Sustainable
Drainage System Strategy

Site Address
8 Hollymoor Lane
Epsom
KT19 KT19 9BZ

Client
William Barcelo

Report Reference
SWDS - 2021 - 000068

Prepared By
STM Environmental Consultants Ltd

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1 Document Control

Sustainable Drainage System Strategy

Site Address:	8 Hollymoor Lane Epsom KT19 9BZ
National Grid Reference:	521071, 162575
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3 Abbreviations

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

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5 Executive Summary

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Grid reference: 521071, 162575</td></tr>
<tr><td>Site Area</td><td colspan="3">265m^2 / 0.0265ha</td></tr>
<tr><td>Proposed Development</td><td colspan="3">A double storey rear extension to an existing residential dwelling.</td></tr>
<tr><td>Current Site and Surrounding Uses</td><td colspan="3">The site is a residential dwelling within a suburb north of Epsom.</td></tr>
<tr><td>Topography</td><td colspan="3">The ground levels range from 31.36mAOD (SW) to 31.92mAOD (NW). The average level of the site is 31.5mAOD.</td></tr>
<tr><td>Hydrology</td><td colspan="3">The nearest main watercourse is a tributary of the Hogsmill River which is located 60m to the East.</td></tr>
<tr><td>Geology</td><td colspan="3">Data from the British Geological Survey indicates that the underlying superficial geology is characterised as River Terrace Deposits. The underlying bedrock geology is characterized as London Clay Formation.</td></tr>
<tr><td>Hydrogeology</td><td colspan="3">BGS information indicates that the site is situated upon a Secondary A superficial aquifer and an Unproductive bedrock aquifer.</td></tr>
<tr><td>Permeability</td><td colspan="3">BGS information indicates that the superficial deposits are freely draining, and the bedrock is classified as highly variable.</td></tr>
<tr><td>Infiltration Potential</td><td colspan="3">The BGS indicates there are likely to be significant constraints for the use of infiltration methods on site.</td></tr>
<tr><td>Fluvial Flood Risk</td><td colspan="3">Low – the site lies within EA Flood Zone 2.</td></tr>
<tr><td>Surface Water Flood Risk</td><td colspan="3">Low - the site is not impacted by the 1 in 100 years rainfall event. However, it will witness 600mm flood depth during the 1 in 1000-year event.</td></tr>
<tr><td>Groundwater Flood Risk</td><td colspan="3">Low - the EA indicates there is potential for groundwater flooding at the surface.</td></tr>
<tr><td rowspan="5">Existing and Proposed Site Layout</td><td>Ground Cover</td><td>Existing</td><td>Proposed (Without SuDS)</td></tr>
<tr><td>Buildings</td><td>76</td><td>84</td></tr>
<tr><td>Driveways/Patio</td><td>67</td><td>85</td></tr>
<tr><td>Gardens/ Soft landscaping</td><td>122</td><td>96</td></tr>
<tr><td>Total Impermeable Area</td><td>143</td><td>169</td></tr>
</table>

Changes in Impermeable Area Without SuDS	Without SuDS, the proposed development would increase the impermeable area of the site by 10% (i.e. 26m^2).		
PROPOSED SUDS			
Run-Off Rates	Greenfield (GF) (l/s) *IH24	Modelled Pre-Development Rates (l/s)	Modelled Post Development Rates **with** SUDS (l/s)
Qbar	0.1190		
1 in 1	0.1012	0.4	0.1
1 in 30	0.2737	0.9	0.5
1 in 100 + CC	0.5628	1.4	1.0
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 target discharge rate was therefore set to a maximum of 1.4l/s during the critical storm scenario, but should aim to achieve a runoff rate of Qbar for the greenfield scenario wherever possible.		
Storage Required to meet Planning Requirement	Using the Microdrainage quick storage estimate method the total storage volume required to match greenfield discharges was calculated to be 10 - 14 m^3.		
Infiltration Testing	The site investigation works were carried out on the 8th of November 2021. A total of 1no. trial pit was excavated to a depth of 1mbgl for undertaking infiltration testing in accordance with BRE DG 365. However, infiltration testing was abandoned due the presence of groundwater at 1mbgl. The geology encountered consisted of Made Ground underlain by CLAY and clayey GRAVEL at depth.		
SuDS Strategy	The proposal, without SuDS, would increase the overall impermeable area of the site by 10% (26m^2) through the introduction of additional a new patio and rear extension. The proposal captures and reduces the runoff for 50% (80m^2) of the impermeable site area to 0.1l/s. Run-off from the remaining area of the site will enter the drainage system at an unrestricted rate. The proposal seeks to establish a runoff rate reduction and attenuation volume at a level appropriate to the scale and type of development. The SuDS strategy will retrofit SuDS planter within the front driveway and a rainwater butt within the rear of the site. The proposed patio will be formed of permeable paving, it provides a reduction of 18m^2 in the effective impermeable area of the site. However, it will be lined with an impermeable liner to prevent infiltration and groundwater intrusion due to elevated groundwater and underlying foul sewer run.		

	The attenuation will be provided through the use of 4.3m^3 of geocellular storage units placed below the patio. Excess run-off from the Geocellular units will be discharged into the existing surface water drainage run on site. An orifice flow control device will limit the discharge from the geocellular attenuation to the drainage system to 0.1l/s during all storm events. As such, the proposal reduces the total post development discharge rate during the critical 1 in 100 years plus 20% climate change to 1.0l/s, which a 29% reduction compared to the pre-development rate.
Conclusion	With the proposed SuDS mitigation measures in place, we believe that the proposed development will reduce local flood risk and therefore be in compliance with the LLFA's current planning policy and the NPPF.

6 Introduction

STM Environmental Consultants Limited have been appointment by William Barcelo to undertake a Sustainable Drainage System (SuDS) Strategy for a proposed development at 8 Hollymoor Lane, Epsom, KT19 9BZ.

6.1 Proposed Development

The SuDS strategy is required to support a planning application (Reference: 20/01803/FLH) for erection of part single, part two storey rear extension (following demolition of existing conservatory), hip to gable and rear dormer roof extensions and installation of front rooflights.

The planning condition states as follows:

> The development hereby permitted shall not commence until details of the design of a surface water drainage scheme have been submitted to and approved in writing by the Local Planning Authority. The design must satisfy the SuDS Hierarchy and be compliant with the NPPF (2019). The required drainage details shall include:
>
> a) Evidence that the proposed final solution will effectively manage the 1 in 30 & 1 in 100 (+20% allowance for climate change) storm event, during all stages of the development, associated discharge rates and storage volumes shall be provided using a discharge rate to be agreed with the LPA and local water authority.
> b) Detailed drainage design drawings and calculations to include: a finalised drainage layout detailing the location of drainage elements, pipe diameters, levels, and long and cross sections of each element including details of any flow restrictions and maintenance/risk reducing features (silt traps, inspection chambers etc.).
> c) A plan showing exceedance flows (i.e. during rainfall greater than design events or during blockage) and how property on and off site will be protected.
>
> Reason: To ensure design does not increase flood risk on or off site and to comply

with Policy DM19 (Development and Flood Risk) of the LDF Development Management Policies Document (2015).

Copies of the development plans and decision noticed are presented in Appendix 1.

6.2 Report Aims and Objectives

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

This report should be read in conjunction with the following reports also prepared for the site by STM:

- Flood Risk Assessment – Ref: FRA/2020/000160

6.3 Legislative and Policy Context

6.3.1 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.

6.3.2 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.

6.3.3 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).

6.3.4 Policy DM19 Development & Flood Risk

In order to manage flood risk, we will take a sequential approach to the allocation of sites in a Site Allocations Policy Document and when determining planning applications.

Development within Flood Risk Zones 2 & 3 or on sites of 1ha or greater in Zone 1 and sites at medium or high risk from other sources of flooding as identified by the Borough Council's SFRA, will not be supported unless:

(i) In fluvial flood risk areas, the sequential and exception tests have been applied and passed and it is a form of development compatible with the level of risk; and

(ii) For all sources of risk, it can be demonstrated through a site FRA that the proposal would, where practicable, reduce risk both to and from the development or at least be risk neutral; and

(iii) Where risks are identified through an FRA, flood resilient and resistant design and appropriate mitigation and adaptation can be implemented so that the level of risk is reduced to acceptable levels.

We will expect development to reduce the volume and rate of surface water run-off through the incorporation of appropriately designed Sustainable Drainage Systems (SUDS) at a level appropriate to the scale and type of development.

7 Site Characteristics

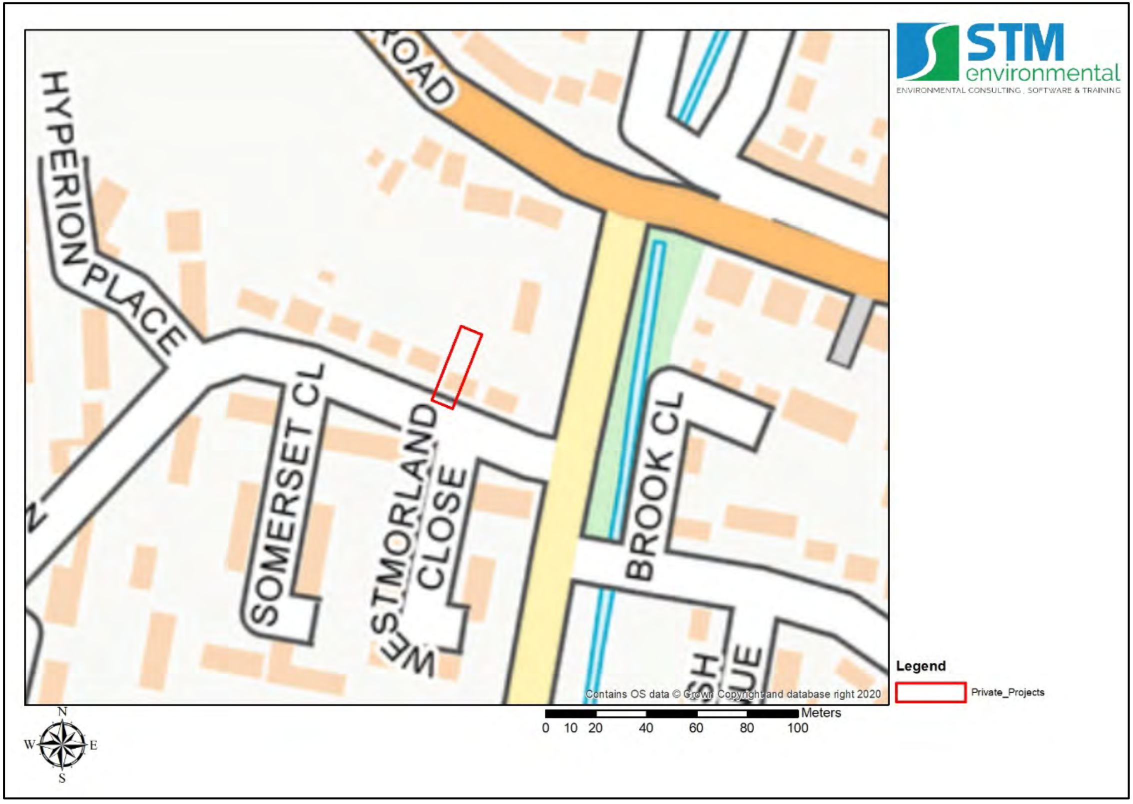
7.1 Location and Area

The site is centred at national grid reference 521071, 162575 and has an area of 265m^2.

It falls within the jurisdiction of Epsom and Ewell District Council in terms of the planning consultation process on flood risk and surface water management. The LLFA is Surrey County Council.

Figure 1 provides the site location map and aerial imagery.

Figure 1: Site location map and aerial photo



7.2 Current Site and Surrounding Uses

The site is currently used as residential dwelling. It is located within a residential suburb 1.5km north of Epsom town centre.

7.3 Site Topography

The mapping provided in Appendix 2 shows 1m DTM LiDAR Data that shows the topography within the site.

The ground levels range from 31.36mAOD (SW) to 31.92mAOD (NW). The average level of the site is 31.5mAOD.

7.4 Hydrology

The nearest watercourse is a tributary of the Hogsmill River which is located 60m to the east.

7.5 Geology and Hydrogeology

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

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

The permeability of the bedrock geology is considered to be highly variable while that of the superficial geology is considered to be freely draining.

The BGS infiltration potential map suggests that there are significant constraints for infiltration methods at the site due to the potential of one or more geo-hazard.

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

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

7.6 Flood Risk

7.6.1 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 2 and is therefore considered to have a low to medium risk of flooding. This equates to a potential yearly risk of flooding of between 0.1 and 1 % Annual Expected Probability.

7.6.2 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 low risk of flooding.

The maps show that the site would remain dry during the 1 in 100-year event and it is expected to flood to depths of up to 600mm during the 1 in 1000-year event.

7.6.3 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. This indicates that there is potential for groundwater flooding to occur at the surface.

7.7 Existing Drainage

The existing drainage for the site is show in Appendix 8.

The surface water drainage connects into a Thames Water surface water sewer, located to the front of the site, on Hollymore Lane. The closest Thames Water Asset is identified as 0592, it has a cover level of 31.87 and an invert level of 30.41mAOD.

An asset map is also available in Appendix 8.

8 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.

8.1 Existing and Proposed Ground Cover

A summary of the existing and proposed site ground cover is shown below in Table 1 and Table 2 below. These tables assume all hardstanding will remain as impermeable surfaces.

Table 1: Breakdown of Ground Cover in the Proposed Development

Ground Cover	Existing Development Area		Proposed Development Area		Difference (m2)
	m^2	%	m^2	%	
Buildings	76	29	84	32	8
Hard Standing	67	25	85	32	18
Soft landscaping	122	46	96	36	26
Total	265	100	265	100	

Table 2: Summary of Permeable and Impermeable Areas

	Impermeable Area		Permeable Area		Total Area
	m^2	%	m2	%	m^2
Existing Site	143	54	122	46	265
Proposed Site	169	64	96	36	265
Difference	26	10	-26	-10	

The proposal will include various SuDS that reduce the impermeable area by substituting the typical surfaces with permeable alternatives.

The proposal will increase the impermeable area of the site by 26m^2 without the inclusion of SuDS.

9 SuDS Requirements

9.1 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.

9.2 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.

9.3 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 4. Table 3 below give a summary of the results.

Table 3: Calculation of post-development run-off rates for the site (without SuDS)

	Greenfield (l/s)	**Greenfield + CC**	**Pre - Development**	**Pre - Development + CC**	**Post Development**	**Post Development + CC**
Qbar	0.1190	0.1764	0.1381	0.2048	0.1416	0.2099
1 in 1	0.1012	0.1500	0.1174	0.1741	0.1204	0.1784
1 in 30	0.2737	0.4057	0.3177	0.4710	0.3257	0.4828
1 in 100	**0.3796**	**0.5628**	**0.4406**	**0.6532**	**0.4517**	**0.6697**

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

A Microdrainage model of the pre-development scenario was created in order to establish a more accurate pre-development discharge rate and volume. The model was designed based on the known drainage information and contributing area.

Table 4 below summarises the critical storm predevelopment discharge rates obtained from the model.

Table 4: Pre-development 6-hour critical storm

	Pre - Development (l/s)	**Pre - Development Discharge Volume (m^3)**

1 in 1	0.4	2.3
1 in 30	0.9	5.0
1 in 100 + 20% CC	1.4	7.8

Therefore, the development should aim to ensure a post development peak discharge rate of no more than 1.4l/s for the critical storm event. However, wherever possible, the excess flows should be restricted to the Qbar (0.1l/s) for the greenfield scenario.

Based on a proposed discharge rate of 0.1l/s, the Microdrainage Quick storage estimate tool calculated the storage required for the proposed development during the 1 in 100 plus 40% CC event to be 10 - 14m^3. Screenshots of the quick storage estimate tool and variables are available in Appendix 4.

10 Site Investigation

10.1 Site Investigation

Site investigation works were carried out on the 8th of November 2021. 1no. trial pit was excavated to 1mbgl for the purpose of undertaking infiltration testing in accordance with BRE DG 365.

10.2 Ground Conditions Encountered

The investigation encountered ground conditions that were generally consistent with the published geological records of the area. Made Ground consisting of dark brown silty, slightly cobbly CLAY with occasional brick fragments and cobbles of flint was encountered to a depth of 0.4mbgl. The Made Ground was underlain by mottled dark brown and dark grey CLAY with occasional roots to a maximum depth of 0.6mbgl, in turn underlain by light greyish yellow and light brown, silty slightly clayey cobbly GRAVEL to a depth of 1mbgl.

10.3 Groundwater

Groundwater was encounter at the base of the trial pit at 1.0mbgl.

10.4 Infiltration Testing

Infiltration testing was abandoned due to the shallow groundwater table encountered and the requirement that any infiltration SuDS should ensure a 1m freeboard between the groundwater table and the invert level of the component.

As a result, the use of infiltration SuDS are not considered suitable as a means of surface water disposal at the site.

Full details including photos, location map and log of the trial pit are available in Appendix 9.

11 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.

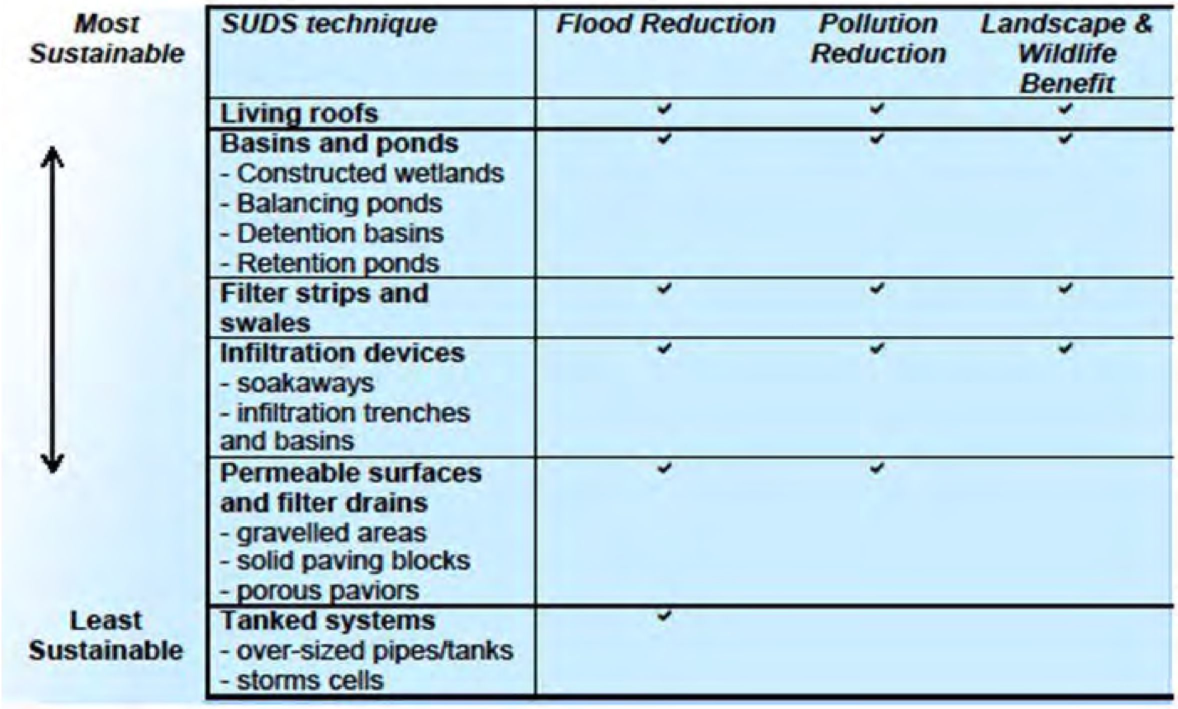
11.1 SuDS Hierarchy

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

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

The SuDS hierarchy is summarised in Figure 2 below.

Figure 2 SuDS Hierarchy



Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	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	✓		

11.2 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 5 and are further discussed below.

11.2.1 Living Roofs

As buildings will cover more than 32% of the site, living roofs are considered to be a viable SuDS technique across the flat roof areas of the development. However, the flat roof areas are limited to already developed areas and an area approximately 2m^2.

11.2.2 Basins, Ponds, Filter Strips and Swales

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

11.2.3 Infiltration Devices

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

However, care must be taken to ensure that contamination of groundwater is prevented. The Environment Agency publication ‘Groundwater protection: Policy and practice (GP3) Section G, 2012, states that the Environment Agency will support sustainable drainage systems for new discharges to ground subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

As discussed in Section 10 the use of infiltration devices is not suitable due to elevated groundwater.

11.2.4 Permeable Surfaces and Filter Drains

Over 33% of the development will consist of car parking, pathways and patios following the proposed development, an increase of 7% (18m^2), which could be designed to be permeable.

However, it should be noted that due to the existence of a foul sewer run and elevated ground water table, this will be required to be lined with an impermeable lining.

11.2.5 Tanked Systems

A tanked system incorporating a hydro brake restricting flow to the sewer would be a viable option as infiltration is not suitable. However, this option is ranked as being the least sustainable in the SuDS hierarchy.

11.2.6 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.

11.2.7 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 5 and Appendix 6.

Table 5: Summary of Results of SuDS Options Assessment

SuDS Technique	Potential Suitability
Rainwater Harvesting	Suitable - small scale
Infiltration: Soakaways Infiltrations trenches and basins	Unsuitable - Elevated groundwater
Green/brown /blue roofs	Suitable - Small scale and outside of scope of development
Rain Gardens	Suitable - Storage only
Permeable Pavements / Surfaces	Suitable - With lining
Swales	Unsuitable - Limited space
Detention basin/ponds	Unsuitable
Storage tanks/ Geocellular storage	Suitable
Oversized piping	Suitable

12 SuDS Implementation

12.1 SuDS Constraints

As mentioned above, there are a number of constraints in relation to type of drainage system that can be implemented.

Firstly, here is a high groundwater table at the site. Secondly an existing foul sewer is located in the rear garden.

A final consideration is the size and scope of the proposed development. The proposal will introduce new hard landscaping; however, no ground works are proposed to the front of the dwelling.

Therefore, the introduction of new SuDS is limited to the retrofitting of SuDS, at surface level or above within areas that remain unchanged. As to not to overburden the scope and budget of the proposed development. The proposal seeks to establish a runoff rate reduction and attenuation volume at a level appropriate to the scale and type of development.

12.2 Proposed SuDS

The proposed SuDS strategy aims to control surface water runoff from 50% of the site's impermeable area.

The use of SuDS planters and rainwater butts will be used on all suitable down pipes from the rooftops.

The excess will discharge directly onto permeable block paving that will form the new patio. It will have a geocelluar sub-base attenuation structure that will be lined to prevent infiltration.

The geocellular attenuation will be controlled via a flow control orifice and will limit the discharge to 0.1 l/s into the existing drainage run.

12.2.1 SuDS Planters

SuDS planters will be placed upon the driveway and will cover a total area of 2m^2.

The SuDS planter will reduce the overall effective impermeable area and provide for water re-use within the planters, and act as interception and a minor attenuation storage structure.

The SuDS planter will be a long trough, they will be vegetated with plants suited to deluge and drought conditions, with a minimum of 500mm of growing substrate (Sand, Soil and Gravel). By intercepting the rainfall, it will directly slow the runoff and in addition provide a filtration medium for the rooftop runoff.

Examples of different types of SuDS planters are available in Appendix 6.

12.2.2 Rainwater Butt

The rear patio forms 18m^2 of the proposed site area. The downpipe to the rear will be fitted with a 220 litre rainwater harvesting butt. It will provide a means of capturing some of the rooftop surface water runoff for re-use later.

Once at capacity the runoff will be discharged directly onto the permeable block paving that is described in more detail below.

12.2.3 Permeable Block Paving

The new patio accounts for 18m^2. Runoff from this area will be managed using permeable block paving and geocellular attenuation. It will accept 50% of the surface water runoff from the proposed development site.

Permeable Paving 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 of sand and a geotextile cloth. The geotextile will prevent fines entering the 250mm thick geocellular attenuation installed below. The geocellular structure will be wrapped in an impermeable lining to prevent ground water intrusion and protect the underlying foul sewer from infiltration. The base of the geocellular storage structure will be padded with a minimum of 100mm of pea gravel.

12.2.4 Discharge Control Device

An orifice flow control chamber will be used to limit the discharge from the geocellular storage into the existing surface water drainage run to 0.1l/s.

The catchment will be retained as existing with the exception of the inclusion of SuDS planters.

12.2.5 Microdrainage Modelling

Microdrainage Modelling was carried out to assess the performance of the proposed drainage system under a variety of modelled storm events. The designed system including the proposed attenuation storage, provides a total storage of 4.8m^3 when including all pipes, manholes and storage structures.

No flooding was indicated during any of the modelled scenarios, including the 1 in 100 years plus 20% climate change.

Table 6: Post Development Modelled Discharge Rate

Model Run	Post - Development (l/s)
1 in 1	0.1
1 in 30	0.5
1 in 100 + 20% CC	1.0

Full results, drainage layout including the proposed discharge point and exceedance flows of this are available in Appendix 10.

12.2.6 Surface Water Discharge Points

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

As the proposal is utilising an already established connection and will provide a reduction in the discharge rate, a capacity check should not be required.

A copy drainage asset search is available in Appendix 9.

12.2.7 Treatment of Run-off

The treatment of roof water runoff will be provided through the provision of rainwater butts, SuDS planters and permeable block paving to intercept gross solids and sediment, guidance will be provided to householders on appropriate maintenance requirements.

12.2.8 Exceedance Flows

The site is mostly flat at 31.45mAOD. However, there is a gradual slope towards the dwelling within the rear garden.

Given the location of the proposed and existing buildings, it is recommended that an overflow connection (Acco Drain or overflow pipe) is installed onto the new flow control device. This will ensure the conveyance of any exceedance flow events will conveyed safely away from the rear of the dwelling and can be contained within the driveway before receding naturally once flood levels reduce on site.

It can be seen from the design proposals; the proposed system includes approximately 4.8m^3 of storage capacity. In addition, a safety factor of 2 was applied to the Microdrainage modelling, which gives a further degree of confidence that exceedance flows are unlikely to occur. Nonetheless, appropriate level design will be employed to ensure that flood waters are directed away from buildings in the unlikely event that an inundation of the proposed system results in overland flows.

A map displaying the exceedance flow is available in Appendix 10.

12.3 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 8.

13 Conclusion and Recommendations

The proposed drainage strategy will ensure there is no increase in the post development runoff rates from the site when compared to the pre-development scenario.

The size and scope of the development has been taken into account. As the proposal does not include any changes to the front of the dwelling or existing hard landscaping, the proposal has been designed to ensure that the rear catchment (50% of the total site impermeable area) will be attenuated and the flow restricted.

The proposal will introduce rainwater butts, SuDS Planters and permeable paving that will be constructed with a geocellular attenuation sub-base.

The use of permeable paving and geo-cellular storage beneath the patio will act as interception and provide 4.3m^3 of attenuation. The discharge from the geocellular attenuation will be limited to 0.1/s via an orifice flow control device.

It will discharge into the existing drainage run on site that will remain at an un-restricted rate into the surface water sewer operated by Thames Water on Hollymoor Lane.

The proposal reduces the post development discharge rate during the critical 1 in 100 years plus 20% climate change to 1.0l/s which a 29% reduction compared to the pre-development rate.

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 as such, will be in compliance with the LLFA’s current planning policy and the NPPF.

14 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. Epsom and Ewell District Council Local Planning Policy – 2015

15 Appendices

15.1 Appendix 1 – Development Plans

All dimensions are to be checked on site.
All dimensions are in millimetres.
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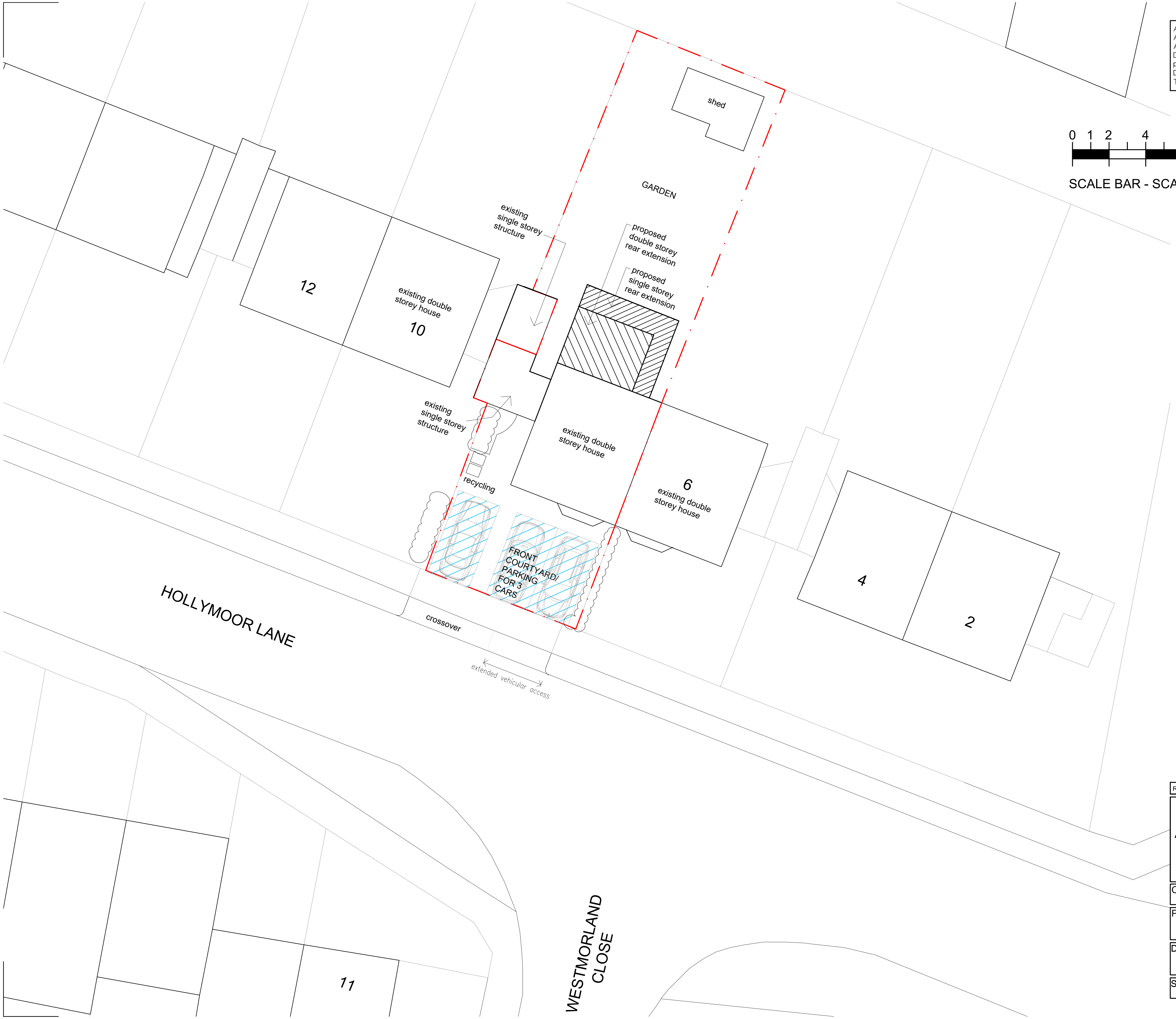

0 1 2 4 6 8 10 12 14 16 18 20m

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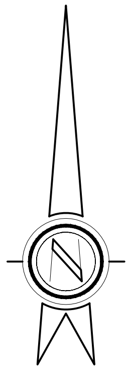

BLOCK PLAN
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FEB.2021

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BLOCK PLAN

JOB No.
20-358

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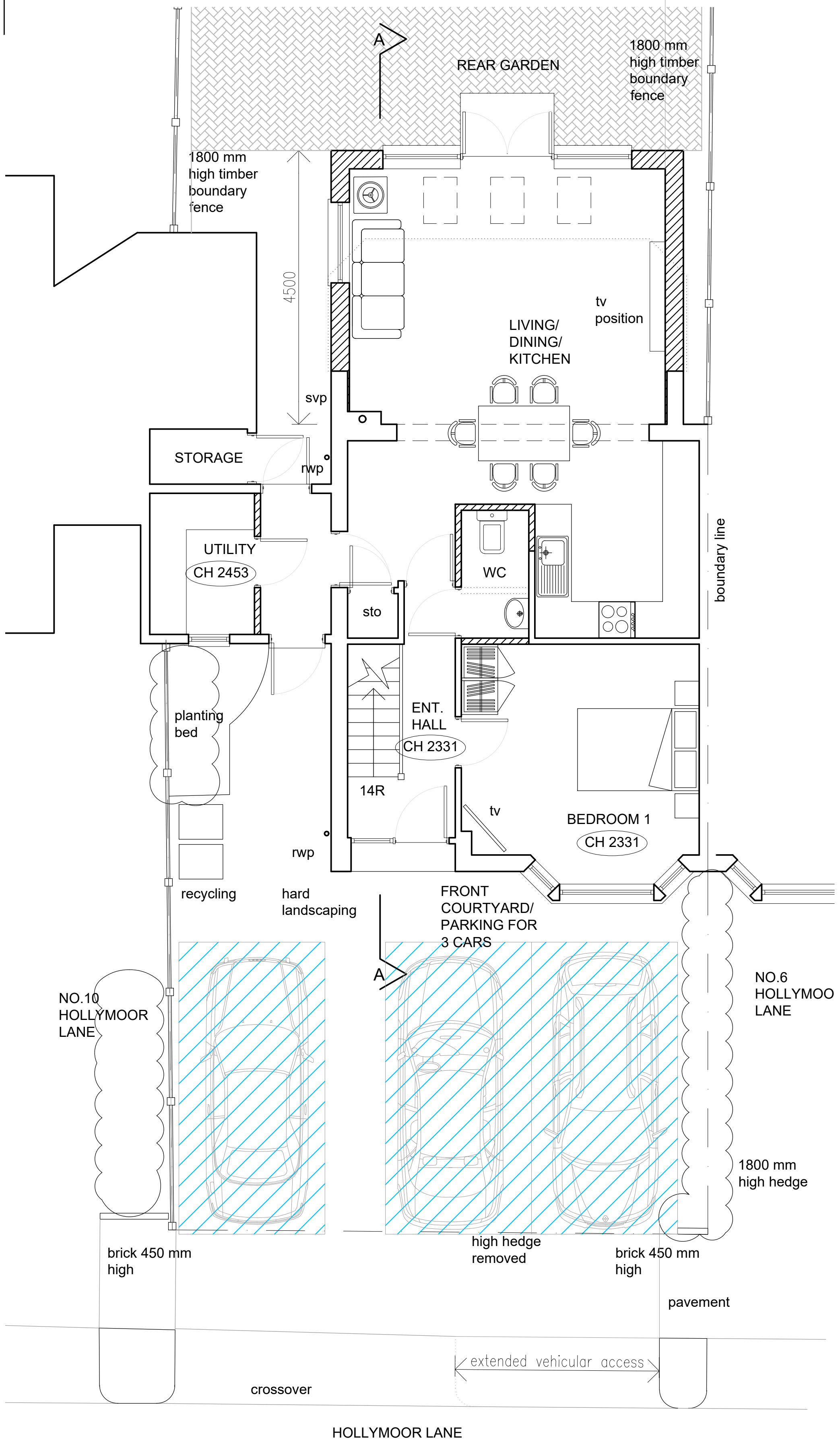

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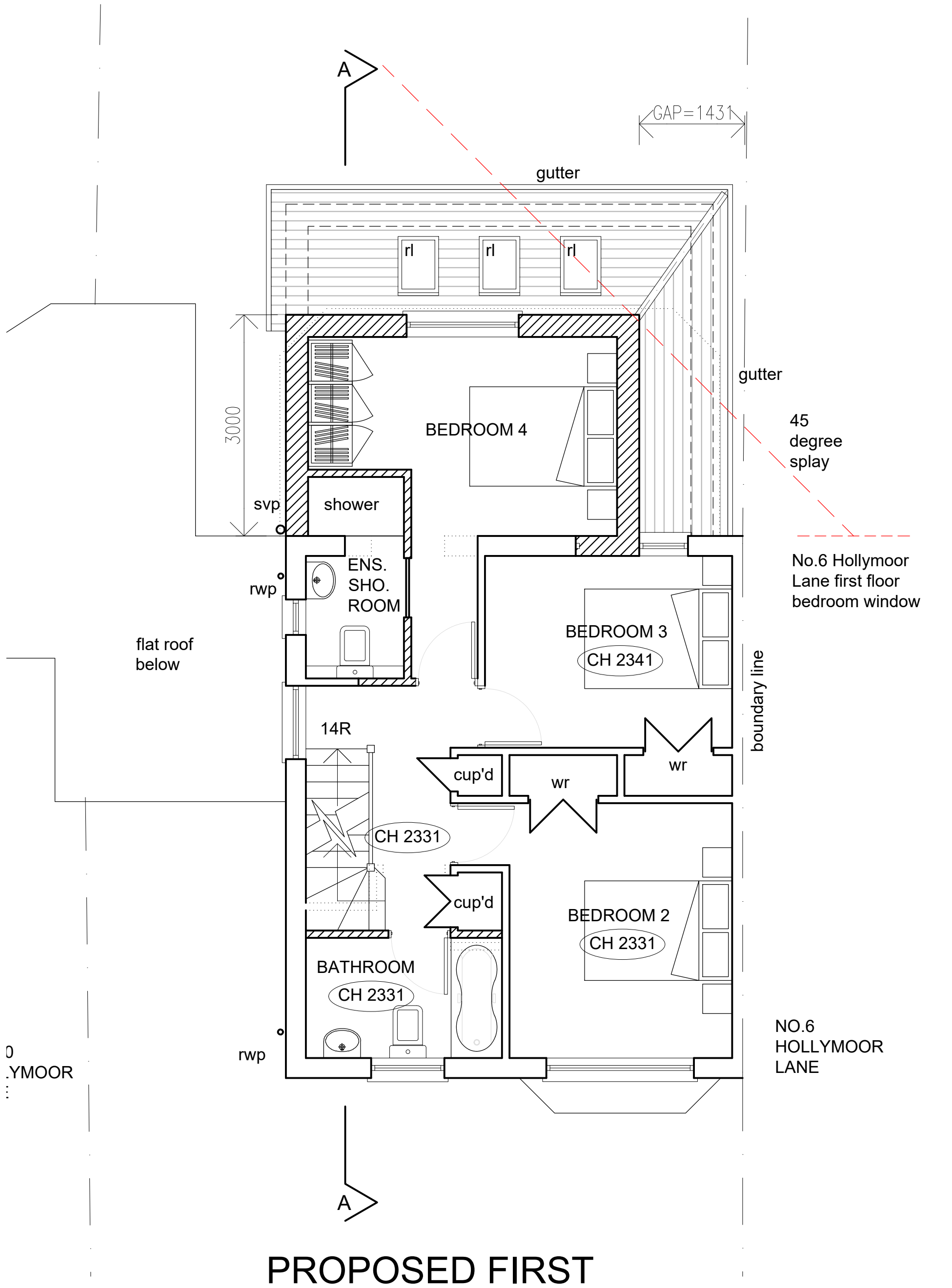

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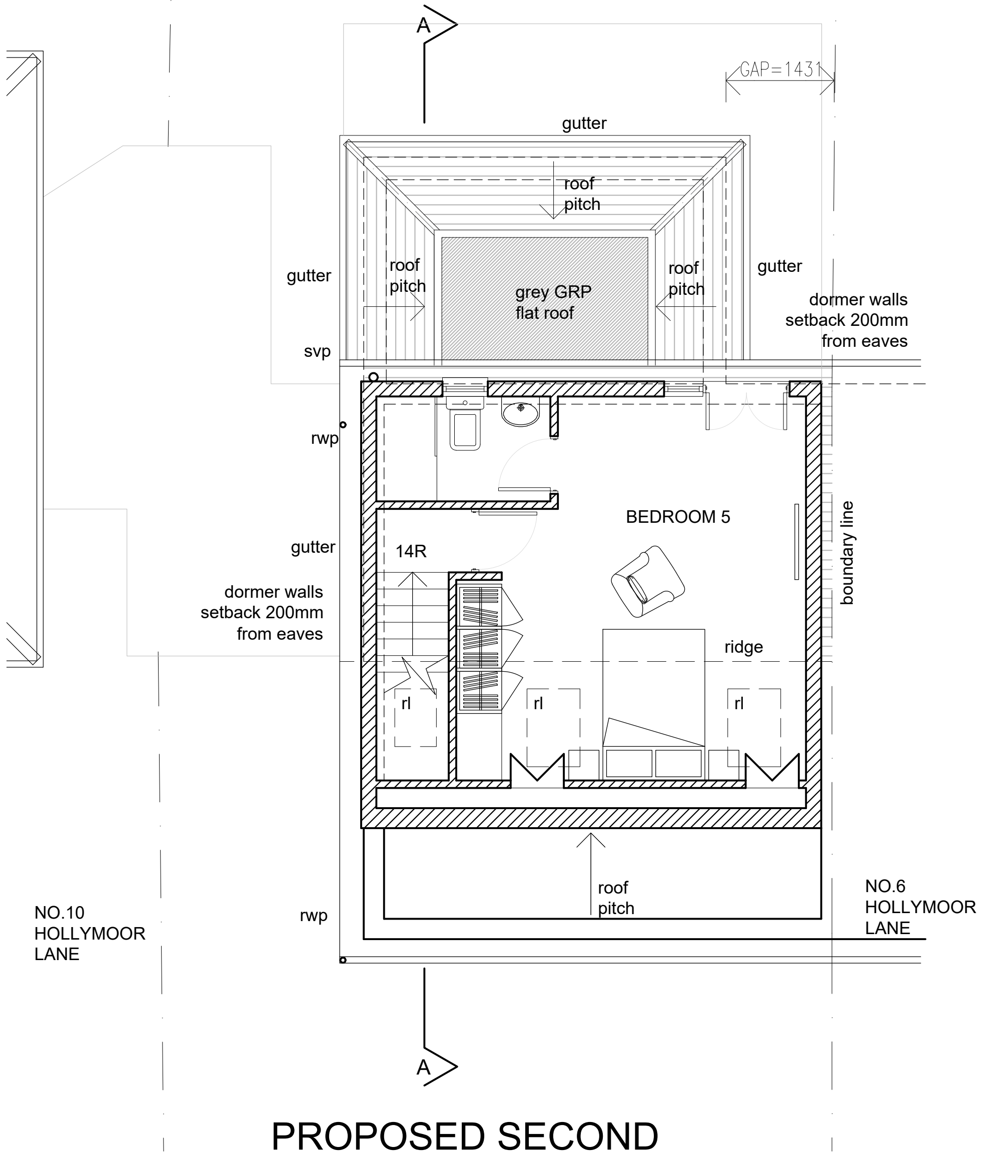

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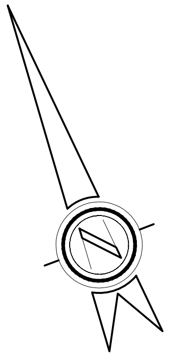

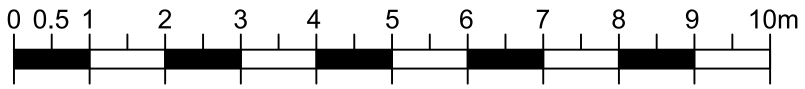

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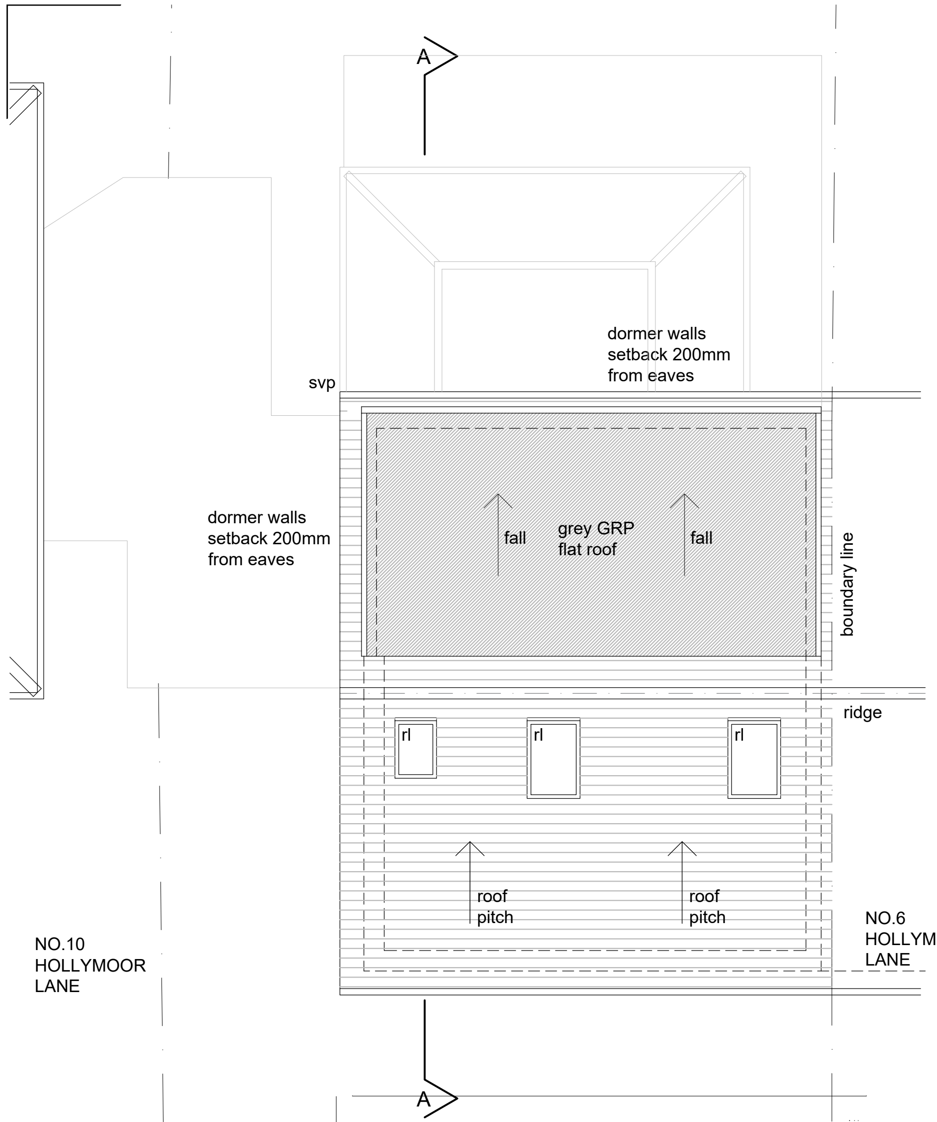

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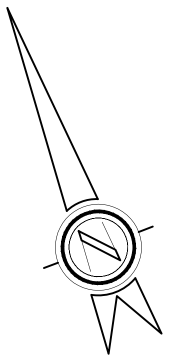
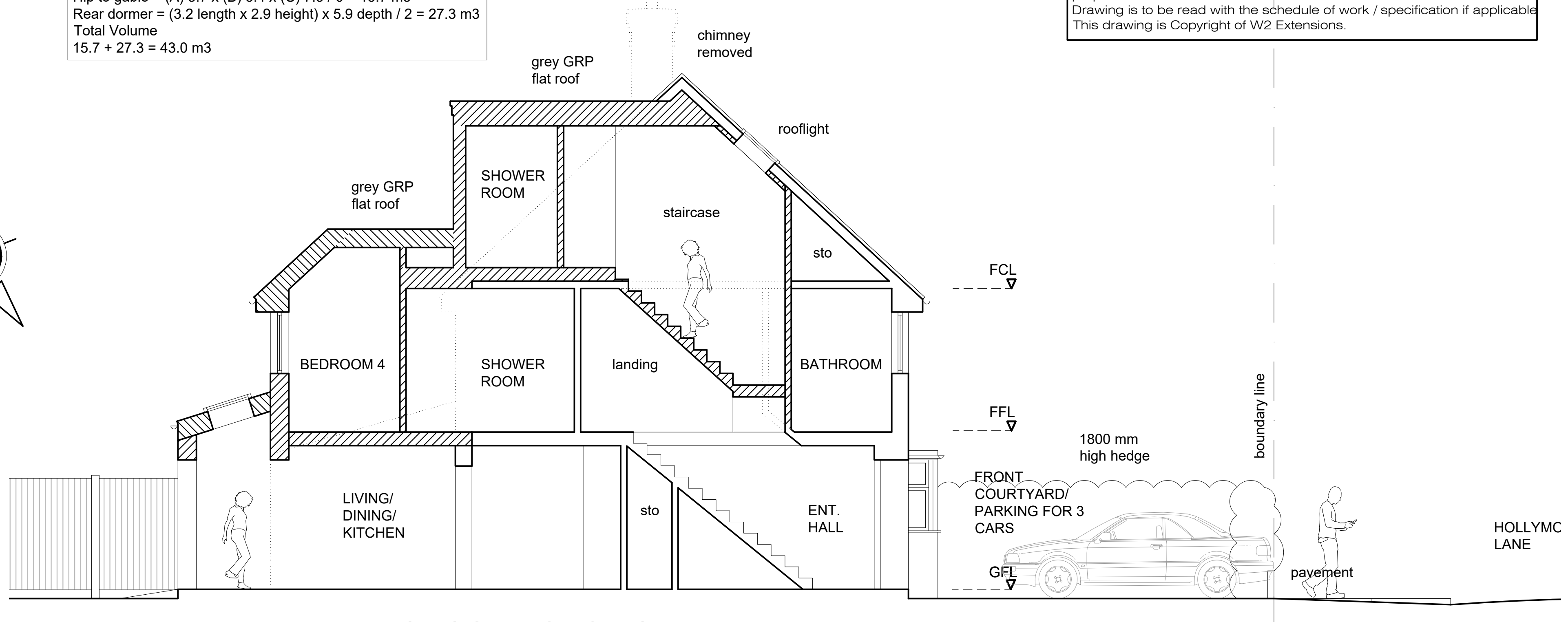


Loft Volume Calculation
Hip to gable = (A) 3.7 x (B) 3.4 x (C) 7.5 / 6 = 15.7 m3
Rear dormer = (3.2 length x 2.9 height) x 5.9 depth / 2 = 27.3 m3
Total Volume
15.7 + 27.3 = 43.0 m3



PROPOSED SECTION AA
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Total Volume
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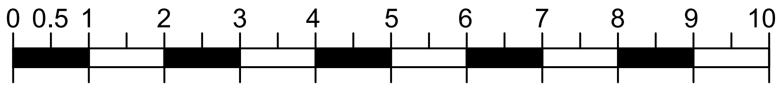

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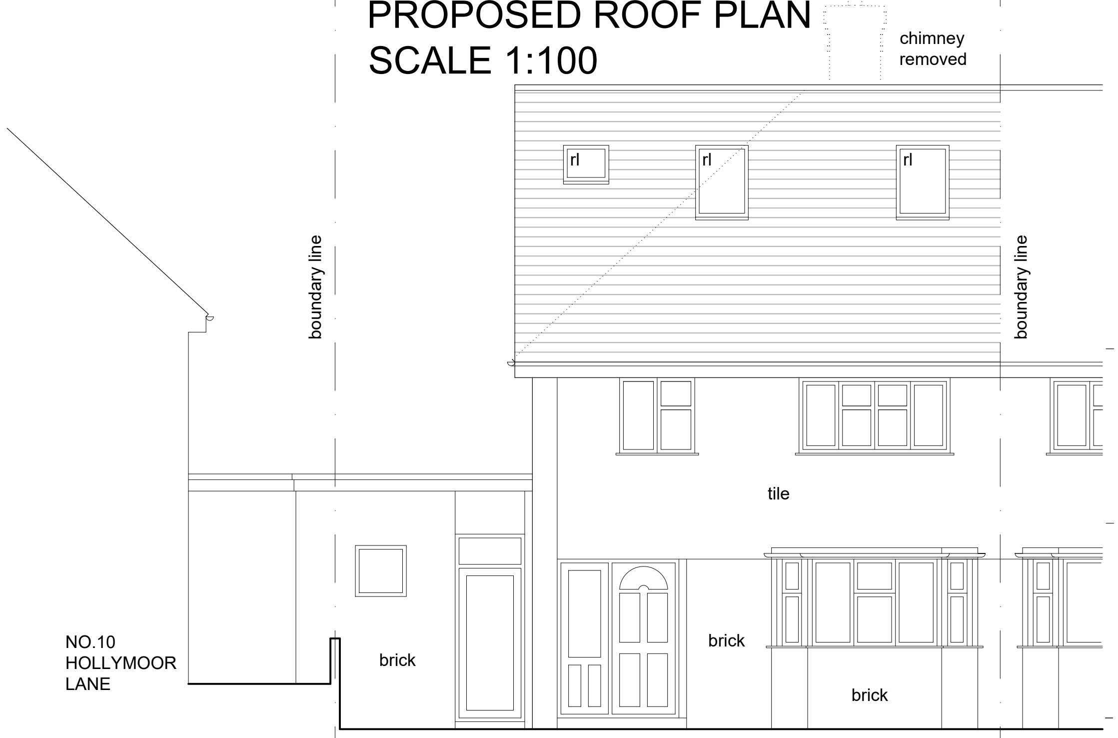

PROPOSED FRONT ELEVATION
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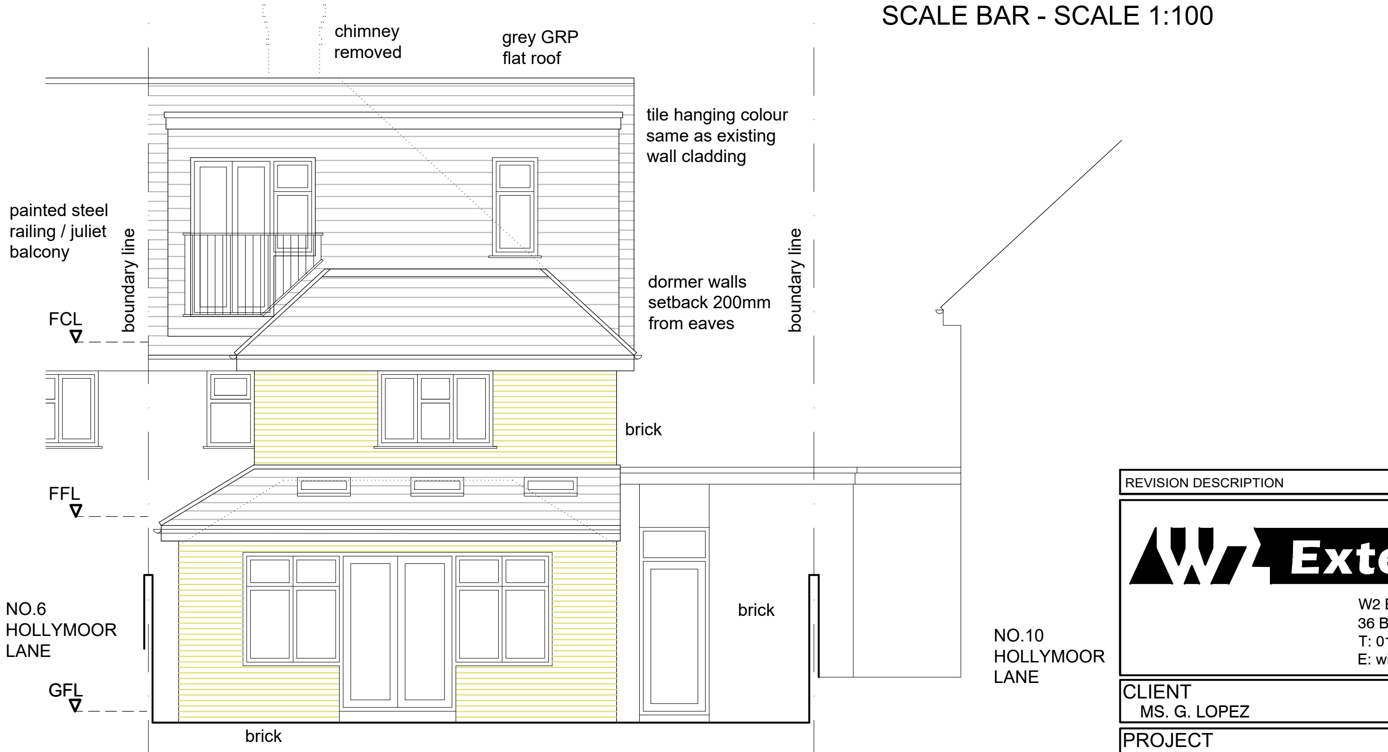

PROPOSED REAR ELEVATION
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STATUS PLANNING	DWG No. PR03-REV01

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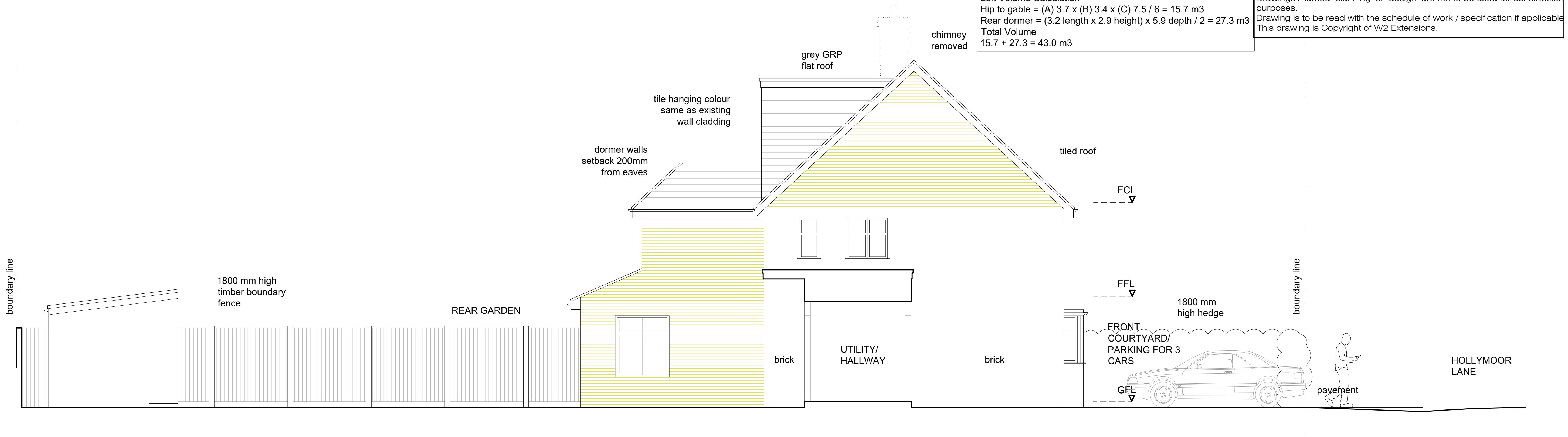
Total Volume
15.7 + 27.3 = 43.0 m3



PROPOSED LEFT SIDE ELEVATION
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Loft Volume Calculation
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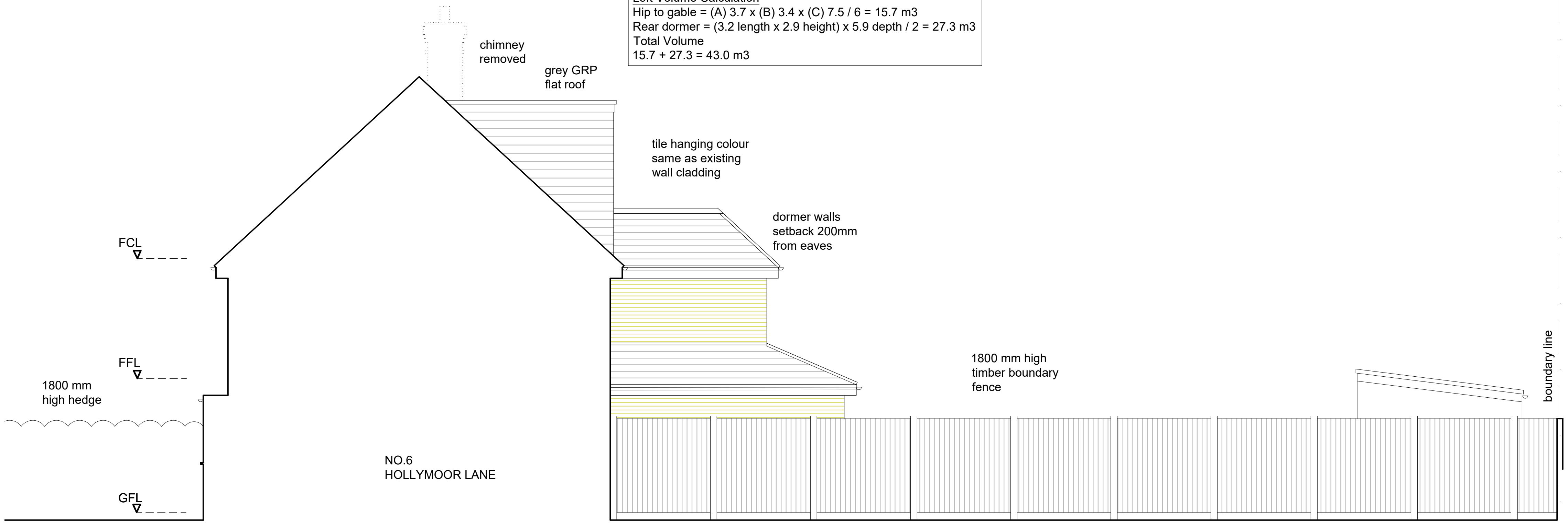
Rear dormer = (3.2 length x 2.9 height) x 5.9 depth / 2 = 27.3 m3
Total Volume
15.7 + 27.3 = 43.0 m3



PROPOSED RIGHT SIDE ELEVATION
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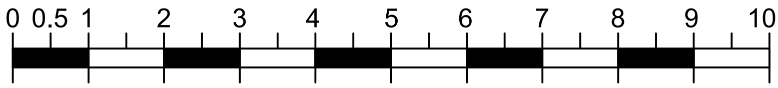

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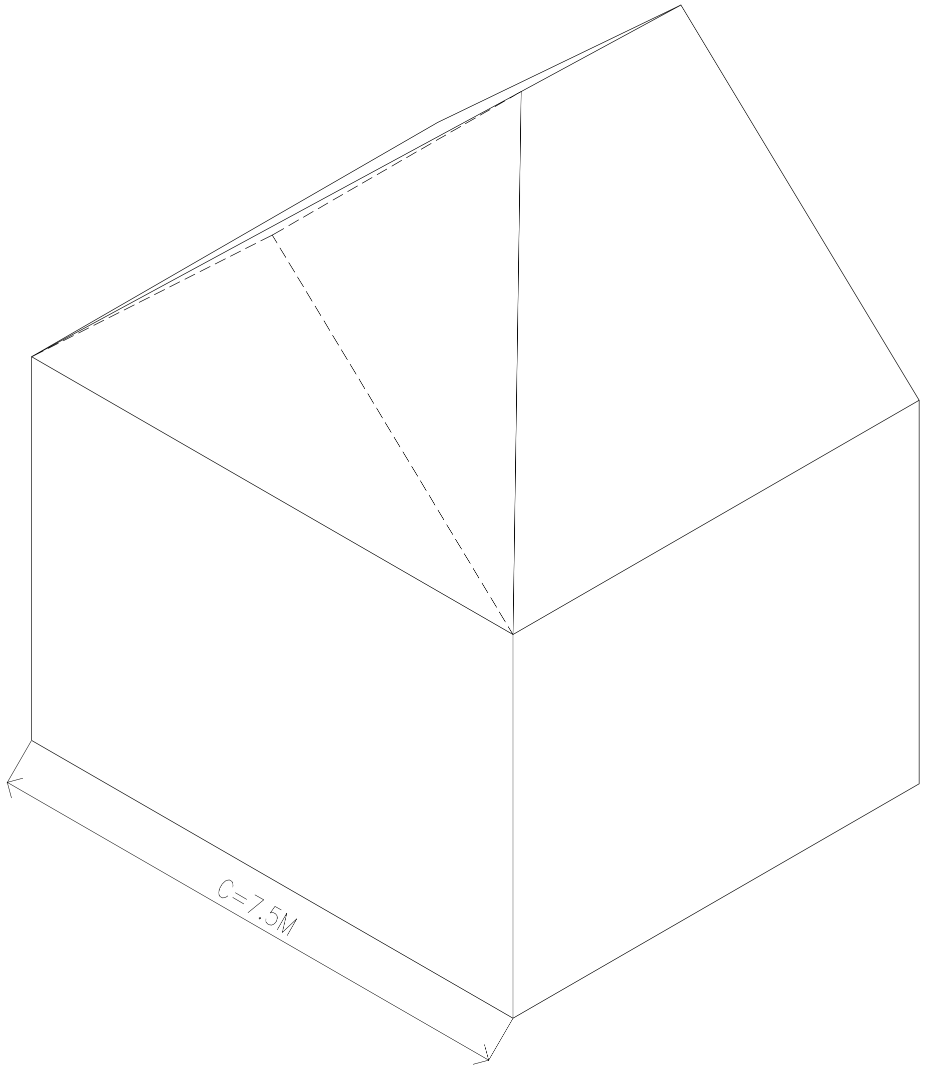

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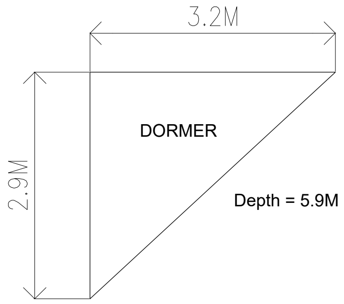

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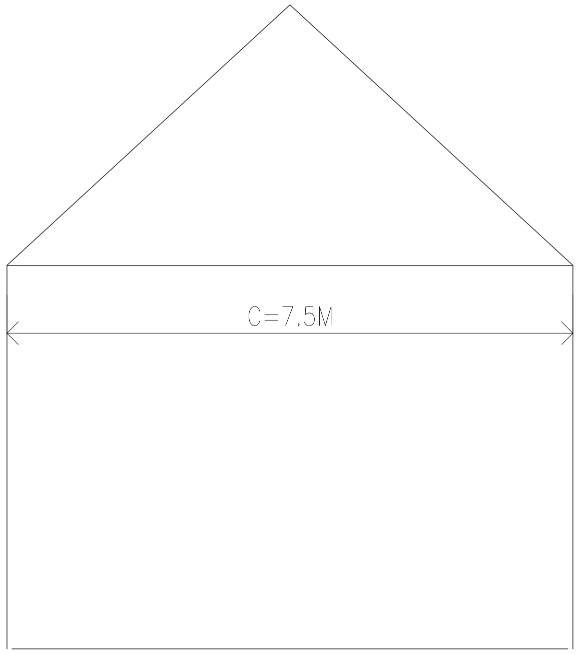
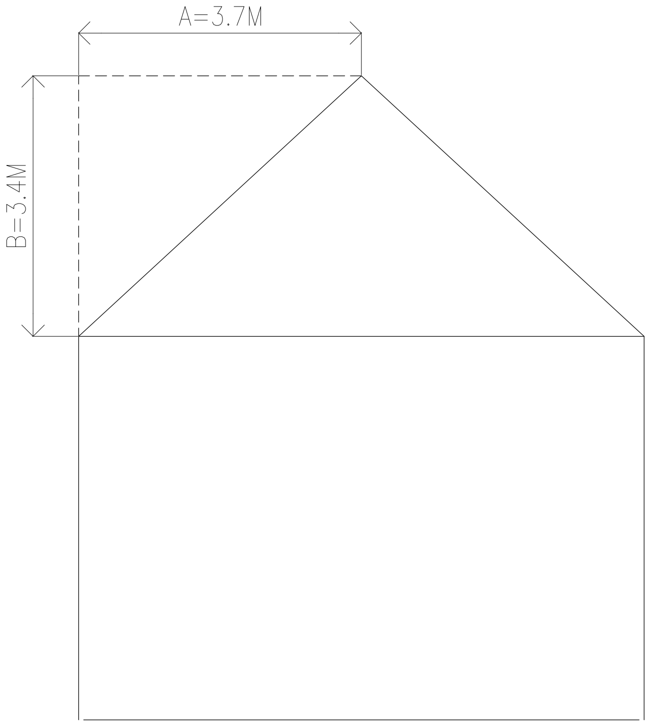
Rear dormer = (3.2 length x 2.9 height) x 5.9 depth / 2 = 27.3 m3

Total Volume

15.7 + 27.3 = 43.0 m3





LOFT VOLUME CALCULATION
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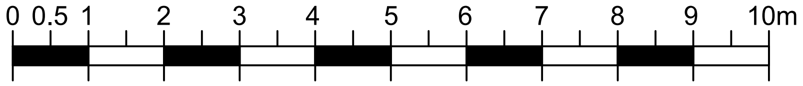

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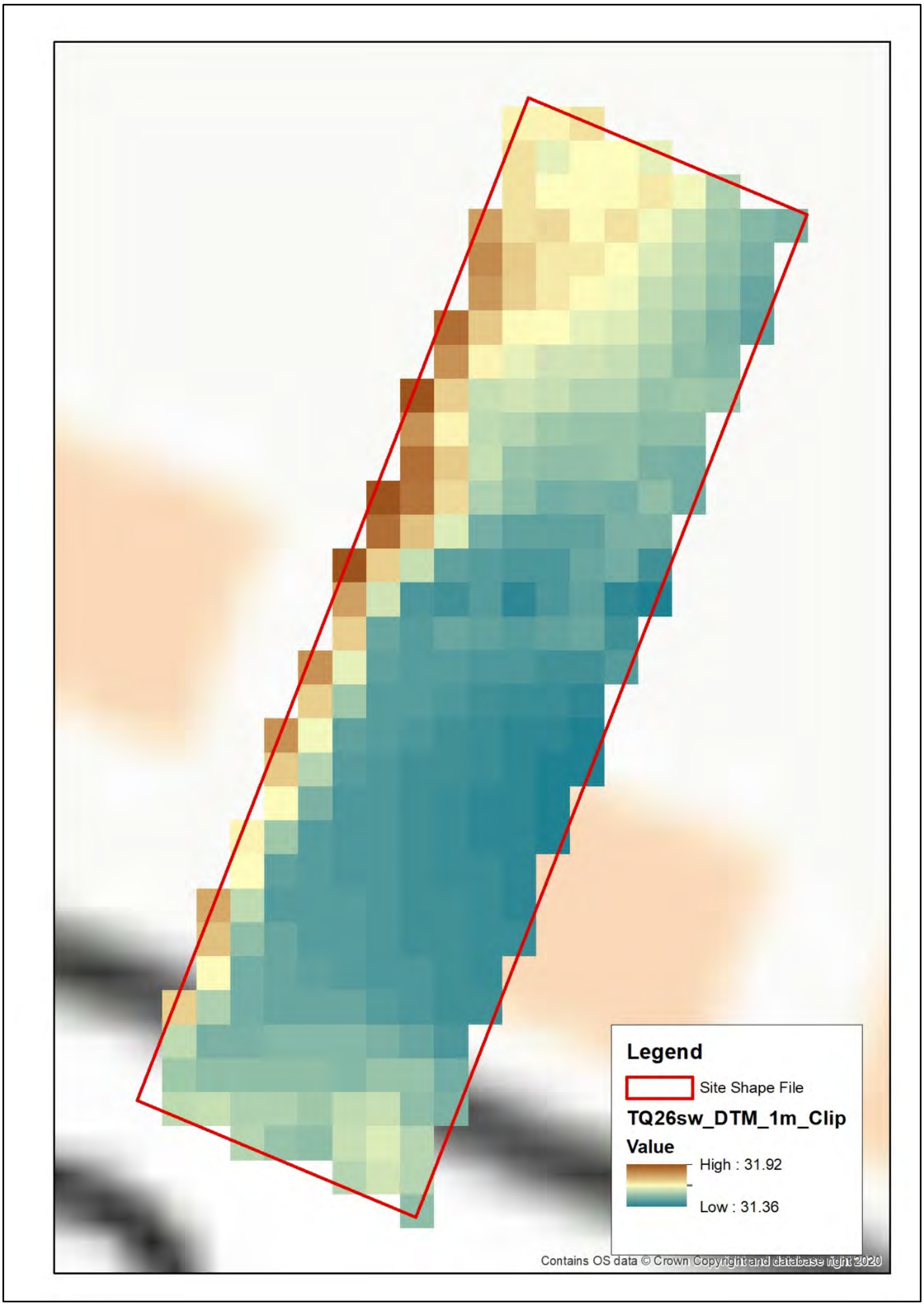
PR05

15.2 Appendix 2– Site Topography and Drainage Characteristics

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



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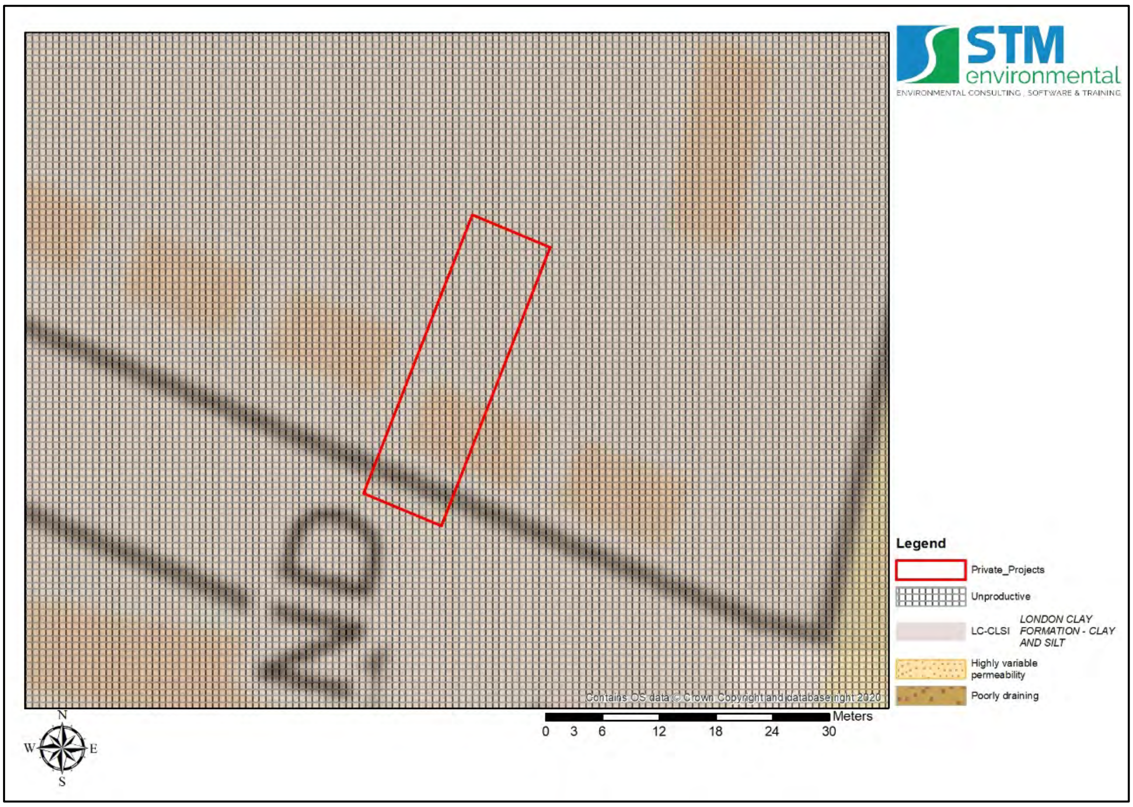
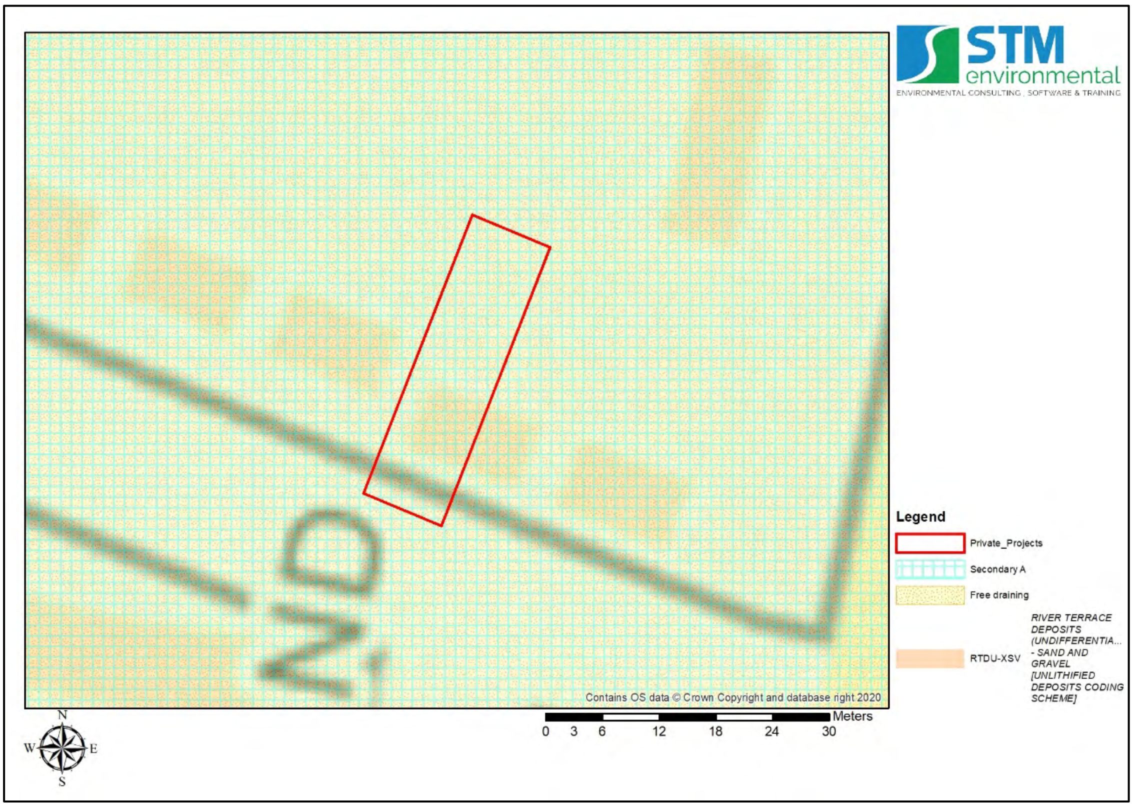
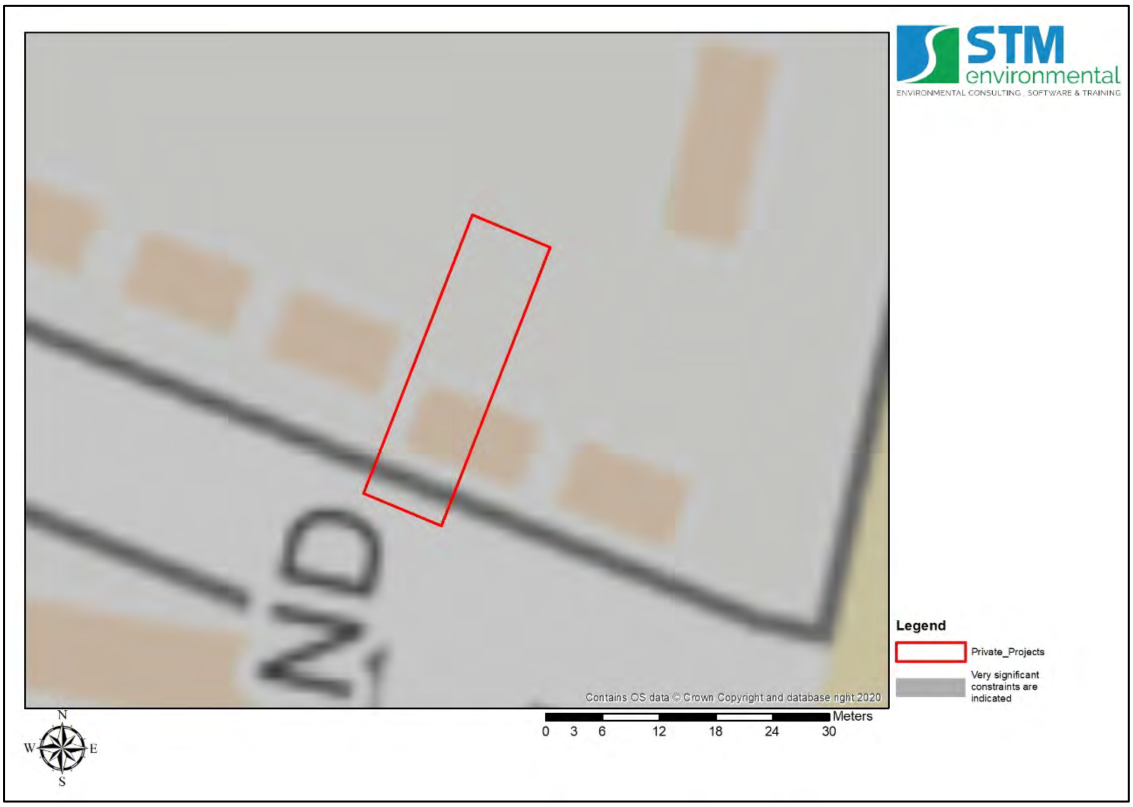
15.2.2 Bedrock Hydrogeology and Permeability (Source: BGS, 2016)



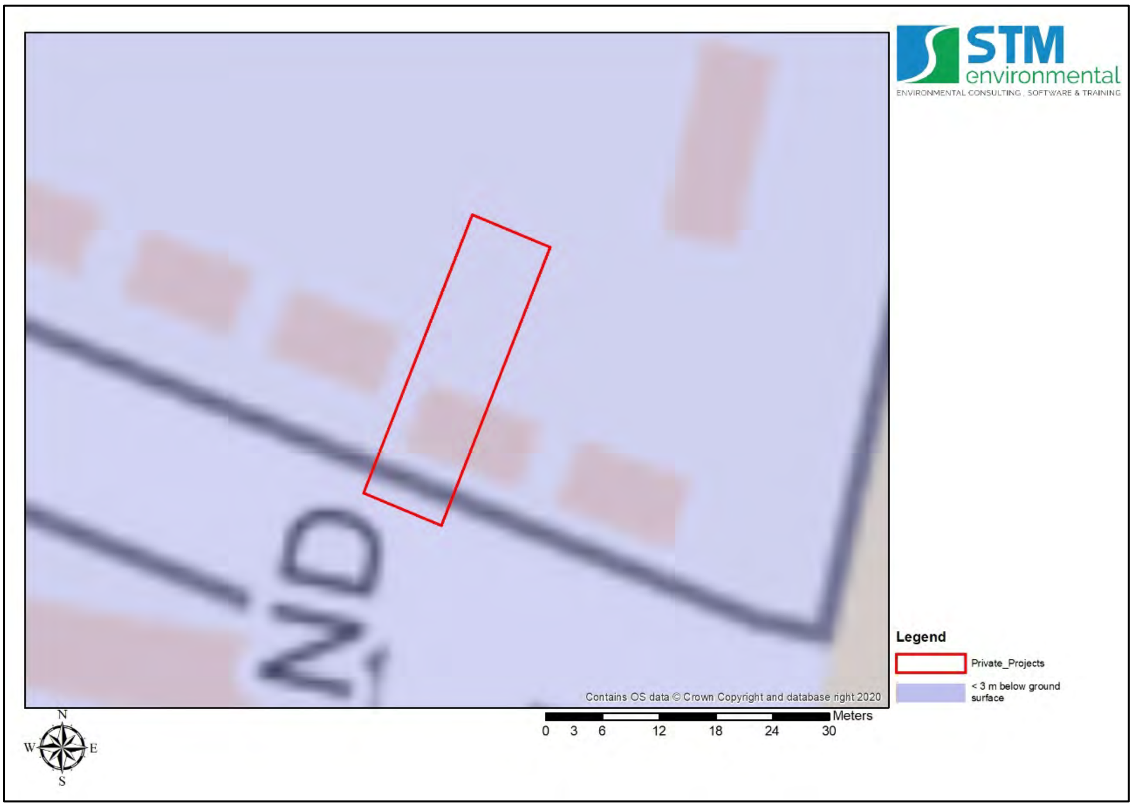
15.2.3 Superficial Hydrogeology & Permeability (Source: BGS, 2016)



15.2.4 Infiltration Drainage Potential (Source: BGS, 2016)

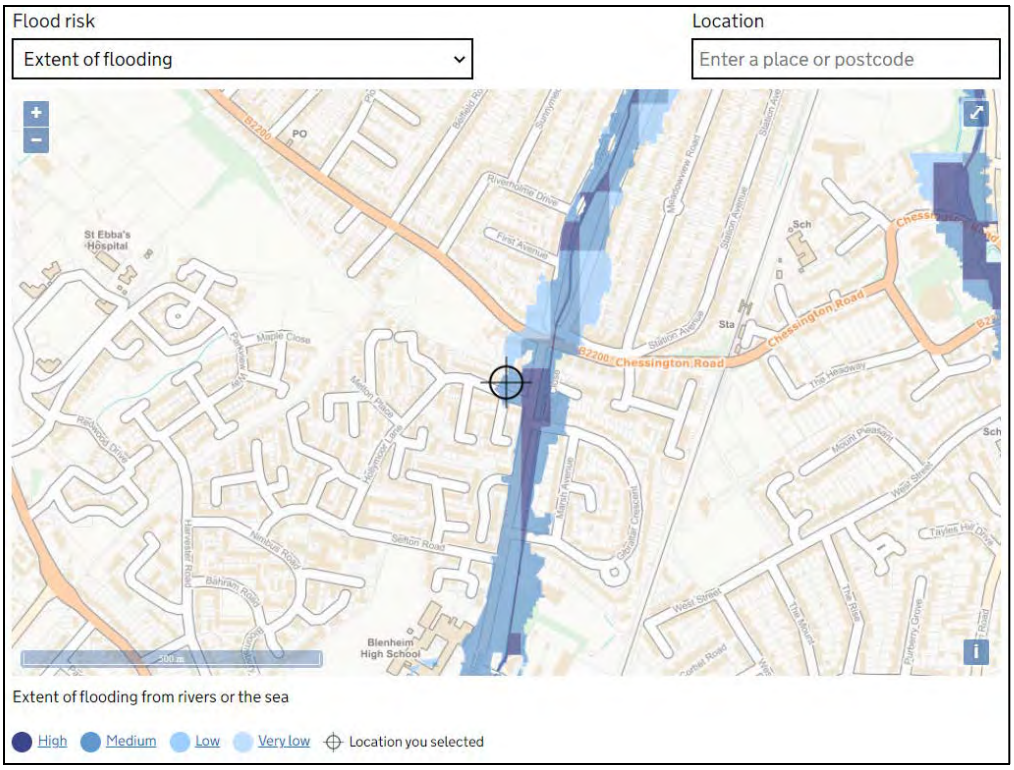


15.2.5 Groundwater Table Depth (Source: BGS 2016)



15.3 Appendix 3 – Flood Risk Mapping

15.3.1 Long Term Flood Risk Maps


Flood risk

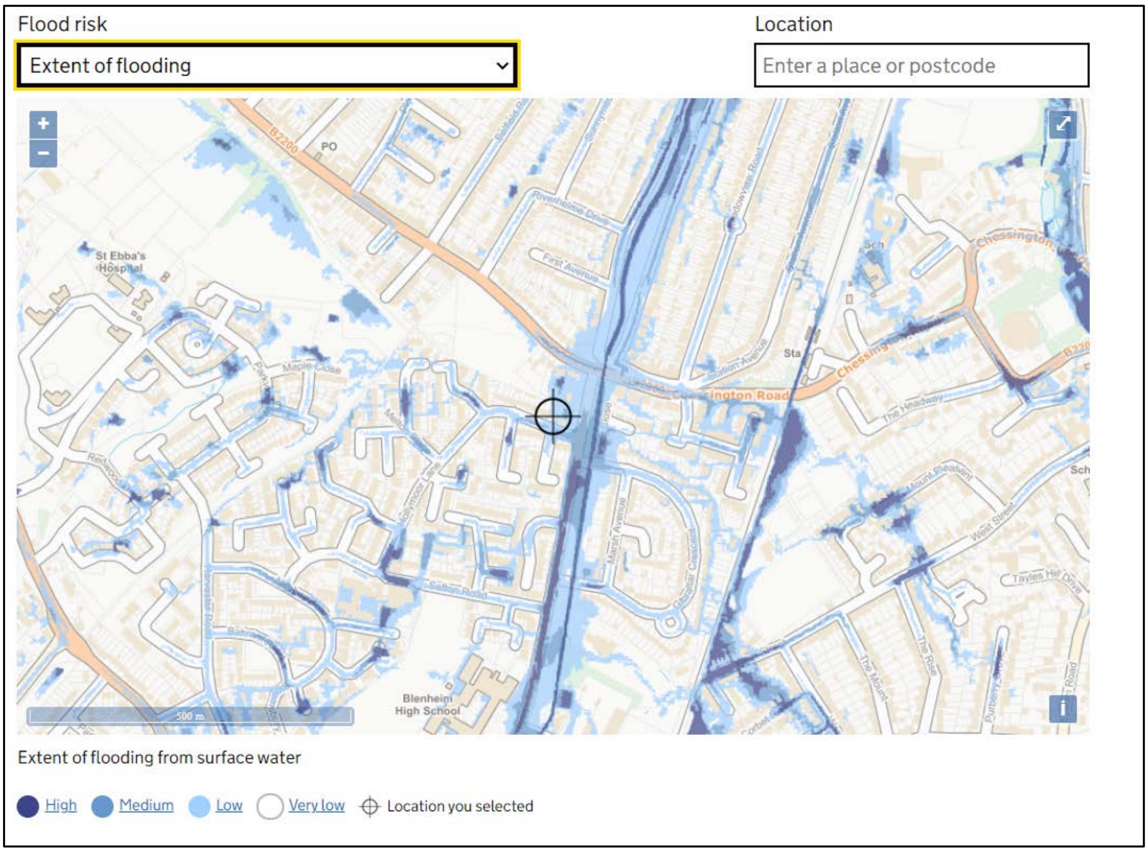
Extent of flooding

Location

Enter a place or postcode

Extent of flooding from rivers or the sea

● High ● Medium ● Low ● Very low ⊕ Location you selected


Flood risk

Extent of flooding

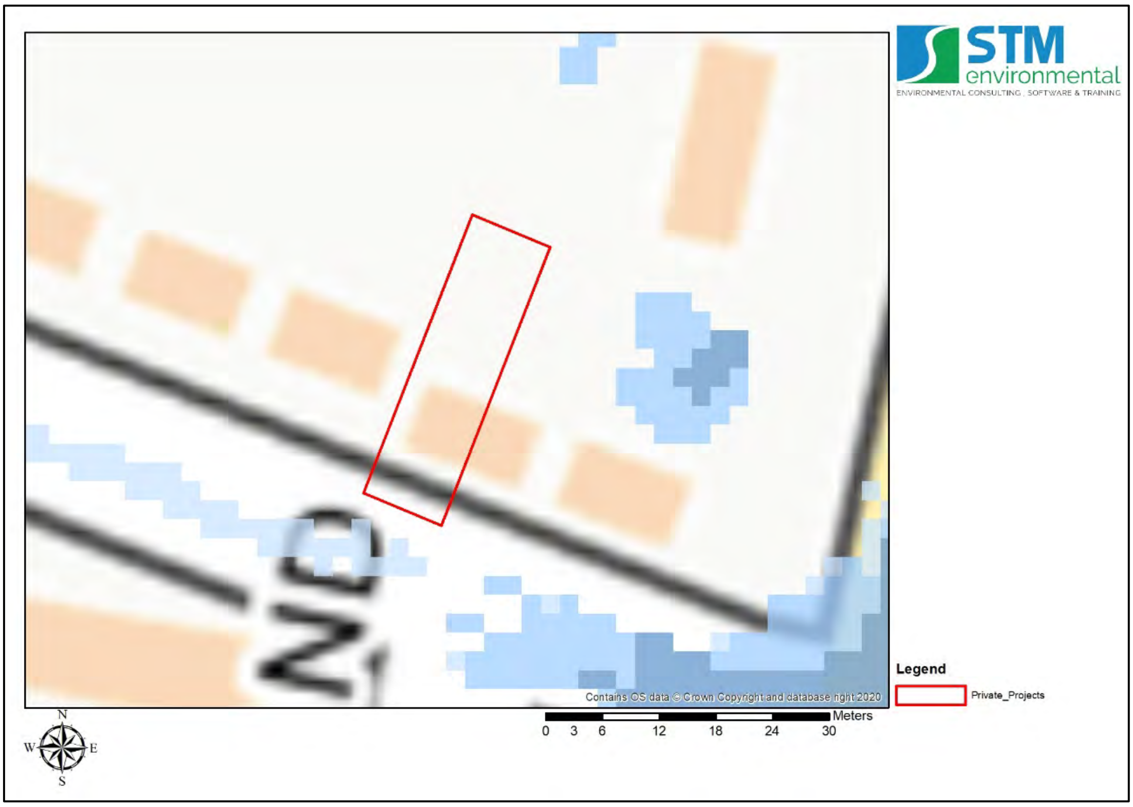
Location

Enter a place or postcode

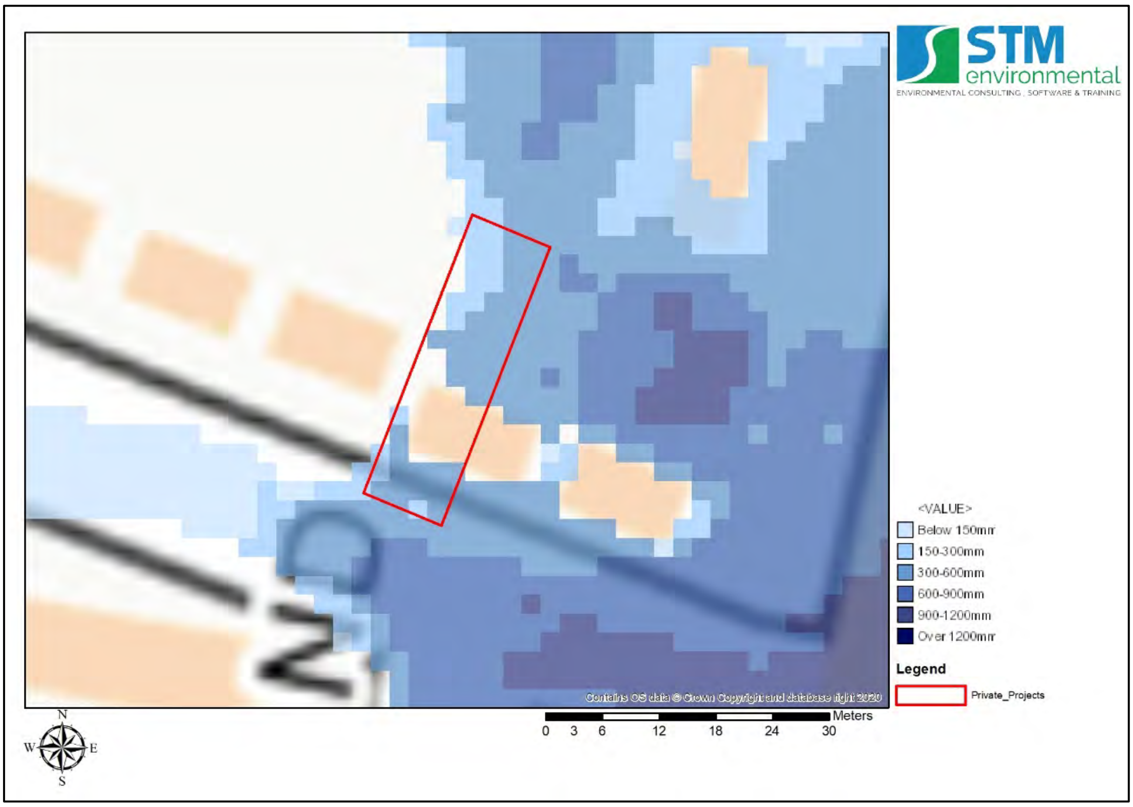
Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

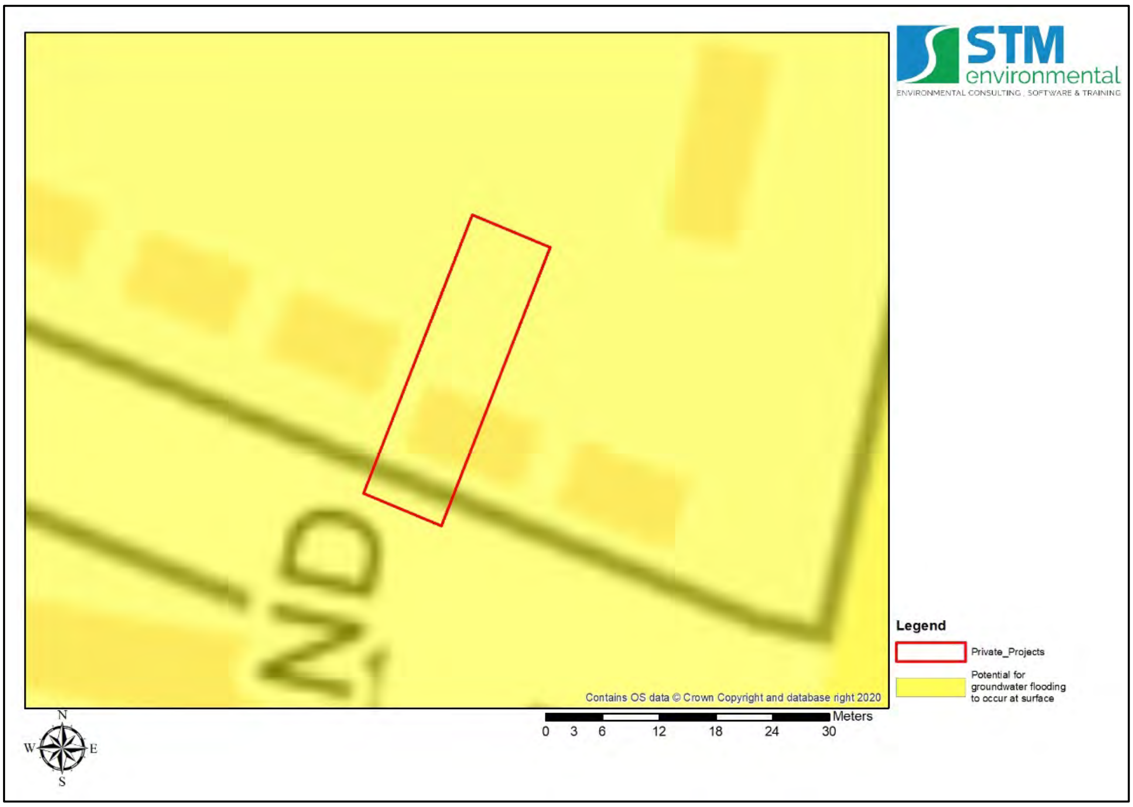
15.3.2 Surface water flood depth during the 1 in 100 rainfall return periods (Source: EA, 2016).



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



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



15.4 Appendix 4 – Run-Off Rate and Storage Calculations

15.4.1 UK SuDS

HR Wallingford
Working with water

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by: Matthew Ashdown

Site name: 8 Hollymoor Lane

Site location: Epsom, KT19 9BZ

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: 51.34943° N

Longitude: 0.26301° W

Reference: 3624395526

Date: Dec 08 2021 13:48

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.1

Methodology

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

SPR estimation method: Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	658	658
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):	0.45	0.45
1 in 1 year (l/s):	0.38	0.38
1 in 30 years (l/s):	1.03	1.03
1 in 100 year (l/s):	1.43	1.43
1 in 200 years (l/s):	1.68	1.68

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.

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Matthew Ashdown
Site name:	8 Hollymoor Lane, Z
Site location:	Epsom, KT19 9B

Site Details

Latitude:	51.34942° N
Longitude:	0.26311° W
Reference:	193091809
Date:	Dec 08 2021 13:53

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 characteristics

Total site area (ha):	0.0265
Significant public open space (ha):	0
Area positively drained (ha):	0.0265
Impermeable area (ha):	0.0169
Percentage of drained area that is impermeable (%):	64
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):	0.03
Net impermable area for storage volume design (ha):	0.02
Pervious area contribution to runoff (%):	30

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

Design criteria

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

Methodology

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

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

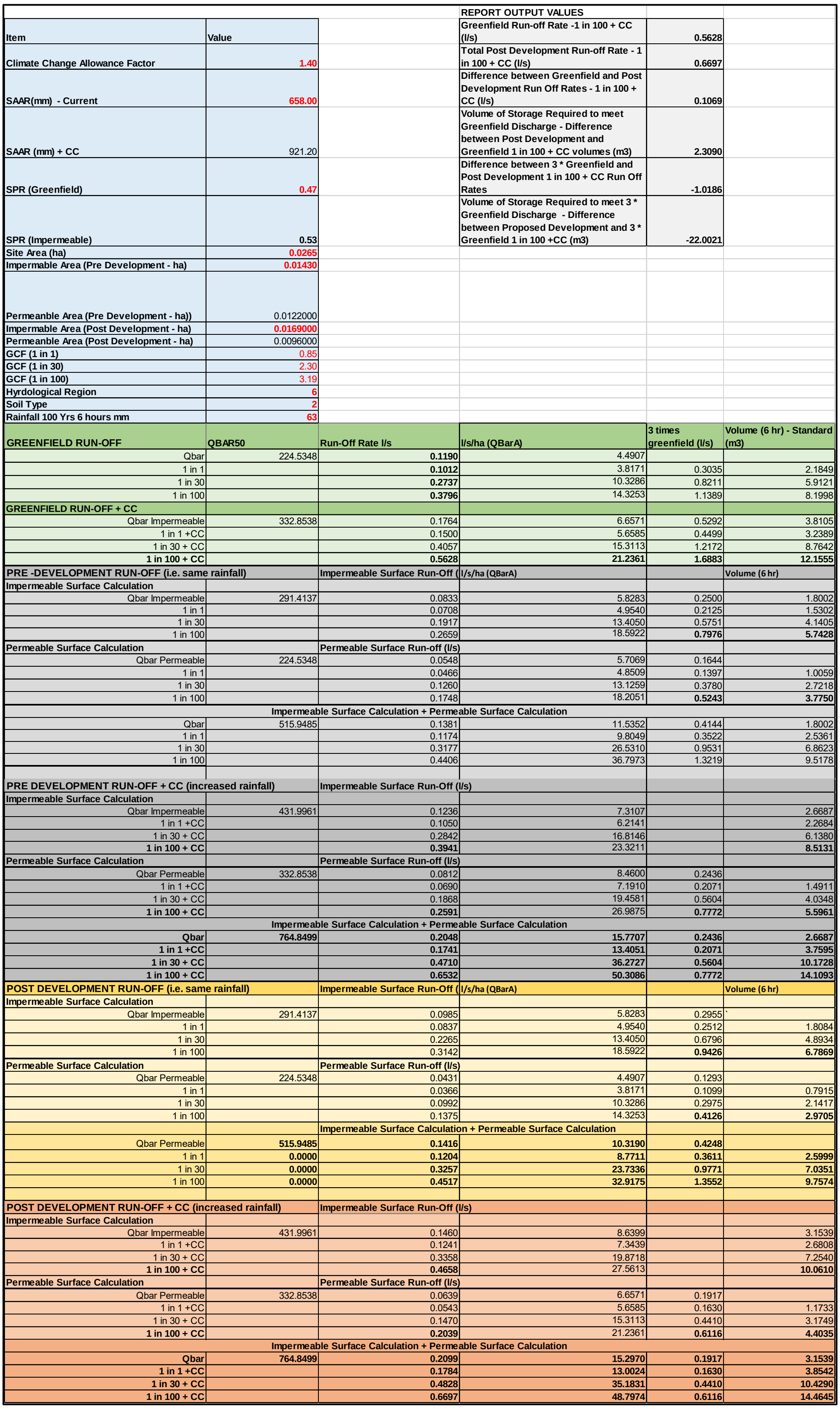
Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	97.79
FEH / FSR conversion factor:	1.27	1.27
SAAR (mm):	658	658
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.12	0.12
Q_{BAR} for net site area (l/s):	0.12	0.12

Site discharge rates	Default	Edited	**Estimated storage volumes**	Default	Edited
1 in 1 year (l/s):	2	2	Attenuation storage 1/100 years (m^3):	3	3
1 in 30 years (l/s):	2	2	Long term storage 1/100 years (m^3):	0	0
1 in 100 year (l/s):	2	2	Total storage 1/100 years (m^3):	3	3

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.

15.4.2 IH124 method



			REPORT OUTPUT VALUES		
Item	Value		Greenfield Run-off Rate -1 in 100 + CC (l/s)	0.5628	
Climate Change Allowance Factor	1.40		Total Post Development Run-off Rate - 1 in 100 + CC (l/s)	0.6697	
SAAR(mm) - Current	658.00		Difference between Greenfield and Post Development Run Off Rates - 1 in 100 + CC (l/s)	0.1069	
SAAR (mm) + CC	921.20		Volume of Storage Required to meet Greenfield Discharge - Difference between Post Development and Greenfield 1 in 100 + CC volumes (m3)	2.3090	
SPR (Greenfield)	0.47		Difference between 3 * Greenfield and Post Development 1 in 100 + CC Run Off Rates	-1.0186	
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)	-22.0021	
Site Area (ha)	0.0265				
Impermable Area (Pre Development - ha)	0.01430				
Permeanble Area (Pre Development - ha))	0.0122000				
Impermable Area (Post Development - ha)	0.0169000				
Permeanble Area (Post Development - ha)	0.0096000				
GCF (1 in 1)	0.85				
GCF (1 in 30)	2.30				
GCF (1 in 100)	3.19				
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	224.5348	**0.1190**	4.4907		
1 in 1		**0.1012**	3.8171	0.3035	2.1849
1 in 30		**0.2737**	10.3286	0.8211	5.9121
1 in 100		**0.3796**	14.3253	1.1389	8.1998
GREENFIELD RUN-OFF + CC					
Qbar Impermeable	332.8538	0.1764	6.6571	0.5292	3.8105
1 in 1 +CC		0.1500	5.6585	0.4499	3.2389
1 in 30 + CC		0.4057	15.3113	1.2172	8.7642
1 in 100 + CC		**0.5628**	**21.2361**	**1.6883**	**12.1555**
PRE -DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	291.4137	0.0833	5.8283	0.2500	1.8002
1 in 1		0.0708	4.9540	0.2125	1.5302
1 in 30		0.1917	13.4050	0.5751	4.1405
1 in 100		0.2659	18.5922	**0.7976**	**5.7428**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	224.5348	0.0548	5.7069	0.1644	
1 in 1		0.0466	4.8509	0.1397	1.0059
1 in 30		0.1260	13.1259	0.3780	2.7218
1 in 100		0.1748	18.2051	**0.5243**	**3.7750**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	515.9485	0.1381	11.5352	0.4144	1.8002
1 in 1		0.1174	9.8049	0.3522	2.5361
1 in 30		0.3177	26.5310	0.9531	6.8623
1 in 100		0.4406	36.7973	1.3219	9.5178
PRE DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	431.9961	0.1236	7.3107		2.6687
1 in 1 +CC		0.1050	6.2141		2.2684
1 in 30 + CC		0.2842	16.8146		6.1380
1 in 100 + CC		**0.3941**	23.3211		**8.5131**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	332.8538	0.0812	8.4600	0.2436	
1 in 1 +CC		0.0690	7.1910	0.2071	1.4911
1 in 30 + CC		0.1868	19.4581	0.5604	4.0348
1 in 100 + CC		**0.2591**	26.9875	**0.7772**	**5.5961**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	**764.8499**	**0.2048**	**15.7707**	**0.2436**	**2.6687**
1 in 1 +CC		**0.1741**	**13.4051**	**0.2071**	**3.7595**
1 in 30 + CC		**0.4710**	**36.2727**	**0.5604**	**10.1728**
1 in 100 + CC		**0.6532**	**50.3086**	**0.7772**	**14.1093**
POST DEVELOPMENT RUN-OFF (i.e. same rainfall)		**Impermeable Surface Run-Off (**	**l/s/ha (QBarA)**		**Volume (6 hr)**
Impermeable Surface Calculation					
Qbar Impermeable	291.4137	0.0985	5.8283	0.2955	`
1 in 1		0.0837	4.9540	0.2512	1.8084
1 in 30		0.2265	13.4050	0.6796	4.8934
1 in 100		0.3142	18.5922	**0.9426**	**6.7869**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	224.5348	0.0431	4.4907	0.1293	
1 in 1		0.0366	3.8171	0.1099	0.7915
1 in 30		0.0992	10.3286	0.2975	2.1417
1 in 100		0.1375	14.3253	**0.4126**	**2.9705**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar Permeable	**515.9485**	**0.1416**	**10.3190**	**0.4248**	
1 in 1	**0.0000**	**0.1204**	**8.7711**	**0.3611**	**2.5999**
1 in 30	**0.0000**	**0.3257**	**23.7336**	**0.9771**	**7.0351**
1 in 100	**0.0000**	**0.4517**	**32.9175**	**1.3552**	**9.7574**
POST DEVELOPMENT RUN-OFF + CC (increased rainfall)		**Impermeable Surface Run-Off (l/s)**			
Impermeable Surface Calculation					
Qbar Impermeable	431.9961	0.1460	8.6399		3.1539
1 in 1 +CC		0.1241	7.3439		2.6808
1 in 30 + CC		0.3358	19.8718		7.2540
1 in 100 + CC		**0.4658**	27.5613		**10.0610**
Permeable Surface Calculation		**Permeable Surface Run-off (l/s)**			
Qbar Permeable	332.8538	0.0639	6.6571	0.1917	
1 in 1 +CC		0.0543	5.6585	0.1630	1.1733
1 in 30 + CC		0.1470	15.3113	0.4410	3.1749
1 in 100 + CC		**0.2039**	21.2361	**0.6116**	**4.4035**
		Impermeable Surface Calculation + Permeable Surface Calculation			
Qbar	**764.8499**	**0.2099**	**15.2970**	**0.1917**	**3.1539**
1 in 1 +CC		**0.1784**	**13.0024**	**0.1630**	**3.8542**
1 in 30 + CC		**0.4828**	**35.1831**	**0.4410**	**10.4290**
1 in 100 + CC		**0.6697**	**48.7974**	**0.6116**	**14.4645**

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.402	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.100
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.013	4-8	0.001

Total Area Contributing (ha) = 0.014

Total Pipe Volume (m³) = 0.240

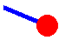
Network Design Table for Storm

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
S1.000	5.869	0.100	58.5	0.000	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.001	5.500	0.093	59.3	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.002	7.240	0.125	57.8	0.007	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.003	5.924	0.101	58.5	0.007	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.004	5.991	0.102	58.5	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓

Network Results Table

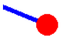
PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
S1.000	50.00	5.10	31.250	0.000	0.0	0.0	0.0	1.01	7.9	0.0
S1.001	50.00	5.19	31.150	0.000	0.0	0.0	0.0	1.01	7.9	0.0
S1.002	50.00	5.31	31.057	0.007	0.0	0.0	0.0	1.01	8.0	0.9
S1.003	50.00	5.40	30.932	0.014	0.0	0.0	0.0	1.01	7.9	1.9
S1.004	50.00	5.50	30.831	0.014	0.0	0.0	0.0	1.01	7.9	1.9

Setting Out Information - True Coordinates (Storm)

PN	USMH Name	Dia/Len (mm)	Width (mm)	US Easting (m)	US Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Layout (North)
S1.000	S1	450		521075.610	162581.175	521075.610	162581.175	
S1.001	S2	450		521070.189	162583.423	521070.189	162583.423	
S1.002	S3	450		521068.281	162578.264			
S1.003	S4	450		521065.644	162571.522	521065.644	162571.522	
S1.004	S5			521063.931	162565.851			

PN	DSMH Name	Dia/Len (mm)	Width (mm)	DS Easting (m)	DS Northing (m)	Layout (North)
S1.004	S	0		521066.601	162560.488	

Setting Out Information - Site Coordinates (Storm)

PN	**USMH Name**	**Dia/Len (mm)**	**Width (mm)**	**US Easting (m)**	**US Northing (m)**	**Intersection Easting (m)**	**Intersection Northing (m)**	**Layout (North)**
S1.000	S1	450		521075.610	162581.175	521075.610	162581.175	
S1.001	S2	450		521070.189	162583.423	521070.189	162583.423	
S1.002	S3	450		521068.281	162578.264			
S1.003	S4	450		521065.644	162571.522	521065.644	162571.522	
S1.004	S5			521063.931	162565.851			

PN	**DSMH Name**	**Dia/Len (mm)**	**Width (mm)**	**DS Easting (m)**	**DS Northing (m)**	**Layout (North)**
S1.004	S	0		521066.601	162560.488	

Area Summary for Storm

Pipe Number	**PIMP Type**	**PIMP Name**	**PIMP (%)**	**Gross Area (ha)**	**Imp. Area (ha)**	**Pipe Total (ha)**
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.007	0.007	0.007
1.003	-	-	100	0.007	0.007	0.007
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.014	0.014	0.014

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S1	100	0.100	0.200	Unclassified	450	0	0.100	Unclassified
S1.001	S2	100	0.200	0.293	Unclassified	450	0	0.200	Unclassified
S1.002	S3	100	0.293	0.418	Unclassified	450	0	0.293	Unclassified
S1.003	S4	100	0.418	0.469	Unclassified	450	0	0.418	Unclassified
S1.004	S5	100	0.422	0.469	Unclassified				Junction

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	S	31.250	30.728	0.000	0	0

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.402		

Summary Wizard of 360 minute 1 year Summer I+0% for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR   Ratio R 0.406
Region England and Wales   Cv (Summer) 0.750
M5-60 (mm) 20.000   Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	**US/MH Name**	**Storm Rank**	**Water Level (m)**	**Surcharged Depth (m)**	**Flooded Volume (m³)**	**Flow / Cap.**	**Overflow (l/s)**	**Half Drain Time (mins)**	**Pipe Flow (l/s)**	**Status**
S1.000	S1	1	31.250	-0.100	0.000	0.00			0.0	OK
S1.001	S2	1	31.150	-0.100	0.000	0.00			0.0	OK
S1.002	S3	5	31.068	-0.089	0.000	0.03			0.2	OK
S1.003	S4	5	30.947	-0.085	0.000	0.06			0.4	OK
S1.004	S5	5	30.845	-0.085	0.000	0.05			0.4	OK*

Summary Wizard of 360 minute 30 year Summer I+0% for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR
Region England and Wales
M5-60 (mm) 20.000
Ratio R 0.406
Cv (Summer) 0.750
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm Rank	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	2	31.250	-0.100	0.000	0.00			0.0	OK
S1.001	S2	2	31.150	-0.100	0.000	0.00			0.0	OK
S1.002	S3	3	31.073	-0.084	0.000	0.06			0.5	OK
S1.003	S4	3	30.956	-0.076	0.000	0.13			0.9	OK
S1.004	S5	3	30.853	-0.078	0.000	0.12			0.9	OK*

Summary Wizard of 360 minute 100 year Summer I+20% for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

```
Rainfall Model               FSR     Ratio R 0.406
        Region England and Wales Cv (Summer) 0.750
    M5-60 (mm)            20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)                         300.0
                 Analysis Timestep 2.5 Second Increment (Extended)
                        DTS Status                            ON
                        DVD Status                            ON
                    Inertia Status                            ON

                      Profile(s) Summer and Winter
              Duration(s) (mins)               360
        Return Period(s) (years)        1, 30, 100
              Climate Change (%)          0, 0, 20
```

PN	**US/MH Name**	**Storm Rank**	**Water Level (m)**	**Surcharged Depth (m)**	**Flooded Volume (m³)**	**Flow / Cap.**	**Overflow (l/s)**	**Half Drain Time (mins)**	**Pipe Flow (l/s)**	**Status**
S1.000	S1	3	31.250	-0.100	0.000	0.00			0.0	OK
S1.001	S2	3	31.150	-0.100	0.000	0.00			0.0	OK
S1.002	S3	1	31.078	-0.079	0.000	0.10			0.7	OK
S1.003	S4	1	30.962	-0.070	0.000	0.20			1.4	OK
S1.004	S5	1	30.859	-0.072	0.000	0.18			1.4	OK*

Summary Wizard of 360 minute 1 year Winter I+0% for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR
Ratio R 0.406
Region England and Wales
Cv (Summer) 0.750
M5-60 (mm) 20.000
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm Rank	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	4	31.250	-0.100	0.000	0.00			0.0	OK
S1.001	S2	4	31.150	-0.100	0.000	0.00			0.0	OK
S1.002	S3	6	31.067	-0.090	0.000	0.02			0.1	OK
S1.003	S4	6	30.945	-0.087	0.000	0.04			0.3	OK
S1.004	S5	6	30.843	-0.088	0.000	0.04			0.3	OK*

Summary Wizard of 360 minute 30 year Winter I+0% for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

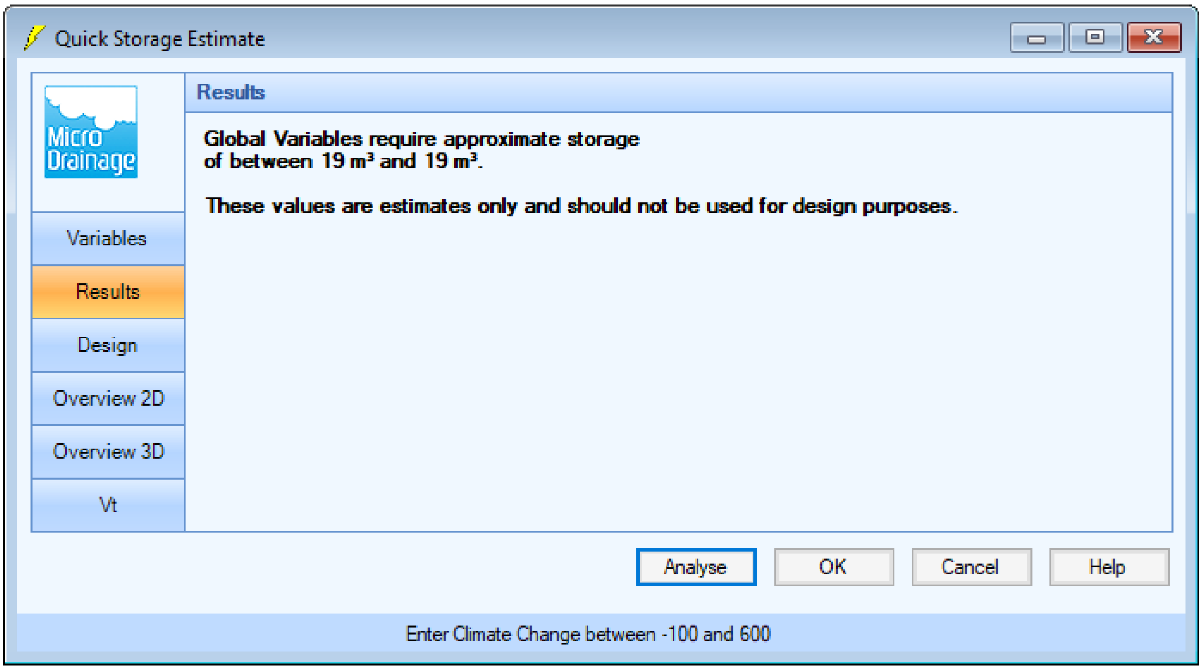
```
               Rainfall Model                FSR     Ratio R 0.406
                       Region England and Wales Cv (Summer) 0.750
                   M5-60 (mm)             20.000 Cv (Winter) 0.840

         Margin for Flood Risk Warning (mm)                          300.0
                        Analysis Timestep 2.5 Second Increment (Extended)
                              DTS Status                                ON
                              DVD Status                                ON
                          Inertia Status                                ON


                               Profile(s) Summer and Winter
                         Duration(s) (mins)               360
                    Return Period(s) (years)        1, 30, 100
                         Climate Change (%)           0, 0, 20
```

```
                       Water  Surcharged Flooded                 Half Drain  Pipe
        US/MH  Storm   Level    Depth    Volume  Flow / Overflow    Time     Flow
   PN    Name   Rank    (m)      (m)      (m³)    Cap.    (l/s)    (mins)   (l/s)  Status

 S1.000    S1      5  31.250     -0.100   0.000   0.00                        0.0      OK
 S1.001    S2      5  31.150     -0.100   0.000   0.00                        0.0      OK
 S1.002    S3      4  31.071     -0.086   0.000   0.05                        0.3      OK
 S1.003    S4      4  30.952     -0.080   0.000   0.09                        0.7      OK
 S1.004    S5      4  30.850     -0.081   0.000   0.08                        0.7     OK*
```

Summary Wizard of 360 minute 100 year Winter I+20% for Storm

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

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

                        Synthetic Rainfall Details
                 Rainfall Model               FSR     Ratio R 0.406
                         Region England and Wales Cv (Summer) 0.750
                     M5-60 (mm)            20.000 Cv (Winter) 0.840

        Margin for Flood Risk Warning (mm)                         300.0
                        Analysis Timestep 2.5 Second Increment (Extended)
                               DTS Status                             ON
                               DVD Status                             ON
                           Inertia Status                             ON


                                Profile(s) Summer and Winter
                        Duration(s) (mins)               360
                  Return Period(s) (years)       1, 30, 100
                        Climate Change (%)          0, 0, 20


                    Water  Surcharged Flooded            Half Drain  Pipe
        US/MH Storm Level    Depth    Volume Flow / Overflow   Time    Flow
    PN   Name  Rank   (m)      (m)      (m³)   Cap.   (l/s)   (mins)  (l/s) Status

  S1.000    S1     6 31.250   -0.100   0.000   0.00                     0.0     OK
  S1.001    S2     6 31.150   -0.100   0.000   0.00                     0.0     OK
  S1.002    S3     2 31.074   -0.083   0.000   0.07                     0.5     OK
  S1.003    S4     2 30.957   -0.075   0.000   0.15                     1.0     OK
  S1.004    S5     2 30.854   -0.076   0.000   0.13                     1.0    OK*
```

15.4.3 Microdrainage Quick Storage Estimates - Pre- Development



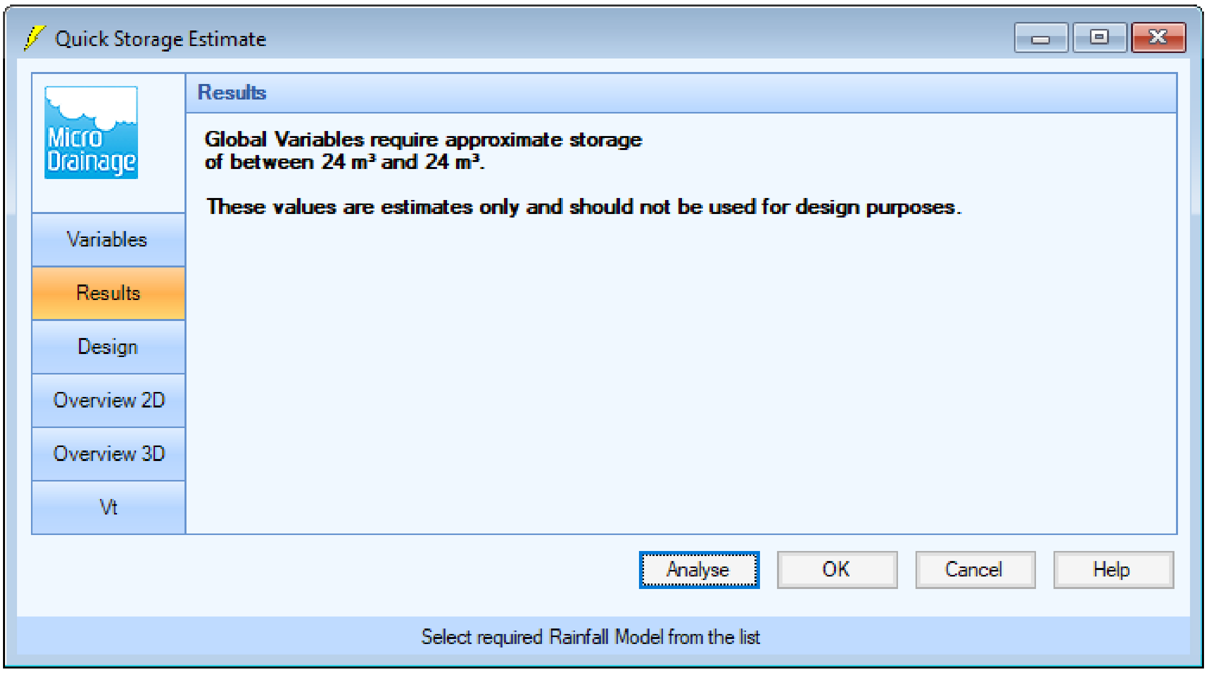
Results

Global Variables require approximate storage
of between 19 m³ and 19 m³.

These values are estimates only and should not be used for design purposes.

Enter Climate Change between -100 and 600

15.4.4 Microdrainage Quick Storage Estimates - Post - Development



Results

Global Variables require approximate storage
of between 24 m³ and 24 m³.

These values are estimates only and should not be used for design purposes.

Select required Rainfall Model from the list

15.5 Appendix 5 – SuDS Suitability Assessment

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
Rainwater Harvesting	Capture of rainwater into a tank(s) for use (usually non-potable) such as irrigation, toilet flushing, vehicle or plant cleansing.	Care is needed to prevent the development of bacteria, algae and insect infestation.	Suitable on small scale for interception storage
Infiltration: Soakaways Infiltration Trenches and Basins	Infiltration components are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, into the groundwater.	Variable draining geology. Groundwater table is potentially < 3m below surface. Could increase flood risk. Maintenance	Unsuitable
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	Unsuitable

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
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 - storage only
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 - Lined
Swales	Dry ditches used as landscape features to allow the storage and infiltration of rainwater. Often used as linear features alongside roads, footpaths or rail lines but capable of being integrated into the design of many open spaces.	Finding available space in proposed site layout	Unsuitable
Detention Basin/Ponds	Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.	Potential health and safety issues. Finding available space in proposed site layout	Unsuitable
Storage Tanks/	Usually below ground level, they attenuate rainwater for	Pumping may sometimes be required	Unsuitable

Suds Technique	Typical Uses	Potential Issues	Potential Suitability
Geocellular Storage	later slow release back into the drainage system.	to empty the tank into the drainage system	
Oversized Piping	Using larger than necessary pipework creates additional space to store rainwater.	Lacks the wider benefits of the green infrastructure-based techniques	Suitable

15.6 Appendix 6 – Descriptions of SuDS Techniques

15.6.1 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.

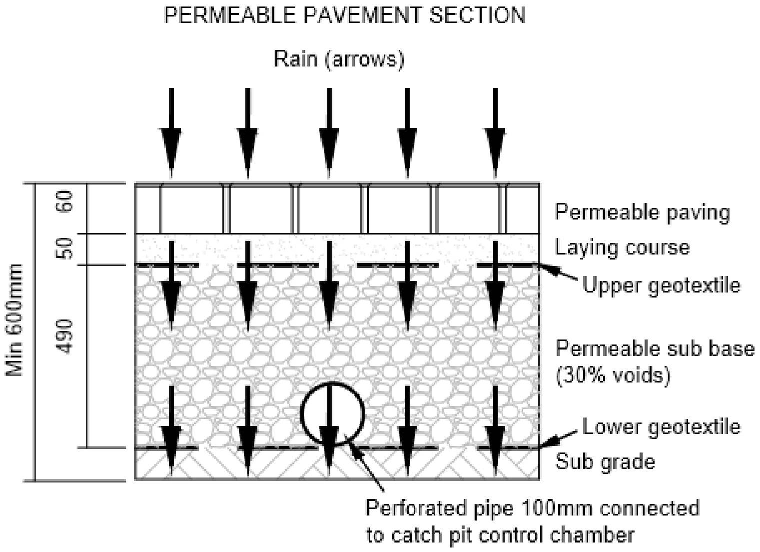


Figure 3 Block Permeable Paving with sub-base

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

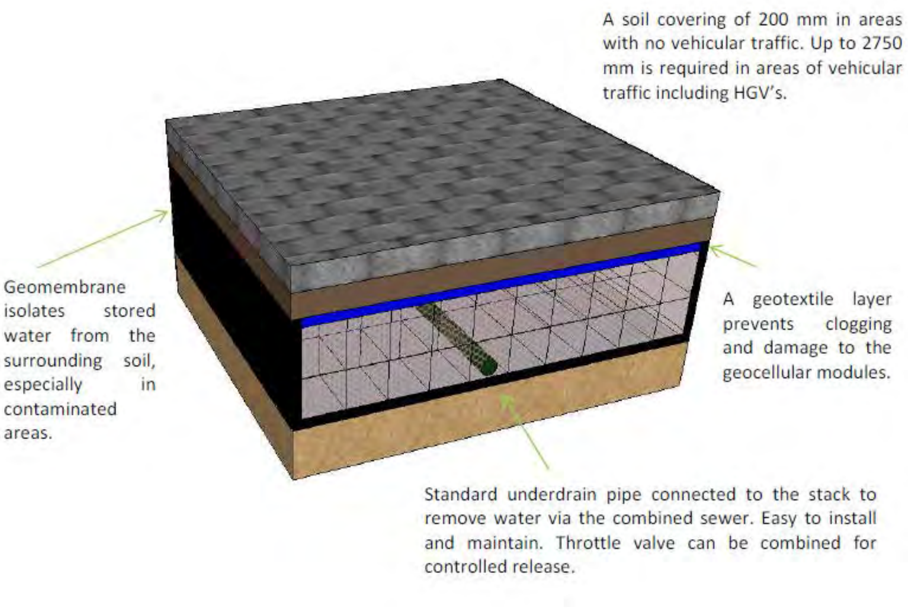


Figure 4 Block Permeable Paving with Geocellular Module

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 5 Plastic or Grid Permeable Paving with Sub-base

15.6.2 SuDs Planter Storage Volume/Rain water Harvesting Systems

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

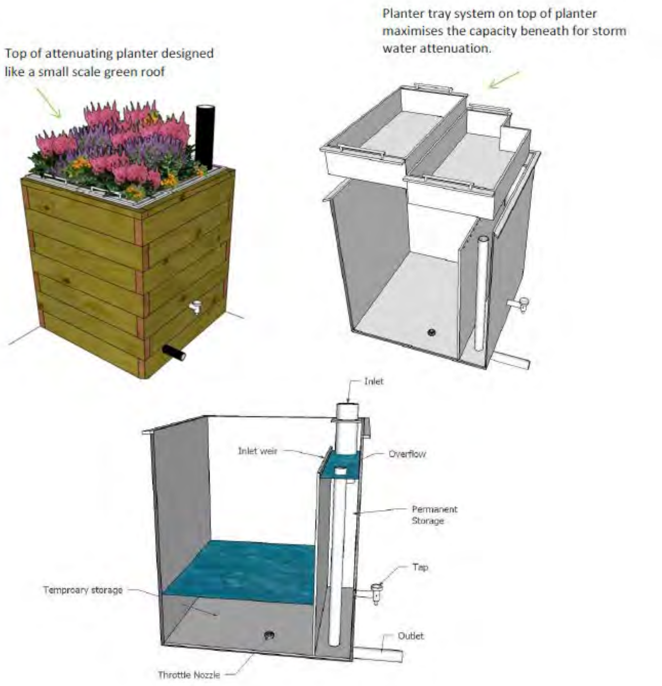


Figure 6: SuDS Planter with attenuation storage (Thames Water)

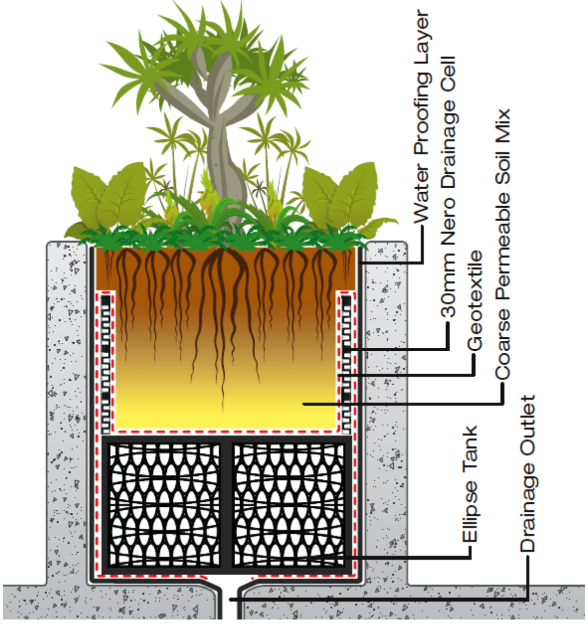


Figure 7: SuDS Planter Cross Section

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

15.6.3 Geocellular structures, oversized pipes and tanks

Modular plastic geocellular structures, with a high void ratio, are a new below ground storage arrangement that can replace underground pipes or tanks that have been used to store water. They can also be used to convey or infiltrate surface water runoff into the ground.

Underground storage features attenuate an agreed volume with a control structure to limit the discharge rate. Structural design must be provided to ensure integrity of the box, pipe or tank under loading. Silt interception and management arrangement is critical to long-term effectiveness of these structures and this must be demonstrated at design stage and confirmed for the design life of the development. It can be implemented either in the form if a modular box system with inlet and outlet pipework connected to the sides of the structure or in the form of a honeycomb structure with perforated pipes running under or through the box. Water is forced into the box when flows increase. There are now shallow, load bearing boxes which can be used under pavements and in particular below permeable pavement which protects the box from silt contamination and provides treatment with enhanced storage. Moreover, geocellular systems can be installed above a high-water table.

15.7 Appendix 7 – SuDS Maintenance Manual

All maintenance activities will be the responsibility of the developer owners of the site will be responsible for undertaking or appointing suitable a management company to undertake the general maintenance duties within the site.

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.

15.7.1 Maintenance of SuDS Planters

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

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

15.7.2 Maintenance of SuDS Rain Water Butts

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;	Grace Lopez will be responsible for setting up the management company or undertaking the maintenance required.
	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.

15.7.3 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.	Grace Lopez will be responsible for setting up the management company or undertaking the maintenance required.
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).	Grace Lopez will be responsible for setting up the management company or undertaking the maintenance required.
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.

15.7.4 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.	Grace Lopez will be responsible for setting up the management company or undertaking the maintenance required.
	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	Grace Lopez will be responsible for setting up the management company or undertaking the maintenance required.
	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

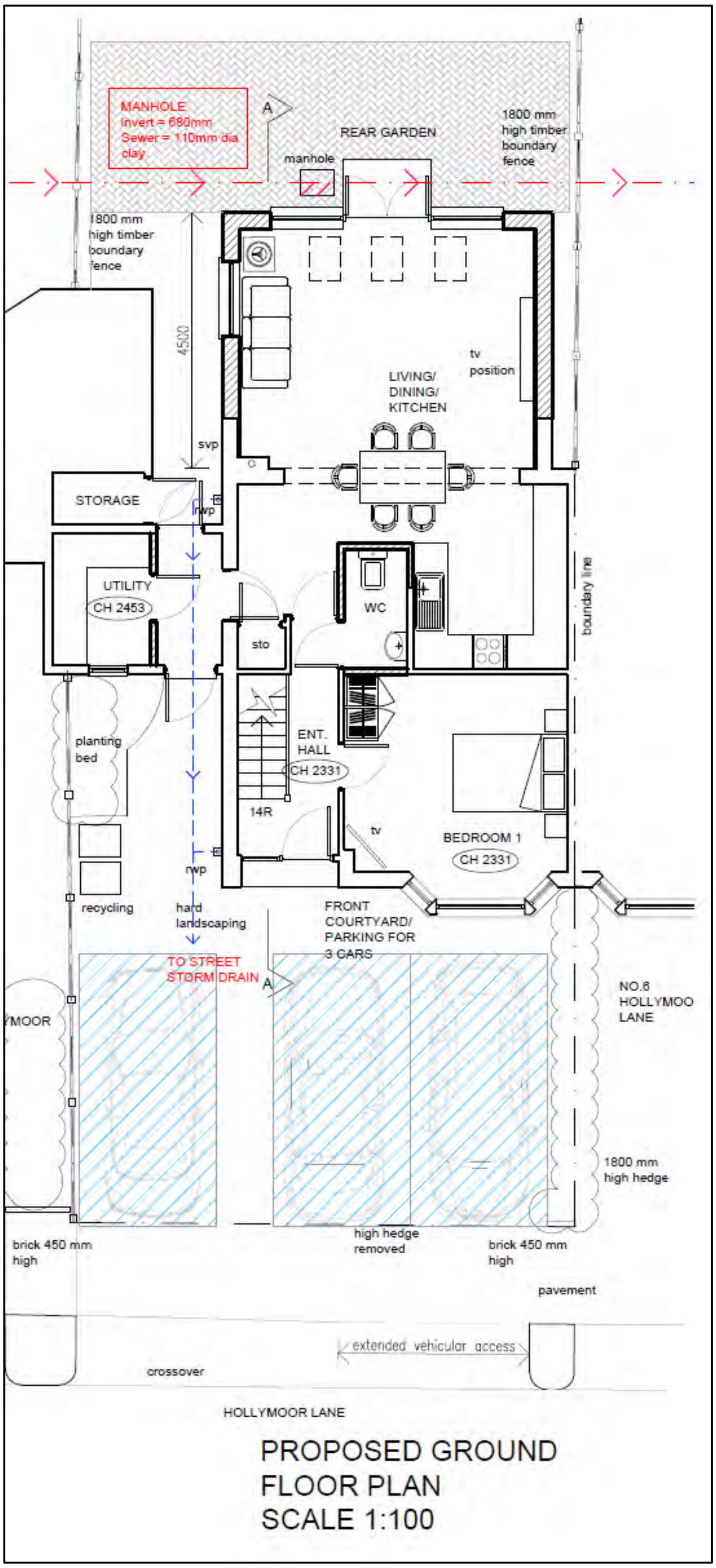
for long periods, deposits can become hard-packed and require considerable effort to remove.
Replacement of the geocellular units will be necessary if the system becomes blocked with silt. Effective monitoring will give information on changes in infiltration rate and provide a warning of potential failure 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.

15.8 Appendix 8 - Existing Drainage and Asset Mapping

15.8.1 Existing Site Drainage



15.8.2 Thames Water Asset Mapping

Asset location search

Thames Water Property Searches

STM Environmental
TWICKENHAM
TW2 6RS

Search address supplied

8
Hollymoor Lane
Epsom
KT19 9BZ

Your reference 8 Hollymoor Lane Epsom KT19 9BZ

Our reference ALS/ALS Standard/2021_4556578

Search date 9 December 2021

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

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

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

0800 009 4540

Search address supplied: 8, Hollymoor Lane, Epsom, KT19 9BZ

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

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

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

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

Tel: 01737 772 000
Fax: 01737 766 807

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Sutton & East Surrey Water
London Road
Redhill
Surrey
RH1 1LJ

Further contacts:

Waste Water queries

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

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

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

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

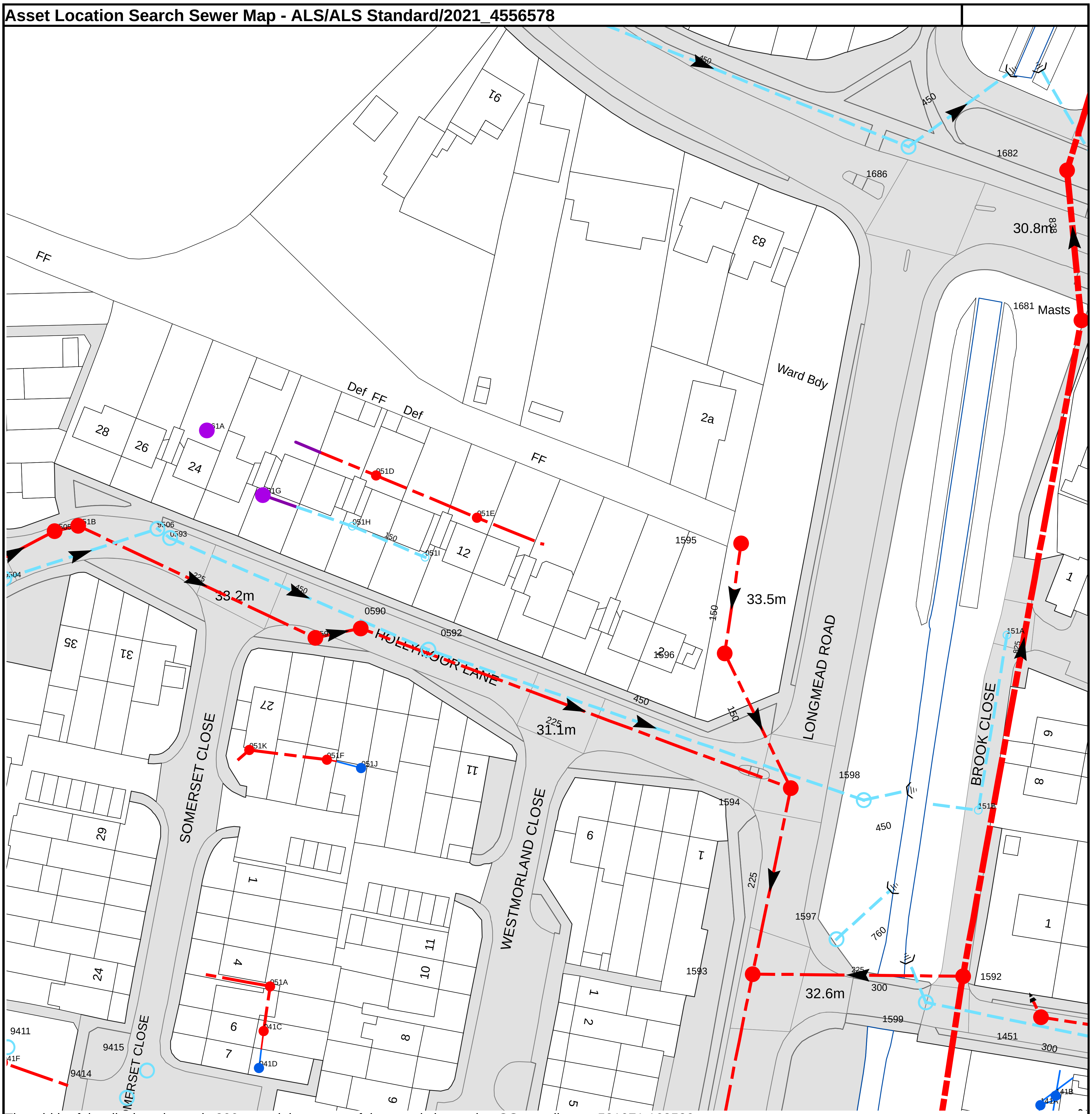
Clean Water queries

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

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

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

Asset Location Search Sewer Map - ALS/ALS Standard/2021_4556578



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 521071,162580

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
1686	31	29.32
151A	n/a	n/a
1682	31.35	25.71
1681	31.35	25.74
1598	30.98	29.73
1599	30.88	29.98
1592	30.961	26.031
151B	n/a	n/a
141A	n/a	n/a
1451	30.85	30.36
141B	n/a	n/a
9414	n/a	n/a
9415	35.16	n/a
041D	n/a	n/a
041C	n/a	n/a
051A	n/a	n/a
1593	30.5	29.17
1597	30.69	29.25
1594	30.74	29.02
051J	n/a	n/a
051F	n/a	n/a
051K	n/a	n/a
1596	31.11	29.68
0592	31.87	30.41
0591	32.728	30.508
0590	32.49	29.64
051I	n/a	n/a
1595	31.25	29.97
0593	33.58	31.48
9505	n/a	n/a
9506	n/a	n/a
051H	n/a	n/a
951B	n/a	n/a
051E	n/a	n/a
051G	n/a	n/a
051D	n/a	n/a
061A	n/a	n/a
9411	n/a	n/a

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

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

- **Foul:** A sewer designed to convey waste water from domestic and industrial sources to a treatment works.
- **Surface Water:** A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.
- **Combined:** A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.
- Trunk Surface Water
- Storm Relief
- Vent Pipe
- Proposed Thames Surface Water Sewer
- Gallery
- Surface Water Rising Main
- Sludge Rising Main
- Vacuum
- Trunk Foul
- Trunk Combined
- Bio-solids (Sludge)
- Proposed Thames Water Foul Sewer
- Foul Rising Main
- Combined Rising Main
- Proposed Thames Water Rising Main

Sewer Fittings

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

- ◆ Air Valve
- Dam Chase
- ■ Fitting
- Meter
- ○ Vent Column

Operational Controls

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

- ⧗ Control Valve
- Drop Pipe
- Ancillary
- Weir

End Items

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

- Outfall
- Undefined End
- Inlet

Other Symbols

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

- ▲/▲ Public/Private Pumping Station
- ✱ Change of characteristic indicator (C.O.C.I.)
- Invert Level
- ◁ Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- ▨ Operational Site
- Chamber
- ▨ Tunnel
- ▨ Conduit Bridge

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

- Foul Sewer
- Combined Sewer
- Culverted Watercourse
- Surface Water Sewer
- Gulley
- Proposed
- Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Searches on 0800 009 4540.

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2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
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8. A charge may be made at the discretion of the company for increased administration costs.

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

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

15.9 Appendix 9 - Infiltration Testing

15.9.1 Trial Pit Log

STM environmental
ENVIRONMENTAL CONSULTING, SOFTWARE & TRAINING

Trial Pit Log

Trialpit No	**TP01**
Sheet	1 of 1
Project Name:	8 Hollymoor Lane, Epsom
Project No.	8 Hollymoor Lane, Epsom
Co-ords:	521075.00 - 162584.00
Level:	31.57
Date	02/11/2021
Location:	8 Hollymoor Lane, Epsom, KT19 9BZ
Dimensions (m):	1 × 0.3
Depth	0.98
Scale	1:25
Client:	W2 Extensions
Logged	M.Forshaw

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.40	31.17	▩	Made Ground - Dark brown Silty, slightly Cobbly CLAY. Occasional brick fragments and occasional flint cobbles. Abundant rootlets.
				0.60	30.97	▤	Mottled dark brown and dark grey CLAY. Occasional roots.
▼				0.98	30.59	⁘	Mottled light greyish yellow and light brown slightly Silty, slightly Clayey, Cobbly GRAVEL.
							End of pit at 0.98 m

1

2

3

4

5

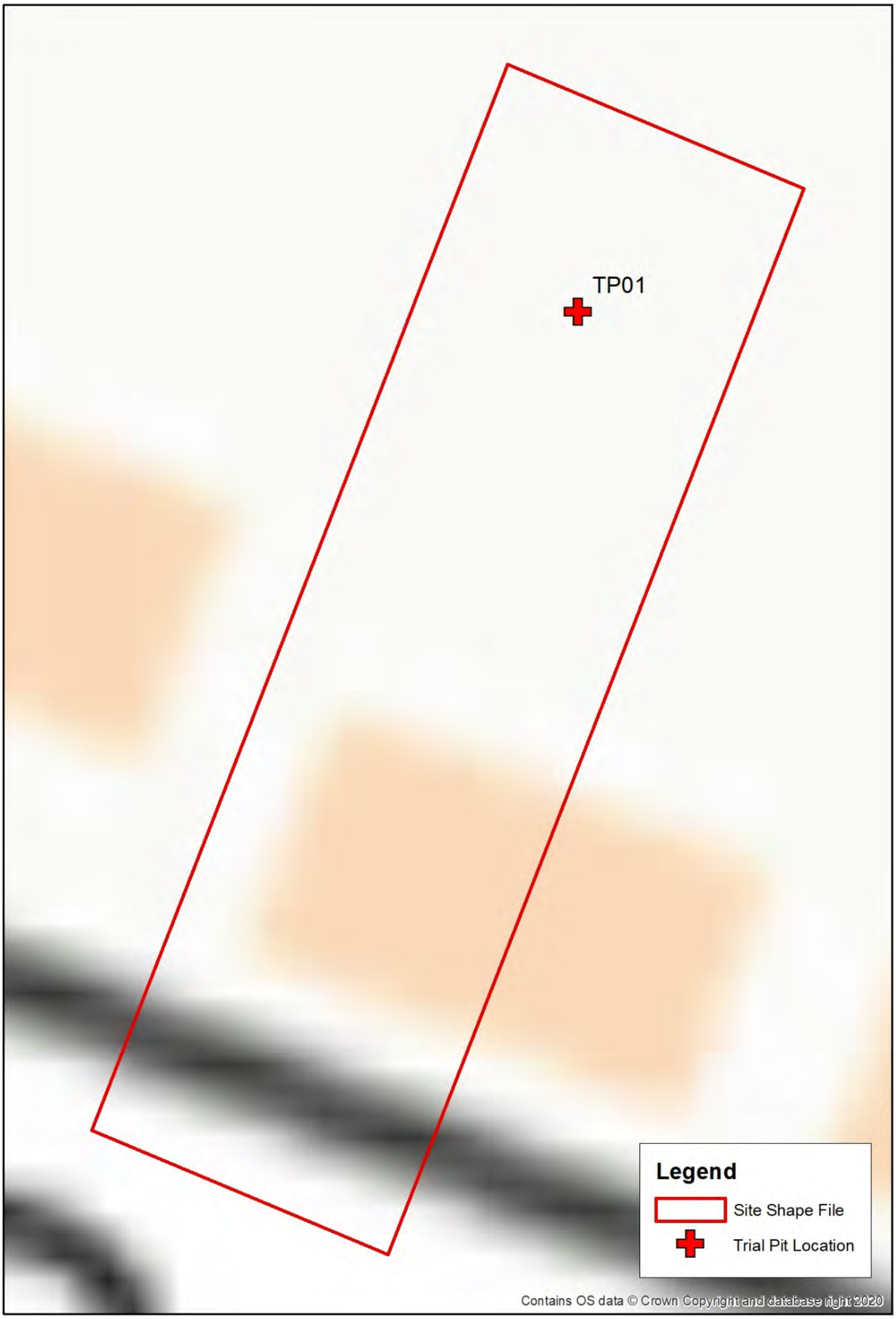
Remarks: Trial pit advanced to a maximum depth of 0.98mbgl. Groundwater strike was recorded at 0.98mbgl, and a rest level was recorded at 0.97mbgl. Trial pit location grid reference and ground level elevation values are estimated using aerial imagery (not measured).

Stability:

AGS

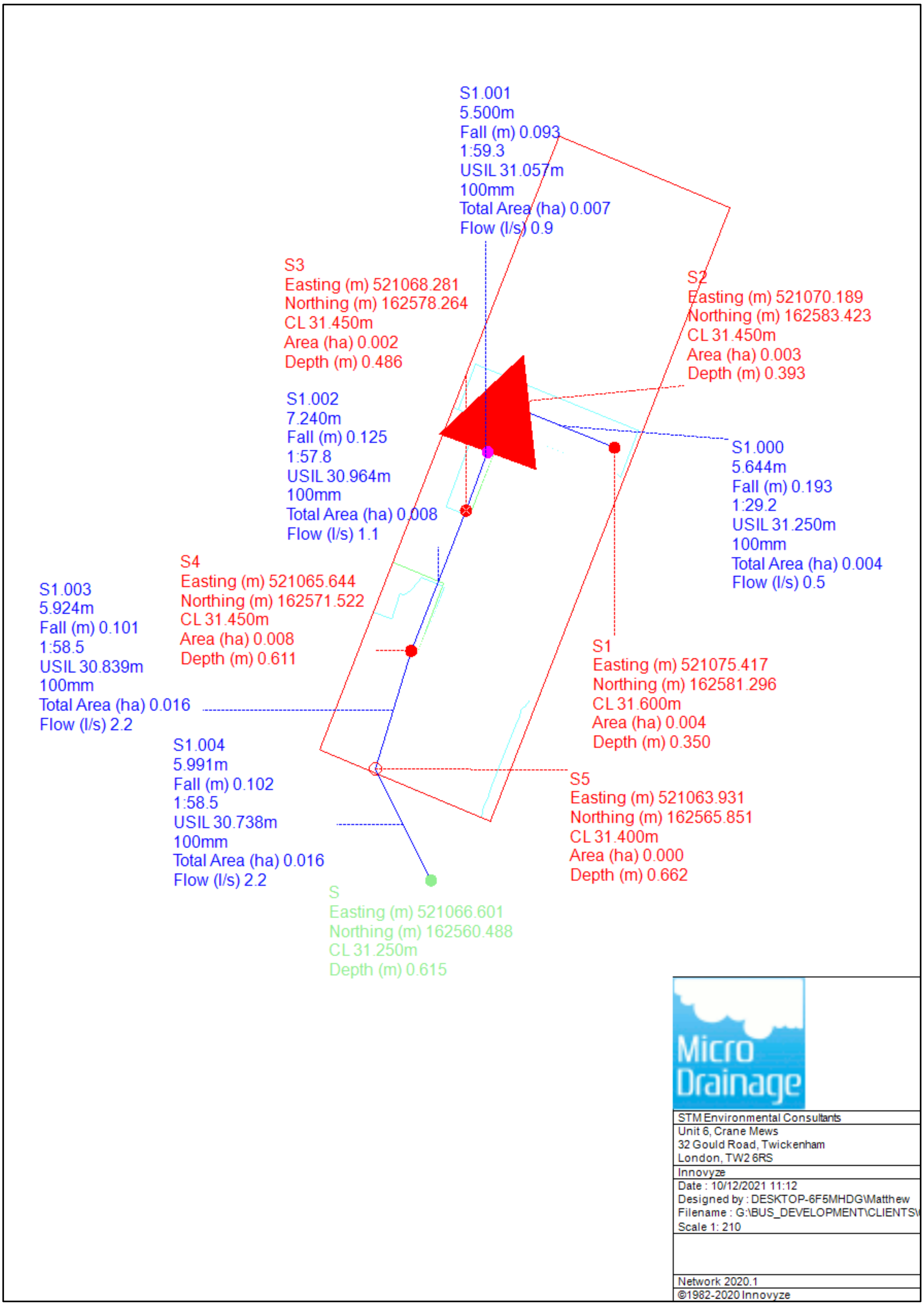
15.9.2 Trial Pit Photos

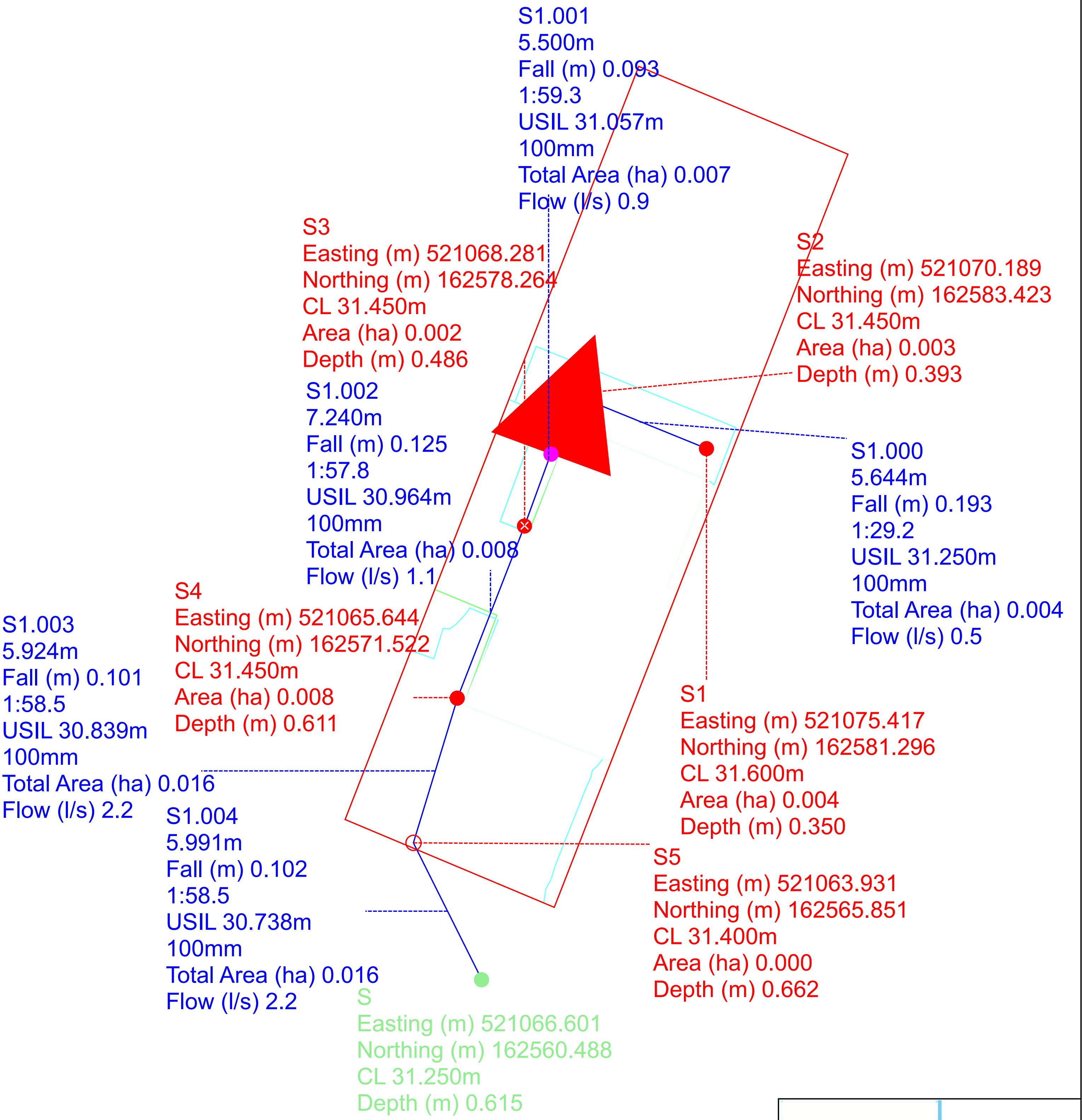
15.9.3 Trial Pit Location Map



15.10 Appendix 10 - Microdrainage

15.10.1 Layout of Network





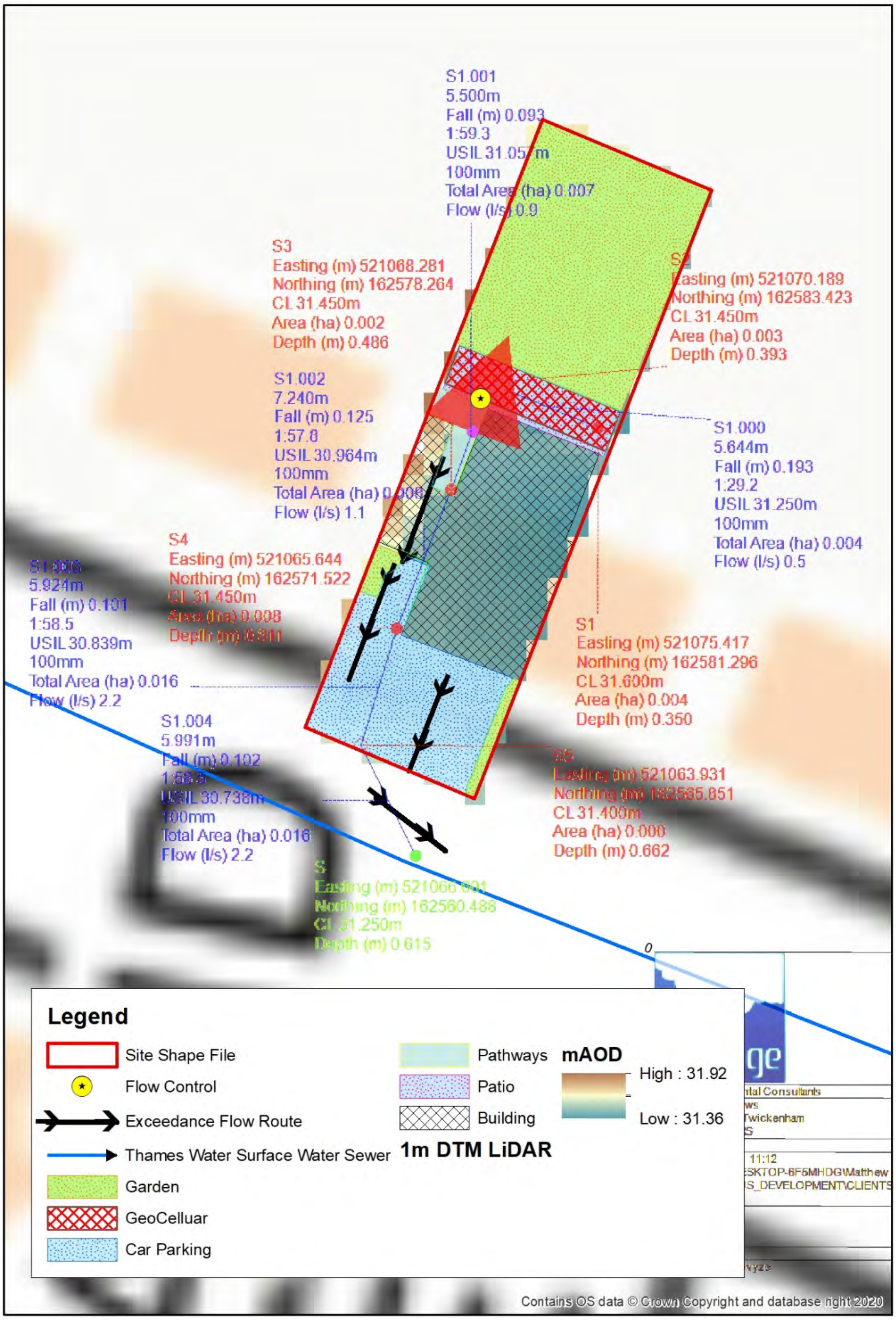
Micro Drainage

STM Environmental Consultants
Unit 6, Crane Mews
32 Gould Road, Twickenham
London, TW2 6RS

Innovyze
Date : 10/12/2021 11:13
Designed by : DESKTOP-6F5MHDG\Matthe
Filename : G:\BUS_DEVELOPMENT\CLIEN
Scale 1: 210

Network 2020.1

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



15.10.3 Microdrainage results

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.402	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.100
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.014	4-8	0.002

Total Area Contributing (ha) = 0.016

Total Pipe Volume (m³) = 0.238

Network Design Table for Storm

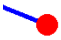
PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
S1.000	5.644	0.193	29.2	0.004	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.001	5.500	0.093	59.3	0.003	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.002	7.240	0.125	57.8	0.002	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.003	5.924	0.101	58.5	0.008	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓
S1.004	5.991	0.102	58.5	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
S1.000	50.00	5.07	31.250	0.004	0.0	0.0	0.0	1.43	11.2	0.5
S1.001	50.00	5.16	31.057	0.007	0.0	0.0	0.0	1.00	7.9	0.9
S1.002	50.00	5.28	30.964	0.008	0.0	0.0	0.0	1.01	8.0	1.1
S1.003	50.00	5.37	30.839	0.016	0.0	0.0	0.0	1.01	7.9	2.2
S1.004	50.00	5.47	30.738	0.016	0.0	0.0	0.0	1.01	7.9	2.2

Manhole Schedules for Storm

MH Name	**MH CL (m)**	**MH Depth (m)**	**MH Connection**	**MH Diam.,L*W (mm)**	**Pipe Out**			**Pipes In**			
					PN	**Invert Level (m)**	**Diameter (mm)**	**PN**	**Invert Level (m)**	**Diameter (mm)**	**Backdro (mm)**
S1	31.600	0.350	Open Manhole	450	S1.000	31.250	100				
S2	31.450	0.393	Open Manhole	450	S1.001	31.057	100	S1.000	31.057	100	
S3	31.450	0.486	Sealed Manhole	450	S1.002	30.964	100	S1.001	30.964	100	
S4	31.450	0.611	Open Manhole	450	S1.003	30.839	100	S1.002	30.839	100	
S5	31.400	0.662	Junction		S1.004	30.738	100	S1.003	30.738	100	
S	31.250	0.615	Open Manhole	0		OUTFALL		S1.004	30.635	100	

MH Name	**Manhole Easting (m)**	**Manhole Northing (m)**	**Intersection Easting (m)**	**Intersection Northing (m)**	**Manhole Access**	**Layout (North)**
S1	521075.417	162581.296	521075.417	162581.296	Required	
S2	521070.189	162583.423	521070.189	162583.423	Required	
S3	521068.281	162578.264			No Entry	
S4	521065.644	162571.522	521065.644	162571.522	Required	
S5	521063.931	162565.851			No Entry	
S	521066.601	162560.488			No Entry	

PIPELINE SCHEDULES for Storm

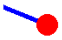
Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	100	S1	31.600	31.250	0.250	Open Manhole	450
S1.001	o	100	S2	31.450	31.057	0.293	Open Manhole	450
S1.002	o	100	S3	31.450	30.964	0.386	Sealed Manhole	450
S1.003	o	100	S4	31.450	30.839	0.511	Open Manhole	450
S1.004	o	100	S5	31.400	30.738	0.562	Junction	

Downstream Manhole

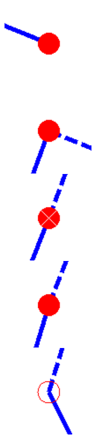
PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	5.644	29.2	S2	31.450	31.057	0.293	Open Manhole	450
S1.001	5.500	59.3	S3	31.450	30.964	0.386	Sealed Manhole	450
S1.002	7.240	57.8	S4	31.450	30.839	0.511	Open Manhole	450
S1.003	5.924	58.5	S5	31.400	30.738	0.562	Junction	
S1.004	5.991	58.5	S	31.250	30.635	0.515	Open Manhole	0

Setting Out Information - True Coordinates (Storm)

PN	**USMH Name**	**Dia/Len (mm)**	**Width (mm)**	**US Easting (m)**	**US Northing (m)**	**Intersection Easting (m)**	**Intersection Northing (m)**	**Layout (North)**
S1.000	S1	450		521075.417	162581.296	521075.417	162581.296	
S1.001	S2	450		521070.189	162583.423	521070.189	162583.423	
S1.002	S3	450		521068.281	162578.264			
S1.003	S4	450		521065.644	162571.522	521065.644	162571.522	
S1.004	S5			521063.931	162565.851			

PN	**DSMH Name**	**Dia/Len (mm)**	**Width (mm)**	**DS Easting (m)**	**DS Northing (m)**	**Layout (North)**
S1.004	S	0		521066.601	162560.488	

Setting Out Information - Site Coordinates (Storm)

PN	**USMH Name**	**Dia/Len (mm)**	**Width (mm)**	**US Easting (m)**	**US Northing (m)**	**Intersection Easting (m)**	**Intersection Northing (m)**	**Layout (North)**
S1.000	S1	450		521075.417	162581.296	521075.417	162581.296	
S1.001	S2	450		521070.189	162583.423	521070.189	162583.423	
S1.002	S3	450		521068.281	162578.264			
S1.003	S4	450		521065.644	162571.522	521065.644	162571.522	
S1.004	S5			521063.931	162565.851			

PN	**DSMH Name**	**Dia/Len (mm)**	**Width (mm)**	**DS Easting (m)**	**DS Northing (m)**	**Layout (North)**
S1.004	S	0		521066.601	162560.488	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.004	0.004	0.004
1.001	User	-	100	0.001	0.001	0.001
	User	-	100	0.002	0.002	0.003
1.002	User	-	100	0.002	0.002	0.002
1.003	User	-	100	0.006	0.006	0.006
	User	-	100	0.002	0.002	0.008
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.016	0.016	0.016

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S1	100	0.250	0.293	Unclassified	450	0	0.250	Unclassified
S1.001	S2	100	0.293	0.386	Unclassified	450	0	0.293	Unclassified
S1.002	S3	100	0.386	0.511	Unclassified	450	0	0.386	Unclassified
S1.003	S4	100	0.511	0.562	Unclassified	450	0	0.511	Unclassified
S1.004	S5	100	0.515	0.562	Unclassified				Junction

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	S	31.250	30.635	0.000	0	0

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.402		

Online Controls for Storm

Orifice Manhole: S2, DS/PN: S1.001, Volume (m³): 0.1

Diameter (m) 0.008 Discharge Coefficient 0.600 Invert Level (m) 31.057

Storage Structures for Storm

Porous Car Park Manhole: S2, DS/PN: S1.001

```
Infiltration Coefficient Base (m/hr) 0.00000            Width (m)   2.0
         Membrane Percolation (mm/hr)    1000           Length (m)   9.0
                Max Percolation (l/s)     5.0          Slope (1:X)   0.0
                        Safety Factor     2.0 Depression Storage (mm)     5
                             Porosity    0.95    Evaporation (mm/day)     3
                     Invert Level (m)  31.100    Cap Volume Depth (m) 0.250
```

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
S1.000	S1	0.500
S1.001	S2	0.500
S1.002	S3	0.500
S1.003	S4	0.500
S1.004	S5	0.000

CASDeF Controller for Storm

PN	US/MH Name	Level Not Exceeded	Modify Control	Modify Pipe Size	Max Pipe Diameter	No. Pipe Failures	Add Storage	No. Storage Failures	Use CASDeF
S1.000	S1	31.600	Yes	No	200	0	Yes	0	Yes
S1.001	S2	31.450	Yes	No	243	0	Yes	0	Yes
S1.002	S3	31.450	Yes	No	336	0	Yes	0	Yes
S1.003	S4	31.450	Yes	No	461	0	Yes	0	Yes
S1.004	S5	31.400	Yes	No	450	0	Yes	0	Yes

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m^3)	Pipe Volume (m^3)	Storage Structure Volume (m^3)	Total Volume (m^3)
S1.000	S1	0.056	0.044	0.000	0.100
S1.001	S2	0.063	0.043	4.275	4.381
S1.002	S3	0.077	0.057	0.000	0.134
S1.003	S4	0.097	0.047	0.000	0.144
S1.004	S5	0.000	0.047	0.000	0.047
Total		0.293	0.238	4.275	4.806

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m^3)	Pipe Volume (m^3)	Storage Structure Volume (m^3)	Total Volume (m^3)
S1.000	S1	0.056	0.041	0.000	0.096
S1.001	S2	0.063	0.040	4.275	4.377
S1.002	S3	0.077	0.053	0.000	0.131
S1.003	S4	0.097	0.045	0.000	0.142
S1.004	S5	0.000	0.047	0.000	0.047
Total		0.293	0.226	4.275	4.793

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

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

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

                        Synthetic Rainfall Details
                 Rainfall Model               FSR     Ratio R 0.406
                         Region England and Wales Cv (Summer) 0.750
                     M5-60 (mm)            20.000 Cv (Winter) 0.840

         Margin for Flood Risk Warning (mm)                           300.0
                          Analysis Timestep 2.5 Second Increment (Extended)
                                 DTS Status                              ON
                                 DVD Status                              ON
                             Inertia Status                              ON


                     Profile(s)                           Summer and Winter
              Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
         Return Period(s) (years)                                1, 30, 100
               Climate Change (%)                                  0, 0, 20
```

```
                                                     Water  Surcharged Flooded
         US/MH                                US/CL   Level     Depth    Volume  Flow /
  PN      Name           Event                 (m)     (m)       (m)      (m³)    Cap.

S1.000     S1  15 minute 1 year Winter I+0% 31.600 31.265    -0.085    0.000    0.05
S1.001     S2 240 minute 1 year Winter I+0% 31.450 31.133    -0.024    0.000    0.01
S1.002     S3  15 minute 1 year Winter I+0% 31.450 30.976    -0.089    0.000    0.03
S1.003     S4  15 minute 1 year Winter I+0% 31.450 30.867    -0.073    0.000    0.16
S1.004     S5  15 minute 1 year Winter I+0% 31.400 30.763    -0.074    0.000    0.15
```

```
                         Pipe
        US/MH Overflow  Flow
  PN     Name   (l/s)   (l/s) Status

S1.000    S1              0.5     OK
S1.001    S2              0.0     OK
S1.002    S3              0.2     OK
S1.003    S4              1.2     OK
S1.004    S5              1.2    OK*
```