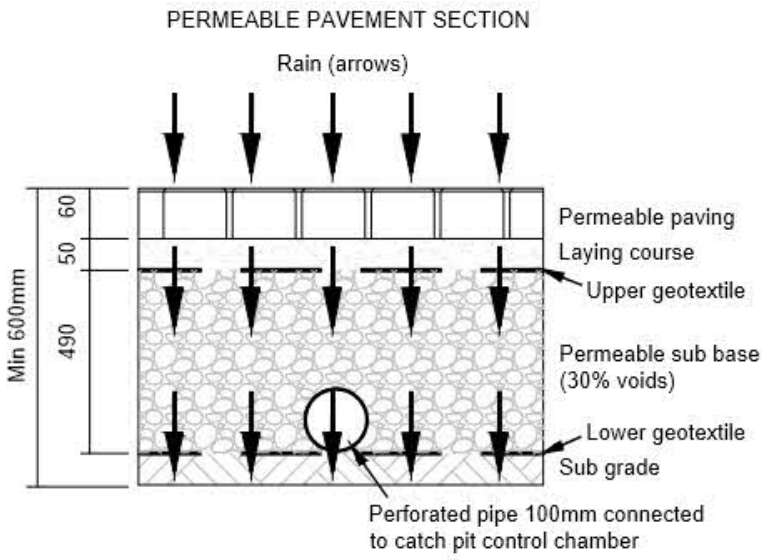


Figure 6 Block Permeable Paving with sub-base

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

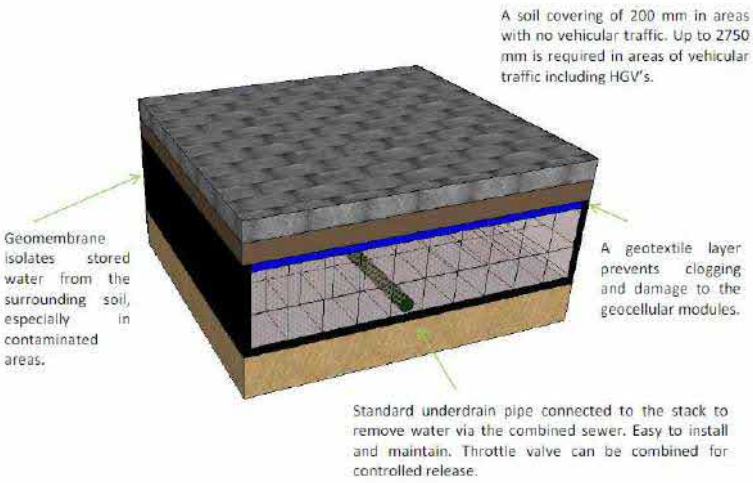


Figure 7: Block Permeable Paving with Geocellular Module

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.

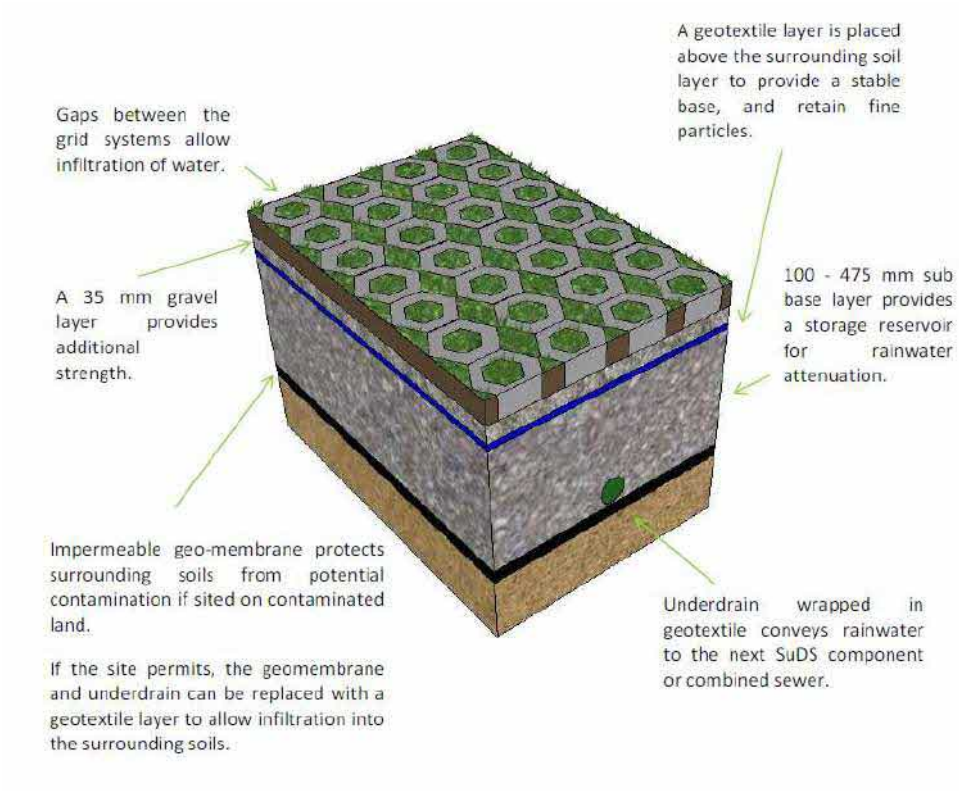


Figure 8: Plastic or Grid Permeable Paving with Sub-base

16.9 Appendix 9 - Microdrainage Modelling

16.9.1 Layout of Network / Cross Sections

PDF to follow this page.

RG_1 - Rain Garden - 30m²

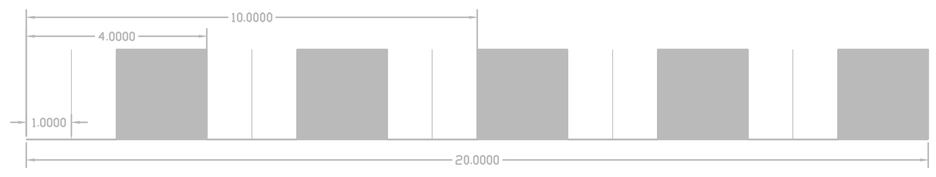
Total Depth: Variable - 1m

Surface Coverage	; Suitable Planting / Decorative Stone / Void Area	; 150 - 200mm (Porosity 1)	;5.4m³
Bedding Material	; Imported well draining soil	; 400mm (Porosity 0.15)	;1.8m³
Filter Fleece	; Filter Fleece	; 2 - 5mm	; -
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 200mm thickness (Porosity 0.3)	; 1.8m³

RG_2 - Rain Garden - 30m²

Total Depth: Variable - 1m

Surface Coverage	; Suitable Planting / Decorative Stone / Void Area	; 150 - 200mm (Porosity 1)	;5.4m³
Bedding Material	; Imported well draining soil	; 400mm (Porosity 0.15)	;1.8m³
Filter Fleece	; Filter Fleece	; 2 - 5mm	; -
Permeable Aggregate	; MOT Type 3 (20mm crushed rock no fines)	; 200mm thickness (Porosity 0.3)	; 1.8m³



Map Legend

- Surface Water Manhole
- Surface Water Inspection Manhole
- Flow Control Chamber
- Rainwater Down Pipe
- Bauder Biointensive Brown Roof
- Geocellular Storage Tank
- Permeable Block Paving
- Rain Garden (Gravel Sub-base)
- Soft Landscaping / Amenity Space
- Rain Water Butt (200l)
- Surface Water Pipe
- Perforated Pipe
- Acco Drainage Channel
- Overflow Flow Route

Project	:SWDS - 2023 - 00025_B
Site	:441-447 Ewell Road, :Surbiton, Surrey, :KT6 7ES
Company	:STM Environmental
Client	:RAA Planning Ltd
Issue	:No.1.0
By	:Matthew Ashdown

North

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

PDF to follow this page.

Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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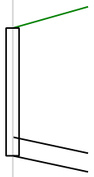
Node Name		MH1
		
Link Name		1.003
Section Type		150mm
Slope (1:X)		51.3
Cover Level (m)		24.030
Invert Level (m)		22.988 22.856
Length (m)		6.777

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Node Name		1st Floor
Link Name		2.000
Section Type		100mm
Slope (1:X)		72.0
Cover Level (m)		24.300
Invert Level (m)		23.800 23.600
Length (m)		14.408

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Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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Node Name	
Link Name	
Section Type	
Slope (1:X)	
Cover Level (m)	
Invert Level (m)	
Length (m)	

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Node Name		G2
Link Name		5.000
Section Type		100mm
Slope (1:X)		19.3
Cover Level (m)		24.300
Invert Level (m)		23.800 23.460
Length (m)		6.562

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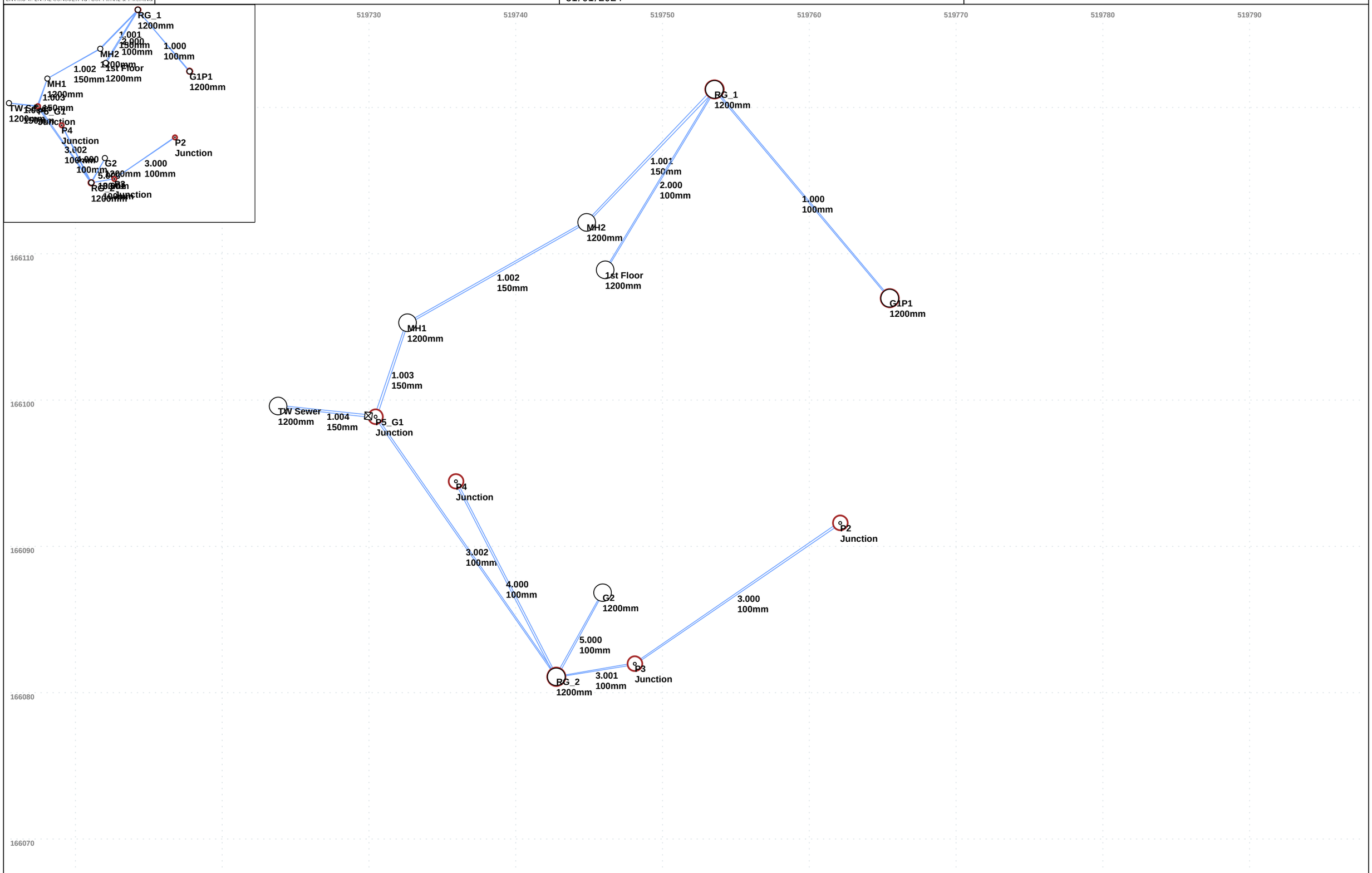
519730
519740
519750
519760
519770
519780
519790
166110
166100
166090
166080
166070
RG_1
1200mm
1.001
150mm
2.000
100mm
1.000
100mm
MH2
1200mm
1st Floor
1200mm
1.002
150mm
MH1
1200mm
G1P1
1200mm
1.003
150mm
TW Sewer
1200mm
1.004
150mm
P5_G1
Junction
P4
Junction
3.002
100mm
4.000
100mm
G2
1200mm
5.000
100mm
RG_2
1200mm
3.001
100mm
P3
Junction
3.000
100mm
P2
Junction

16.9.3 Drainage Network Modelling Results

16.10 Appendix 10 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer RAA Planning Ltd.

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.

16.10.1 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.	RAA Planning Ltd will be responsible.
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).	RAA Planning Ltd will be responsible.
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.

16.10.2 Rain Garden Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components	Quarterly; As required.	RAA Planning Ltd will be responsible.
	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 Summer; As required Quarterly during Winter month; Or as required.	
Remedial actions	Replace dead or overgrown vegetation as required.	As required.	
	Replacement of clogged geotextile (will require reconstruction of raingarden).	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 raingardens 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.

16.10.3 SuDS Rain Water Butt Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in inlet and outlet components;	Quarterly; As required. Increase freq. to Monthly during Autumn;	RAA Planning Ltd will be responsible.
	Inspection & Cleaning of gutters and any filters on downpipes feeding into the Rain Water Butts.	Quarterly; Increase freq. to Monthly during Autumn;	
Remedial actions	Cleaning of the water butt. Fully drain the water butt and clear out debris and enable access; Scrub out the inside of the butt or tank with a coarse brush, if accessible, using a proprietary cleaning product such as Just Water Butt Cleaner or garden disinfectant; Rinse with clean water; Cleaning of Gutters; Clean or fit a new filter;	Annually; Or as required.	
Remedial actions	Use water/empty water butts - to clean, water plants (inside & out); Empty water Butt more frequently during the winter, to allow for storage during storms and to keep the water fresh;	Once every two weeks; as required	

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.

16.10.4 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	RAA Planning Ltd will be responsible.
	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	RAA Planning Ltd will be responsible.
	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	RAA Planning Ltd will be responsible.

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	RAA Planning Ltd will be responsible.
	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.	

16.10.5 Geo-Cellular Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of Inspection tube or chamber and inside of concrete manhole rings.	Annually.	RAA Planning Ltd will be responsible.
	Cleaning of gutters and any filters on downpipes.	Annually (or as required based on Inspections).	
	Trimming any roots that may be causing blockages.	Annually (or as required).	
Occasional maintenance	Remove sediment and debris from manhole, storage structure and components and floor of inspection tube or chamber and inside of concrete manhole rings.	As required, based on Inspections.	
Remedial actions	Reconstruct geocellular and/or replace or clean void fill, if performance failure occurs	As required	RAA Planning Ltd will be responsible.
	Replacement of clogged geotextile (will require reconstruction of soakaway).	As required.	
Monitoring	Inspect silt raps and note rate of sediment accumulation.	Monthly in the first year and then annually.	
	Check soakaway to ensure emptying is occurring.	Annually.	

Maintenance will usually be carried out manually, although a suction tanker can be used for sediment / debris removal for large systems. If maintenance is not undertaken

for long periods, deposits can become hard-packed and require considerable effort to remove.

Replacement of the geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure in the long term.

Areas draining to infiltration components should be regularly swept to prevent silt being washed off the surface. This will minimize the need for maintenance.

Maintenance responsibility should be placed with an appropriate organisation, and maintenance schedules should be developed during the design phase.

16.10.6 Flow Control Maintenance

Maintenance Schedule	Required Action	Typical Frequency	Responsibility
Regular maintenance	Inspect for sediment and debris;	Quarterly; As required.	RAA Planning Ltd will be responsible.
	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;	

16.11 Appendix 11 - Timeline for Implementation

16.11.1 Timeline

Phase 1 (1 month) : Site clearance / Levelling / Foundations

Phase 2 (12-14 month): Construction Phase / Internal Plumbing Connections / Installation of Green Roof

Phase 3 (1 months) :

Permeable Paving Construction and Rain Garden Construction;

Construction of flow control / connection to Thames Water Sewer;

Installation after Phase 2 will ensure SuDS do not get damaged during construction phase;

Where necessary, drainage connections will be blocked off until suitable filtration of runoff can be provided.